MARINE SCIENCE in ALASKA

Program of Events

2006 Symposium

January 22-25, 2006

Anchorage Hilton, Anchorage, Alaska

Sponsored by:

Alaska Ocean Observing System • Alaska Sea Grant College Program
Alaska SeaLife Center • Alliance for Coastal Technologies
Exxon Valdez Oil Spill Trustee Council • Kachemak Bay Research Reserve
Minerals Management Service • NOAA Alaska Fisheries Science Center
North Pacific Fishery Management Council • North Pacific Research Board
Oil Spill Recovery Institute • Pollock Conservation Cooperative Research Center
Prince William Sound Science Center • University of Alaska
US Arctic Research Commission • US Geological Survey Alaska Science Center

Sunday, January 22: Registration and Poster Reception

– Bristol Bay Ballroom –

4:00 - 9:00 p.m.
Registration

6:00 - 9:00 p.m.
Poster Reception

Monday, January 23: Gulf of Alaska

– Aleutian/Alaska Ballrooms –

Morning Emcee:
Shannon Atkinson, Alaska SeaLife Center

8:30 - 9:00 a.m.

- Welcome by ***Anchorage Mayor Mark Begich***
- Keynote: ***Pete Peterson*** Ecological considerations in developing marine ecosystem-based management

Session 1: Climate and Oceanography

9:00 - 9:30 a.m.
Mike Litzow Introduction and Poster Review
Presentation: Has climate change produced oscillating ecosystem control in the Gulf of Alaska?

9:30 - 9:45 a.m.
Mark Johnson Water and ice dynamics in Cook Inlet

9:45 - 10:00 a.m.
Eddie Zingone Analyzing surface wind fields near lower Cook Inlet and Kodiak waters using SAR

10:00 - 10:15 a.m.
Carol Ladd The Gulf of Alaska eddy field: interannual variability as derived from altimetry data

10:15 - 10:30 a.m.
Break (Refreshments in Bristol Bay Ballroom)

Session 2: Lower Trophic Levels

10:30 - 10:45 a.m.
Russ Hopcroft Introduction and Poster Review
Presentation: Seward Line oceanographic observations for 2005

10:45 - 11:00 a.m.
Michael Dagg *Neocalanus* spp. and food web structure in the High Nutrient-Low Chlorophyll (HNLC) Gulf of Alaska

11:00 - 11:15 a.m.
Dennis Lees Assessment of bivalve recovery on treated mixed-soft beaches in western Prince William Sound

Session 3: Fish and Fish Habitat

11:15 - 11:30 a.m.
Michael Sigler Introduction and Poster Review

11:30 - 11:45 a.m.
Clifford Ryer Perceived predation risk influences habitat preference and utilization by juvenile age-0 flatfish in an Alaskan nursery area

11:45 - noon
Scott Gende Persistence of forage fish hotspots and its association with foraging Steller sea lions in southeast Alaska

noon - 1:30 p.m. Lunch (provided in Alaska/Denali Ballrooms)

Keynote Speakers:

- ***Monica Riedel*** (Alaska Native Harbor Seal Commission)
  Building research and management capacity through partnerships between the Alaska Native and science communities
- ***Dr. William Hogarth*** (NOAA Assistant Administrator for Fisheries)
  The intersection of science and management

Afternoon Emcee:
Nancy Bird, Prince William Sound Science Center

1:30 - 1:45 p.m.
Spencer James Taggart How patchy are king and Tanner crab populations in southeastern Alaska? Integrating movement, distribution, and habitat data

1:45 - 2:00 p.m.
Kray Van Kirk A multispecies age-structured assessment model for the Gulf of Alaska

2:00 - 2:15 p.m.
Mark Buckley The Digital Observer: an alternative system for monitoring commercial fisheries

Session 4: Seabirds and Marine Mammals

2:15 - 2:45 p.m.
Jennifer Burns Introduction and Poster Review Presentation: Working harder in the dark: winter diving and foraging patterns in juvenile Steller sea lions

2:45 - 3:00 p.m.
Ed Melvin The distribution of seabirds on the Alaskan longline fishing grounds: implications for seabird avoidance regulations

3:00 - 3:15 p.m.
Ann Edwards A bird's eye view of fisheries discards in Alaskan waters

3:15 - 3:45 p.m.
Break (Refreshments in Bristol Bay Ballroom)

3:45 - 4:00 p.m.
Anne Hoover-Miller Changes in harbor seal population dynamics in Aialik Bay, Alaska

4:00 - 4:15 p.m.
Volker Deecke Studying killer whale predation in the field: A sound approach to detecting kills

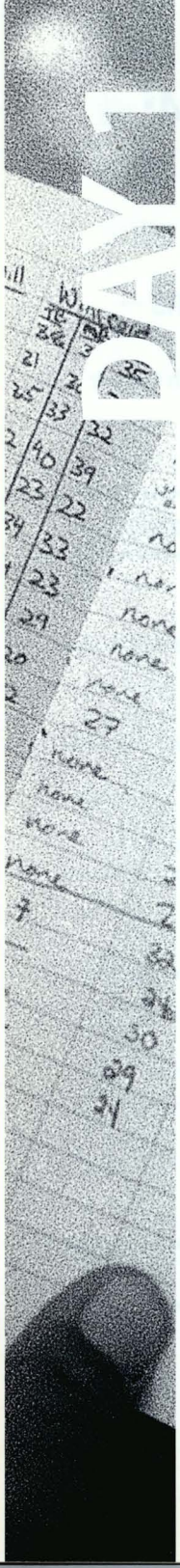
4:15 - 4:30 p.m.
Joseph Liddle Estimating sperm whale abundance with Bayesian mark-recapture

Session 5: Gulf of Alaska Integrated Ecosystems, Observing and Sensors

4:30 - 4:45 p.m.
Mark Johnson Introduction and Poster Review Presentation: The Alaska Ocean Observing System

4:45 - 5:00 p.m.
Carl Schoch A demonstration of the Alaska Ocean Observing System in Prince William Sound

5:00 - 5:15 p.m.
Yi Chao Development of a regional ocean modeling system (ROMS) for real-time forecasting in Prince William Sound and adjacent Alaska coastal waters



5:15 - 5:30 p.m.
Stephen Okkonen Monitoring seasonal changes in Prince William Sound circulation

5:30 - 5:45 p.m.
James Bodkin Long term monitoring of nearshore habitats in the Gulf of Alaska: Why and how?

5:45 - 6:00 p.m.
Sonia Batten Relevance of the continuous plankton recorder (CPR) survey results to Alaskan fisheries resource issues

6:00 - 6:15 p.m.
David Hyrenbach Basin-wide seabird distributions across the sub-arctic North Pacific (2002-2005): seasonal and interannual variability

6:15 - 7:30 p.m. Poster Reception (Bristol Bay Ballroom) (and dinner on own)

Monday Evening Sessions

7:30 - 9:30 p.m.
***Exxon Valdez* Oil Spill Restoration Process** (Alaska Ballroom)
Opening remarks followed by panel discussion and Q&A.

Panelists:

- ***Craig Tillery*** *Exxon Valdez* Oil Spill Trustee Council: How we got to where we are today
- ***Ted Cooney*** The ecological face of restoration science in the northern Gulf of Alaska
- ***Jeff Short*** Lingering *Exxon Valdez* oil remains the dominant cause of cytochrome P450 1A induction of biota in Prince William Sound
- ***Jacqui Michel*** Identifying and evaluating oil remediation technologies
- ***Lucinda Jacobs*** Report on Integral Consulting synthesis studies

7:30 - 10:00 p.m.
Satellite and *in-situ* Observations of Alaska's Seas: Defining needs in partnership with the Alliance for Coastal Technologies (ACT) Program (Fireweed Room)
Coordinators: ***Lyn McNutt*** and ***Shannon Atkinson***

Tuesday, January 24: Bering Sea and Aleutian Islands

– Aleutian/Alaska Ballrooms –

Emcee: Heather McCarty,
Pollock Conservation Cooperative Research Center

8:00 - 8:30 a.m.
Keynote: ***John Piatt*** Marine eco-regions of Alaska

Session 1: Climate and Oceanography

8:30 - 8:45 a.m.
James Overland Introduction and Poster Review
Presentation: A major climate/ecosystem shift observed in the northern Bering Sea

8:45 - 9:00 a.m.
Phyllis Stabeno Spatial and temporal variability over the eastern Bering Sea shelf

9:00 - 9:15 a.m.
Gleb Panteleev Estimates of summer transport of the Kamchatka Current as a variational inverse of hydrographic and surface drifter data

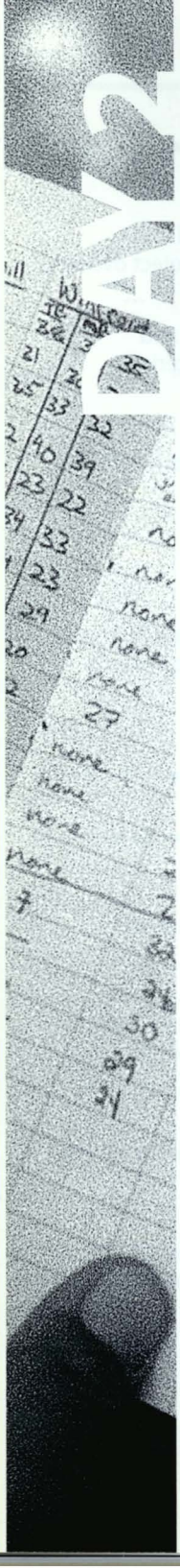
9:15 - 9:30 a.m.
Katherine Hedstrom Multi-decadal coupled sea-ice/ocean numerical simulations of the Bering Sea

9:30 - 9:45 a.m.
Haoguo Hu Modeling the Bering Sea circulation and thermodynamic characteristics using a coupled ice-ocean model (CIOM)

9:45 - 10:15 a.m.
Break (Refreshments in Bristol Bay Ballroom)

Session 2: Lower Trophic Levels

10:15 - 10:30 a.m.
George Hunt Introduction and Poster Review
Presentation: Bering Ecosystem Study (BEST)



10:30 - 10:45 a.m.
Kohei Mizobata Biochemical enhancement related to mesoscale eddies in the Bering Sea Green Belt

10:45 - 11:00 a.m.
Jeffrey Napp Regulation of zooplankton standing stock and production in the southeast Bering Sea: top-down vs. bottom-up control and recent climate-related declines in a subarctic ecosystem

11:00 - 11:15 a.m.
Lisa Eisner Variations in physical and biological oceanography and forage fish distributions during fall in the eastern Bering Sea

Session 3: Fish and Fish Habitat

11:15 - 11:45 a.m.
Chris Rooper Introduction and Poster Review
Presentation: Determining juvenile Pacific ocean perch habitat in the eastern Aleutian Islands

11:45 a.m. - noon
Toshihide Hamazaki Analyses of Bering Sea bottom trawl surveys in Norton Sound: absence of regime shift effect on epifauna and demersal fishes

noon - 1:15 p.m. Lunch (Alaska/Denali Ballrooms)

Keynote speakers:
- ***Charles Wohlforth*** The Whale and the Supercomputer
- ***Susan Sugai*** and students in Ocean Science Bowl

1:15 - 1:30 p.m.
Gerald Hoff Nursery Grounds of the Alaska Skate

1:30 - 1:45 p.m.
Tim Loher Investigating declining halibut *(Hippoglossus stenolepis)* abundance in the Pribilof Islands: is temperature important?

1:45 - 2:00 p.m.
Christian Zimmerman Estuarine ecology of juvenile chum salmon in Kuskokwim Bay, Alaska

2:00 - 2:15 p.m.
Shigehiko Urawa NPAFC international cooperative research designates the distribution of Asian and North American chum salmon stocks in the Bering Sea and North Pacific Ocean

2:15 - 2:30 p.m.
Gunnar Knapp An overview of Alaska pollock markets

Session 4: Seabirds

2:30 - 2:45 p.m.
David Roseneau Introduction and Poster Review
Presentation: Expanding the seabird tissue archival and monitoring project (STAMP) in the north Pacific: project overview

2:45 - 3:00 p.m.
Paul Becker Expanding the seabird tissue archival and monitoring project (STAMP) in the north Pacific: interim analytical results

3:00 - 3:15 p.m.
Ian Rose Seabird diet and nesting success: indicators of ocean conditions in the northern Bering Sea

3:15 - 3:45 p.m. Break
Refreshments in Bristol Bay Ballroom

3:45 - 4:00 p.m.
Shiway Wang Foraging patterns of northern fulmars *(Fulmarus glacialis)* in Alaska inferred from fatty acid signature analysis

4:00 - 4:15 p.m.
TBA

Session 5: Marine Mammals

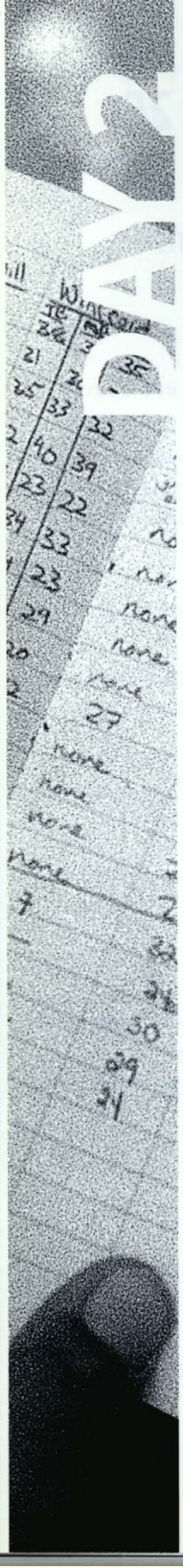
4:15 - 4:45 p.m.
Michael Cameron Introduction and Poster Review
Presentation: Ribbon seal habitat selection and seasonal movements

4:45 - 5:00 p.m.
Sara Iverson Consequences of fur seal foraging strategies (COFFS): relationships to opposing population trends and reproductive performance in the Bering Sea

5:00 - 5:15 p.m.
Alexander Burdin Sea otter survey on the Commander Islands in 2005

5:15 - 5:30 p.m.
Lance Barrett-Lennard The role of transient killer whales in structuring marine mammal communities in the Aleutian Islands: insights from predation hotspots

5:30 - 5:45 p.m.
Craig Matkin Ecotypic variation and predatory behavior of killer whales in the eastern Aleutians



5:45 - 6:00 p.m.
Paul Wade Use of chemical profiles in assessing the feeding ecology of Alaska killer whales

6:00 - 7:30 p.m. Poster Reception (Bristol Bay Ballroom)
(and dinner on own)

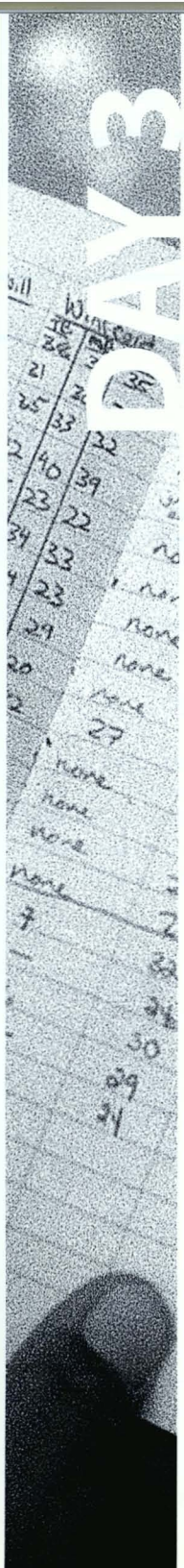
Tuesday Evening Session

7:30 - 9:00 p.m.
The Meeting Point between Science and Policy
(Aleutian Ballroom)

Panel Moderators:
Heather Brandon Alaska Department of Fish and Game
Heather McCarty Pollock Conservation Cooperative Research Center

Panelists include:
- ***Doug DeMaster*** International Whaling Commission
- ***Jack Tagart*** North Pacific Research Board
- ***Brock Bernstein*** Pribilof Island Collaborative
- ***Scott Gende*** Glacier Bay Science Advisory Board

Panelists will summarize the process of how science is used to inform management in their organizations; provide examples, experiences and insight on that process; and describe how managers communicate their information needs to researchers. A discussion among the panelists and audience will round out the session.



Wednesday, January 25: Arctic Ocean

– Aleutian/Alaska Ballrooms –

Emcee: Lawson Brigham
U.S. Arctic Research Commission

8:00 - 8:30 a.m.
Keynote: ***Lawson Brigham*** Changing main access in the Arctic Ocean

Session 1: Climate and Oceanography

8:30 - 9:00 a.m.
Ignatius Rigor Introduction and Poster Review
Presentation: An outlook for summer sea ice north of Alaska

9:00 - 9:15 a.m.
Meibing Jin Development of coupled ice-ocean ecosystem and application to the ice-core data in land-fast ice offshore Barrow

9:15 - 9:30 a.m.
Jia Wang The response of arctic sea ice to the winter atmospheric Dipole Anomaly (DA)

9:30 - 9:45 a.m.
David Musgrave Surface currents from HF radar in the Beaufort Sea

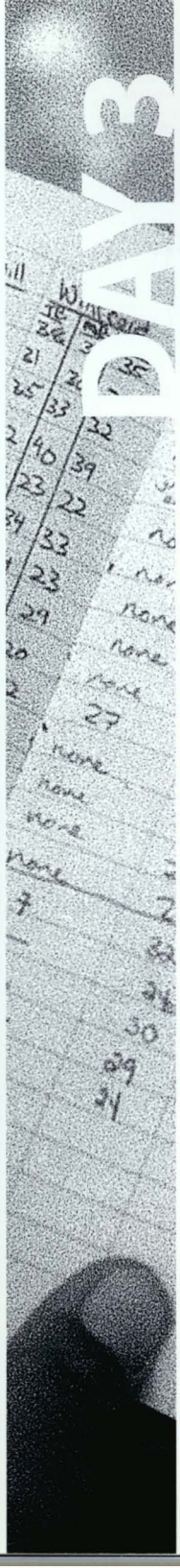
9:45 - 10:15 a.m.
Break (Refreshments in Bristol Bay Ballroom)

Session 2: Living Marine Resources

10:15 - 10:30 a.m.
Brendan Kelly Introduction and Poster Review
Presentation: Movements and population genetics of ice-associated seals

10:30 - 10:45 a.m.
Lori Quakenbush Ice seal biomonitoring in the Bering-Chukchi Sea region

10:45 - 11:00 a.m.
Bodil Bluhm Chukchi Sea food web structure and epibenthic community composition



11:00 - 11:15 a.m.
Stephen Murphy Evaluating variation in abundance of Arctic cisco in the Colville River using existing scientific information and traditional knowledge from subsistence fishers

11:15 - 11:30 a.m.
Carin Ashijan Environmental variability, bowhead whale distributions, and inupiat subsistence whaling: preliminary results of a 2005 late summer field program

11:30 - 11:45 a.m.
Sue Moore Gray whales as sentinels of Alaskan ecosystem variability

11:45 - noon
Stephen Braund Synthesis: three decades of research on socioeconomic effects related to offshore petroleum development in coastal Alaska

Adjourn: Lunch and Workshops

noon - 1:30 p.m.
Lunch (provided in Alaska/Denali Ballrooms)

1:30 - 5:30 p.m.
Alaska salmon research and data inventory
Coordinator: ***Eric Knudsen*** (Birch Room)

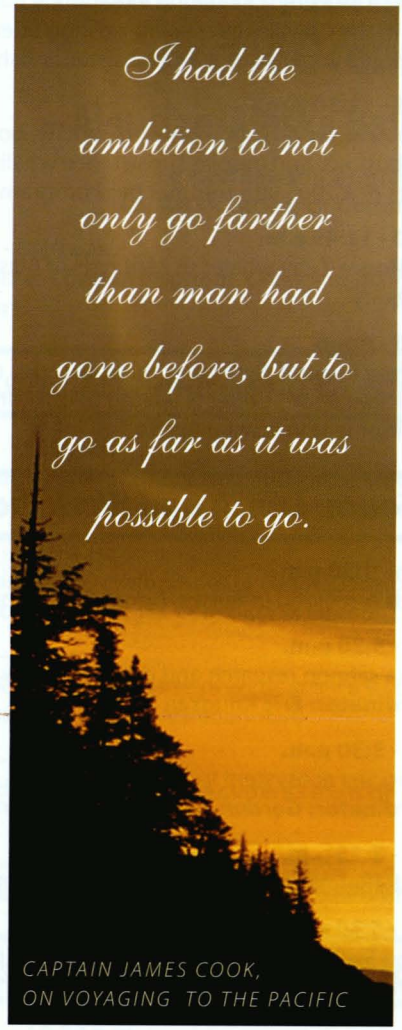
1:30 - 3:30 p.m.
Bering Sea ecosystem indicators
Coordinator: ***Gordon Kruse*** (Aleutian Ballroom)

3:30 - 3:45 p.m.
Break (Refreshments in Bristol Bay Ballroom)

3:45 - 5:30 p.m.
Bering Sea integrated ecosystem research program
Coordinator: ***Francis Wiese*** (Aleutian Ballroom)

Thursday, January 26: NPRB Metadata Workshop

8:30 a.m. - 3:00 p.m.
Morning and afternoon sessions on metadata
Coordinator: Francis Wiese (Chart Room)



2006 Marine Science Symposium

Thank You to Our Sponsors

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MARINE SCIENCE in ALASKA

Marine Research Organization Summaries

2006 Symposium

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NORTH PACIFIC RESEARCH BOARD

"Building a clear understanding of the North Pacific, Bering Sea, and Arctic Ocean ecosystems that enables effective management and sustainable use of marine resources."

Tylan Schrock, Chairman
Stephanie Madsen, Vice-Chairman
Clarence Pautzke, Executive Director

1007 West 3rd Avenue, Suite 100
Anchorage, AK 99501
Phone: (907) 644-6700 Fax: 644-6780

North Pacific Research Board Mission and Goals

The North Pacific Research Board (NPRB) was created by Congress in 1997 and first organized in 2001 to recommend marine research activities to the Secretary of Commerce. Funding is based on interest earned from the Environmental Improvement and Restoration Fund. The enabling legislation requires funds to 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). NPRB must strive to avoid duplicating other research and must place a priority on cooperative research efforts designed to address pressing fishery management or marine ecosystem information needs.

NPRB's vision 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. Five supporting goals include (1) improved understanding of North Pacific marine ecosystem dynamics and use of the resources; (2) improved ability to manage and protect those resources; (3) improved ability to forecast and respond to effects of changes; (4) cooperation with other entities conducting research and management in the North Pacific; and (5) support of high quality projects that promise long-term results as well as those with more immediate applicability.

Science Plan and Scope of Research

NPRB's science plan, available at www.nprb.org or by contacting NPRB, is based on guidance from the National Research Council of the U.S. National Academy of Sciences. The plan places emphasis on three large marine ecosystems (LMEs) off Alaska: the Gulf of Alaska, Bering Sea and Aleutian Islands, and Arctic Ocean (Chukchi and Beauforts seas). NPRB emphasizes marine research, but also may fund freshwater research on anadromous species.

The science plan envisions a broad range of integrated ecosystem research in the three LMEs, from basic oceanography and lower trophic level productivity studies up through fish and invertebrates, seabirds, marine mammals, and man, including their habitat. NPRB also may support research on contaminants, harmful algal blooms, invasive species, aquaculture, and climate change impacts on the marine environment. NPRB encourages development of local and traditional knowledge, coordination and partnerships with other research entities and programs, cooperative research with industry, and education, outreach, and community involvement.

The science plan is intended to be an evolving, "living" document that is updated periodically. The NPRB intends to request reappraisals of its science plan and research activities by a qualified entity every five years, but the first review may come after seven years or so to allow early research programs to come to fruition before the plan is revised. In planning research, NPRB will seek advice from stakeholders and its Advisory and Science panels. NPRB also relies on workshops and syntheses to guide its science program.

Integrated Ecosystem Research Programs

The NPRB is developing implementation plans for integrated ecosystems research programs in the Bering Sea and Aleutian Islands and the Gulf of Alaska. The focus of the Gulf plan has not been determined yet. The Bering Sea program will attempt to address research questions related to climate change and its impacts on the marine systems off Alaska:

- *How are the distributions and abundances of species in the Bering Sea ecosystem changing in response to climate change?*
- *How are physical and chemical attributes of the ecosystem changing in response to climate change?*
- *How is lower trophic level production (quantity and form) changing in response to climate change?*
- *What are the principal processes controlling energy pathways in the Bering Sea? What is the role of climate change in these processes?*
- *What are the linkages between climate change and vital rates of living resources in the Bering Sea?*
- *What are the economic and sociological impacts of a changing ecosystem on the coastal communities and resource users of the Bering Sea?*

The Board will seek advice from various working groups in developing its research agenda on the above issues. Their planning products will provide direction to the 2007 request for proposals this coming fall.

Annual Requests for Proposals

Specific and general research needs are identified in the requests for proposals released each October. The tentative schedule for 2006-2007 is to release the 2007 request for proposal on October 6, 2006, with proposals due December 8. After obtaining reviews, the Board will meet in March 2007 to select meritorious projects for funding based on recommendations of its Science Panel.

Research Support 2002-2005

NPRB has funded over ninety projects totaling $17 million as a result of four requests for proposals released from early 2002 through mid-2005. The projects are described under research at www.nprb.org and fall into seven broad categories as shown in Table 1.

Table 1. NPRB-supported research initiated in 2002-2005.

Categories of Research	Projects	Total Funding	Percent
Oceanic and Estuarine Salmon	9	$2.29 million	13
Other Fisheries-Related Research	22	$2.66 million	15
Fish Habitat	12	$3.15 million	18
Marine Mammals	16	$2.76 million	16
Seabirds	10	$2.07 million	12
General Ocean and Ecosystem Studies	19	$3.79 million	21
Education, Outreach and Synthesis	6	$1.12 million	6

Response to the 2006 Request for Proposals

The deadline for proposals to the 2006 RFP was December 9, 2005. The Board received 126 proposals requesting over $24 million. Proposals are now out for technical review. The Science Panel will meet on March 14-15, 2006 to develop recommendations and the Board will make final decisions at the end of March. The funding target for this year is $5.15 million.

Alaska Ocean Observing System
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Anchorage, AK 99501
907.644.6703 – phone
907.644.6780 – fax
www.aoos.org – website

Molly McCammon, Executive Director
mccammon@aoos.org

The Alaska Ocean Observing System is part of a growing national network of integrated ocean observing systems (IOOS) 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.

MISSION

To develop and sustain a network of ocean and marine-related observations, gathered by a multitude of federal, state and private entities, and seamlessly integrated into information products and tools that aid our understanding of the status of Alaska's marine ecosystem and allow stakeholders to make better decisions about their use of the marine environment. 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.

GOALS

- Improve the safety and efficiency of marine operations;
- More effectively mitigate the effects of natural hazards, including coastal erosion;
- 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.

OTHER GOALS

- Identify gaps in existing ocean observing activities and data and recommend needed enhancements;
- Increase efficiencies of existing ocean observing activities and data;
- Enhance usefulness of ocean observations for a wider variety of users; and
- Integrate observations and data management through planning, coordination, and facilitation.

GEOGRAPHIC PURVIEW & SCOPE

Alaska's oceans and coastal areas extending to 200 mile limit, organized by the Large Marine Ecosystem (LME) concept and consistent with the national Integrated Ocean Observing System (IOOS) program.

PRIMARY DATA TYPE OF INTEREST

Integrated and sustained physical, chemical and biological observations for use in information products to meet identified user needs.

SIGNIFICANT PLANNING DOCUMENTS

First annual IOOS Development Plan and other IOOS planning documents – www.ocean.us
AOOS MOA, planning documents, workshop results – www.aoos.org

FUNDING

Contributions from partners and three NOAA planning grants (03, 04, 05) for $580,000 total.
Received $2 million grant in NOAA 05 budget and $1.7 million in NOAA 06 budget.

SIGNIFICANT ACCOMPLISHMENTS IN FY 2005

- Received three-year grant to develop administrative infrastructure and implementation plan.
- Continued outreach to potential stakeholders through more than 50 individual and group meetings and presentations.
- Received Congressional grant to begin implementation of AOOS statewide activities and enhance ocean observing in three AOOS regions: Arctic, Bering Sea/Aleutians, and Gulf of Alaska.
- Established Data Management, Modeling and Analysis group at University of Alaska Fairbanks with support from Alaska Regional Supercomputer Center. Developed AOOS portal and website. Advised by DMAC Committee. Participated in national IOOS DMAC development.
- Held four workshops to further develop AOOS within the Gulf of Alaska subregions: Cook Inlet, Prince William Sound, Kodiak, and Southeast by working with users to identify monitoring needs and gaps.
- Continued development of PWS demonstration project and associated meteorological, wave, and ocean circulation models.

2006 GOALS

- Finalize AOOS statewide and regional observing system implementation plans, based on stakeholder needs and benefits, and including education and outreach.
- Expand observing capacity across state. Hold Arctic user needs workshop. Initiate contact with oil and gas development community through individual meetings and workshop.
- Continue to develop data and information products for users, including real-time information when possible and addition of biological information.
- Continue development of AOOS data management plan and work to integrate data across components, regions, agencies, and funding sources.
- Begin implementation of AOOS education plan.

OPPORTUNITIES FOR RESEARCH COLLABORATION AND COOPERATION

Since development of an IOOS is one of the primary action items included in the President's Ocean Action Plan in response to the Commission on Ocean Policy's report, there will be many opportunities for coordination, collaboration, and leveraging. The same holds true in Alaska since AOOS is co-located with the North Pacific Research Board and is governed by a board representing most of the major ocean observing activities in the state.

IF YOU WOULD LIKE TO BE ADDED TO THE AOOS MAILING LIST, PLEASE SIGN UP ON THE AOOS WEBSITE: www.aoos.org.

Exxon Valdez Oil Spill Trustee Council

441 West 5th Ave. Suite 500, Anchorage, AK 99501-2340

Contact Information

Michael Baffrey, Interim Executive Director
Web: www.evostc.state.ak.us
Email: michael_baffrey@evostc.state.ak.us
(800)478-7745 (Alaska) (800) 283-7745 (outside)
Local (907) 278-8012
(Fax) 907-276-7178

Mission and Goals

The mission of the *Exxon Valdez* Oil Spill Trustee Council is to efficiently restore the environment injured by the *Exxon Valdez* Oil Spill to a healthy, productive, world renowned ecosystem, while taking into account the importance of the quality of life and the need for viable opportunities to establish and sustain a reasonable standard of living.

The restoration has been and will be accomplished through the implementation of a comprehensive interdisciplinary recovery and rehabilitation program that includes:

- natural recovery
- monitoring and research
- resource and service restoration
- habitat acquisition and protection
- replacement
- meaningful public participation
- project evaluation
- fiscal accountability
- efficient administration

Geographic Purview

The primary focus has been on restoration and recovery of injures resources and services in the area of the *Exxon Valdez* Oil Spill including Prince William Sound, Kodiak Archipelago the Gulf of Alaska and Cook Inlet.

Primary Species and Data of Interest

Archaeological Resources, Bald Eagles, Black Oystercatchers, Clams, Commercial Fishing, Common Murres, Cormorants, Cutthroat Trout, Designated Wilderness Areas, Dolly Varden, Harbor Seals, Harlequin Ducks, 1n-1 Organisms, Killer Whales, Marbled Murrelets, Mussels, Passive Use, Pigeon Guillemot, Pink salmon, Recreation and Tourism, River Otters, Rockfish, Sea otters, Sediments, Sockeye Salmon, Subsistence, Subtidal Organisms

Significant Planning Documents

1994 Restoration Plan
Interim Guidance Document

Proposal Cycle
Annual Work Plans with Invitations to Submit Proposals

Significant Accomplishments in FY2005
Initiated a Synthesis Study to assist in the 2006 Update Status of Injured Resources and Services List

Significant Data and Metadata Bases
Data System
The *Exxon Valdez* Oil Spill Trustee Council data management staff has been working over the past three years to develop methods, systems, and tools for tracking and organizing scientific information produced from *Exxon Valdez* Oil Spill Trustee Council sponsored research projects. In the past year, the data management staff has created a public portal to access the information contained in the data system. This portal can be accessed at the following URL: **http://www.gem.state.ak.us/projects/searchstart.cfm**.

Metadata
The *Exxon Valdez* Oil Spill Trustee Council data management section has chosen Ecological Metadata Language (EML) as the most appropriate solution for metadata documentation of *in situ* style datasets. The *Exxon Valdez* Oil Spill Trustee Council is currently sponsoring studies which are collecting primarily physical, biological and taxonomic-style measurements with a small amount of sponsored projects collecting real time data from ships of opportunity. The data management section has completed the second version of a regional metadata keyword scheme which provides a classification structure for describing regional marine, estuarine, and freshwater research. This scheme has been utilized by both AYK and the NPRB to classify their research.

Opportunities for Research Collaboration

The *Exxon Valdez* Oil Spill Trustee Council data management section has been working intimately with the NPRB data management section to create solutions which meet the needs of both institutions. These solutions include the development of automated peer review systems and the development of metadata and data organizing and archiving technologies.

SFOS School of Fisheries and Ocean Sciences

UAF UNIVERSITY OF ALASKA FAIRBANKS

www.sfos.uaf.edu

MISSION

The School of Fisheries and Ocean Sciences is dedicated to the pursuit of excellence in education, research and public service concerning marine and freshwater ecosystems, and to fostering sustainable use of these resources for the benefit of Alaska, the nation and the world.

ABOUT US

The School of Fisheries and Ocean Sciences is one of the most diverse schools in the University of Alaska Fairbanks both in geographic distribution and academic mission, with faculty in twelve locations.

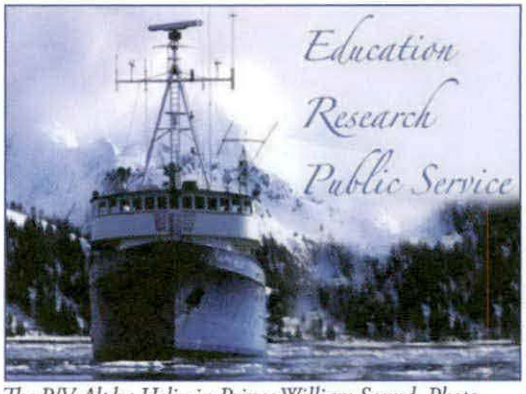
SFOS offers programs leading to baccalaureate degrees in Fisheries and master's and doctoral degrees in Oceanography, Fisheries, and Marine Biology. We are educating the next generation of leaders for the fisheries and ocean related industries in Alaska and the Northwest.

Faculty research at the School of Fisheries and Ocean Sciences extends from the rivers of Alaska to the fisheries of the Bering Sea and from Arctic Ocean oceanography to marine mammals in the Antarctic.

Rock Greenling near Amchitka Island, Alaska. Photo courtesy of Stephen Jewett, SFOS Scientific Diving Program.

FACTS

- ***Over $16 million in research funding each year***
- ***55 faculty in five major locations across Alaska***
- ***155 students in M.S. and Ph.D. programs***
- ***SFOS faculty and research staff collaborate with over 60 state, national, international and private agencies.***
- ***Marine Advisory Program (MAP) agents are located in Dutch Harbor, Homer, Kodiak, Bethel, Cordova, Dillingham, Anchorage, Petersburg and Ketchikan.***



The R/V Alpha Helix in Prince William Sound. Photo credit: Tom Kline.

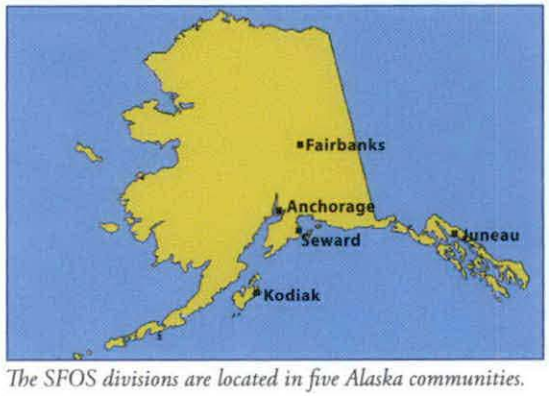
SELECTED RESEARCH PROGRAMS

Census of Marine Life (CoML)

SFOS faculty have a leadership role in this 70-nation, ten-year initiative. Funded by the Sloan Foundation, CoML strives to assess and explain the diversity, distribution and abundance of marine life in the world's oceans. ***www.coml.org***

West Coast & Polar Regions Undersea Research Center

WCPRURC supports highly-rated, peer-reviewed proposals to conduct in situ research in the region offshore California, Oregon, Washington, Alaska, and the Arctic and Antarctic. ***www.westnurc.uaf.edu***



The SFOS divisions are located in five Alaska communities.

Alaska Ocean Observing System (AOOS)

SFOS faculty are leading the effort to construct an expanded ocean observing system in waters off Alaska. This program will combine data collection and modeling to provide real time information on oceanographic conditions in the Gulf of Alaska, Bering Sea and Arctic Ocean. ***www.aoos.org***

Pollock Conservation Cooperative Research Center

The PCCRC focuses on the commercial fisheries of the Bering Sea and Aleutian Islands and funds SFOS faculty to investigate problems important to the seafood industry. ***www.sfos.uaf.edu/pcc***

SFOS School of Fisheries and Ocean Sciences

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www.sfos.uaf.edu

SFOS DIVISIONS

Institute of Marine Science

IMS is active in research and graduate training at the master's and doctoral levels. IMS conducts marine science studies in the world's oceans, with special emphasis on arctic and Pacific subarctic waters.

Fishery Industrial Technology Center

Our Kodiak faculty work to increase the value of the Alaska fishing industry through academic and research programs in sustainable harvesting and seafood technology.

Fisheries Division

Through collaborative efforts with state, national and international organizations, our fisheries faculty study how to develop and maintain sustainable fisheries programs in Alaska and global waters.

Alaska Sea Grant/Marine Advisory Program

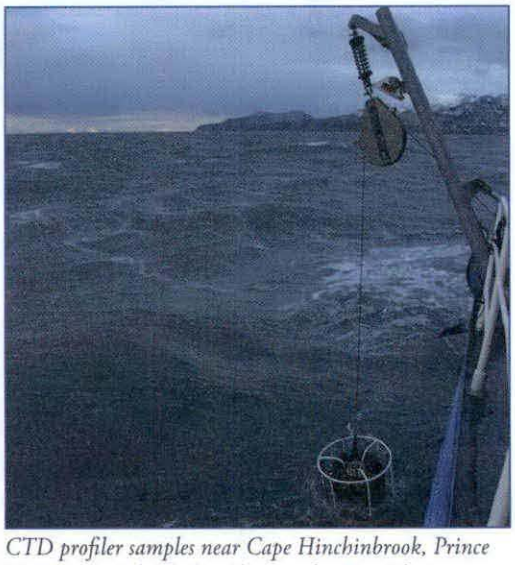
Alaska Sea Grant funds marine research, provides education and advisory services and distributes information about Alaska's seas and coasts.

Global Undersea Research Unit

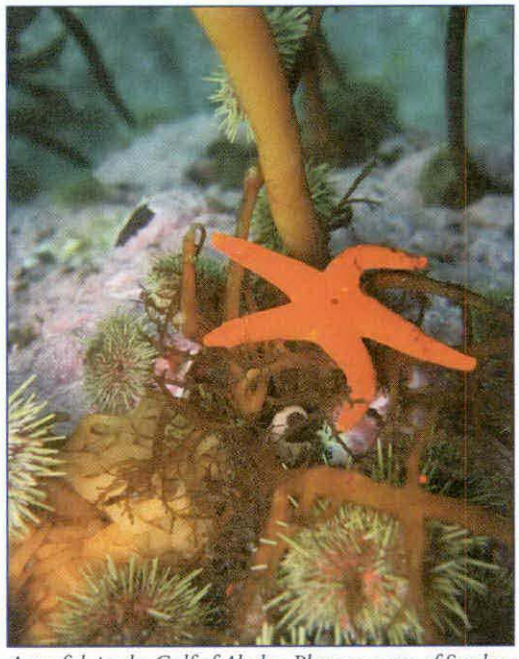
GURU's faculty and graduate students emphasize seafloor research in marine biology and geology. GURU provides access to undersea technologies and operates NOAA's Kasitsna Bay Laboratory near Seldovia.

Seward Marine Center

SMC provides access to saltwater laboratories and the coastal environment with excellent laboratories, constant temperature chambers and a running seawater system.



CTD profiler samples near Cape Hinchinbrook, Prince William Sound, Alaska. Photo credit: Tom Kline.



A starfish in the Gulf of Alaska. Photo courtesy of Stephen Jewett, SFOS Scientific Diving Program.

2005 ACCOMPLISHMENTS

- *Graduated 100th M.S. student in Fisheries*
- *Completed Alaska Region Research Vessel design*
- *Captured 30% of North Pacific Research Board funding*
- *Discovered four new species (CoML Arctic Ocean Diversity Project: www.sfos.uaf.edu/research/arcdiv)*
- *Secured state funding to complete the Lena Point fisheries education and research facility in Juneau*

2006 GOALS

- *Enhance undergraduate fisheries program*
- *Continue to develop a leadership role in the Alaska Ocean Observing System*
- *Improve education and research facilities for SFOS faculty and students*

CONTACT US

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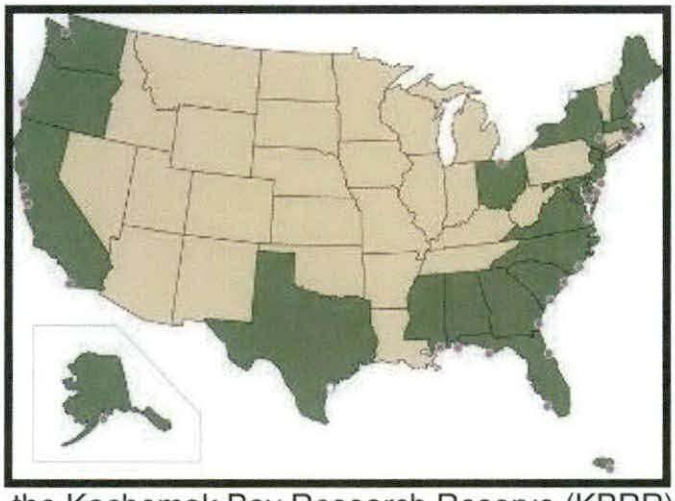
www.sfos.uaf.edu

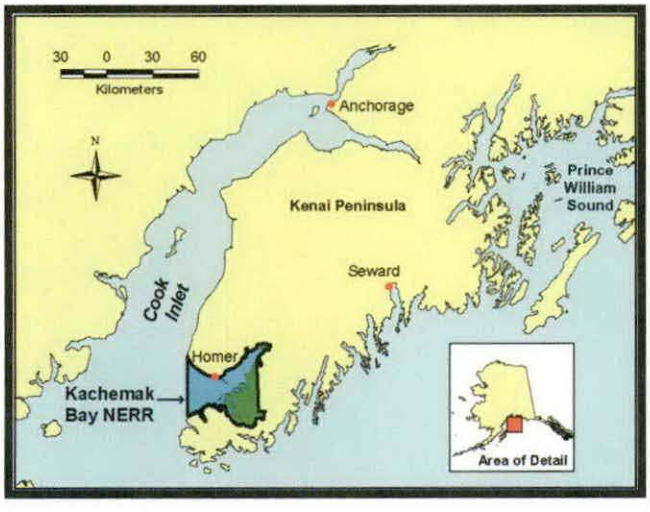
KACHEMAK BAY RESEARCH RESERVE
PROGRAM OVERVIEW

NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM

The National Estuarine Reserve System was created by the Coastal Zone Management Act of 1972. Recognizing both the value of estuaries and human threats to their existence, Congress established the National Estuarine Research Reserve System in 1972 to provide opportunities for long-term estuarine research and education, and to provide a basis for more informed management and use of coastal resources.



The system currently encompasses 26 unique estuaries in 21 states and territories, the largest of which is the Kachemak Bay National Estuarine Research Reserve, also known locally as the Kachemak Bay Research Reserve (KBRR). KBRR was designated by the National Oceanographic and Atmospheric Administration (NOAA) in February 1999 and is managed by the state (Alaska Department of Fish and Game) in partnership with NOAA.



Protecting over one million acres of estuarine lands and waters, the reserves within the NERR System are established and managed through a federal/state partnership to ensure longterm management and protection.

The Kachemak Bay National Estuarine Research Reserve was dedicated in Homer on National Estuaries Day 1998 and designated by NOAA February 1999. Since early 2002, the Kachemak Bay Research Reserve Community Council, comprised of nine community members and nine agency representatives, has provided a vital connection between the Reserve and Kachemak Bay communities, agencies, researchers, environmental educators, conservation groups and others interested in natural science, research and education.

The Kachemak Bay Research Reserve programs are funded by NOAA and granting organizations that support the Reserve's mission.

Kachemak Bay National Estuarine Research Reserve
95 Sterling Highway, Suite 2, Homer, Alaska 99603
Phone: 907-235-4799; Fax: 907-235-4794; Website: kbayrr.org

Boundaries

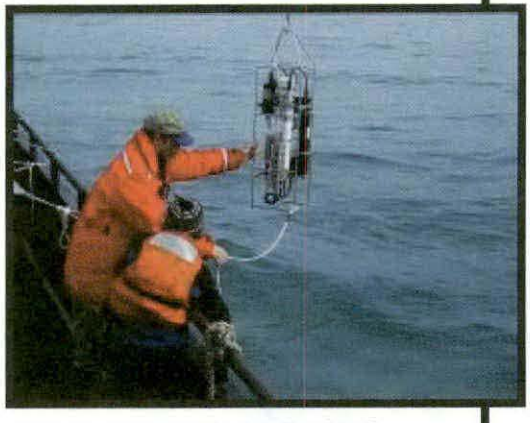
The Kachemak Bay Research Reserve is composed of over 365,000 acres of terrestrial and aquatic habitats in and around Kachemak Bay, including 230 miles of shoreline. The KBRR designation only affects land and waters already owned by the public. Three legislatively-designated areas are included within the Reserve: the Kachemak Bay and Fox River Flats Critical Habitat Areas, portions of the Kachemak Bay State Park/Wilderness Area, and most of Beluga Slough in Homer.

Mission

To develop and implement research and educational programs that enhance our understanding and appreciation of natural and human processes occurring in Lower Cook Inlet and Kachemak Bay to ensure that these estuarine ecosystems remain healthy and productive.

Facilities

The Kachemak Bay Research Reserve offices (together with the Alaska Maritime National Wildlife Refuge) are located in the Alaska Islands & Ocean Visitor Center on the Sterling Highway (Homer Bypass), overlooking Bishop's Beach and Beluga Slough. The Reserve also maintains a temporary lab, storage and workshop on Bay Avenue in Homer.



Research Focus

l "Bottom-up" processes in oceanic, nearshore, and watershed habitats – the physics and chemistry that create habitat for the animals and plants that live here – drive the research program.

l The core of our research is an ocean water sampling program, with measurements of temperature, conductivity, salinity, and nutrients being taken at specific locations on regular intervals to detect change over time; weather data are collected simultaneously.

l The research program is currently adding a biologist and is moving to integrate biological monitoring with the established physical baseline.

Education and Outreach

Reserve scientists and marine science educators share research and findings through:

l *Coastal Training Program* - scientific workshops to promote enhanced decision-making

l *Bay Science* - a bi-weekly feature in the *Homer News*

l Teacher training workshops

l Marine science education programs for students

l Fun, hands-on marine science programs for visitors at the Alaska Islands & Ocean Visitor Center

l Research Reserve website

Kachemak Bay National Estuarine Research Reserve
95 Sterling Highway, Suite 2, Homer, Alaska 99603
Phone: 907-235-4799; Fax: 907-235-4794; Website: kbayrr.org

1. Alliance for Coastal Technologies (ACT)
   c/o UMCES Chesapeake Biological Laboratory,
   Post Office Box 38,
   Solomons,
   Maryland, 20688.
   USA
   Telephone: 410 326 7385
   Fax: 410 326 7428
   Email: info@act-us.info
   http://www.act-us.info/contact.php

2. Dr. Ken Tenore
   Director at Alliance for Coastal Technologies
   tenore@cbl.umces.edu

   Dr. Shannon Atkinson
   Science Director at the Alaska SeaLife Center
   ACT Northwest Alliance Member
   shannon_akinson@alaskasealife.org

   Brendan Smith
   Research Education Coordinator
   ACT Northwest Alliance Member
   brendan_smith@alaskasealife.org

3. The Alliance for Coastal Technologies (ACT) is a NOAA-funded partnership of research institutions, state and regional resource managers, and private sector companies interested in developing applying sensor/sensor platform technologies for monitoring and studying coastal environments.

4. The ACT headquarters is based at the UMCES Chesapeake Biological Laboratory. Headquarters staff coordinate with organizations such as NOAA, EPA, Ocean.US, NSF, CICEET, and EuroACT. There are ACT partners and Alliance Members who bring expertise with sensor technology internationally. The ASLC and UAF represent the Northwest Alliance Member.

5. ACT was established to serve as a comprehensive information clearinghouse on sensor technology specification/performance for use in coastal waters; a forum for capacity building through technology workshops on sensor needs/capabilities for specific monitoring needs; an unbiased, third-part testbed for evaluating new and developing coastal sensor technologies. Organizations such as ACT are trying to aid in developing an Integrated Ocean Observing System (IOOS). Respective to Alaska, ACT is involved with the Alaska Ocean Observing System.

6. Reports, evaluations, and technologies are all accessible via the internet. Please refer to http://www.act-us.info/ for detailed specific reports concerning sensor technology.

7. Annual or other requests for proposal cycles
   N/A

8. These values below indicate the involvement with ACT and the Northwest Alliance Members of UAF/ASLC. Please note that ACT has many Alliance Members and the reported amounts do not reflect total funding. It should also be noted that this Alliance between UAF/ASLC and ACT began in 2005. Research funding amounts from ACT to UAF/ASLC in 2005-2006: $64,760.

9. Significant accomplishments in FY2004
   Please refer to ACT's organizational web site at http://www.act-us.info/.

10. Program goals/plans/opportunities for FY2006
    - The coastal observing community is able to identify and select technologies that are appropriate for actual needs, circumstances, and capacities.
    - Technology developers have tools for trend identification, forecasting, competitive analysis, and targeted marketing.
    - The latest, innovative, and most effective technologies are continuously integrated into observing capabilities.

11. Significant data and meta databases and associated hyperlinks
    N/A

12. Opportunities for research collaboration and cooperation
    - Broad ecosystem research
    - Oceanographic including physical, chemical and biological research
    - Meteorological research
    - ROV's
    - Sensor technology development

Oral Program Overviews

Alaska Sea Grant College Program

Brian Allee, Ph.D.

Alaska Sea Grant College Program
University of Alaska Fairbanks
brian.allee@sfos.uaf.edu

The Alaska Sea Grant College Program (ASG) has operated in the state for 35 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, and extension (marine advisory program) services to a diverse group of marine constituents in Alaska's coastal communities.

The stated vision of the ASG is that Alaska will have the nation's most vibrant and productive marine, estuarine and coastal watershed environments, maintained through ecosystem approaches to management balancing wise use and conservation. Alaskan people and communities will reconcile different values about resource use and conservation by blending and applying objective, science-based, and traditional ecological knowledge for the social and economic benefit of all Alaskans.

By assessing 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 embodied in the following five themes: coastal Communities and Economies, Ecosystems and Habitats, Fisheries, Marine and Aquatic Science Literacy, Seafood Science and Technology.

The ASG 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 principle contact for the ASG is director Brian Allee located at the University of Alaska Fairbanks in the School of Fisheries and Wildlife. The web site address for the ASG is http//www.uaf.edu/seagrant/.

MMS, Alaska OCS Region, Environmental Studies Program

1. Organization Name and address

Alaska Environmental Studies Program
Office of Leasing and Environment
Minerals Management Service (MMS), Alaska OCS Region
3801 Centerpoint Drive, Suite 500
Anchorage, Alaska 99503

2. Contact information: individual name and email address; Web Site

Cleve Cowles, Ph.D.
Chief, Environmental Studies Section
Tel: 907-334-5281
Fax:907-334-5242
eMail: cleveland.cowles@mms.gov

Web site: http://www.mms.gov/alaska/ess/index.htm

3. Mission and Goals

The purpose of the MMS Environmental Studies Program (ESP) is to define information needs and implement studies to assist in predicting, projecting, assessing, and managing potential effects on the human, marine, and coastal environments of the OCS and coastal areas that may be affected by offshore gas and oil development. To attain program goals, scientific results on specific environmental hypotheses/questions arising from offshore leasing are required. The ESP then monitors to measure potential effects during and after oil exploration and development.

4. Geographic Purview and Scope/General Types of Research Activities

Since 1974, MMS has sponsored more than $285 million toward environmental studies in 15 planning areas in the Arctic, Bering Sea, and Gulf of Alaska regions.

5. Primary Species or Data Type of Interest (e.g. kittiwakes, nitrate transport, etc.)

Studies are grouped into broad categories of physical oceanography, fate and effects of pollutants, biology, protected species, socioeconomics, multidisciplinary and other.

6. Significant planning documents or science plan

We distribute an *Alaska Annual Studies Plan, Final FY 200x*, usually in September, to approximately 200 Federal, State, local, environmental, Native, industry, international, and other organizations with a letter requesting suggestions for new studies for the next FY plan. We consider respondent comments and also recommendations from various program reviews. In addition, we request suggestions for new studies from Alaska OCS Region staff and consider their comments in identifying needed studies. The ESP also considers research needs identified through public comment provided at MMS Information Transfer Meetings (ITM).

7. Annual or other requests for proposal cycles

If MMS studies are to be contracted, RFP's are announced in "FedBizOpps" at various times. "Helpful Hints" on how to respond to MMS' RFP's can be found at http://www.mms.gov /eppd/sciences/esp/hints.htm. MMS also supports research through its Cooperative Agreement for the Alaska Coastal Marine Institute (CMI) at the Univ. of Alaska Fairbanks, and via inter- or

intra-agency agreements. Procedures for the CMI funding cycle can be found at http://www.sfos.uaf.edu/cmi/

8. Research funding amounts available annually for past 3 years and for FY 2006

MMS has funded about $2 - $3 M for *new* studies offshore Alaska in the last few years.

9. Significant Accomplishments in FY 2005

We initiated 8 new research projects relevant to MMS information needs in FY 2005, including 2 through the CMI . The Alaska Region's 10th Information Transfer Meeting was held in March, 2005 in Anchorage, followed by an Information Update Meeting in Barrow, Alaska. More than 60 ongoing Environmental Studies are currently managed by the MMS Alaska ESP. Of these, the major multi-disciplinary study titled "Arctic Nearshore Impact Monitoring in Development Area" was continued in FY 2004-07 in order to provide information needed for managing post-lease industry activities in the nearshore central Beaufort Sea. We continued our active interagency coordination on MMS studies in a number of ways.

10. Program goals/plans/opportunities for FY 2006

See the *Alaska Final Annual Study Plan, FY 2006* at: http://www.mms.gov/alaska/ess/index.htm. There are several *planned* new studies for FY 2006 listed (p. 144) and profiled there. We are among several co-sponsors of the 2006 Marine Science Symposium.

11. Significant data and meta databases and associated hyperlinks

Two basic levels of studies information are obtained: (1) scientific peer-reviewed products, most frequently as MMS OCS Environmental Study Reports and journal articles, published on paper or as electronic media and (2) data. In general the demand for unanalyzed data by, or from, MMS is low. Conversely, the demand for research reports or other value-added forms of information is high. Copies of MMS Final Reports are available at the Alaska Resources Library and Information Services (ARLIS). Another convenient source for literally hundreds of MMS Final Reports is the Environmental Studies Program Information System (ESPIS) which is easily accessed through http:// www.mms.gov/espis,

Considerable data from MMS sponsored studies are archived by, and publicly available through, the National Oceanic Data Center (NODC) and such archival is a required element of most ESP contracts and agreements. Organizations conducting studies supported by MMS generally archive data at NODC, in addition to archiving data in other systems they may have developed or are mandated. MMS' direct archival of ESP-generated data also is accomplished within the MMS Technical Information Management System (TIMS) which is a centralized corporate database.

12. Opportunities for research collaboration and cooperation

Opportunities are numerous, at both the program and project level. Please contact Chief, Environmental Studies Section.

Pollock Conservation Cooperative Research Center
School of Fisheries and Ocean Sciences
University of Alaska Fairbanks

Address:

P.O. Box 757220
Fairbanks, AK 99775-7330

Contacts:

Dr. Vera Alexander: vera@sfos.uaf.edu
Heather McCarty: rising@ptialaska.net

Website: www.sfos.uaf.edu/pcc/

The Pollock Conservation Cooperative Research Center (PCCRC) was established in February 2000. **The PCCRC's mission** is to improve knowledge about the North Pacific Ocean and Bering Sea through research and education, focusing on the commercial fisheries of the Bering Sea and Aleutian Islands.

The Center provides:

1. grants and fellowships to faculty and graduate students for research on pollock, other groundfish species, the fisheries for these species, and on marine mammals;
2. funding for marine education, technical training, and equipment; and
3. funding for research in the area of marine resource economics.

Funding for the PCC Research Center is provided by a sector of the North Pacific fishing industry – the seven members of the Pollock Conservation Cooperative (PCC), a group of companies that operate catcher/processor vessels in the Bering Sea and Aleutian Islands pollock fishery:

- Alaska Ocean Seafood, LP
- American Seafoods Company, LLC
- Arctic Storm, Inc.
- Glacier Fish Company, LLC
- Highland Light Seafoods LLC
- Starbound, LLC
- Trident Seafoods Corporation

The annual RFP cycle begins in August with the publication of a request for proposals detailing the amount available and that cycle's research priorities. Proposals are due in mid-October, and the funding decisions are announced the following February.

Proposals to the Center are peer reviewed, then prioritized by a six-member Advisory Board, which is comprised of three members representing the PCC, one member representing state and federal fisheries management agencies, and two members representing the University of Alaska Fairbanks. The Dean of the School of Fisheries and Ocean Sciences reviews the Advisory Board recommendations and selects the projects to be funded.

The PCC Research Center welcomes projects with funding from multiple sources, and projects with industry and agency collaboration. At least one principal investigator on each project must

be faculty, staff or affiliate of the University of Alaska, and proposals must be submitted through the University of Alaska.

During the last three years, the PCCRC RFP's have been: for 2003, $350,000; for 2004, $300,000, and for 2005, $250,000. Funded research from 2000 through 2005 totals $2 million.

In addition to funding research projects, each year the PCCRC places a sizeable portion of their donations into a research endowment fund, and into an endowment fund for a fisheries faculty chair. In 2005, the PCCRC completed the funding for the new faculty position in Marine Policy.

For the 2006 funding cycle, the Center has a total of $325,000 available and anticipates funding projects dealing with the following research priorities:

1. The sustainability of the northern fur seal and other marine mammals, and identification of factors influencing their population dynamics, including a literature review of studies assessing environmental conditions and other factors that may be affecting northern fur seals in the North Pacific;

2. Development of a detailed plan and methodology for the benthic mapping of the Aleutian Islands, including in particular the development and/or evaluation of cost-efficient methods for large area mapping of habitats of fish species;

3. Improvements in fishery stock assessment models, sampling methods and surveys, and management measures, particularly with regard to:
   a) research which explores a range of management options to protect rockfish from potential overfishing (proposals may advance methods to identify rockfish refugia and habitat areas of particular concern); and
   b) the assessment of important non-target species stocks (e.g., large sharks, skates, and squids) and the assignment of species to stock assemblages;

4. Alaska pollock stock dynamics, including: (a) fisheries interactions and the concept of localized depletions; (b) general environmental factors affecting pollock stock abundance; and (c) the interrelationship (if any) between the Pollock fishery in Russian waters and the status of Pollock stocks in the Eastern Bering Sea;

5. A comparison of the physical and biological features of the Aleutian Islands and Bering Sea with a primary focus on species of commercial significance, as a basis for evaluating the ecological exclusivity of these two ocean areas and the appropriate FMP management structure; and

6. Assessments of regime changes and other factors affecting marine mammal populations of the Gulf of Alaska, Bering Sea and Aleutian Islands, based on traditional ecological knowledge of coastal community elders and commercial fishermen.

Also, in 2006 the School of Fisheries and Ocean Sciences looks forward to the appointment of the **Ted Stevens Professor of Marine Policy.**

North Pacific Universities Marine Mammal Research Consortium

Dr. Andrew W Trites
Research Director

UBC Marine Mammal Research Unit
Room 247, AERL, 2202 Main Mall
Vancouver, BC, Canada V6T 1Z4

www.marinemammal.org

Tel: 604 822-8181
Fax: 604 822-8180
consortium@zoology.ubc.ca

Mission

The mission of the *North Pacific Universities Marine Mammal Research Consortium* is to undertake a long-term research program on marine mammals and the effects of fisheries, species interactions and oceanographic conditions on their status in the North Pacific Ocean and Eastern Bering Sea.

Geographic Purview and Scope

The *North Pacific Universities Marine Mammal Research Consortium* was formed in 1992 with four participating institutions: the University of Alaska, the University of British Columbia, the University of Washington, and Oregon State University.

The Consortium's Research Program consists of four components:

- field studies
- captive studies
- new measurement techniques
- mathematical modeling and laboratory studies

To date, the field studies have been contrasting healthy sea lion populations in Southeast Alaska with declining populations in the Gulf of Alaska. Research on sea lions has extended from Alaska to California. Captive studies on Steller sea lions at the Vancouver Aquarium Marine Science Centre are providing data about the animals' nutritional requirements and how they use the energy they derive from their food. This information is difficult to obtain in the wild. Captive studies enable testing and development of new techniques for studying sea lions in the wild. Developing new measurement techniques for processing biological samples, and analyzing historical data sets, constructing math-ematical models, and conducting laboratory studies comprise the last two components.

The Research Program balances short-term and long-term studies designed to test the various hypotheses that have been put forward to explain the decline of Steller sea lions and other species of marine mammals. The studies are integrated and draw on the expertise and talents of university-based physiologists, engineers, ecologists, chemists, marine mammalogists, fisheries specialists and oceanographers.

Primary Species of Interest

Consortium research focuses on marine mammals that may be affected by the fishing industry. The primary species of interest has been Steller sea lions, with an expanding research focus on killer whales, northern fur seals, harbor seals, pollock, Atka mackerel and a range of forage fish.

Annual Requests for Proposals

The Research Program of the Consortium is funded by the *North Pacific Marine Science Foundation*, which was formed specifically for that purpose. Contributions come from other foundations, federal grants, coastal communities and a wide spectrum of donors representative of the fishing industry.

A Research Committee, composed of research leaders from the four universities and three government institutions, is responsible for reviewing proposals for research each year and for reporting on progress to the Scientific Advisory Committee. The Scientific Advisory Committee oversees the research program, and is made up of representatives from universities, industry, and government agencies. The Consortium has been greatly aided in its work by the guidance and assistance provided by the National Marine Fisheries Service and the Alaska Department of Fish and Game.

A call for four-page pre-proposals is distributed to the four member universities in September of each year. Researchers from member universities may propose to undertake collaborative studies with researchers from non-member institutions. The Research Committee meets in early December to review and rank the pre-proposals. Full proposals are requested for those that receive the highest rankings. Full proposals are due in early February and are sent to the Scientific Advisory Committee for final selection in February.

Research Funding Available to Participating Universities

2006/07 – $2.0 million	2004/05 – $2.4 million
2005/06 – $2.4 million	2003/04 – $2.6 million

Significant Accomplishments

The Consortium's independent research program is distinguished by its diversity and integration of captive, field, modeling and laboratory studies.

Consortium researchers have a proven track record of conducting and publishing innovative and cost effective research that is reshaping our understanding of marine mammals in the North Pacific. To date, research supported in part or in whole through the Consortium has resulted in 101 publications, 20 graduate theses, and over 200 presentations at scientific conferences. The body of research has encompassed the leading hypotheses proposed to explain the dramatic population declines in Alaska.

Consortium Researchers were the first to study Steller sea lions in captivity, the first to take trained sea lions into the open ocean, the first to examine the possible role of killer whale predation in the decline of sea lions, and the first to experimentally demonstrate the connection between low energy prey such as pollock and the decline of sea lions in the Gulf of Alaska and Aleutian Islands.

Details of the research program and copies of publications and the annual report can be obtained from www.marinemammal.org.

Future Program Goals/Plans

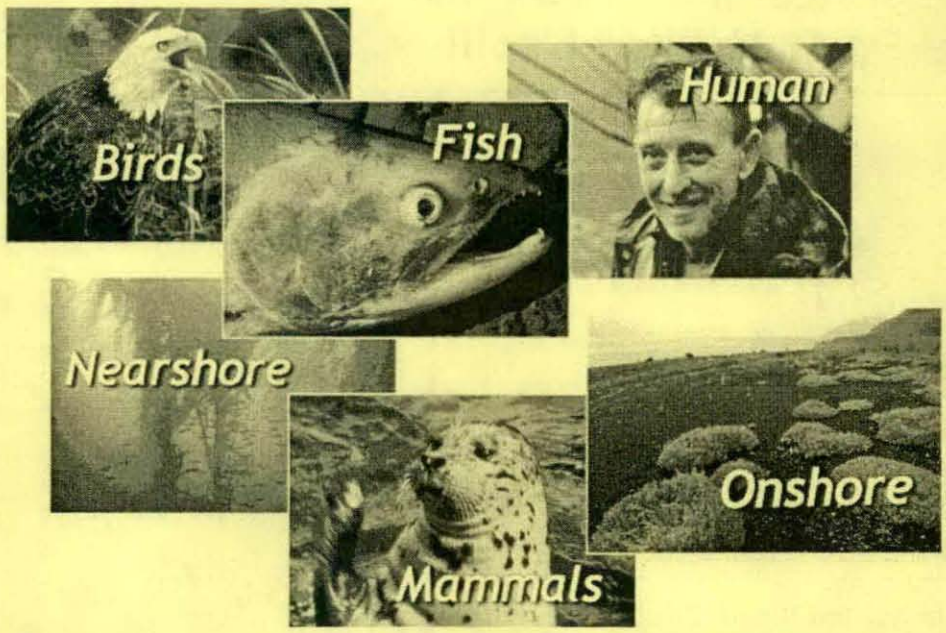
Research is continuing on understanding the decline of Steller Sea lions and what can be done to aid in their recovery. The current research program is expanding to more fully address the declines of northern fur seals and harbor seals through captive, field and laboratory based studies.

Opportunities for Research Collaboration & Cooperation

Collaborations are encouraged between the four university members and with researchers from other universities, government agencies, and non-government organizations.

Injured Resources and Services List Update

Exxon Valdez Oil Spill Trustee Council



Seventeen years after the *Exxon Valdez* oil spill, many resources and services injured by the spill have not fully recovered.

The 2003 Assessment

The 1994 Restoration Plan officially recognized 30 resources and services as injured by the spill. The last reassessment of the status of recovery of those injured by the spill occurred in 2003, when the Trustee Council considered seven resources to be "recovered" and moved two resources – killer whales (AB pod) and wilderness areas – to the "recovering" category. Pacific herring were returned to the "not recovering" category. Subtidal communities were moved to the "recovery unknown" category.

Where We Stand Now

Seven resources are considered fully recovered; 14 resources and four services have still not fully recovered; and the recovery of five resources is considered unknown. **See other side for details.**

Next Steps

The Council will assess what work is still needed to better understand the effects of lingering oil, with the aim of reaching closure on the status of injured resources and services.

Proposed Timeline of Events: Winter through Summer 2006

STEP ONE	Consider information relative to Lingering Oil and Injured Resources and Services Synthesis efforts. Prepare Draft Update of Injured Resources and Services List for peer and public review.
STEP TWO	Solicit public input on Draft Update of Injured Resources and Services List through community meetings, public notices, on-line notification and provide a means of receiving written comments.
STEP THREE	Convene a Public Advisory Committee Meeting to review the Draft Update of Injured Resources and Services List and solicit comments.
STEP FOUR	Revise Draft of Injured Resources and Services List considering public and peer review comments. Revised Draft with supporting documentation submitted to Trustee Council for consideration.

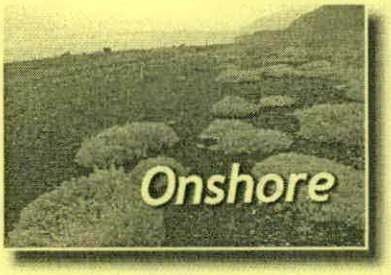
***Exxon Valdez* Oil Spill Trustee Council**

441 West 5th Avenue, Suite 500 • Anchorage, AK 99501 • 907-278-8012 • www.evostc.state.ak.us • January 2006

Current Status of Resources and Services injured by the 1989 *Exxon Valdez* oil spill

Bald Eagle ..... **RECOVERED**
Black Oystercatcher ..... **RECOVERED**
Common Loon ..... **NOT RECOVERING**
Common Murre ..... **RECOVERED**
Cormorant
(Pelagic, Red-faced, Double-crested)
..... **NOT RECOVERING**
Pigeon Guillemot **NOT RECOVERING**
Harlequin Duck ... **NOT RECOVERING**
Murrelet
(Kittlitz's) ..... **UNKNOWN**
(Marbled) ..... **RECOVERING**

Commercial Fishing .... **RECOVERING**
Subsistence ..... **RECOVERING**
Recreation/Tourism ..... **RECOVERING**
Passive Use ..... **RECOVERING**



Archaeological ..... **RECOVERED**
Wilderness Areas ..... **RECOVERING**

Harbor Seal ..... **NOT RECOVERING**
Otter
(Sea) ..... **RECOVERING**
(River) ..... **RECOVERED**
Killer Whale ..... **RECOVERING**

Clams ..... **RECOVERING**
Intertidal ..... **RECOVERING**
Mussels ..... **RECOVERING**
Sediments ..... **RECOVERING**
Subtidal Communities..... **UNKNOWN**

Cutthroat Trout ..... **UNKNOWN**
Dolly Varden ..... **UNKNOWN**
Pacific Herring ..... **NOT RECOVERING**
Rockfish ..... **UNKNOWN**
Salmon (Pink, Sockeye) **RECOVERED**

DEFINITIONS OF RECOVERY*

RECOVERED Recovery objectives have been met.

RECOVERING Substantive progress is being made toward recovery objectives. Human services will be considered recovered when the injured resources on which they depend are recovered.

NOT RECOVERING Little or no clear improvement since injury.

RECOVERY UNKNOWN Limited data are available; research inconclusive or incomplete.

**from EVOSTC 2003 Annual Report. List last updated June 2003.*

Abstract for January 2006 Marine Science Symposium (EVOS, NPRB, etc.)

Persistent *Exxon Valdez* Oil on Gulf of Alaska Boulder-Armored Beaches: Sixteen Years Post Spill

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For sixteen years following the *Exxon Valdez* spill, oil has persisted on Gulf of Alaska beaches distant from the spill origin. In 2005 we revisited 5 exposed rocky sites, most of which are boulder-armored, to assess the nature and extent of lingering oil and the processes that contribute to its persistence. These sites include four in Katmai National Park and Preserve and one in Kenai Fjords National Park and Preserve. Mousse-like oil persists at these sites in the sheltering provided by boulders, cobbles, and, bedrock. We examined the extent of surface oiling by resampling permanently marked quadrats and subsurface oiling through examination of "dipstones" dislodged from the boulder matrix. We hypothesize that the stability of the boulder armor is largely responsible for the persistence of this oil. Remeasurement of rock bolts placed in the boulders provided data on the degree of boulder movement. Much of the oil present resembled oil sampled in 1999. Then, oil at 5 of the 6 sites was chemically similar to 11-day old *Exxon Valdez* oil. We are chemically analyzing the oil for fingerprinting and determining its weathering state.

Marine Science in Alaska:
2006 Symposium

Late Abstracts

Using GIS to identify mother-pup pairs in a harbor seal population

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Identification of pups from aerial photographs is a challenge for estimating productivity of harbor seal populations, partly due to the presence of yearlings, which are similar to pups in size and appearance. To distinguish harbor seal pups from yearlings, researchers typically rely on visual assessments of relative size, proximity, and orientation to nearest neighbors, as well as pelage color. Since most of these criteria are spatial in nature, we used a geographic information system (GIS) to quantify our identifications of pups in aerial photographs from biweekly surveys of a harbor seal population in Disenchantment Bay, Alaska during the pupping season (May-June, 2004). Because the seals hauled out on relatively flat glacial icebergs and contrasted strongly with the ice, we were able to accurately measure body lengths and inter-seal distances on our georeferenced photographs. We calculated the relative size and proximity of each seal to its closest neighbor and plotted three-dimensional histograms of these variables for five surveys. As the pupping season neared its peak, three distinct modes developed in the length-proximity distribution. Two of these modes were observed among seals in close proximity: one represented seals much smaller than their nearest neighbors (likely pups) and the other, seals much larger than their nearest neighbors (likely mothers). The third mode represented nearest neighbors of similar lengths and various proximities. The length-proximity distributions of known mother-pup pairs (*i.e.*, pairs that were nursing) closely matched those of likely mothers and pups, though such a pattern could also include yearlings closely associating with adults. These results suggest that spatial measures are useful for identifying mother-pup pairs, and that refinements, such as including pelage color gradation to further discriminate between pups and yearlings, may aid in quantifying age-class structure of harbor seal populations.

Long-term variation in northern fur seal maternal foraging trip duration, pup mass and pup mortality

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We examined interannual trends and associations among maternal foraging trip duration, pup mass and pup mortality of northern fur seals on Pribilof Island rookeries in the Bering Sea. Data span periods of high fur seal abundance (1960s), decline (1960s-80s) and low abundance with decline (since 1990). Mean maternal foraging trip duration from St. Paul Island during early pupping (Jul-Aug) decreased from 9.2 d to 6.5 d after 1977, but varying sampling methodologies and study rookeries complicated comparisons. The range in August trip durations measured since 1996 with satellite recorders encompassed the durations observed during the early 1960s at nearby rookeries. Mean pup mass at about 1-month old increased for both sexes by ~ 0.07 kg/yr during 1957-1971, but there was no significant trend during 1984-2004. Pup mass was unrelated to early pup mortality rates. Pup mortality rates at St. Paul Island were lower after 1977, corresponding in timing to a warming of mean summer air temperatures, but may also have been influenced by density-dependent effects. Though current fur seal abundance does not likely produce density dependency upon these metrics, their use in evaluating environmental quality is complicated by an incomplete understanding of responses to changes in prey abundance or distribution.

Evidence of continuing declines in fecundity of Steller sea lions in the central Gulf of Alaska

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From 2000 to 2004, index counts of western stock Steller sea lions (*Eumetopias jubatus*) in the Gulf of Alaska and Aleutian Islands increased by ~10%, reversing a 30-year, 80% decline. A demographic model based on counts of pups and non-pups and the proportion of juvenile sea lions on haul-out sites in the central Gulf of Alaska indicated that the steep decline experienced by the population in the 1980s was caused primarily by a large drop in the survival rate of juvenile sea lions, but smaller decreases in the rates of adult survival and female fecundity occurred as well. As the rate of population decline slowed through 1998, juvenile and adult survival rates increased, but the decline in fecundity persisted. Here we report that these trends continued through 2004. These findings support the hypothesis that factors affecting the condition and reproductive potential of adult females (e.g., disease, nutritional stress), rather than direct mortality sources affecting some or all of the population (e.g., illegal shooting, predation), are the primary threats to recovery of the western Steller sea lion population.

Remote sensing of rapid shifts in harbor seal population structure

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The floating ice emanating from tidewater glaciers supports some of Alaska's largest aggregations of harbor seals (over 5000) during the vital periods of pupping and molting. Recent population declines in some glacial fjords underscore the need to understand population structure and trends. We developed a technique for estimating the size-class structure of a harbor seal population in a glacial fjord using aerial photogrammetry and a geographic information system. Using geo-referenced, high-resolution digital images of seals hauled out on ice, we measured the lengths of 1200+ seals observed in six days of transect sampling prior to and during the pupping season (May-June 2004). At peak abundance prior to pupping, seal sizes were normally distributed. At the onset of pupping, when abundance had declined 40%, the distribution was skewed toward larger seals, with a minor mode of smaller (juvenile) seals. This juvenile mode strengthened as the pupping season progressed but the mode of adult-sized seals gradually diminished, even as abundance returned to pre-pupping levels. These findings indicate that the composition of harbor seal populations can vary dramatically over short time periods. Our method for acquiring large samples to assess age-class structure can provide detailed context for related studies of seal abundance, trends, movements, and genetic population structure.

An Approach to Utilizing Traditional Ecological Knowledge in Resource Management

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Traditional Ecological Knowledge (TEK) includes observations of the environment in addition to resource management techniques that have been passed down from generation to generation. This approach provides useful information that can contribute significantly to ecosystem sustainability, management actions and help individuals understand how an ecosystem functions. Specifically, this approach uses maps, ecosystem posters, community workshops, and conceptual models to help incorporate traditional ecological knowledge into resource management programs, plans and remediation efforts. To simplify the complex nature of describing ecosystems, this approach focuses on detailing information pertaining to one organism at a time. By developing and compiling models for several organisms, a complete ecosystem view can be formed. The conceptual approach is a way for small communities to utilize students to collect, document, refine and organize TEK information, that will be used by the community to drive relevant science and influence resource management at the State and National levels as well as encourage relationships between community members, scientists and resource managers.

Environmental composition of habitat used by juvenile Steller sea lions (*Eumetopias jubatus*)

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The decline of the western stock of Steller sea lions (Eumetopias jubatus) over the past three decades may have been attributed to the synergistic effects of fisheries and environmental perturbations, which may have altered distribution or abundance of prey. Previous studies have indicated that prey occurrence and diet diversity were related to population decline within metapopulation regions of the western stock of Steller sea lions in Alaska. The objective of this study, therefore, was to examine diversity of habitat used by Steller sea lions with respect to population trajectories. Habitat use was assessed by deploying satellite-depth recorders and satellite relay data loggers on juvenile Steller sea lions (n=50) over a five-year period (2000 to 2004) within four regions of the western stock. Areas used by sea lions during summer months (June, July, and August) were demarcated using satellite telemetry data and characterized by environmental variables (sea surface temperature and chlorophyll-a), which possibly serve as proxies for environmental processes or prey. Shannon's Diversity Index (ShDi), a measure of composition that indicates how evenly the proportions of environmental patch types are distributed (ShDi=0 when area contains only 1 patch), was quantified for each area using a spatial pattern analysis computer program. Although there was considerable interannual variability within and among all areas, indices of diversity of sea surface temperature for the Eastern Aleutian Islands (range = 1.39-1.70) and Central Aleutian Islands (range 1.04¬1.30), which are areas of population stability or increase, were consistently greater than indices for the Western Aleutian Islands (range 0.69-1.38) or the Central Gulf of Alaska (range 0.94-1.27), which are areas of decline. Additional pattern metrics of composition and configuration will further our understanding of sea lion behavior and distribution with respect to environmental heterogeneity.

Modeling haul-out site selection in harbor seals

Robert A. Montgomery

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Animals are expected to spatially distribute themselves non-randomly and select the most appropriate habitat to suit their immediate needs of reproduction, foraging and predator avoidance. Therefore, observing the ways that animals use heterogeneous space is central to understanding their ecology. Pinnipeds haul-out on land or ice to rest, bear and rear their pups and molt. As these behaviors are fundamental to life history there are likely to be strong preferences for specific features of haul-out sites. Habitat selection studies of marine mammals commonly use satellite telemetry data to understand space use in the aquatic environment. However, for species of pinnipeds that are easily observed while on land, techniques aside from telemetry can be employed to research terrestrial habitat selection. In this analysis I used aerial survey data from April, June, August and October to count harbor seals at their haul-outs in central and lower Cook Inlet, Alaska. I then modeled haul-out site selection based on a series of environmental features. I converted the data into a raster based Geographic Information System (GIS) with values in each cell for seal abundance, bathymetry, sea-bed type, proximity to anthropogenic disturbance, substrate, wave exposure and prey availability. As seal abundance and several environmental features varied temporally, four separate models were developed to account for conditions specific to each survey month. I compared the observed haul-out sites with areas devoid of seals and found that the distribution of haul-out sites was most consistent with logical predictions that seals would avoid areas high in anthropogenic disturbance and aggregate near available prey. The seals also preferred offshore haul-outs, such as rocks and reefs, and avoided areas prone to high degrees of wave exposure. This study identifies likely harbor seal habitat and may have practical applications in assessing potential exposure to industrial accidents such as oil spills.

Sexual and colony segregation in northern fur seals (*Callorhinus ursinus*)

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This paper explores colony and sexual segregation in foraging between juvenile male and parturient female northern fur seals (Callorhinus ursinus) captured on St. Paul Island, Alaska. Fur seals were equipped with satellite transmitters, satellite dive recorders and/or time depth recorders. A directional analysis and a regression tree model were used to examine differences in foraging parameters between colonies and between sexes. Two fur seal colonies (Reef and Vostochni) foraged in distinct regions of the Bering Sea, as did juvenile males and parturient females. = 208 ± 21.1 km; t = 3.9, df = 31, p0 = 365 ± 31.6 km vs. Juvenile males foraged farther in distance (< 0 = 18.0 ± 1.6 d vs. 00.001) and longer in duration (= 6.9 ± 0.7 d; t = 5.8, df = 31, p < 0.001) than their parturient female counterparts. Dive density (number of dives/10 km2) results suggested that the foraging habitat may be more optimal for juvenile males traveling greater than 282.5 km from their departure colony. The lower dive densities within parturient female foraging habitat and the level of habitat segregation between the colonies and sexes suggests that spatial variability in habitat conditions can effect specific northern fur seal colonies.

Using remotely-sensed satellite and autonomous underwater vehicle measurements to characterize northern fur seal migratory habitat

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This study combined remotely sensed (sea surface height and chlorophyll a) and in-situ data collected by two Seagliders (autonomous underwater vehicles), with northern fur seal migratory movement patterns to characterize part of their foraging habitat. On four occasions, two satellite-tagged northern fur seals moved through areas where Seagliders were profiling temperature, salinity, dissolved oxygen, fluorescence, and backscatter (surface to 1000 m) at horizontal resolutions of 5-10 km. A seal migrating through the Gulf of Alaska appeared to respond to variability associated with a cyclonic eddy (identified by remote sensing), by passing though it's northern edge but lingering to forage for a week along the southern boundary. Seaglider profiles reveal elevated fluorescence and backscatter values within the upper 50 m along the southern edge, decreasing to the north. This suggests higher productivity along the eddy's southern side and possibly explains why the fur seal stopped to forage in that region. These results show that autonomous sampling technologies (e.g. Seagliders and floats) can be employed to help explain northern fur seal migratory movement patterns and potentially identify foraging areas by characterizing vertical variations of their foraging habitat.

Optimal foraging predictions of an index to patch quality applied to juvenile Steller sea lions in Prince William Sound

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Mori and Boyd (2004) used an optimal foraging approach in calculating an Index to Patch Quality (IPQ) for Antarctic fur seals that related the transit, foraging and recovery times of a dive cycle to the variation in the expected net energetic gain obtained while foraging at the bottom of the dive. Under the assumption that divers optimize their bottom time while foraging in a prey patch, the IPQ controls for variation in transit time (depth) and animal diving capacity, and estimates the quality of the prey patch in terms of the expected rate of energy gain. Here we apply that method to examine variation in IPQ during bouts and across seasons for a sample of juvenile Steller sea lions foraging in Prince William Sound, Alaska. We used data from 17 sea lions equipped with satellite-linked dive recorders in 2003-2005 that relayed time, depth, dive duration and interdive intervals, as well as dive shapes and bottom times. Results were consistent with our predictions that IPQ would decline during dive bouts due to prey depletion and dispersion caused by foraging in a prey patch, and that there would be seasonal shifts in IPQ reflecting the changing depth distributions and behavior of likely target species.

When the ice is gone, where will all the seals go?

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There are over 100,000 glaciers in Alaska covering 5% of the total land mass; most, however, are in rapid retreat. In 1983, there were 52 recorded tidewater glaciers (terminating in the ocean) in Alaska; in 2004 we documented 31 remaining and all but about 5 were receding. Harbor seals use the floating ice calved from at least 17 of these glaciers, which seem to provide relatively safe locations to pup and molt, free from most predators and disturbance. Haul-out space on the floating ice is nearly always available, and is independent of tide height. Our research has shown that seals migrate from terrestrial haul-out sites during late May and early June to tidewater glaciers to bear and nurse their young. Recent concerns for seals have arisen from increased vessel traffic and disturbance by sightseeing and cruise ships in several tidewater glacial regions. We are conducting research, in collaboration with Alaska Native groups and the cruise ship industry, to understand and mitigate the impact of this traffic on harbor seals. Each spring from 1998 to the present, we censused three of the main glacial pupping areas in SE Alaska: Tracy Arm (Sawyer Glacier), Endicott Arm (Dawes Glacier), and LeConte Glacier. The seals at these sites were composed almost entirely of mother-pup pairs. In June of 2005, the Sawyer Glacier, which had been steadily decreasing by only tens of meters each year, was found to have receded by more than 2 kilometers. The width of the glacier (at sea level) was reduced approximately 66%. If this retreat continues at its current rate, the Tracy Arm will no longer have a tidewater glacier within a year or two. This reduction of prime pupping habitat could have a significant impact on harbor seal populations in Alaska.

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PRINCE WILLIAM SOUND SCIENCE CENTER
CORDOVA, ALASKA

the Breakwater

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P.O. Box 705 Cordova, AK 99574 USA—www.pwssc.org

A view of Cordova from the reservoir.

INSIDE

Biological Monitoring Program Completes Busy Year, Contemplates Another

By Dr. Richard Thorne

The biological monitoring program efforts in 2005 continued to focus on Pacific herring and its importance to the endangered Steller sea lion population. The Steller Sea Lion Winter Food Limitation Research, now funded at $1.9 million over four years (2005-08), will expand in 2006 to cover the role of juvenile herring. In addition, the OSRI-funded monitoring of zooplankton abundance in PWS during spring completed its sixth year in 2005.

A major finding of the program in 2005 was further documentation of the impact of the Exxon Valdez Oil Spill on herring. Recent evidence suggests that the herring population did not collapse in 1993 as previously believed; it actually began a substantial decline in 1989, coincident with the oil spill, and that decline persisted from 1989 to 1994.

The evidence is based on a reconstruction of the population abundance using a combination of acoustic assessment and aerial surveys of miles of herring spawn. The pattern of persistent decline from 1989 to 1994 is also supported by abundance trends of several major predators of herring, including Steller sea lions.

Further evidence can be found in a comparison of the estimates from the reconstruction with those from the age structured model that was used to manage the fishery. Both methods are in excellent agreement from 1980 to 1988, then sharply diverge from 1989 to 1994 (See Fig 1). The most logical explanation is an increase in the herring mortality rate associated with the oil spill in 1989 that caused the age-structured

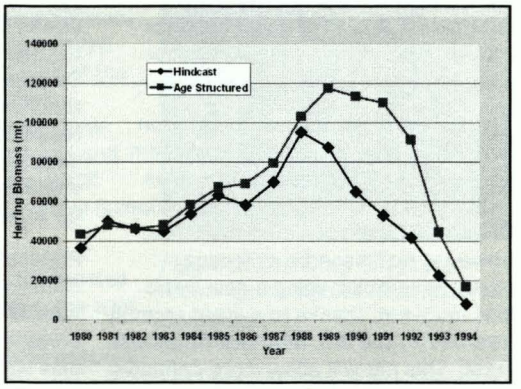
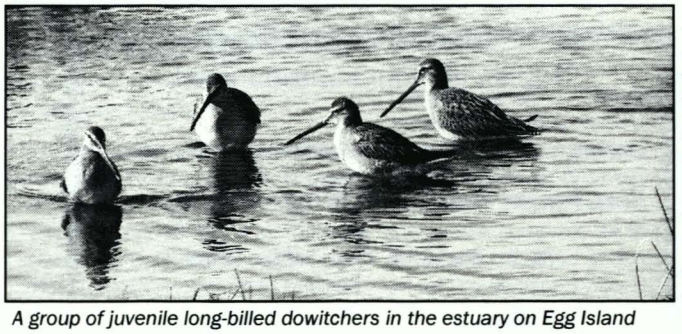


Fig. 1. Comparison of the reconstructed historical herring population in PWS from 1980 to 1994, with population estimates from the age-structured model used to manage the fishery. The deviation after 1988 is likely the result of an increase in the herring mortality rate associated with the Exxon Valdez Oil Spill. A three-year smoothing function has been applied to both estimators.

(Continued on page 6)

Monitoring Shorebirds on Barrier Islands of the Copper River Delta

By Mary Anne Bishop, Ph.D.



A group of juvenile long-billed dowitchers in the estuary on Egg Island

Flying into Cordova, one of the most beautiful vistas is the Copper River Delta's barrier islands and the vast mudflats that lie behind them. The protected mudflats with their high densities of *Macoma* clams, are what make the Delta one of the most important shorebird stopover sites in North America.

I have been studying how shorebirds use the Copper River Delta since the early 1990's. My research methods have varied from aerial flights to count shorebirds, to radio-tracking shorebirds previously tagged in Mexico, California, and Washington, to airboat surveys to determine species composition, to mist netting shorebirds and taking blood samples. However, until this summer, my research on shorebird migration has focused almost exclusively on when and how shorebirds use the intertidal mudflats in spring.

In July 2005 I began to investigate how shorebirds use the Delta's extensive barrier islands. Relatively little information exists on how shorebirds use ocean beaches, even though >25 species migrate or winter along the Pacific coast beaches from California northward.

The objectives of the study include to: a) determine the timing, relative abundance and species composition of shorebirds using the outer barrier islands of the Copper River Delta during spring and fall migration; b) examine spatial and temporal distribution of shorebirds on outer beaches; and, c) establish permanent transects for baseline and long-term studies.

The project is funded by the Alaska Department of Fish and Game — Nongame Program and the Prince William Sound Oil Spill Recovery Institute. Other cooperators include Chugach National Forest-Cordova Ranger District and Alaska Department of Fish and Game

(Continued on page 3)

President's Corner

It's difficult to find a day when all of the Science Center's staff are "in" as our scientists and educators stay busy. Dick Thorne is either out on a fishing vessel collecting more information about herring, Pollock or zooplankton, or he's preparing for or presenting at a scientific symposium.

Tom Kline's work, focused on salmon habitats in Eyak Lake and the western Copper River Delta region, as well as food web analysis using stable isotopes, keeps him a little closer to the office. However, he'll soon be collecting plankton samples using a new hydro-bios multi-net, thanks to a grant recently awarded by the M.J. Murdock Charitable Trust. This net will allow more definitive sampling, for the first time, of the deepest region of Prince William Sound and should help answer questions on plankton population reproduction which is so critical to fish and other species higher in the food chain.

Mary Anne Bishop continues to manage multiple projects in the Copper River Delta region focused on fish, critical habitats and shorebirds. Her trawling surveys are revealing nursery habitat regions for halibut and other fish species in the Delta; and, the shorebird surveys she is coordinating with support from the Non-game program of Alaska Dept. of Fish & Game are demonstrating a wider variety of bird species migrating through the Delta than previously known. She is also working with Dick Thorne on a seafood waste study in Orca Inlet to monitor alternate methods of disposal from the current EPA-mandated grinding of all offal material.

The Science Center's observational oceanography program continues to collect seasonal data and is redoubling efforts to make that data available to other scientists as well as the general public through the PWS Observing System website, a program within the Alaska Ocean Observing System (AOOS). The deployment last spring of multiple acoustic Doppler current profilers (ADCPs) moored in Hinchinbrook Entrance and Montague Strait is resulting in new data on current strengths, direction and salinity that will be particularly important to validate ocean circulation models for Prince William Sound.

Physical oceanographer Claude Belanger and oceanography marine technician Shelton Gay have been extremely busy in the past year preparing for and doing the deployments of this new equipment, as well as setting up programs to make the data readily available over the Internet.

Efforts to translate scientific data for the non-scientist are often challenging. In partnership with data managers at the University of Alaska Fairbanks, Carl Schoch is working to do that through the PWSOS website which will be unveiled in late January. There will be presentations at both the January Alaska Marine Symposium and the February Alaska Forum on the Environment on this website which is designed to provide data to scientists, aviators, fishermen, educators and the general public. While Carl is leaving Cordova this month, he will be continuing work on the PWSOS as he moves to work in the AOOS office in Anchorage beginning in January.

Our educators – Allen Marquette, Kate Alexander and Lindsay Butters – work full-time to make science fun and understandable for the general public and school age kids. Their programs continue to be very popular with all ages. I'm delighted this year that additional funding support is allowing us to include more regular work with high school age students. It's also great to be partnering with the Marine Advisory Program on our weekly community lecture programs!

As 2005 comes to a close, several staff members are transitioning to new work. We wish the best of studies to Shelton Gay as he starts a doctoral program at Texas A&M, and best wishes to Carl Schoch in his move to work more on the AOOS program. They've been important contributors to a lot of our programs! Shelton plans to be back for the summer and will return to the Science Center at the end of his studies.

Also departing is lab tech Bess Ranger, but we're happy that the Coast Guard is relocating her and her husband to Juneau so we'll get to see her on visits.

Please drop by to visit us anytime. As a community-based and member-driven organization, we welcome your comments, suggestions and feedback. Finally, I wish you good health, wonderful visits with family and friends and safe travels during this season of good cheer and new beginnings.

Nancy Bird, President

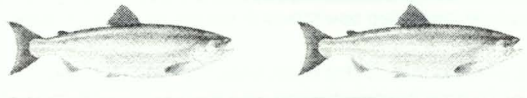
(left) The PWS Science Center Board of Directors invites you to join and receive a membership sticker! Pictured in the back row, l to r: Chuck Meacham, Ed Backus, Steve Smith, Mead Treadwell, Ed Zeine, John Allen, Molly McCammon, and Dave Reggiani. Front row, l to r: John Goering, Walt Parker, Nancy Bird, Jerry Gallagher and Meera Kohler.

Thanks for your contributions!

Barbara Smith—Super Discovery Room Volunteer

Bess Ranger—Lab Tech, Good luck in Juneau!

M.J. Murdock Charitable Trust



Prince William Sound Ocean Observing System Moorings (*the first recovery)*

By Shelton Gay

In late October 2005, oceanographers from the Science Center recovered four long (150-240m) moorings in Hinchinbrook Entrance (HE) and Montague Strait (MS), and one short (5m) mooring in Prince of Wales Pass (PWP) that were initially deployed in June 2005. The instrument configurations and goals of this project were described in recent editions of the Breakwater (March and August 2005).

The moorings were recovered by triggering acoustic releases that hold them to railroad wheel anchors. This is accomplished by lowering a transducer over the side and sending acoustic commands to request information such as the status and slant range. Finally, when all is ready a command is sent to activate the release, and the mooring buoys then begin to appear at the surface one by one.

Once all of the mooring components have been recovered, the instruments are serviced and the data are uploaded. The instruments are then reprogrammed, reinstalled and the mooring is redeployed.

The two Flotation Technologies low drag buoys recovered from Hinchinbrook Entrance (HE) are shown in Fig. 1. In summary, the sensors on these buoys consist of two basic types: 1) acoustic Doppler current profilers (ADCPs); and 2) conductivity, temperature and depth recorders (CTDs). One of the up-looking ADCPs can be seen in the forward buoy in Fig. 1. Note that the transducers are rotated 45 deg. clockwise. (See previous Breakwater issues for technological explanations of these sensors)

The buoys in Fig. 1 are highly streamlined (i.e. designed to reduce drag) and they also have vertical and horizontal stabilizers (tail fins) designed to minimize the vertical pitch and yawl of the buoys in the high current environment. In general, these buoys performed quite well and the pitch and roll of the ADCP transducers remained under 6 degrees.

However, there were differences in performance between the east

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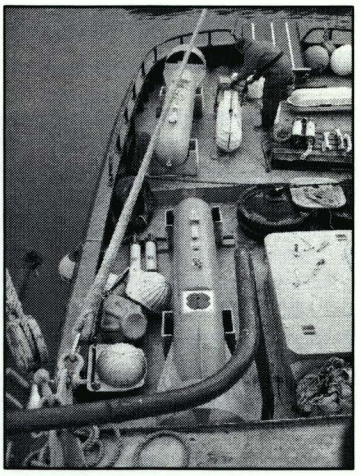


Figure 1. Low Drag Buoys from moorings located at Hinchinbrook Entrance

Thermosalinograph Installation on a Bow-Picker

By Shelton Gay

In early December, a new array of oceanographic sensors was set-up on board a local fishing vessel, the *Alena K*, owned by Andy Craig. The set of instruments (Fig. 1) is comprised of a *thermosalinograph* and a *fluorometer* and *transmissometer* attached in series to an inlet hose supplying a continuous stream of ocean water.

The measurements consist of temperature, salinity, fluorescence and turbidity, and are collected as the vessel is under way at high speed (> 20 kts). The data are relayed to a data logger, which in turn sends them to an onboard PC to be saved into a file.

This information will be collected seasonally from transects across all the major basins of Prince William Sound (PWS), and the data will be useful in identifying the presence of various water masses within the sound and geographical variation in freshwater distribution. All of these factors are important in their affects on buoyancy driven circulation within PWS.

In addition, concentrations of phytoplankton (inferred from fluorescence) will indicate which regions of PWS experience early primary production and how this progresses through the spring and summer.

For example, during a recent shake-down cruise from Cordova to Double Bay (located on the north end of Hinchinbrook Island) the instruments revealed the surface physical properties to vary significantly due to the interaction of cold dry weather conditions in November and the recent warm, wet conditions which have resulted in much local low elevation snow melt.

This was inferred from cold (3-4 C), brackish (S=26-27) conditions within Orca Inlet gradually becoming warmer (7-8 C) and saline (S=30-31) in regions of Orca Bay where convective mixing had taken place the previous month. As the vessel traversed the edge of middle ground shoal the surface water again became colder and fresher, with a corresponding increase in turbidity.

The latter may be the result of Copper River water intruding into PWS through Hawkins Cutoff, or it may indicate local runoff mixed with re-suspended sediments caused by wind turbulence in the lower portion of Orca Inlet near Strawberry Entrance.

Shorebird cont'd

(Continued from page 1)

Cordova office.

We established a field camp at Egg Island, a 6.3 km wide and 14.5 km long island located on the western edge of the Copper River Delta. Two intrepid biologists, River Gates and Jean Francois Lamarre lived on the island from late July through mid September.

They conducted a series of transects for shorebirds including on the exposed outer beach (facing the Gulf of Alaska), in a small estuary on the island, and in the uplands, close to and parallel to the beach.

Over the course of 101 transects they recorded 13,560 shorebirds representing 27 species. The most abundant species observed on the beach were Least Sandpiper and Semipalmated Plover, both local breeders, followed by Pacific Golden Plover and Black Turnstone, both migrants from western Alaska.

Semi-palmated plover

In the island's estuary the most abundant species observed were Least Sandpiper, Long-billed Dowitcher (a migrant), and Short-billed Dowitcher, a local breeder. Upland transects were dominated by migrant Pectoral Sandpipers.

One of their most interesting observations was of a juvenile Semipalmated Sandpiper that had been color-marked just 11 days earlier on Alaska's North Slope.

While River and Jean Francois observed shorebirds on the ground, I flew fixed-wing surveys of the outer beaches during high tide. Shorebirds were observed almost exclusively on the barrier islands west of the Copper River. This exciting study will continue next year, when we will document shorebird migration from spring through fall on the islands. Stay tuned!

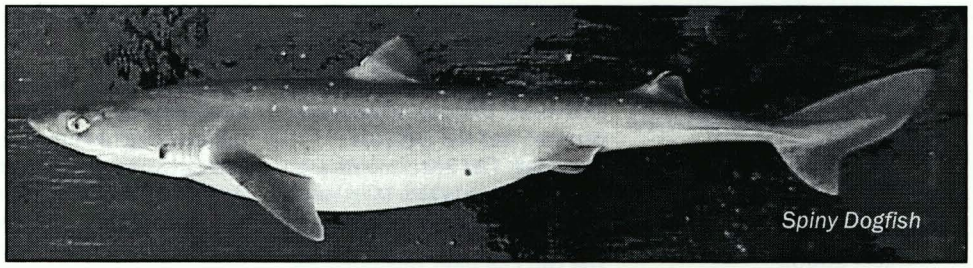
Science of the Sound

Update on the education programs of the Prince William Sound Science Center

Community Education Off To a Great Start This Fall

By Allen Marquette

This season has seen some changes in the Community Education program with a partnership between the Prince William Sound Science Center and the Alaska Sea Grant Marine Advisory Program. With the combined efforts of both agencies, the diversity of evening presentations should provide Cordovans with many interesting and informative programs.


Spiny Dogfish

Both the Eccles Elementary and Cordova Middle and High Schools have become more involved in the Community Education programs this year with teachers giving students extra credit for attending the science programs and writing a paper on what they've learned. Most programs have from three to twelve students attending.


Lionfish from the Andaman Sea

One of the programs in September was given by commercial fisherman and diver, Gonzolo Villalon. Sixty three people attended his presentation on the Andaman Sea where he showed spectacular underwater documentary style footage of many of the denizens of the reef system off the coast of Thailand. Gonzolo shared breathtaking images of organisms from a few millimeters long to a whale shark ten meters in length. Many of the organisms he filmed were interacting with other organisms living on this colorful and interesting reef.

In September, Allen Marquette participated in a five day fieldtrip to the Kennecott Copper Mine with 15 high school students in the geology class from the high school. Students explored the geology, history and unique habitat surrounding the mine and town of Kennecott. After the trip, students produced a presentation for their parents and the community.

Another interesting program was given by Cindy Tribuzio, with the UAF, Juneau branch. She shared current research she is doing on the Spiny Dogfish of Prince William Sound. Cindy had excellent information, statistics and photos explaining the lifestyle of these unique and sometimes troublesome sharks. Fishermen were especially interested in learning about these predators that they often find tangled in their nets while salmon fishing.

River Gates, a seasonal biologist working for the science center, recently presented a program titled *"Fall Bird Migration on the Barrier Islands".*

Discovery Room Students Blossom into Botanists

By Lindsay Butters

Discovery Room staff are pleased to announce that another year of science education is well underway. This year the budding scientists from Mt. Eccles elementary will be visiting the Discovery Room to study the world of plants. Each month the students will explore different topics related to plants and their importance to the ecosystems they support.

Discovery Room programming kicked off in October with an Introduction to Plants, Leaves and Seeds. Students learned the parts of a plant and what plants require to grow and reproduce. By looking at a variety of seeds students identified seed adaptations and methods of dispersal away from the parent plant.

They also studied the anatomy of a developing plant by dissecting lima bean seeds. Students applied their new knowledge of plants and leaf shapes in an activity using dichotomous keys to identify preserved plant samples collected around Cordova.

November's Discovery Room program focused on soils, compost and planting seeds. Students learned about how soil nutrients and permeability affect plant growth. They conducted chemical tests to measure the amount of essential plant nutrients in soil samples and held permeability heats to test which type of soil allows water to flow through the quickest.

The students also built compost bins to take back to their classrooms and discussed what materials can be recycled in a compost pile. The final activity for this month was a seed planting exercise. Each student planted radish seeds to take home and the 4-6 graders set up growth experiments. These experiments include the effects of fertilizer on plant growth and how germinating seeds are affected by gravity.

Plant topics that will be explored in the coming months include biomes and plant adaptations, invasive species, economic and cultural importance of plants and a spring field trip to explore local

(Continued on page 6)


Discovery Room students take a close look a carnivorous plant adaptations.

Thanks to our sponsors: *Oil Spill Recovery Institute, ConocoPhillips, Education Legacy Fund, BP, Wells Fargo, Cordova Telephone Cooperative, Alaska Marine Lines, Cordova Electric Cooperative and Alaska Commercial Co.*

Traveling Oceanography Kit to Debut in Prince William Sound

By Lindsay Butters

Educators from the PWS Science Center and the Imaginarium in Anchorage have teamed up to create a portable ocean education kit. Science Center educators will be taking the kit to the Tatitlek during their winter outreach trip to the village.

The kit contains materials for an introductory assembly and three age-appropriate lessons to further students' knowledge of Earth's oceans and the marine plants and animals that they support.

The *World o' Water* assembly is an exciting array of demonstrations illustrating the properties of water, including density and water pressure and how they influence the anatomy and behaviors of marine organisms.

The assembly makes use of a kid-sized ball pit, each color ball representing a component of ocean water, to demonstrate concepts such as buoyancy, viscosity and ocean currents.

Living On the Edge is a lesson for grades K-2 that explores the adaptations of intertidal organisms to the changing, and sometimes dangerous, conditions of the intertidal zone. Students discuss what life is like in the high, middle and low tide zones and what kinds of organisms live in each.

Through examination of pictures or live creatures, students will identify the adaptations of intertidal organisms that allow them to survive extreme conditions and avoid predators. In the culminating activity the students create their own model intertidal organisms, presumably well adapted to life on the edge.

Students in grades 3-5 participate in *Floating Food*, a lesson about plankton and their important role in the ocean food web. After viewing a short video students will be able to describe plankton and their adaptations for slow movement through the ocean.

Students then use a variety of materials to create their own plankton with the goal of creating an organism that will sink very slowly to the bottom of an "ocean." Once all of the creations are completed, each will have a turn in a race tank. The plankton that takes the longest time to reach the bottom wins.

Poke A Squid is a dissection activity for grades 6-8. Students first discuss what kinds of adaptations organisms must have to have in order to survive in an ocean environment. Following is an exploration of the phylum Mollusca and what types of adaptations are specific to mollusks.

Students then dissect a squid, identifying its organs and comparing them to those of humans or other animals.

The oceanography kit will debut in Cordova during the Science Festival during Iceworm Festival in February.

New Program: Prince William Sound Field Notes

Each week, Allen Marquette records a three to five minute radio program on science with many of the programs focusing on the Prince William Sound. This new partnership with the PBS radio station-KCHU Terminal Radio in Valdez has allowed the science center to reach many communities besides Cordova, including Valdez, Yakatat, Tatitlek, Chenega Bay and communities of the Copper River Basin. These radio programs will also be listed on the archive web page and available for interested listeners enjoy. Presently there have been over 25 programs produced and aired!

Prince William Sound Science Center Announces Lingering Oil Education Project

By Kate Alexander

8/3/04 Residual subsurface oil in shallow pit. Smith Is., PWS by DJanka

High school students living in communities impacted by the Exxon Valdez Oil Spill are invited to participate in an essay contest documenting how their families, communities, culture or environment has been affected by the oil spill. Four students will be selected from the entries and will tour Prince William Sound next March, followed by a visit to Washington, D.C. in order to share with Congress what is learned on the trip through Prince William Sound.

Sponsored by the Prince William Sound Science Center (Cordova – www.pwssc.org), the lingering oil education project is designed to encourage the next generation of community members since the 1989 spill to learn about its immediate and lasting impacts, the biological and technological research conducted since the spill and the improvements in prevention and response methods since the event.

The essays are to be 800-1200 words in length and must be submitted by January 9, 2006. They will be judged by a panel including teachers, oil industry experts and scientists.

The four students whose essays are selected will participate in a field trip through Prince William Sound that starts in Valdez. Here students will visit oil industry related facilities, as well as have informational sessions with industry and state representatives, the Prince William Sound Regional Citizens Advisory Council, and the U.S. Coast Guard.

The students will travel by boat to Bligh Reef to see where the Exxon Valdez grounded and then continue to Green Island, Knight Island, and other Western PWS islands. Here they will meet Dr. Jeffrey Short, a scientist from NOAA's Auke Bay Lab who led a 2001 shoreline survey for lingering oil.

The survey looked at about 8,000 meters of shoreline and estimated that approximately 27 acres of shoreline in PWS were still contaminated with oil.

The oil found was usually located subsurface in the intertidal zone where it can be stored in the sediments for years before being dispersed and without losing much of its original toxicity. Any disturbance to the sediment can release this oil into the environment, including disturbance by animals living in the sediment and wave action on the shores.

Dr. Short will assist the students in the collection of oiled sediment samples. These samples, along with bound copies of all submitted student essays, will be delivered to Congress during the students' trip to Washington, D.C.

The contest is open to high school students living in the oiled regions of the Prince William Sound, Kodiak Island and the Lower Kenai Peninsula regions, including Cordova, Seward, Homer, Kodiak, Valdez, Whittier, Tatitlek, Chenega Bay, Nanwalek, Seldovia, Larsen Bay, and Port Graham. For further information, contact Kate Alexander at the Prince William Sound Science Center in Cordova (907)424-5800 x 231, kate@pwssc.gen.ak.us

Community education cont'd

(Continued from page 4)

This year for the first time, two biologists River Gates and Jean Francois Lamarre, were stationed on Egg Island on the mud flats of the Copper River Delta for several weeks. The two scientists from the science center were identifying and counting birds as they were leaving Alaska for their journey south after breeding and fledging in the north. A tremendous amount of first-time data on bird species and numbers was compiled. Many of the people attending the presentation had detailed questions about the project and the results of the survey.

Many interesting and informative programs are scheduled for the winter season so please stop in at the science center and enjoy one of our programs on Tuesday evenings at 7:00pm. Contact Allen Marquette for more information at (907) 424-5800 ext 237 or allen@pwssc.gen.ak.us.

Discovery Room cont'd

(Continued from page 4)

plant communities.

There is also a field component to the Discovery Room plant program that provides students in 4-6 grades the opportunity to visit two study plots in the local temperate rainforest. During monthly field trips to the forest plots students learn how forest scientists use random plot sampling to gather information about an entire forest. They will use equipment to take tree measurements and calculate the basal area in each of the plots, as well as to collect weather data that will be used in exercises later in the year.

Discovery Room is run in partnership with the USFS/Cordova Ranger District

Moorings cont'd

(Continued from page 3)

and west sides at HE3 and HE1 respectively (Fig. 2) showing the pitch (P) for at HE3 to have consistently higher values. This was most likely induced by "kiting" of the upper SUBS buoy at HE3, possibly resulting from greater variation in current vectors between 30 and 100m.

The buoy at HE3 experienced both an upward pitch and a side-wards force. Since the sensors were rotated 45 deg. clockwise in the buoys (Fig. 1) and the values of P were positive and values of R negative (Fig. 3), this meant that the buoy experienced both an upward pitch and a lateral roll.

In contrast, the buoy on the west side had similar positive values of P and R meaning the buoy experienced an upward tilt only with roll being negligible.

For more information contact Carl Schoch, cschoch@pwssc.gen.ak.us, Claude Belanger, belanger@pwssc.gen.ak.us or Shelton Gay, smg3ak@earthlink.net. .

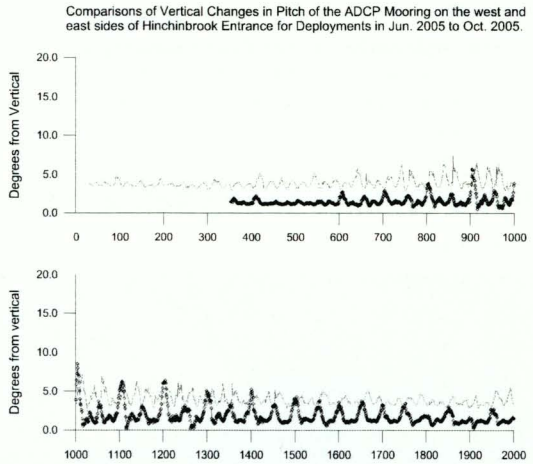


Figure 2. Variation in pitch values for ADCP buoys on the east and west sides of Hinchinbrook Entrance. HE1 is black and HE3 is blue.

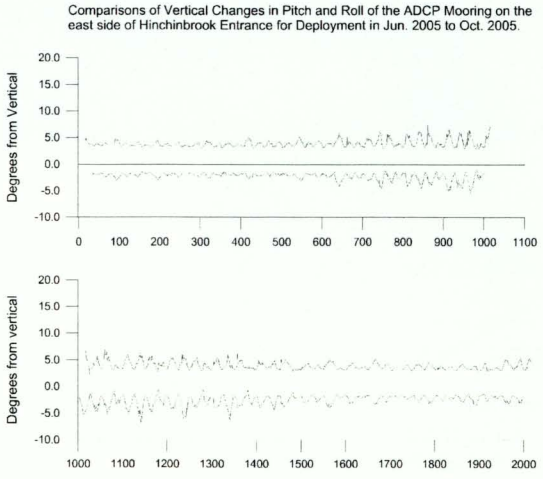


Figure 3. Values of pitch and roll for the ADCP buoy HE3, located on the east side of Hinchinbrook Entrance.

Biological Monitoring cont'd

(Continued from page 1)

model to overestimate herring abundance.

The year 2005 also saw another pink salmon return that could be compared with the results of zooplankton monitoring. The 2005 return was higher than expected from large zooplankton abundance during spring of the nursery year, but was well correlated with the relative abundance of large-bodied copepods.

High salmon returns in 2001, 2003 and 2005 were associated with a high percentage of large-bodied copepods, while low returns in 2002 and 2004 were associated with low percentages of large copepods (See Fig 2). The results suggest that distributional characteristics of the large copepods may be as important as their overall abundance.

PWSSC senior investigator, Richard Thorne, who directs the biological monitoring program, participated in three zooplankton cruises in Prince William Sound, two herring cruises each in Prince William Sound and Kodiak.

He also gave five oral presentations and four poster presentations at scientific conferences, provided oversight of the Science Center's Seafood Waste Disposal Project, gave guest lectures for a new course in fisheries acoustics at the Rosentiel School of Marine and Atmospheric Sciences in Miami and a presentation before the EVOS Trustee Council, as well as the usual data analysis, project reports and a journal refereed publication.

Next year could be even busier with the addition of two juvenile herring cruises and a pollock cruise in PWS.

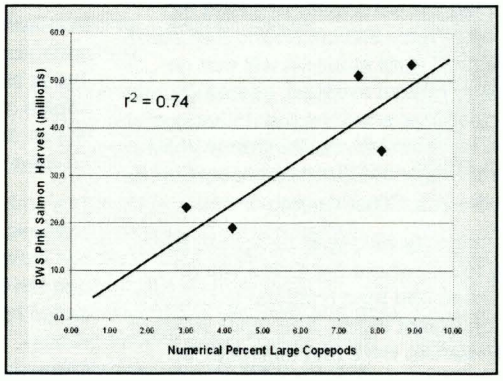


Fig. 2. Comparison of adult pink salmon returns with the numerical percent of large-bodied copepods in net catches from spring zooplankton cruises during the nursery year.

PWSSC and OSRI Board News

The PWSSC Board of Directors met in late September, both to conduct its Annual Meeting and in a workshop focused on science and infrastructure plans for the future.

Ted Cooney, retired University of Alaska Fairbanks professor and a long-time researcher in Prince William Sound, was invited by the Board to share his thoughts on scientific directions the Center might focus on as well as help brainstorm ways to finance the work. The discussions included several scientific staff members. Follow-up meetings amongst the Board's committee chairs are planned this winter.

Meera Kohler was honored at the meeting's end for her three years service as Board Chair. New officers elected by the Board include Chair Ed Backus, 1st Vice Chair Meera Kohler, 2nd Vice Chair Jerry Gallagher, Secretary Molly McCammon, Treasurer Gale Vick and David Reggiani as an Executive Committee member-at-large. Walt Parker's nine years of service on the Board (3 years as Chair) was honored by his appointment as an Emeritus Board Member.

Newly elected to the Board are Tom Weingartner, Ph.D. (Univ. of Alaska Fairbanks), and Eric Knudsen, Ph.D. (fisheries consultant who retired about 18 months ago from the U.S. Geological Survey). Both have extensive research experience in Alaska and are great additions to the Board!

The next regular Board of Directors meeting is Friday, **June 16, 2006**, in Cordova, just before the **June 17 Copper River Nouveau!** Contact Nancy Bird if you'd like to receive a meeting agenda or are interested in Board committee meetings which occur periodically throughout the year.

OSRI Board News

Actions taken by the OSRI Advisory Board at their Annual Meeting Sept. 26 in Cordova included:

*Approval of the FY06 Annual Work Plan including a new partnership for a joint proposal solicitation by OSRI and the North Pacific Research Board.

* John Goering, Ph.D., who served as Chair of the Scientific and Technical Committee (STC) for over 10 years, was honored with a plaque. While John remains on the STC (and the OSRI Board), Phil Mundy was elected Chair of the committee last spring.

The Board also passed a motion of appreciation for Carl Schoch's energy and vision for the OSRI program. Schoch resigned as OSRI Science Director Nov. 30 and is working through 2006 as a PWSSC contract employee for the Alaska Ocean Observing System and the North Pacific Research Board.

The next OSRI Board meeting will be in Anchorage in mid to late March.

Looking ahead...

New Science Center web page link for previous Community Education Programs

There will be a new link on the education page listing many of the previous Community Education programs PowerPoint Presentations. Each program will have a brief description of the presentation and contact information for the person who gave the program. This should be a great resource for teachers or students who would like to find current information on an issue, project or organisms and their environments.

Cordova Team will be featured in 2006 NOSB promotional video

Susan Sugai, one of the coordinators for Alaska's National Ocean Science Bowl (NOSB) program, will be visiting Cordova and the Science Center in January, 2006. The purpose of her visit is to get video footage of the community, the Science Center, and the Cordova High School students and their coach, Science Center educator Kate Alexander. The Cordova Science Bowl team will be participating in their third Science Bowl competition this February in Seward. The topic for this year's research project requires students to develop a plan for implementing an ecosystem-based approach to management of a local marine resource. For more information, contact Kate at the Science Center at (907)424-5800 x 231, kate@pwssc.gen.ak.us, or see the Alaska NOSB website at http://www.uaf.edu/seagrant/nosb/info/index.html

Happy Holidays!

from the Crew at the Prince William Sound Science Center

James, Dick, Claude, Penny, Mary Anne, Shelley, Tom, Lindsay, Signe, Bess, River, Marika, Nancy D., Kate, Allen, Nancy and Elvis

Not pictured: Shelton, Brad, Carl and Liz

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WWW.PWSSC.ORG

Become a Member of the Prince William Sound Science Center

The mission of the Prince William Sound Science Center is to:

- Contribute to the comprehensive description, sustained monitoring and ecological understanding of Prince William Sound, the Copper River and Gulf of Alaska;
- Promote the goal of maintaining long-term, self-regulating biodiversity, productivity and sustainable use of renewable resources;
- Educate and inform the youth and the general public about the critical interdependence of the biology and regional economies of Alaska

Your contribution supports locally based research and education in Prince William Sound, the Copper River Delta and Gulf of Alaska.

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- ❑ $1,000—Orca
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Please mail to: PWS Science Center
PO Box 705, Cordova, AK 99574

Premium gifts include mugs, posters, sweatshirts, T-shirts and aprons!
Credit card contributions may be made by calling (907) 424-5800 x 223 or 227.

Thank you for contributing!

The Prince William Sound Science Center is a 501(c)3 corporation, your contribution is tax deductible.

See the latest news about our research and education programs as well as membership premium gift details on our web site: www.pwssc.org

The Prince William Sound Science Center is an independent, nonprofit research and education organization based in Cordova, AK. Most of our research and education programs are grant-funded. Communications and research planning activities are funded by membership contributions. Help us to continue to serve the public as an information resource.

16.21.01

Workshop at the Alaska Marine Science Symposium

7:30 PM Monday

Alaska Marine Science Symposium
Anchorage Hilton Hotel
22-25 January 2006
Anchorage, AK
USA

For Details, Contact:
S. Lyn McNutt
University of Alaska
Email: lyn@gi.alaska.edu

For Details, Contact:
Shannon Atkinson
Alaska SeaLife Center
Email:shannona@alaskasealife.org

Satellite and In-situ Observations of Alaska's Seas: Defining needs in partnership with the Alliance for Coastal Technologies (ACT) Program

Location: Fireweed Room, Anchorage Hilton Hotel

Time: Monday, 23 January 2006, 7:30 PM

Workshop Goals –

This Workshop will focus on a discussion of satellite remote sensing and ancillary (*in situ*) data needs for the Bering Sea/Aleutian Islands to define satellite remote sensing information requirements. It is the goal of this workshop to create a white paper summarizing satellite data requirements to secure access to data and resources, and to define a level of effort in support of programs in these areas. The workshop summary will include a listing of satellite data sources, measurements required, derived products, and recommendations on *in situ* measurements to support the use of the derived products.

Scheduled Speakers:

Ken Tenore: Alliance for Coastal Technology

"Providing information on sensor/sensor platform technologies for observing systems: the Alliance for Coastal Technologies (ACT)"

Don Atwood: Alaska Satellite Facility, University of Alaska

"Satellite Remote Sensing Resources in Alaska"

S. Lyn McNutt: Geophysical Institute, University of Alaska

"Satellite Remote Sensing Data Requirements for Large Marine Ecosystems (LME) in Alaska: the Bering Sea/Aleutian Island Region"

After the Workshop:

Following the workshop, strawman data requirements will be circulated for comment by the participants, and those who were unable to attend. Final data for comments is 31 March 2006. Comments should be sent to: lyn@gi.alaska.edu or shannona@alaskasealife.org

Bering Sea Ecosystem Indicators Workshop
Wednesday, January 25th, 1:30 – 3:30 pm

Participants in the Alaska Marine Science meeting are cordially invited to participate in an afternoon session on *Integration of Ecological Indicators for the North Pacific with an Emphasis on the Bering Sea* on Wednesday afternoon January 25th during 1:30-3:30. As part of a NPRB-funded project through the North Pacific Marine Science Organization (PICES), Gordon Kruse (University of Alaska Fairbanks), Pat Livingston (Alaska Fisheries Science Center), and Jim Overland (Pacific Marine Environmental Lab) will introduce a framework for ecosystem-based fishery management using ecological indicators available for the Bering Sea. They seek advice from the scientific community and public on priority marine ecosystem issues, including stressors affecting both ecological and human environments. A short panel session will be used to stimulate public suggestions on priorities, key indicators, and specific operational objectives to be considered by future management of the Bering Sea using the selected management alternative from the Alaska Groundfish Fisheries Final Programmatic Supplemental Environmental Impacts Statement to guide the discussions. All interested members of the scientific community and public are invited to join this informative and stimulating session.

Agenda

1. Description of the ecological indicators project
2. Overview of goals and definitions of an ecosystem approach to management
3. Specific objectives for ecosystem approach to fisheries management in the eastern Bering Sea
4. Panel discussion highlighting key eastern Bering Sea influences
    a. Climate stressors
    b. Ecological processes
    c. Social/economics
5. Feedback and questions from audience

NBII Metadata Workshop

This half-day workshop introduces the Federal Geographic Data Committee (FGDC) Content Standard for Digital Geospatial Metadata and includes the Biological Metadata Profile – allowing for documentation of both spatial and non-spatial data sets. The Biological Profile encompasses the entire geospatial metadata standard and includes additional elements to describe taxonomy, methods, and analytical tools (such as models).

The NBII metadata workshop provides an introduction to the metadata standard with hands-on practice producing documentation for a sample data set using Metavist software. The focus of the workshop is an understanding of the metadata standard, but other topics will include the metadata clearinghouse, metadata development tools and strategies for metadata production.

Workshop Topics:

Introduction to Metadata: What is it? What is the value of metadata to data users, data developers, and organizations?

Standards: A brief history of the FGDC Standard and the Biological Data Profile.

FGDC Standard and BDP: An introduction to the 7 sections of the standard, the Biological Data Profile, and tips to navigating the standard.

Metadata Tools and Resources: A survey of available Metadata Creation and Validation Tools, including a survey of pros and cons of each.

Implementation: A look at the types of data sets that require documentation, funding metadata development, and organizational approaches to metadata implementation.

Clearinghouse: An introduction to the NBII Clearinghouse, how to contribute records, and search techniques.

Create a record: Demonstration of software tool (Metavist), and an opportunity for participants to practice using the software to create a record.

The NBII website is found at www.nbii.gov. More information on NBII Metadata is located at www.nbii.gov/datainfo/metadata.

NBII Metadata Coordinator: Viv Hutchison (vhutchison@usgs.gov)
NBII Metadata Trainer: Terry Giles (terry_giles@usgs.gov)

Oral Program Overviews

Alaska Sea Grant College Program

Brian Allee, Ph.D.

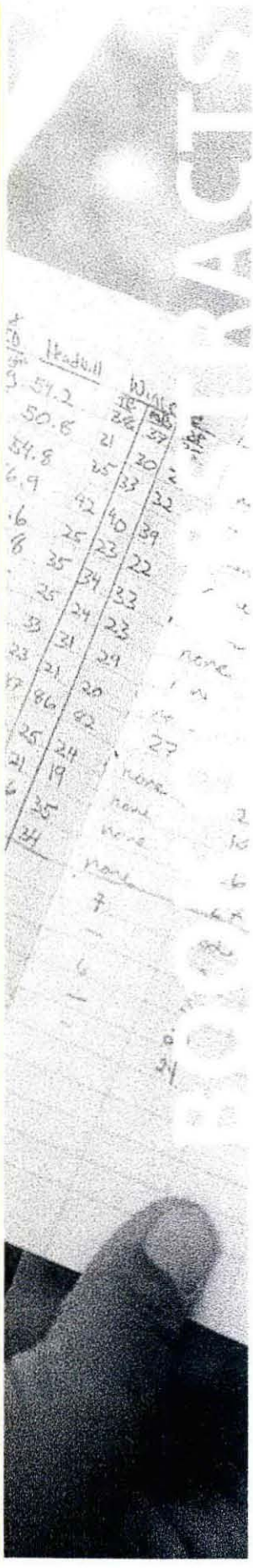
Alaska Sea Grant College Program
University of Alaska Fairbanks
brian.allee@sfos.uaf.edu

The Alaska Sea Grant College Program (ASG) has operated in the state for 35 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, and extension (marine advisory program) services to a diverse group of marine constituents in Alaska's coastal communities.

The stated vision of the ASG is that Alaska will have the nation's most vibrant and productive marine, estuarine and coastal watershed environments, maintained through ecosystem approaches to management balancing wise use and conservation. Alaskan people and communities will reconcile different values about resource use and conservation by blending and applying objective, science-based, and traditional ecological knowledge for the social and economic benefit of all Alaskans.

By assessing 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 embodied in the following five themes: coastal Communities and Economies, Ecosystems and Habitats, Fisheries, Marine and Aquatic Science Literacy, Seafood Science and Technology.

The ASG 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 principle contact for the ASG is director Brian Allee located at the University of Alaska Fairbanks in the School of Fisheries and Wildlife. The web site address for the ASG is http//www.uaf.edu/seagrant/.



MARINE SCIENCE in ALASKA

Book of Abstracts

2006 Symposium

January 22-25, 2006

Anchorage Hilton, Anchorage, Alaska

Sponsored by:

Alaska Ocean Observing System
Alaska Sea Grant College Program
Alaska SeaLife Center
Alliance for Coastal Technologies
Exxon Valdez Oil Spill Trustee Council
Kachemak Bay Research Reserve
Minerals Management Service
NOAA Alaska Fisheries Science Center
North Pacific Fishery Management Council
North Pacific Research Board
Oil Spill Recovery Institute
Pollock Conservation Cooperative Research Center
Prince William Sound Science Center
University of Alaska
US Arctic Research Commission
US Geological Survey Alaska Science Center

Marine Science in Alaska: 2006 Symposium
Book of Abstracts

- Monday, 23 January 2006
  - Morning Keynote Address: Charles H. Peterson
  - Gulf of Alaska - Climate & Oceanography
  - Gulf of Alaska - Lower Trophic Levels
  - Gulf of Alaska - Fish & Fish Habitat
  - Gulf of Alaska - Seabirds & Marine Mammals
  - Gulf of Alaska - Integrated Ecosystem Observing Systems and Sensors
  - *Exxon Valdez* Oil Spill Restoration Process
- Tuesday, 24 January 2006
  - Morning Keynote Address: John Piatt
  - Bering Sea & Aleutian Islands - Climate & Oceanography
  - Bering Sea & Aleutian Islands - Lower Trophic Levels
  - Lunch Keynote Address: Susan Sugai
  - Bering Sea & Aleutian Islands - Fish & Fish Habitat
  - Bering Sea & Aleutian Islands - Seabirds
  - Bering Sea & Aleutian Islands - Marine Mammals
  - Bering Sea & Aleutian Islands - Integrated Ecosystem Observing Systems
  - Ocean Policy, Resource Management and Governance
- Wednesday, 25 January 2006
  - Arctic Ocean - Climate, Oceanography, & Lower Trophic Levels
  - Gulf of Alaska - Living Marine Resources

Addendum to Abstract Booklet

Posters: Bering Sea and Aleutian Islands - Fish and Fish Habitat

Atka mackerel Reproductive Biology (NPRB Proj. 522), Genetic assessment of cannibalism and the mating system of Atka mackerel (*Pleurogrammus monopterygius*)

Ingrid Spies, Mike Canino

Filial cannibalism (consuming one's own offspring) is common in fish species exhibiting paternal care. In Atka mackerel, males in spawning coloration (i.e. putative nest guardians) actively engage in cannibalizing eggs containing developing embryos. Mature females also consume eggs, although to a much lesser extent. Whether these behaviors represent filial cannibalism or heterocannibalism (consumption of unrelated offspring) is unknown. We expected that guardian males may engage in filial cannibalism and that females would exhibit heterocannibalism. Highly polymorphic DNA markers were used to assess parentage of embryos consumed by five adult Atka mackerel of each gender. Gut contents contained both single eggs and one or two egg masses. Most of these egg masses consisted of batches of developing full and half-sib embryos produced by multiple (3 - 8) parents. All female cannibals were excluded as the mother of embryos they had eaten, thus indicating heterocannibalism. Similarly, four of five males in spawning coloration were excluded as the sire for cannibalized embryos. One male was determined to be the sire of two half-sib families detected in one egg mass (consisting of egg batches deposited by multiple females), documenting filial cannibalism. However, this male sired only 22 % of the embryos genotyped in the egg mass, which contained a minimum number of eight parental genotypes. It is unknown if he was the attendant male or possibly an adjacent territory holder. These preliminary analyses of partially cannibalized egg clutches indicate a complex polygamous mating system in Atka mackerel, and suggest that sneaked fertilizations and nest raiding by adjacent guardian males may be common behaviors in this species.

Gulf of Alaska - Morning Keynote Address

Ecological Considerations in Developing Marine Ecosystem-Based Management

Charles H. Peterson
cpeters@email.unc.edu

Two ocean policy commissions call for a more comprehensive, integrated ecosystem-based approach to address current and emerging management challenges of our oceans. The goal of ecosystem-based management (EBM) is to restore and sustain the health, productivity and resilience of the ecosystem so that it can continue to provide the services that humans want and need. EBM differs from traditional management by encompassing important interconnections among all processes, factors, and components that interact to influence the values of concern to managers and to the broader public. Certain key concepts underlie marine EBM. First, functions of strong interacting species within an ecosystem are essential to maintain if ecosystem services are to be sustained. These include especially habitat engineers, some apex predators, and some universal forage species. Second, the dynamics and intrinsic complexity of marine ecosystems require a long-term perspective and the flexibility to adapt management to unpredictable, even abrupt, state changes. Third, ecosystems can recover from many disturbances but are not infinitely resilient, so preserving resilience rises high in management priorities. Fourth, ecosystem services are almost always undervalued. Marine ecosystems today reflect the scope of many kinds of intense human impacts, including especially overfishing apex predators, fishing at unsustainable levels on many stocks, contaminating and impairing reproductive capacity of top consumers like killer whales and albatrosses through release of organic pollutants, and modifying ocean productivity and circulation through indirect effects of global warming. The breadth and serious nature of these and other human impacts on ocean ecosystems demands EBM to provide the holistic integration of multiple interacting stressors and thereby achieve sustainability.

Gulf of Alaska - Climate & Oceanography

Monday, 23 January 2006: 9:00 - 10:15 AM

Session Chair and Poster Review: Mike Litzow

TALKS

Speaker	Title
Mike Litzow	Has Climate Change Produced Oscillating Ecosystem Control in the Gulf of Alaska?
Mark Johnson	Water and Ice Dynamics in Cook Inlet
Eddie Zingone	Analyzing Surface Wind Fields near Lower Cook Inlet and Kodiak Waters Using SAR
Carol Ladd	The Gulf of Alaska Eddy Field: Interannual Variability as Derived from Altimetry Data

POSTERS

First Author	Title
Edward Cokelet	GEM Biophysical Observations Aboard the Alaskan State Ferry *Tustumena*
Joel Curtis	A Catalog of Marine Gap Winds for the Western and Northern Gulf of Alaska
Gail Irvine	Geochemical Analyses of Archeological Midden Materials Reveal Changes in Climate and Ocean Conditions in the Northern Gulf of Alaska over the Last 6,000 Years: Initial Results
Markus Janout	Yakutat Eddies and Shelf/Slope Exchange in the Coastal Gulf of Alaska
Calvin Mordy	Nutrient Dynamics in the Gulf of Alaska
Anne Pasch	Invertebrate Evidence for an Early Holocene/Late Pleistocene Shoreline North of the Present Ice Margin of the Bering Glacier
W. Scott Pegau	Oceanographic Boundary Conditions to Cook Inlet

Has Climate Change Produced Oscillating Ecosystem Control in the Gulf of Alaska?

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The 1976/77 climate regime shift resulted in reorganization of the Gulf of Alaska ecosystem, but the mechanisms underlying this reorganization are poorly understood. I used a time series of small mesh trawl surveys conducted between 1972 and 2005 to test the hypothesis that the regime shift produced an oscillation between bottom-up and top-down control in the Gulf of Alaska. I compared catch rates of high and low trophic level taxa to test for either bottom-up control (indicated by positive or weak correlations between trophic groups) or top-down control (indicated by negative correlations between trophic groups). I found evidence of initial bottom-up control (high shrimp and forage fish biomass, low groundfish biomass). This was followed by a period of negative correlation between trophic groups beginning in 1976/77, indicating that top-down control played an important role in the transition to a post-regime shift community. Following the completion of this transition, the abundance of the two trophic groups has been positively correlated, suggesting a reversion to bottom-up control in the new community state. I also used data from the time series on the abundance of a predator, Pacific cod *(Gadus macrocephalus)*, and an important prey taxon, Pandalid shrimp, to test the hypothesis that climate change regulates top-down ecosystem control by directly affecting predator abundance. These results should contribute to our understanding of the role of trophic interactions in climate-forced ecosystem transitions.

Water and Ice Dynamics in Cook Inlet

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A 3-D tidal model (Finite Volume Community Model, or FVCOM) of Cook Inlet with spatial resolution of 160 m near the coastline and 13 km along the open boundary has been used to simulate the 8 major tidal waves in this region (5 semidiurnal and 3 diurnal). Tidal data are from satellite-based archives of tidal constituents for the Gulf of Alaska and Northern Pacific Ocean. Model results of the tidal elevations and phases of the four major waves are in good agreement with observations. To help validate the model and understand better the Cook Inlet tidal rips, nearly 45 drifting buoys have been deployed for us by Cook Inlet Spill Prevention and Response, Inc. (CISPRI). Velocities are computed using centered differences. Tidal fronts are typically associated with convergence zones. In Cook Inlet, drifting sea ice tends to collect along tide rip fronts thereby providing strong visual signatures for frontal locations. Radar backscatter (brightness) from sea ice is typically larger than from open water. As a consequence, the ice edge (frontal) location exhibits a relatively large spatial gradient in radar backscatter. Frontal locations identified from nine SAR images acquired in February 2002, December 2003, January 2004, and February 2004 show that the greatest number of frontal features occurs in a zone extending southwestward from near the West Foreland to along and beyond the eastern shore of Kalgin Island. This zone roughly corresponds to the location of the West Rip and qualitatively agrees with the buoy observations and model results.

Analyzing Surface Wind Fields Near Lower Cook Inlet And Kodiak Waters Using SAR

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The unique combination of terrain and dynamic weather systems makes the coastal waters of lower Cook Inlet and Kodiak Island a complex and difficult place to forecast coastal winds. In addition, there are only a few real-time in situ observations available. However, this region has a large concentration of maritime operations that require accurate, high resolution wind information. Spaceborne synthetic aperture radar (SAR) - based surface wind speed fields, at 200 m resolution, provides detailed location and character of the wind patterns, regardless of time of day or cloud conditions. Some case studies are presented to demonstrate the usefulness of the SAR-based winds to: 1) greatly improve operational marine forecasts issued for an area where synoptic and mesoscale meteorological events coexist; 2) provide detailed validation of the forecasted coastal winds; and 3) give insight on complex wind patterns and extreme winds that occur in a data sparse area.

The Gulf of Alaska Eddy Field: Interannual Variability as Derived from Altimetry Data

Carol Ladd, Elizabeth Dobbins and Sigrid Salo
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Eddies formed in the eastern Gulf of Alaska have important consequences to the biology and physics of the gulf. Sea surface height anomaly maps produced by the CLS Space Oceanography Division were used to calculate eddy kinetic energy (EKE) in the Gulf of Alaska. Regions of particularly high EKE denote formation regions and propagation pathways for Haida, Sitka, and other northern GOA eddies. Time series of eddy kinetic energy amplitude in these regions illustrate an annual cycle as well as interannual variability. Eddies are regularly observed northeast of Kodiak Island and have been implicated in high offshelf chlorophyll concentrations apparent in SeaWiFS data. Altimetry data show that while eddies in this region occur quasi-annually since 2000, they were less frequent prior to that time. Using data and model simulations, implications of this variability will be discussed.

GEM Biophysical Observations Aboard the Alaskan State Ferry *Tustumena*

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In autumn 2004, an oceanographic measurement system began operating aboard the Alaska Marine Highway System ferry *Tustumena* as part of long-term monitoring in the Gulf of Alaska sponsored by the Exxon Valdez Oil Spill Trustee Council's GEM program. The underway system samples water from 4-m depth to measure (1) temperature and salinity - basic physical variables, (2) dissolved nitrate - an essential nutrient for phytoplankton production, (3) chlorophyll fluorescence - an indicator of phytoplankton concentration, (4) colored dissolved organic matter (CDOM) fluorescence - an indicator of terrestrial runoff, and (5) optical beam transmittance - an indicator of suspended particle concentration. We report on 14-months of observations, from 15 September 2004 when sampling began to 18 November 2005 when the ship entered a shipyard for routine maintenance. *Tustumena* sailed between Homer, Kodiak, Seward and Prince William Sound, AK, on a regular basis - crossing the Alaska Coastal Current over 280 times per year. It made monthly trips to Dutch Harbor in the Aleutian Islands during summer. The temperature time series shows the annual cycle of cooling and warming in the Gulf of Alaska with lows in February- March and highs in July-August. Temperature extremes occur in bays such as Kachemak Bay (near Homer), Resurrection Bay (near Seward) and Prince William Sound. These confined waters receive fresh water from rivers and melting glaciers that lead to thin, less-dense surface layers. Sheltered from winds, these waters mix less than in the open ocean. The fresher, thin surface layers cool in winter forming ice on occasion and warm in summer from sunlight, leading to temperature extremes. The annual time series of near-surface ocean salinity measured along *Tustumena*'s track is dominated by high-frequency variations due to spatial differences as the ship moves between bays and the open ocean. During winter, salinity variability is reduced because freezing binds the fresh water into ice. A newly available dissolved nitrate meter that uses optical, as opposed to chemical, methods was part of the measurement system. After a series of new-instrument problems were overcome, we found high nitrate concentrations over shoals and in narrow passages implying that tidal-currents are instrumental in mixing nutrient-rich water from below into the nutrient-depleted surface layers.

A Catalog of Marine Gap Winds for the Western and Northern Gulf of Alaska

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Gap winds are an integral part of the wind regime all along Alaska's rugged coastline. It is well known that wind accelerates through gaps in the terrain, and gap winds can be some of the strongest winds that occur in the marine environment. Dynamical forcing considerations of gap winds will be presented in this poster session. The wind speeds in gaps are currently forecasted with the aid of simple, linear relationships based on the sea level pressure difference down the gap; it will be shown how these estimates compare with a non-linear model based on Bernoulli theory. A catalog of gap winds for the NWS Anchorage Forecast Office area of responsibility will be shown by both a list and the examination of a topographical map. Impacts upon marine ecosystems of these strong wind zones will also be presented and discussed.

Geochemical Analyses of Archeological Midden Materials Reveal Changes in Climate and Ocean Conditions in the Northern Gulf of Alaska over the last 6,000 Years: Initial Results

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Geochemical examination of bivalve midden material from Mink Island (XMK-030), located in the Shelikof Strait of the Gulf of Alaska, provides insight into how climate and biological productivity of the Alaska Coastal Current (ACC) have changed over the last ~6,000 years. Analysis of $\delta^{13}C$ 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*, produces sub-monthly data spanning multiple years. Analyses of ancient bivalve midden material, representing well-documented climatic episodes, were contrasted with analyses of modern material from the same site. 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. There are striking 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 the Medieval Warm Period (~850 BP) material show the most distinctive pattern, with variable but sustained year-round productivity that is in some ways similar to an emerging El Niño pattern. The data from these different climate periods may help predict how ACC dynamics and ocean productivity will respond to future changes in climate, including global warming. Additionally, the use of stable isotope analyses of modern bivalve materials provides a tool for long-term monitoring of coastal marine environments, and is especially applicable to sampling of specific sites and/or remote environments.

Yakutat Eddies and Shelf/Slope Exchange in the Coastal Gulf of Alaska

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The Gulf of Alaska (GOA) is characterized by low salinity shelf water due to large coastal freshwater runoff whose influence reaches as far as the Bering and Chukchi Seas. Yakutat Eddies which propagate along the continental slope from Yakutat to south of Kodiak are assumed to aid the transport of shelf waters into the GOA basin similar to observations made in slope eddies in the Gulf Stream region. However, the volume of freshwater runoff lost to the basin due to eddies is speculated to be large but has yet to be determined. Two fine scale surveys of a 2003 Yakutat Eddy show cross-slope transport in May but not in August. Surface properties of the region off Kayak Island in March 2003 show freshwater seaward of the continental slope in the presence, but not in the absence of an eddy. An Argo profiling float randomly profiled a Yakutat Eddy in 2001 and shows characteristic salinity signals within the eddy. In aggregate, the observations suggest that: a) Yakutat Eddies promote shelf-slope exchange along the GOA shelf break, but b) loss of coastal freshwater due to eddies is limited to certain regions, c) the amount of freshwater lost from the shelf due to eddies is significantly smaller (3%-10%) than previously assumed (14%-43%) d) freshwater is entrained during eddy formation but not during eddy translation along the slope, and e) eddies produce upwelling of nutrient rich waters along the leading and trailing edges, which enhances biological production.

Nutrient Dynamics in the Gulf of Alaska

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Between 2001 and 2005, nutrients in the northern Gulf of Alaska were measured from hydrographic surveys, from moorings and from underway measurements on ships of opportunity. Together, these results provide an understanding of seasonal and interannual nutrient dynamics over much of the northern shelf. In early spring, surface concentrations were generally high across the shelf, but interlaced with bands of water containing high fluorescence and low nitrate. In summer, low surface concentrations were observed over the entire northern shelf, except for a region of complex bathymetry off Kodiak Island. Important cross-shelf exchange mechanisms in summer include relaxation of downwelling and flow up canyons. Deep, nutrient-rich layers are brought to the surface through storms and through tidal mixing in canyons and over shallow banks, and these mixing events sustain new production throughout the summer in the vicinity of Kodiak Island. Observations such as these provide the opportunity to collect long-term observations that will permit us to detect the ocean's response to shifts in climate.

Invertebrate Evidence for an Early Holocene/Late Pleistocene Shoreline North of the Present Ice Margin of the Bering Glacier

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Marine invertebrates collected from the Holocene glacial deposits of the Bering Glacier indicate that the Gulf of Alaska shoreline was several kilometers north of its present position during the late Pleistocene/early Holocene. A total of 96 species of mollusks, bryozoans, arthropods, echinoderms, polychaetes and a single protozoan have been identified from shells and fragments. Species from the glacial deposits are similar to species from the contemporary Gulf of Alaska and represent a variety of ecological niches at various depths on different types of substrates. Intertidal and shallow subtidal species dominate, indicating that the deposits had an origin close to a shoreline. Conventional radiocarbon dates of 9 bivalves from 4 glacial deposit localities range from 7,190 ± 140 to 13,050 ± 70 years BP. The shells and other remains were deposited by melt water at the face of the ice, and were clearly transported in portions of the Bering Glacier as it flowed southward. Therefore, the invertebrates were incorporated into the ice steam at point to the north of the existing glacier front. The unusual preservation of delicate invertebrate skeletons during transport in glacial ice is difficult to explain. Sediment preserved in the interior of some mollusk shells is a sticky silt. If the invertebrates were encased in this material and it was ripped up from the sea floor in a frozen state, skeletons could have been protected by this sediment during transport in ice and released intact when the silt blocks thawed during deposition on outwash. Fragments of shells are ubiquitous in all outwash deposits south of the glacier front, but only outburst floods provided unique conditions for the unusual deposition of fragile skeletal remains

Oceanographic Boundary Conditions to Cook Inlet

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Measurements of temperature and salinity have been collected during the pass two years at the entrance of Cook Inlet. Surface (3 m) measurements have been collected on the ferry Tustumena between Kodiak and Homer. Profiles have been collected along survey lines through Kennedy and Stevenson Entrances and through Shelikof Strait. We use this data to examine the seasonal changes in the boundary conditions to Cook Inlet. In particular, the strength and position of the Alaska Coastal Current, the effect of the Barren Islands, and outflow from Cook Inlet.

Gulf of Alaska - Lower Trophic Levels

Monday, 23 January 2006: 10:30 - 11:15 AM

Session Chair and Poster Review: Russ Hopcroft

TALKS

Speaker	Title
Russ Hopcroft	Seward Line Oceanographic Observations for 2005
Michael Dagg	*Neocalanus* spp. and Food Web Structure in the HNLC Gulf of Alaska
Dennis Lees	Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Western Prince William Sound

POSTERS

First Author	Title
Sandra Lindstrom	Biogeography of Alaskan Seaweeds
Svein Vagle	A Deep Water Profiling High-Frequency Echo-Sounder for Monitoring Mesozooplankton and Micronekton Populations in the Oceanic Subarctic Pacific

Seward Line Oceanographic Observations for 2005

Russ Hopcroft, Ken Coyle, Terry Whitledge, and Tom Weingartner
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In 2005, we completed the 8th consecutive year of observations on oceanographic physics, chemistry and pelagic biology along the Seward Line in the Coastal Gulf of Alaska. Compared to previous years, May of 2005 was warmer than normal. On the shelf, phytoplankton biomass appeared typical of this time of year, but zooplankton biomass was larger than normal, due in part to the more rapid development of the larger zooplankton characteristic of the gulf. In contrast, zooplankton biomass in Prince William Sound was lower than normal, and more reflective of summer conditions. In September, zooplankton communities had unusually large contributions of "southern" species that are not typical of the region, but that have been observed previously in association with El Niño periods. We present the magnitude of these deviations in comparison to previous years, and consider the potential impact of these conditions on fisheries and higher trophic levels.

Neocalanus Spp. And Food Web Structure in the HNLC Gulf of Alaska

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The open Gulf of Alaska is a High Nutrient Low Chlorophyll (HNLC) system, characterized by low concentrations of phytoplankton, a community dominated by small cells, and iron limitation of, especially, the larger phytoplankton, the diatoms. In such systems the main energy and material flow is through the microbial web, with large copepods considered primarily to be grazers on the larger microzooplankton occupying the top of this web. Consistent with this is the recognition that much of the nutrition of the dominant copepods in this system, three species of the genus Neocalanus, is derived from microzooplankton. Also, these copepods consume only a small fraction of the available phytoplankton production. Recent data from the Gulf of Alaska GLOBEC program indicate the contribution made by *Neocalanus* spp. to establishing and maintaining the community structure of this ecosystem should be re-evaluated. These grazers have very high clearance rates on large particles, including both large phytoplankton and microzooplankton, and this selective removal contributes to establishment and maintenance of the observed structure the foodweb in the Gulf of Alaska. *Neocalanus* (a) directly prevents the accumulation of large phytoplankton cells (which are growing slowly due to iron limitation but nevertheless are growing), and (b) indirectly stimulates the accumulation of the smaller phytoplankton by consumption of their major predators, the microzooplankton. Key components of this revision are: low growth rates of large cells due to iron limitation; low concentrations of large cells that result in high (maximum) removal rates by copepods; copepod ingestion of both large phytoplankton and microzooplankton that otherwise would consume smaller phytoplankton; and large populations of *Neocalanus* spp. concentrated in the upper layer of the ocean.

Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Western Prince William Sound

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As late as 1997, data from a limited number of intertidal sites sampled during a long-term NOAA study in western Prince William Sound suggested that bivalve assemblages in mixed-soft sediments treated with high-pressure (HP) warm- or hot-water washing methods remained severely damaged in terms of species composition and function. An EVOS Trustees Council study was initiated during summer 2002 to assess the generality of (or recovery from) this apparent injury. Thirteen oiled reference beaches, twenty-three oiled beaches documented as probably having received HP washing, and four washed NOAA sites were sampled to evaluate population density, recent recruitment, and size/age structure of the bivalve assemblage. Sediment from each site was analyzed for particle grain size, Total Organic Carbon, and Total Organic Nitrogen. Sample analyses indicated that our earlier conclusions were generally accurate and that previously observed effects were still detectable. We found that, by 2002, bivalve assemblages at a considerable proportion of treated mixed-soft beaches in the sound still: 1) remained significantly disturbed; and 2) were functionally impaired in terms of their ability to support foraging by nearshore vertebrate predators. The long-term effects of HP washing were apparent in species composition, population density, species size structure, and ecological function. Major k-selected species were generally significantly less abundant at Treated than at Reference sites. In contrast, important r-selected species were significantly or marginally more abundant at Treated sites. While the results are not conclusive, the weight of evidence suggests that HP-HW washing caused: 1) considerable damage to intertidal sediments; and 2) considerably more damage to bivalve assemblages than exposure to stranded oil by itself. Furthermore, 3) bivalve assemblages have not recovered functionally; and 4) the sediments have partially recovered and do not appear to be playing a role in the lagging recovery at the Treated sites.

Biogeography of Alaskan Seaweeds

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A recent survey of seaweed specimens collected in Alaska over the past two centuries, together with the application of molecular techniques to recent collections, has revealed a surprisingly diverse flora given the history of glaciation, large areas of unsuitable habitat, and otherwise harsh environmental conditions. The number of recognized species has increased from 376 in 1977 to about 550 today. Species show a variety of biogeographic patterns: species that occur primarily to the south and have their northern limit in Alaska, species that occur primarily to the west and have their eastern limit in Alaska, species that are primarily Atlantic but extend through the Arctic to Alaska, and a number of endemics. Within these broad distribution patterns are more localized patterns often involving disjunctions. These disjunctions, the occurrence of endemic species, patterns of genotype distributions, and the overall richness of the seaweed flora support the idea that marine refugia must have existed in Alaska during Pleistocene glaciations.

A Deep Water Profiling High-frequency Echosounder for Monitoring Mesozooplankton and Micronekton Populations in the Oceanic Subarctic Pacific

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The biological productivity of the oceanic Subarctic North Pacific, although large, undergoes very strong seasonal and interannual fluctuations. Nearly all of the food supply for economically and sociologically important pelagic predators such as Pacific salmon funnels through one or both of two key intermediate steps in the North Pacific food web: Large calanoid copepods (0.4-1 cm adult body length), and midwater 'micronekton' (~5-10 cm body length, primarily myctophid fishes and small squids). Both of these groups spend much of their lives at depths between 400 and 1200m, the copepods because of a seasonal vertical migration to a prolonged deep dormant phase of their life cycle, the micronekton because many are strong diurnal vertical migrators from surface to the same mesopelagic depths occupied by the dormant copepods. Knowing the biomass and distribution of these zooplankton and micronekton taxa is a key ingredient to understanding variations in food supply for their predators, such as Pacific salmon and walleye Pollack, especially in autumn and winter when upper ocean food sources are most scarce. However, for several reasons linked to their body size and depth distribution, year-round quantification of both the large copepods and the micronekton is problematic with existing methods. To address this knowledge gap we are presently building, with support from NPRB, a dual frequency (110 and 330kHz) acoustical echo-sounder system for deep water (>2000 m) monitoring of the spatial, seasonal, and interannual variations of the zooplankton and the micronekton. Simultaneous sampling with two frequencies allows discrimination between targets of differing body size (e.g. 5 mm copepods vs. 5 cm fish and squids). The sounder will be built in a self-contained form, with complete internal raw data storage, for mounting on ship-based systems such as Rosette samplers and simple CTD systems as well as for longer term mooring deployments. Some of the challenges we are dealing with include the requirement to minimize the power requirements, minimize size and weight, and maximize onboard data processing. The ultimate goal of this work includes deployments of multiple such systems on autonomous OR unattached platforms like the drifter buoys used by the multinational Argo program for real time monitoring of large areas of the oceanic Subarctic Pacific.

Gulf of Alaska - Fish & Fish Habitat

Monday, 23 January 2006: 11:15 AM - 2:15 PM

Session Chair and Poster Review: Michael Sigler

TALKS

Speaker	Title
Clifford Ryer	Perceived Predation Risk Influences Habitat Preference and Utilization by Juvenile Age-0 Flatfish in an Alaskan Nursery Area
Scott Gende	Persistence of Forage Fish Hotspots and its Association with Foraging Steller Sea Lions in Southeast Alaska
Spencer James Taggart	How Patchy Are King and Tanner Crab Populations in Southeastern Alaska? Integrating Movement, Distribution, and Habitat Data
Kray Van Kirk	A Multispecies Age-structured Assessment Model for the GOA
Mark K. Buckley	The Digital Observer: an Alternative System for Monitoring Commercial Fisheries.

POSTERS

First Author	Title
Alisa Abookire	Spatial and Temporal Variation in Potential and Realized Growth Rates of Age-0 Northern Rock Sole
William Bechtol	Historical Harvest Distribution for Red King Crab Around Kodiak Island, Alaska
Nate Bickford	Otolith Chemistry Works: Where Do We Go from Here
Mary-Anne Bishop	Ecology of the Nearshore Areas of the Copper River Delta
Switgard Duesterloh	Marine-terrestrial Linkages in Gulf of Alaska Watersheds: Spatial and Temporal Fluctuations of Limnological Parameters and Smolt Production in Karluk and Spiridon Lakes
David Ebert	Life History and Population Dynamics of Alaskan Skates: Providing Essential Biological Information for Effective Management of Bycatch and Target Species
Andrew Eller	Estuarine Distribution and Abundance of Eulachon *(Thaleichthys pacificus)* Larvae in Berners Bay, Alaska
Bruce Finney	Marine-Terrestrial Linkages in Gulf of Alaska Watersheds: Monitoring the Effects of Marine-derived Nutrients on Biological Production in Sockeye Salmon Systems
John Harper	16,000 Kilometers of ShoreZone in the Gulf of Alaska
Lisa Hoferkamp	Polybrominated Diphenyl Ethers (PBDEs) in Sediments and Biota in Pristine Southeast Alaska Watersheds and Near a Municipal Waste Landfill in Juneau AK
Jon Houghton	The Blind Eating the Blind - the Ecology of Knik Arm

Gulf of Alaska - Fish & Fish Habitat

POSTERS (continued)

First Author	Title
Peter-John Hulson	The Decline in Prince William Sound Herring after the Oil Spill: Insights from an Age-structured Assessment Model
Katrin Iken	Kelp - Grazer Interactions in Kachemak Bay, Alaska
Gail Irvine	A Probability-Based Design for Long-term Intertidal Monitoring as Developed for Glacier Bay National Park and Preserve
Lisa Kamin	Interannual and Spatial Variation in Population Genetic Composition of Northeastern Gulf of Alaska Young-of-the-year Pacific Ocean Perch.
Sean-Bob Kelly	Larval Migrations of Prince William Sound Pacific Herring (*Clupea pallasii*)
Thomas Kline	Preliminary Assessment of Marine-Derived Nutrients in the Copper River Delta, Alaska Using Stable Isotope Analysis
Terrie Klinger	Determination of Recovery from Disturbance in Rocky Intertidal Systems in Kasitsna Bay, Alaska
Elizabeth Logerwell	Processes Affecting the Productivity of Capelin and Pollock in the Gulf of Alaska
Mary Morris	Intertidal Shore Stations in the Gulf of Alaska: Linking Ground Sites to Shorezone
Sean Powers	Utilization of Estuarine Habitat by Sockeye and Coho Salmon on the Copper River Delta, Alaska
Daniel Rinella	Marine Derived Nutrients (MDN) in Riverine Ecosystems: Developing Monitoring Tools for Tracking Mdn in Alaska Watersheds
Astrid Scholz	Life-cycle Assessment of Salmon Production
Michael Sigler	Ecological Significance of Seasonal Aggregations of Marine Forage Species for Steller Sea Lions
Rachel Speller	A Comparison of ESI Shore Type and ShoreZone Classification in Southeast Alaska
Cindy Tribuzio	Progress Report of an Ecological Investigation of Spiny Dogfish in the Gulf of Alaska
Coowe Walker	Investigations into the Relationship Between Water Chemistry and Salmon Escapement: Can a Nutrient Proxy for Escapement Be Developed?
Matt Wilson	Do Forage Fishes Benefit from an Abundance of Large Prey in the Alaska Coastal Current?
Mark Zimmermann	Comparison of Single-beam EchoSounder Reflections to Bottom Trawl Survey Catches

Perceived Predation Risk Influences Habitat Preference and Utilization by Juvenile Age-0 Flatfish in an Alaskan Nursery Area

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Models of flatfish habitat requirements typically considered sediment, depth and temperature as primary predictors of fish abundance. Video surveys of Kodiak embayments/nurseries indicate that juvenile (age-0 yr) Pacific halibut *Hippoglossus stenolepis*, northern rock sole *Lepidopsetta polyxystra* and English sole *Parophrys veletus* abundances are influenced by the distribution of emergent structural features; worm-tubes, shell, algae, etc. Further, laboratory experiments demonstrated that emergent structure impedes predator foraging (pre-encounter process) and facilitates escape behavior (postencounter process) of age-0 flatfish, indicating refuge value may be causative in juvenile flatfish habitat selection. A manipulative field experiment was undertaken wherein bivalve shell was scattered across the seafloor in 5 replicate tracts (100m x 5m), with the expectation that juvenile (age-0) flatfish would immigrate to the shell tracts. The shell and adjacent control tracts were assayed with a camera sled 2, 4, 8 and 40 days later. Contrary to our expectations, the abundance of age-0 flatfish was lower in shell than in control tracts. However, larger (age-2 and up) rock sole were more abundant in shell, suggesting that the age-0 fish might be avoiding larger, potentially predatory fish. The manipulation was repeated in another embayment where larger flatfish are less abundant, and although large flatfish were still present in greater number within the shell tracts, age-0 juveniles no longer avoided the shell tracts. Subsequent laboratory experiments revealed that age-0 fish avoid the disturbance created by, and the perceived risk associated with with larger flatfish. This field manipulation demonstrates that juvenile flatfish consider not only structural features in selecting habitat, but also take into account relative predator abundance. This suggests that fish habitat must be evaluated in the context of overall community ecology rather than the simple presence or absence of more obvious structural features which are often utilized to define essential fish habitat.

Persistence of Forage Fish 'Hot Spots' and its Association with Foraging Steller Sea Lions in Southeast Alaska

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Marine foraging vertebrates face many constraints in finding patchily distributed prey in a three-dimensional water space. For visually searching predators such as seals and sea lions, the relative costs of encountering high-density prey aggregations ('hot spots') may be high unless the density of hot spots are high or persist through time. Should these hot spots persist, marine predators can use previous experience to minimize search costs and maximize foraging efficiency. We examined the quantity and location of pelagic forage fish species in southeast Alaska, to determine (1) the existence and density of prey hot spots over a 36-month period, (2) whether the location of these hot spots persisted over several months or across seasons. The density of prey hot spots varied across months and seasons. Large schools of Pacific herring were the most important prey. Perhaps more importantly, certain areas consistently supported high-density fish aggregations, although persistence was highest during the winter months, November-February. Using a foraging model that included a random and Bayesian forager, we demonstrate that the importance of predictable prey was inversely related to density of productive foraging spots. When predictability was low foraging effort was high only when the density of productive foraging spots was low. In contrast, when prey densities were low, (Bayesian) foragers were able to minimize search effort if productive foraging areas were predictable. Identifying forage fish hot spots (both density and persistence) on small time scales (days, weeks), will help further elucidate the relative 'costs' of finding prey, in addition to the rewards, and enhance our ability to link foraging and fitness of marine vertebrates.

How Patchy Are King and Tanner Crab Populations in Southeastern Alaska? Integrating Movement, Distribution, and Habitat Data

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We systematically sampled (1.5 km grid) for Tanner and king crabs throughout Glacier Bay to estimate their relative density and relative abundance. We tagged 31 male Tanner crabs (*Chionoecetes bairdi)* and 27 red king crabs (*Paralithodes camtschaticus*) with ultrasonic transmitters and tracked the crabs for 2 years in Glacier Bay with a combination of active tracking and ultrasonic gates. Although the average monthly movement of king and Tanner crabs was similar (approximately 1km/month), king and Tanner crabs moved very different net distances annually. King crabs had regular seasonal migrations and consequently their net annual movement was very small, while Tanner crabs dispersed from their location the previous year. In addition to small regular annual migrations, king crabs were extremely aggregated; 73% of the king crabs were captured from 7 adjacent pots. We hypothesize that the grouping and migratory behaviors of king crabs are likely to split adults into discrete local populations. Tanner crabs had more random movements; random walk models using our sonic tracking data predict that Tanner crabs would move over large parts of southeastern Alaska during their lifetimes. However, when movement data are combined with relative abundance and habitat data, it seems more likely that Tanner crabs are restricted to discrete patches in southeastern Alaska. Tanner crabs were widely distributed throughout the Glacier Bay; except for a large area at the entrance, which was devoid of Tanner crabs. Habitat analysis (multibeam sonar) revealed an abrupt change to a harder substrate in the area devoid of crabs. The lack of Tanner crabs in this area suggests that it might be a habitat barrier for adult Tanner crabs which could limit the exchange between Glacier Bay and nearby Icy Strait, splitting them into discrete patches of adults. Adult Tanner and king crabs may occupy discrete patches within southeastern Alaska.

A Multispecies Age-Structured Assessment Model for the Gulf of Alaska

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In keeping with the recommendation from the U.S. Commission on Ocean Policy to move towards an ecosystem-based approach to fisheries management, we have developed a multispecies age-structured assessment model (MSASA) for the Gulf of Alaska, including arrowtooth flounder, Pacific cod, and walleye pollock. Recruitment is estimated through a stochastic Ricker spawner-recruit relationship, and age- and year-specific mortality is comprised of fishing mortality, a flexible predation mortality derived from stomach data (provided by Dr. Patricia Livingston of NMFS), and a constant residual natural mortality. The incorporation of predation mortality into the model significantly alters the dynamics of all three species. Predation tends to target younger age-classes, reducing the number of individuals that eventually make up the spawning biomass and creating critical weak points within a web of species connected by predator-prey relationships. Estimating recruitment, mortality, and calibration parameters for three species simultaneously is considerably more complicated than for single species models. The advantage of greater biological realism of MSASA comes at the expense of greater uncertainty in parameter estimation.

The Digital Observer: an Alternative System for Monitoring Commercial Fisheries.

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Fisheries observers perform a variety of functions when they are at sea, all designed to provide monitoring of commercial fishing activities and catches. Observers, however have limitations. Those include the increasing costs of observer coverage and the fact that observers cannot be in several places at once. Since 2000 researchers in Kodiak, Alaska have been developing integrated hardware and software for a video monitoring system that allows for the at-sea capture of multiple streams of high-resolution video, plus other data. The data are stored on removable hard drives. On the vessel's return to port, the data are taken to an office where custom software affords efficient review by 'virtual observers'. This system has been deployed on Alaska trawlers and longliners and recently underwent a successful trial in the Gulf of Alaska.

Spatial and Temporal Variation in Potential and Realized Growth Rates of Age-0 Northern Rock Sole

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The possibility of prey limitations on the growth performance of age-0 northern rock sole *Lepidopsetta polyxystra* was evaluated at three sites along the northeast coast of Kodiak Island, AK by comparison of observed to potential growth rates. Growth potential was measured in the laboratory across the range of temperatures likely encountered by this species during the first summer of life. Growth potential increased with water temperature between 2°C and 13°C, according to: $mm.d^{-1} = 0.0151 + 0.3673[\log_{10}(\text{Temperature})]$. There were significant differences in growth rate between the three field sites such that Holiday Beach fish were 7.1 mm longer than Shakmanof Beach fish by mid- September, with Pillar Creek Cove fish of intermediate size. Temperature differences between sites accounted for less than half of this variation. The remainder may relate to differences in prey availability among sites in association with observed differences in sediment characteristics. In addition to the spatial variability, there was significant monthly variation in growth performance. Realized growth rates between July and August were in excess of 85% of potential. However, between August and September, realized growth fell to 43-71% of potential indicating a decline in conditions for growth. The spatial variation in growth rates was not density-dependent as the site with the highest fish densities (Holiday Beach) also supported the highest growth rates. The available data indicate that for this subtidal species, interannual variation in growth may be more important than site variation. Future work should determine the stability of these spatial and temporal patterns in realized growth and evaluate growth and recruitment at various spatial scales.

Historical Harvest Distribution for Red King Crab Around Kodiak Island, Alaska

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The harvest history of red king crab (*Paralithodes camtschaticus*) around Kodiak Island, Alaska provides an intriguing example of fishery development in response to resource opportunity and available technology. Red king crabs were first harvested off Kodiak Island in the 1920s, although harvest data were not recorded until 1950. During the late 1950s, salmon purse seine vessels were used to harvest salmon in summer and crabs in winter. However, the lack of live tanks limited fishing to inshore, shallow areas near the ports of landing. Introduction of flowing seawater tanks in the 1960s allowed vessels to follow summer king crab migrations to deep offshore trenches. By the late 1960s, inshore areas were becoming depleted. Concurrently, mean vessel size increased and many were equipped with flowing seawater tanks. Because these vessels could harvest crab more efficiently and could also follow the summer crab migration to deep offshore trenches, effort shifted to offshore fishing grounds in attempts to maintain catches. Annual landings peaked at 43,000 mt (94 million lb) in 1965, and at the time it was the state's largest red king crab fishery. But catches plummeted to about 5,500 mt (12 million lb) by 1969, and then ranged from 5,000 to 11,000 mt (11 to 24 million pounds) during the 1970s. Landings again declined sharply in the early 1980s, and the commercial fishery has been closed since 1983, although a low level subsistence fishery continues. This poster uses geographically referenced harvest data within a Geographic Information System (GIS) to examine changes in the harvest distribution during the rise and collapse of the Kodiak red king crab fishery.

Otolith Chemistry Works: Where Do We Go From Here?

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The research performed by the Fisheries Otolith Group (FOG) explores the utility of otolith (fish ear stone) chemistry in the reconstruction of past habitat use, the identification of essential habitat, and the connectivity between fish populations. The identification of essential spawning habitat and the ability to assess recruitment within major commercial fish populations has profound consequences for these fisheries. By identifying past habitat use we can delineate stocks and identify stocks to natal regions. The location and identification of essential fish habitat has become a major focus of fisheries ecologists, particularly since the promulgation of the Sustainable Fisheries Act in 1996. Traditional assessments of habitat use have relied on mark and recapture techniques which often fail to identify critical juvenile habitats due to tag induced mortality and issues of poor re-capture reporting. In recent years marine fisheries researchers have increasingly relied on otolith microchemistry as a mechanism to locate nursery habitats and develop management strategies that protect those habitats that contribute significant numbers of recruits to the adult population (source habitats). This technique has had demonstrated success in locating essential habitats of marine anadromous fish such as Weakfish and Spot. This geochemical technique uses the chemical variations preserved in fish otoliths as natural tags of fish movement to and from habitat regions. This relatively new technique is a more effective method for estimating past habitat use by juvenile and adult fish than mark and recapture or traditional tag and release studies.

Ecology of the Nearshore Areas of the Copper River Delta

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Nearshore areas serve as a critical connection between terrestrial and marine ecosystems. We characterized the temporal and spatial patterns in key physical and chemical parameters for the Copper River Delta and Orca Inlet (southeast Prince William Sound) in 2004. Surface and bottom water salinities throughout the Delta and Orca Inlet were significantly reduced during the summer in response to the large input of freshwater from the Copper River. At delta sites, lowest salinity values for both surface and bottom were recorded during August. The Copper River is also a source of nitrate to the Delta ecosystem as well as a source of nitrates to the Gulf of Alaska through exchanges between Egg Island and Pete Dahl channels. Highest nitrate concentrations occurred in late spring and late summer/fall. Ammonia inputs, primarily from the Copper River and Alaganik Slough, were associated with large eulachon returns during March and April. Phosphate concentrations were influenced by both oceanic and riverine sources, whereas silicate appears to be delivered in large quantities primarily from riverine sources. Chl *a* concentrations in surface waters reflected an input of phytoplankton from the Gulf of Alaska during spring and early summer. In intertidal sediments, chl *a* concentration increased with distance from the Copper River. Our data set serves as the first description of the relatively pristine waters of the Copper River estuary, an area of significant economic and cultural value to the North Pacific.

Marine-terrestrial Linkages in Gulf of Alaska Watersheds: Spatial and Temporal Fluctuations of Limnological Parameters and Smolt Production in Karluk and Spiridon Lakes

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Freshwater productivity is an important control on salmon production. The water chemistry and nutrient composition of the lakes and headwaters of salmon producing systems is essential to the understanding of fluctuations in smolt outmigration and subsequent adult returns. A series of sampling dates throughout the growing season enabled us to describe changes in the lake environment and smolt forage base. The study lakes (anadromous Karluk and control Spiridon), which are similar in physical attributes except salmon access, differ in several parameters, including phosphorus and silicon content and the timing of maximum abundance of preferred zooplankton forage. Data collected at river stations provide insight in the role of headwater systems in the distribution of nutrients and productivity in the lakes. Known levels of presmolt stocking and a complete count of out-migrating smolt at Spiridon Lake provide a unique opportunity to study the influence of freshwater conditions on smolt survival.

Life History and Population Dynamics of Alaskan Skates: Providing Essential Biological Information for Effective Management of Bycatch and Target Species

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The Pacific Shark Research Center (PSRC) has been engaged in a broad-based program to study the life history (i.e.; age and growth, reproduction, feeding ecology) of skates (Chondrichthyes; Rajiformes) in Alaskan waters. The susceptibility of skates to fishing pressure has been well documented in the North Atlantic where fishing pressure has notably impacted the abundance, population structure, and distribution of several species. Results from this project will serve to support ongoing National Marine Fisheries Service groundfish surveys and provide an improved understanding of the basic life history of skate species. Research on basic biology, life history, and demography of skates will contribute significantly to the body of information necessary for assessing their population dynamics and status. This should enable better decision-making in areas of public policy, especially regarding fisheries management. Additionally, results of this research will be incorporated into a life history data matrix developed by the PSRC (http://psrc.mlml.calstate.edu/) for eastern North Pacific (ENP) chondrichthyans, and made available to professionals and the general public via the worldwide web. Activities conducted by the PSRC provide benefits in the areas of original research, education, and cooperative programs involving ENP skate resources.

Estuarine Distribution and Abundance of Eulachon (*Thaleichthys pacificus*) Larvae in Berners Bay, Alaska

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The eulachon (*Thaleichthys pacificus*), an anadromous smelt, spawns in the lower reaches of coastal rivers along the northern Pacific of North America. During their spawning run these small fish play a significant ecological role in Alaska. Eulachon are a valuable food resource for humans, piscivorous fishes, marine mammals and seabirds. After hatching eulachon larvae are flushed out of their spawning streams into estuaries, where they have to successfully initiate feeding after yolk-sac absorption and physiologically and behaviorally adjust to the new habitat. Their distribution in estuaries indicates a residence lasting anywhere from weeks to possibly months. We are testing the hypothesis that larval eulachon are retained in the Berners Bay estuary of the Upper Lynn Canal in Southeast Alaska. Timing of emigration and duration of stay of eulachon larvae are examined by analyzing their length and age-specific seasonal occurrence. Eulachon larvae were sampled weekly during the summer of 2004 off a small skiff using three different capture methods, i.e., surface plankton tows, plankton tows to 10 m depth and vertical plankton tows to 35 m. Additional opportunistic sampling was conducted in the winter with mid-water trawl gear from larger research vessels. Larval density was compared to salinity, temperature and surface turbidity parameters to provide insight into larval distribution and habitat preference In 2004, eulachon spawning occurred from April 26 to May 14. Eulachon larvae were first collected in the bay on June 5 and positive catches were recorded until July 22. Eulachon larvae hatched at 6 mm standard length and reached size of ~20 mm at the end of July. Young-of-the-year (YOY) eulachon captured in winter had reached a length of x cm. The occurrence of YOY eulachon in Berners Bay during the winter supports our hypothesis that in 2004 eulachon larvae were retained in the Berners Bay estuary.

Marine-terrestrial Linkages in Gulf of Alaska Watersheds: Monitoring the Effects of Marine-derived Nutrients on Biological Production in Sockeye Salmon Systems

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Pacific salmon transport marine-derived nutrients (MDN) into freshwaters when they return to spawn. As freshwater productivity is an important control on salmon production, there may be feedbacks between escapement, nutrient loading, aquatic productivity and subsequent salmon production effected by climatic and commercial fishing. This project examines the role of MDN in lake productivity by integrating studies of nutrient cycling, primary productivity, zooplankton, juvenile sockeye and stable isotopes. The sampling design utilizes detailed and contemporaneous vertical and temporal sampling of the water column, coupled with primary productivity measurements, and integrated stable isotope analyses. The study lakes (anadromous Karluk and control Spiridon) are similar in physical attributes except salmon access. Ultimately, we hope to provide a framework for long-term monitoring of marine-terrestrial linkages. Lake thermal stratification begins in June and breaks down in late-August. Total phosphorus (TP) in Karluk is about double that of Spiridon. TP decreases throughout the season at Spiridon, while Karluk has a peak in August. Karluk has higher chlorophyll a during all periods, with annual depth-integrated concentrations (mg m^{-2}) of 95 compared to 32 for Spiridon. Chlorophyll peaks in Spiridon in July, but in both May and August at Karluk. Karluk primary productivity is higher during all periods by a factor of ~2, and shows a different seasonal pattern with an additional late-August peak. Seasonal averaged zooplankton biomass (mg m^{-2}) is significantly higher in Karluk (772), than Spiridon (355). Average $\delta^{15}N$ values for lake POM, zooplankton and sockeye smolts are more than 4 °/oo higher in Karluk than Spiridon. Karluk $\delta^{15}N$ POM has larger seasonal variability with peaks in spring and late-summer. Our preliminary data indicates higher nutrients, algal and zooplankton biomass and productivity in the anadromous system, with distinct seasonal patterns and $\delta^{15}N$ enrichment in biota. Such characteristics are consistent with positive influences of MDN on productivity.

16,000 Kilometers of ShoreZone in the Gulf of Alaska

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During the summer of 2005 almost 8,000 km of shoreline in the Gulf of Alaska were imaged using the ShoreZone mapping methodology, which records biophysical habitat attributes of the shoreline. The 2005 survey effort brings the total shoreline imaged in Alaska to more than 16,000km. The Alaska extent complements the existing 36,000 km of ShoreZone mapping in British Columbia and 5,000 km of Washington state bringing the total Pacific Northwest coverage close to 60,000 km of shoreline. The 16,000 km of Alaska imagery is web-posted, allowing anyone with internet access to 'all-weather', low-tide imagery of both developed or remote sections of shoreline (www.CoastAlaska.net). The 1-second video captures permit the user to 'fly' the coastline along the original flightline tracks. Coarse-level habitat mapping data is also web-posted allowing users to view mapped attributes such as eelgrass, kelp, shore type, sediment texture, wave exposure, etc. for the 8,000 km where mapping has been completed (16,000km should be web-posted by summer 2006). Downloads are available of ArcGIS files and these files provide the complete geo-referenced, database for use with complex queries. The broad-scale mapping reveals regional trends and anomalies. For example, two previously unreported, large, permanent *Macrocystis* beds have been identified on Kodiak Island, 1,000km tot he west of their normal limit. Use of the website for both imagery display and data access will be demonstrated real-time during the presentation.

Polybrominated Diphenyl Ethers (PBDEs) in Sediments and Biota in Pristine Southeast Alaska Watersheds and Near a Municipal Waste Landfill in Juneau AK

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Polybrominated diphenyl ethers (PBDEs) are used extensively as chemical flame-retardants in consumer goods. Varying degrees of bromination at the diphenyl ether skeleton produces multiple congeners. Three formulations are produced in particularly large quantities; the penta-mix, octa-mix and deca-mix. Unregulated disposal allows for appreciable quantities of these compounds in municipal landfills and may provide a significant source for PBDE contamination in surrounding areas. PBDEs are considered persistent organic pollutants (POPs) and their potential for bioaccumulation in exposed organisms and their ability to disrupt physiological processes are topics of great concern. In Juneau, AK the municipal landfill is bordered by several streams that drain into the Lemon Creek estuary that serves as important habitat for emigrating salmonids and invertebrate species. Sediment and biota were collected from areas adjacent to the municipal landfill and downstream from the landfill in the estuary. Sediment and biota samples were also collected from estuarine areas with similar geographic features as the Lemon Creek estuary but that were removed from the municipal landfill and subject to limited sources of anthropogenic contaminants. Preliminary sediment samples collected early in the study were subjected to Soxhlet extraction and analysis with low-resolution GS-MS. Sediment and biota samples collected from sites representing a grid-like pattern around the landfill and the control sites will be extracted and analyzed with analogous methods. Significant levels of some PBDE congeners were identified in preliminary sediment samples collected near the landfill. Control sites indicated a low but measurable background of some PBDE congeners. PBDE levels in sediments and biota from sampling around the landfill and control sites will be presented. PBDE levels in sediments will be compared to total organic carbon levels. The results from this study provide an assessment of PBDE levels in sediments and their accumulation into the tissues of organisms.

The Blind Eating the Blind - The Ecology of Knik Arm

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Knik Arm is a shallow glacial estuary with extreme physical habitats characterized by large tidal ranges, strong currents, massive inputs of glacial and coastal sediment, extreme turbidity, and severe seasonal ice scour. Despite these conditions, beach seining during spring 1983 demonstrated a surprising level of biological activity. Eighteen species of fish were captured and all had been feeding. The present work was initiated to expand understanding of the broader temporal fish and invertebrate use of nearshore areas in the Arm and the potential contributions of fish populations to the food web supporting Cook Inlet beluga whales. We conducted beach seining at 6 to 15 sites from July through freeze-up in November, 2004 and again from breakup through September 2005, capturing over 7,000 fish. High abundances of invertebrates, especially gammarid amphipods and crangonid and mysid shrimp were found throughout the area. The data present a remarkable picture of prolonged use of the Arm for rearing and growth by juvenile sockeye, coho, and Chinook salmon as well as several typically more northern species such as Bering cisco and saffron cod. Offshore tow net sampling found a similar biota with several invertebrates commonly considered to be benthic or epibenthic found in the surface layer of waters over 30 m deep. Adult salmon, saffron cod and osmerids (longfin smelt and eulachon) are identified as the most probably prey of beluga whales in the Arm at various times of the year. Presence of so much biological activity where turbidities range from 100s to 1,000s of NTU raises questions regarding how fish feed and migrate with few, if any, visual cues.

The Decline in Prince William Sound Herring After the Oil Spill: Insights from an Age-structured Assessment Model

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The Prince William Sound (PWS) herring population declined suddenly and dramatically in 1993. When the Exxon Valdez oil spill (EVOS) occurred in 1989, there was major concern about the effects on PWS herring but the population appeared to remain at high abundance for the next few years. The primary management tool in Prince William Sound at that time was an age-structured assessment (ASA) model, which integrates numerous data sources in a least squares setting to obtain estimates of herring abundance. In the years 1989 and 1993, there were major conflicts among the data sources, in particular between estimates from an egg deposition survey and aerial observations of milt coverage. The inability to foresee a major change in natural mortality in 1993 led to overestimation of abundance by the ASA model. After 1993, disease impacts of the virus VHSV and the fungus *Ichthyophonus* on natural mortality were introduced into the ASA model to explain the sudden decline in abundance. Upon incorporation of the disease information, the ASA model correctly forecasted disease events in 1997 and 2001. Furthermore, the ASA model contains important information about the biological response of herring to disease. In order to explain the dynamics of the herring population subsequent to EVOS, several interesting changes in population parameters have been deduced from the model. The recruitment of more recent cohorts tends to follow a 3-4 year cycle. In addition, a stochastic Ricker spawner-recruit relationship between egg production and age 3 recruitment is necessary to obtain realistic estimates of recruitment, suggesting that both biological and environmental factors are important in population rebuilding. The estimated proportion of the population that is mature and participates in spawning increased after 1997 for both ages 3 and 4, suggesting a change in population response to low population levels. Thus the ASA model not only allows accurate estimation and forecasts of abundance, but also provides insight into fundamental population processes undergoing change.

Kelp - Grazer Interactions in Kachemak Bay, Alaska

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The health and diversity of Northeastern Pacific coastal ecosystems rely heavily on the abundance of habitat provided by kelp forests. Canopy-forming species like *Nereocystis luetkeana*, and bed-forming species such as *Agarum clathratum, Laminaria bongardiana* and *L. saccharina*, offer three-dimensional space as spawning and foraging habitats for many fishes and invertebrates. Mesograzers as snails are often highly abundant during the summer and may therefore be capable of causing considerable tissue damage to kelp. Consequently, brown algae often are able to produce defensive chemicals such as phlorotannins for protection against grazing. We seek to support the hypothesis that seasonal and small-scale spatial patterns of phlorotannin production in kelp vary proportionally with grazing intensity by the snail, *Lacuna vincta*. Grazer densities on the four mentioned kelp species were established monthly from May 2004 through November 2005 within Kachemak Bay. *Lacuna vincta* had peak abundances in early to mid-July and preferentially resided on *N. luetkeana* and *L. bongardiana* blades. Phlorotannin measurements showed *L. bongardiana* and *N. luetkeana* to have lowest and *A. clathratum* the highest overall concentrations in blade tissue. Hence, *L. vincta* had greatest abundance on the two algal species with the lowest overall phlorotannin levels.

A Probability-based Design for Long-term Intertidal Monitoring as Developed for Glacier Bay National Park and Preserve

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One of the challenges of monitoring is detecting trends against the background variation that is such a part of biological systems. A second is having the ability to extrapolate the results of the monitoring to a broader universe than just the sites sampled. The extent to which this latter challenge is met is determined by the design of the monitoring regime, including how sites are selected. A multi-staged sampling approach having a probability-based design was applied to the intertidal regions of Glacier Bay proper. This three-staged sampling plan included: 1) broad-scale sampling conducted via aerial surveys to determine habitat types of 241 systematically selected segments, 2) low intensity sampling of a large number (n=25) of sites randomly selected from the pool comprising the selected habitat type, and 3) high intensity sampling of a smaller number (n=6) of the sites in (2). The aerial surveys revealed an unexpected predominance of cobble/boulder habitat, which caused a change in the selection of the habitat type to be monitored. Power analyses of the first year's data, which compared the sampling results from (2) and (3) above, revealed that there was greater ability to detect change in the abundances of the predominant species by sampling more sites with less intensity [(2) above]. Power analyses conducted on four years of the lower intensity sampling of the 25 sites demonstrated that the sampling had high power to detect change in the abundances of the three predominant species or species groups found in the intertidal at Glacier Bay.

Interannual and Spatial Variation in Population Genetic Composition of Northeastern Gulf of Alaska Young-of-the-year Pacific Ocean Perch

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We are evaluating geographic and interannual differences in genetic compositions of young-of-the-year Pacific ocean perch (*Sebastes alutus*). The genetic structure of a species mirrors the distribution and scale of productivity units and is key in developing management strategies. We know little about populations of Gulf of Alaska and Bering Sea rockfish, including Pacific ocean perch; or about early life history information exists for rockfish species, although larval and juvenile rockfish incur the highest mortalities. To understand and interpret the population genetic structure of adult rockfish, we are investigating the genetic variation, which results from dispersal of and genetic divergence between cohorts of age classes of fish from the same geographic area. Young-of-the-year Pacific ocean perch were collected serendipitously during transect surveys of salmon juveniles in the Gulf of Alaska in 1998-2003 and the Bering Sea in 2002. These large concentrations of juvenile rockfish, the first observed and collected in Alaskan waters, provide an unparalleled opportunity to study Pacific ocean perch genetics. Coincidence in timing and location of several collections between years permits analysis of interannual microsatellite variation (between cohorts) and geographic variation (within cohorts). The genetic compositions of these collections are evaluated in the context of adult geographic population genetic structure. Conclusions of this Pacific ocean perch genetic analysis will be pertinent to management decisions for Pacific ocean perch and may assist in interpretations of genetic structures of other rockfish species.

Larval Migrations of Prince William Sound Pacific herring (*Clupea pallasii*)

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Investigation into the larval migrations of Prince William Sound Pacific herring (*Clupea pallasii*) has lead to the identification of regional elemental signatures. Preliminary results of otolith analysis have revealed differences in the core (spawning) and edge (capture) regions. These natural tags identify the spatial region an individual herring inhabited as well as temporally through accumulation of rings within the otolith. Using archived juvenile herring collected on the Sound Ecosystem Assessment (SEA) from 1995-98 we extracted and processed the otoliths. We have begun to isolate regional elemental signature in the otolith using an Inductively Coupled Mass Spectrometer with Laser Ablation, ICPMS-LA. The objective of this research is to (1) identify the natural tags within the core (natal) and edge (nursery) of the juvenile herring, (2) recreate this migration for each management region, Northeast, Southeast, Naked Island, and Montague Island and (3) compare these larval migrations to a model for larval drift in PWS (3D-PWS). The model has not been ground-truthed and the present research can validate or help refine the model.

Preliminary Assessment of Marine-derived Nutrients in the Copper River Delta, Alaska Using Stable Isotope Analysis

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Stable carbon and nitrogen analysis (SIA) was preformed on maturing and juvenile anadromous sockeye and coho salmon, and periphyton in two Copper River Delta watersheds of southcentral Alaska to trace marine-derived nutrients (MDN) during 2003-2005. Maturing salmon were isotopically enriched relative to alternate freshwater C and N sources as expected, with only slight species, gender, and year-to-year differences, enabling use of SIA to trace MDN. Periphyton naturally colonized, incubated, and collected using Wildco Periphtyon Samplers in and near spawning sites was 15N-enriched, as expected, and 13C-depleted in all freshwater sites relative to maturing salmon whereas periphyton at estuarine sites was 13C-enriched. Periphyton values suggested that SIA could be used to distinguish MDN production derived via re-mineralization from MDN via direct utilization. Juvenile salmon SIA ranged in values consistent with using production derived from re-mineralization as well as direct utilization. Sockeye juveniles only appear to use re-mineralized MDN whereas coho salmon juveniles use MDN from both pathways.

Determination of Recovery from Disturbance in Rocky Intertidal Systems in Kasitsna Bay, Alaska

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Determination of recovery following pulse disturbance to rocky intertidal communities is problematic because recovery endpoints are difficult to define, especially in highly dynamic systems such as temperate rocky intertidal zones. We addressed this problem through direct experimental manipulation at a rocky intertidal site in Kasitsna Bay, Alaska. We cleared experimental plots in the summers of 1999 and 2000 and followed their recovery through 2005. We tested whether 1) disturbed plots would eventually resemble their starting conditions; 2) disturbed plots would eventually resemble undisturbed (control) plots; 3) abundance of focal taxa in disturbed plots would fluctuate in parallel with those in undisturbed plots; and 4) synchronous cycles of growth and decline in Fucus abundance would occur in disturbed plots but not undisturbed plots. We found that after a 5-6 year recovery period, disturbed plots did not differ significantly from undisturbed control plots on the same beach, but did differ from their original starting condition and from the condition of plots on an adjacent beach. Abundance of focal taxa in disturbed plots fluctuated in parallel with undisturbed plots after a recovery period of about 2 years. We found no evidence of synchronous cycles of growth and decline in Fucus abundance following disturbance. Our results suggest that 1) recovery to pre-disturbance conditions is not a reasonable endpoint because the systems themselves are dynamic, and 2) recovery can lead to convergence between disturbed and undisturbed plots where the scale of disturbance is small and the physical distance between disturbed and undisturbed plots is very short, but convergence may not occur over larger scales of comparison, for example, between beaches. Consequently, convergence may not be a reliable endpoint for determination of recovery. Funding for this study was provided by the Exxon Valdez Restitution Program through NOAA/OR&R/HAZMAT.

Processes Affecting the Productivity of Capelin and Pollock in the Gulf of Alaska

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The Gulf of Alaska (GOA) is a highly productive ecosystem that is influenced by oceanographic forcing and climate variation. Studies that examine the distributional ecology of key fish species in the GOA relative to environmental variables provide an opportunity to better understand how external forcing factors influence and modify fish production. We present information on the effects of local hydrography on the distribution and feeding ecology of two key forage species in the GOA, juvenile walleye pollock (*Theragra chalcogramma*) and capelin (*Mallotus villosus*). Multiple research cruises were undertaken in Barnabus Trough, located to the east of Kodiak Island. Biophysical sampling (temperature and salinity profiles, chlorophyll-a concentrations, acoustic backscattering) in these areas suggests that juvenile walleye pollock and capelin were spatially separated by a local hydrographic front in Barnabus Trough. These observed differences in habitat selection have implications for resource use and competition between pollock and capelin in that region. Our current research examines whether mesoscale hydrography is associated with differences in zooplankton composition, limits in geographic distribution, and fish feeding and diet. Results will provide a better understanding of the mechanisms by which climate variability influences fish populations in the Gulf of Alaska.

Intertidal Shore Stations in the Gulf of Alaska: linking ground sites to ShoreZone

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Since 2002, the ShoreZone mapping program in coastal Gulf of Alaska has included ground station surveys. The objectives of these field programs have been to provide detailed biophysical site survey data to nest in the spatial framework of the ShoreZone mapping. Over 200 sites have been visited during summer low tides, including surveys in the Katmai National Park, Kenai Fjords National Park, lower Cook Inlet and in the Kodiak archipelago. Data collected at ground stations includes both physical and biological observations, such as species present with relative abundance, as well as geomorphology and substrate descriptions. Observations are recorded according to a standard protocol and all sites are specifically geo-referenced, within the hierarchical system of the ShoreZone mapping program. Cluster analysis of the species data by station shows regional distribution patterns of intertidal community assemblages mapped in ShoreZone, and is useful for determining definitions of indicator and associated species in different coastal regions. These patterns, within the regional framework of the wide-spread ShoreZone mapping data are a useful planning tool and permit quantitative summaries of shoreline lengths of a variety of attributes.

Utilization of Estuarine Habitat by Sockeye and Coho Salmon on the Copper River Delta, Alaska

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Substantial variability in the early life history and migratory behavior of coho and sockeye salmon, each of which support important fisheries in the North Pacific, exist on both local and regional scales. Of particular importance for stock assessments are the ages and consequently size of juveniles during out migrations. For both species, juveniles have been found in estuaries as age 0 fry, 0+, 1, 1+ year old smolts. Once in the estuary, in area seldom studies in regard to salmon, residence time is highly variable (days to months) and is probably correlated to the age of out migration (i.e. longer residence has been reported for age 0 salmon). Because estuarine habitats are critical for osmoregulatory adjustment to marine waters and offer rich foraging opportunities for smolt, estuarine habitats represent in essential habitat for salmonid fisheries. Quantifying variability in both age at out-migration and the subsequent time spent in estuarine habitats are critical for stock assessments because both parameters have been shown to affect survival and growth of coho and sockeye. The project couples intensive field surveys with otolith microchemistry analyses to quantify ages of out-migration and estuarine residence time for coho and sockeye salmon within the Copper River Delta, Alaska, a major site for salmon harvest and a system which is representative of many estuaries in Alaska. Both the Strontium signature in salmon otoliths and the field sampling demonstrate that a large proportion of juvenile sockeye and coho utilize estuarine areas of the Copper River Delta.

Marine Derived Nutrients (MDN) in Riverine Ecosystems: Developing Monitoring Tools for Tracking MDN in Alaska Watersheds

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Our primary objective is to track and measure marine derived nutrients and carbon (MDN) effects in stream and riparian environments on the Kenai Peninsula. Our approach in the first 2 years of this 3-year effort was to link stream chemistry, marine isotope signatures, and lipid and fatty acid measures along a gradient from headwaters to river mouth in watersheds with and without spawning salmon. During year 2 we chose 3 streams (i.e., 2 salmon spawning streams and 1 salmon-free reference) in each of 3 regions (Cooper Landing, Homer, and Seldovia) that differed in expected ambient nutrient concentrations and limitations based on underlying parent geology. Analyses are ongoing but some preliminary results are available. Our data suggest that Cooper Landing and Seldovia streams were P limited (ambient N:P ratios of >100 and >700, respectively). Cooper Landing streams had ambient P concentrations ~10x higher than did Seldovia streams. Homer streams showed high P concentrations and may be N limited (ambient N:P ~ 1) or limited by some factor other than nutrients. Stable isotope data from salmon-bearing Homer and Cooper Landing streams shows grazing and detritivorous macroinvertebrates to be enriched in ^{15}N relative to salmon-free reference streams, suggesting incorporation of MDN into stream foodwebs. This pattern showed little seasonal variation, suggesting that MDN was incorporated into biota and sequestered for extended periods of time. Fatty acid data from Homer streams showed increased ω3: ω6 ratios in Dolly Varden, suggesting the detection of direct consumption of salmon eggs and/or flesh. The ongoing analysis of lipids and fatty acids and N, C, and S stable isotopes will give additional information into temporal and spatial patterns of MDN uptake and the utility of stable isotope and fatty acid analysis as tools for MDN tracking.

Life-Cycle Assessment of Salmon Production

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This talk introduces the North-East Pacific (Alaska and British Columbia) segment of a three-year, international project to rigorously evaluate and compare the major life cycle environmental and social impacts associated with the production of salmon for human consumption. Using a formal Life Cycle Assessment (LCA) framework, the project assesses the relative environmental and social impacts of alternative salmon production systems, both wild and farmed, and from harvest through processing and distribution to final product forms consumers encounter in stores and restaurants. Originally pioneered in Industrial Ecology, the Life-Cycle Assessment (LCA) approach can be used to assess the cradle-to-grave impacts of seafood production systems, forming the basis for inter and intra-regional, gear, and product mode comparisons, as well as informing labels and standards, consumer choices, and policy decisions. We will give an overview of LCA, including methods and applications to various food systems, its compatibility with the ISO 14,000 standards and extensions to social impacts. We will review existing research and applications of the LCA approach and related environmental impact assessments to fisheries, before introducing the LCA project on North-East Pacific salmon. The analysis of salmon products sourced from commercial fisheries will take into account the diversity of harvesting technologies currently employed on the major salmon fishing grounds of the north Pacific (purse seine, gill net and troll). Similarly, the analysis of the environmental and social impacts associated with contemporary farmed salmon production will account for the major differences, e.g., pertaining to feed formulation or stocking densities. The analysis will also include the assessment of the life cycle environmental and social impacts associated with both a certified organic and a land-based farmed salmon system.

Ecological Significance of Seasonal Aggregations of Marine Forage Species for Steller Sea Lions

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Ecosystems tend to develop components that maximize utilization of seasonally available energy pulses. A seasonal study of Steller sea lion abundance, diet, movements and available prey in southeast Alaska during 2001-2004 indicated that seasonal aggregations of marine forage species are ecologically significant for sea lions. A plausible annual foraging strategy for sea lions is to concentrate on herring during November to February, eulachon and herring (and possibly capelin and northern lampfish) during March to May, salmon intermittently during summer and fall, and pollock and hake during the intervening periods. The timing of the energy pulses may affect the success of sea lion lactation, pregnancy, and breeding (a fasting period). This strategy depends on sea lions remembering prey locations and these locations being predictable from year to year. These energy pulses may be crucial for sea lions not just in southeast Alaska where sea lion abundance is increasing, but also in western Alaska where Steller sea lions are classified as endangered and their decline has substantially affected major fisheries in the Bering Sea and Gulf of Alaska. This study was conducted cooperatively by NMFS Auke Bay Laboratory, University of British Columbia, Alaska Department of Fish and Game, University of Alaska, and NMFS National Marine Mammal Laboratory.

A Comparison of ESI Shore Type and ShoreZone Classification in Southeast Alaska

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In the mid-1970s a technique was developed to categorize coastal regions based on their sensitivity to oiling. The Environmental Sensitivity Index (ESI) uses wave exposure, slope, substrate, and biological productivity to place shorelines into 1 of 10 rankings (27 total categories) where 1 indicates the shoreline is least susceptible to oiling and 10 is most susceptible. This ESI system has been used to map most of the coastline in the US including Alaska. As this system was being developed in the US, another classification system was being developed in Canada to map the British Columbia coastline. The ShoreZone Mapping System uses morphology, substrate, and wave exposure to place a section of shoreline (an alongshore unit) into 1 of 34 categories. The categories in this system indicate both the morphology and sediment type of each unit. Each alongshore unit is further described by across-shore components. These components describe the physical characteristics (morphology, texture, width, process, and ORI) of the unit from the vegetation line to the low water line. Once the geomorphological units have been divided, biological data is added making each segment of shoreline very rich in data. The ShoreZone Mapping System has been used to map all of BC, Washington, and parts of Alaska. Where these two classification systems overlap it is possible to do a comparison of the value of each system. In the studied area of Southeast Alaska the mean unit size of the ESI shoreline is 390 m while the mean unit size of the ShoreZone shoreline is 250m. These smaller shore units add a degree of detail to the mapping. Also, 32% of the ShoreZone shoreline is mapped as one of the 15 'Rock & Sediment' shore types. This important combination of rock and sediment shoreline can not be classified using the standard ESI mapping system where the unit can be rock only or sediment only.

Progress Report of an Ecological Investigation of Spiny Dogfish in the Gulf of Alaska

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Spiny dogfish (*Squalus acanthias*) have supported commercial fisheries in the Pacific Ocean for >100 years. Tagging studies suggest diverse stock structure, including migratory offshore stocks and distinct non-migratory inshore stocks. Regional biological differences exist. For example, in a related study, one of us (CAT) found differences in timing of dogfish parturition in inside waters of British Columbia versus nearby Puget Sound, Washington. However, knowledge of dogfish biology is limited for the northeast Pacific and virtually lacking for Alaska. Directed dogfish fisheries are prohibited in Alaska, but increasing numbers of dogfish are being landed as 'bycatch' and large numbers are discarded at sea. Our objectives are to: (1) estimate demographic parameters such as size/age at maturity, fecundity, and mortality; (2) elucidate dogfish life history; and (3) better understand their ecology, particularly feeding habits. Here, we report on our progress since we began sampling spiny dogfish in the northern Gulf of Alaska in July 2004. Our cooperative research, coupled to a companion University of Washington study of population dynamics, is intended to assist state and federal fishery managers to develop fishery management plans based on region-specific information on dogfish stock abundance, distribution, and productivity.

Investigations into the Relationship Between Water Chemistry and Salmon Escapement: Can a Nutrient Proxy for Escapement Be Developed?

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We investigated the potential for developing a nutrient proxy for salmon escapement by estimating the relationship between a suite of water chemistry components (in particular NH_3, $N0_3$ and $N0_2$) and salmon numbers in five different streams. Initial investigations in 2004 on the Anchor River on the lower Kenai Peninsula revealed that nutrient concentrations were not related to salmon escapement. We hypothesized that the phosphorous-rich underlying geology of the lower Kenai Peninsula may make these systems relatively unresponsive to additional nutrient inputs from anadromous salmon. In 2005, we explored this possibility by expanding the number of study systems to include streams outside of the lower Kenai Peninsula, including systems with phosphorous-poor underlying geology. We also explored the possibility that a biologically inert by-product of salmon metabolism (chloride) may be a more appropriate water chemistry proxy. The range of variation in chloride levels within systems was low and was not related to stage or cumulative fish levels. Cumulative fish counts accounted for little of the variability between $N0_3$ and $N0_2$ variation after accounting for colinearity between these nutrients and stage in any of the systems examined. Results for NH_3 were more promising in terms of developing a nutrient proxy. On the Russian River, cumulative fish counts accounted for less than 1% of the total variability after taking into account colinearity between ammonium and stage. However, on the Deshka River and Anchor River, cumulative fish counts accounted for 80% and 75% of the total variability in NH_3 after accounting for colinearity with stage. The Deshka and Anchor Rivers are non-lake fed systems, draining glacial drift geology while the Russian is a lake-source system draining granitic geology. These investigations show variability in NH_3 provides a potential opportunity to develop a nutrient proxy for salmon escapement in non-lake systems.

Do Forage Fishes Benefit from an Abundance of Large Prey in the Alaska Coastal Current?

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Localized enrichment of zooplankton in the Alaska Coastal Current (ACC) may enhance forage fish feeding opportunities. The southward-flowing branch of the ACC, which follows the Shelikof Sea Valley to the slope, was associated with an abundance of euphausiids and large copepods relative to adjacent areas of the shelf. Two forage fish species, eulachon *(Thaleicthys pacificus)* and juvenile walleye pollock (*Theragra chalcogramma*), were also more abundant in the Shelikof Sea Valley. This study tests the hypothesis that the consumption of euphausiids and large copepods by these fishes and capelin (*Mallotus villosus*), another common forage fish, varied geographically in accordance with ACC-related prey enrichment. Fish were collected day and night from a grid of 44 pre-determined stations located in and between the Shumagin and Shelikof sea valleys during September 2000, 2001, and 2003. Stomach contents of 4263 fish were examined to determine gut content weight, and the number, weight, and state of digestion of all prey. The importance of euphausiids and large copepods in the diets of these fishes was confirmed from taxonomic composition of the prey, and from the weight of intact individual prey. Statistical test results provided some support for a significant geographic effect on the number of euphausiids and large copepods in forage fish stomachs that was consistent with ACC-related prey enrichment, especially for age-1+ walleye pollock. There was, however, no geographic effect on gut content weight. Lack of geographic variation in gut content weight was not explained by compensatory variation in the weight of intact individual euphausiids or large copepods consumed (i.e. few large individuals versus many small individuals). The results are discussed with regard to availability of alternate prey.

Comparison of Single-beam Echosounder Reflections to Bottom Trawl Survey Catches

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Commercial-grade echo-sounders may provide an inexpensive methodology for characterization of sea floor habitat, but the utility of this technique has not been fully evaluated. This approach can potentially provide information over broader spatial scales than can be obtained from physical samples (benthic grabs, dredges, etc.). Additionally, this approach may produce data with less expense than video sampling and sonar (sidescan and multibeam) techniques, the latter of which may not measure those factors to which fish respond. We analyzed the seafloor reflections from a commercial-grade, Simrad ES-60, 38kHz single-beam echosounder collected during the 2003 Alaska Fisheries Science Center bottom trawl survey of the Gulf of Alaska. Analysis was performed only on data with the same collection settings, spanning about 200 trawl hauls, mostly on the continental shelf from the eastern Aleutian Islands to around Kodiak Island. Data were extracted in EchoView and then processed in QTC Impact software, which makes 166 measurements on the shape of the reflected waveforms. We compared waveform measurements summarized over each bottom trawl haul to the species composition and CPUE of fish catch. Differences were observed in the acoustic characteristics of hauls containing species of different habitat requirements, such as rockfish and flatfish. This technique may provide a basis for stratifying trawl surveys by habitat types rather than depth, thus potentially reducing the variances of estimated survey biomass for stocks, such as some rockfish, which may be strongly associated with a particular habitat type.

Gulf of Alaska - Seabirds & Marine Mammals

Monday, 23 January 2006: 2:15 - 4:30 PM

Session Chair and Poster Review: Jennifer Burns

TALKS

Speaker	Title
Jennifer Burns	Working Harder in the Dark: Winter Diving and Foraging Patterns in Juvenile Steller Sea Lions
Ed Melvin	The Distribution of Seabirds on the Alaskan Longline Fishing Grounds: Implications for Seabird Avoidance Regulations
Ann Edwards	A Bird's Eye View of Fisheries Discards in Alaskan Waters
Anne Hoover-Miller	Changes in Harbor Seal Population Dynamics in Aialik Bay
Volker Deecke	Studying Killer Whale Predation in the Field: a Sound Approach to Detecting Kills
Joseph Liddle	Estimating Sperm Whale Abundance with Bayesian Mark-recapture

POSTERS

First Author	Title
Victoria Baker	Seabird Avoidance Gear Alternatives in Alaska Longline Fisheries: Collaborative Research with Small Vessel Operators
Carrie Beck	Using Quantitative Fatty Acid Signature Analysis (QFASA) to Estimate Diet in Young Steller Sea Lions in Prince William Sound, Alaska
Gail Blundell	Remote Monitoring of Vital Rates in Harbor Seals (*Phoca vitulina*)
Joni Bryant	Community-based Harvest Monitoring of Subsistence Harvest of Harbor Seals and Steller Sea Lions.
Alejandro Frid	Do Food and Predators Play Inseparable Roles in the Decline of Prince William Sound Harbor Seals?
Caroline Jezierski	Harbor Seal (*Phoca vitulina*) -- Kayak Interactions in Pederson Lake, Kenai Fjords National Park
John Kennish	A Quality Assurance and Quality Control Program (QA/QC) for Lipid Extraction and Gas Chromatographic Analysis for Fatty Acids (FA): an Interlaboratory Study.
Matt Kookesh	Tsaa Tl'ooni, "Tlingit Seal Hunter"
Kathy Kuletz	Distribution and Abundance of Juvenile Kittlitz's Murrelets in Kachemak Bay, Alaska, 2004-2005
Beate Litz	Non-invasive Monitoring of Testosterone in an Endangered Species, the Steller Sea Lion (*Eumetopias jubatus*)
John Maniscalco	Are Killer Whales Affecting the Recovery of Steller Sea Lions? Assessing Evidence in Kenai Fjords, Alaska

Gulf of Alaska - Seabirds & Marine Mammals

POSTERS (continued)

First Author	Title
Elizabeth Mathews	Declines in Harbor Seal Numbers in Glacier Bay National Park, Alaska
Matthew Myers	Variability in Organochlorine Contamination in Both Blood and Blubber over Time in Captive Steller Sea Lions (*Eumetopias jubatus*)
Jill Prewitt	Muscle Biochemistry of Nursing Harbor Seal (*Phoca vitulina*) Pups
Danielle Savarese	Samples from Subsistence: Harbor Seal Biosampling Program
Carol Stephens	Disease and Health Monitoring in Juvenile Steller Sea Lions *(Eumetopias jubatus*) Held in Temporary Captivity
Jan Straley	Using Longline Fishing Vessels as Research Platforms to Assess the Population Structure, Acoustic Behavior and Feeding Ecology of Sperm Whales in the Gulf of Alaska
Aaron Thode	Observations of Sperm Whale Longline Depredation in the Gulf of Alaska
Dominic Tollit	Validation Studies of Blubber Quantitative Fatty Acid Signature Analysis (QFASA) with Captive Steller Sea Lions (*Eumetopias jubatus*)
Cory Williams	Fatty Acid and Stable Isotope Signatures Reveal Annual, Seasonal, and Age-Related Variability in Tufted Puffin Diets

Working Harder in the Dark: Winter Diving and Foraging Patterns in Juvenile Steller Sea Lions

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Recent studies of the diving behavior of young Steller sea lions have shown that there is considerable seasonal variation in dive metrics, with animals making dives that are nearly twice as deep and half again as long during the winter months (November - March) than during spring These differences in dive metrics have been linked to seasonal changes in prey distribution and abundance. However, behavioral shifts may also have consequences for the foraging efficiency of juveniles, if dives are longer than the aerobic dive limit. While winter foraging efficiency is not likely a critical factor during the first winter of life because young pups (5-9 months of age) are still largely, if not completely, dependent on maternal resources, foraging success during the second winter may significantly impact juvenile (age 17- 21 months) sea lion success, as these animals are likely completely or partially weaned. To assess whether winter foraging poses a physiological challenge to foraging juvenile sea lions, we determined the proportion of anaerobic dives during bouts of diving activity for 32 young Steller sea lions for which we also had measured the aerobic dive limit. Overall, an average of 53 ± 1.3% of dives made by juvenile sea lions during long trips away from the haulout during winter were anaerobic, as compared to 26 ± 4% of dives during the remainder of the year (April - July). In addition, juveniles dove more frequently and spent an increased amount of time at sea diving during winter months. Together, these findings suggest that juvenile sea lions are working harder to obtain prey resources during winter months, which therefore may be the time of the year that this age class is most vulnerable to reductions in prey availability.

The Distribution of Seabirds on the Alaskan Longline Fishing Grounds: Implications for Seabird Avoidance Regulations

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The incidental mortality of seabirds in commercial fisheries is a global conservation concern. In Alaska, seabird bycatch mitigation practices are driven primarily by possible takes of the US-listed endangered short-tailed albatross, and secondarily by takes of Laysan and black-footed albatrosses. In order to develop appropriate seabird avoidance regulations, systematic information on seabird abundance and distribution on fishing grounds is essential, though absent for most fisheries. We used fish stock assessment cruises by the International Pacific Halibut Commission, National Marine Fisheries Service and Alaska Department of Fish and Game as platforms to conduct systematic seabird surveys, yielding the most comprehensive and current database of at-sea seabird sightings on the Alaska, British Columbia and Washington/Oregon longline fishing grounds. Approximately 1,350 surveys were done each year for three years (2002-2004) and seabird distributions were analyzed by species and area. Across all three years, all three albatross species were absent or rare in the inside waters of Prince William Sound (PWS) and Southeast Alaska (SE-AK). Short-tailed and Laysan albatrosses were generally restricted to the Western Gulf of Alaska (W-GOA), the Aleutians and the Bering Sea, while black-footed albatrosses were most abundant east and south of the W-GOA. Based on these results we will recommend to the North Pacific Fishery Management Council that seabird avoidance regulations be relaxed for vessels fishing in PWS and SE-AK. In 2005, these stationary seabird surveys were extended to all fishery surveys conducted by the Alaska Science Center. We strongly recommend that the collection and processing of data from these seabird surveys be institutionalized in NOAA Fisheries to ensure that a long-term data set is available for ecosystem-based fisheries management.

A Bird's Eye View of Fisheries Discards in Alaskan Waters

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The Alaska groundfish fishery in the Gulf of Alaska, Aleutian Islands and Bering Sea combined extracts more than 1,800,000 metric tons of marketable fish each year. However, a significant proportion of that biomass is returned to the sea as offal. In addition, 140,000 metric tons of unmarketable or lesser marketable fish are discarded each year. Seabirds are known to follow vessels in large numbers, specifically to consume discards and offal. The adverse consequences to seabird populations of fatal entanglement in fishing gear have been important subjects of investigation for a number of years. However, the potential positive effects on seabirds of provisioning by fisheries are only now being investigated in the North Pacific and the Bering Sea. Data will be presented by fishing sector on the spatio- temporal patterns of discards and offal produced at sea by the Alaska groundfish fishery. Emphasis will be placed on the characteristics of the discharge (e.g., whole fish, head and guts, or post-fishmeal slurry) that affect consumption by surface-foraging seabirds. The potential effects on seabird populations of provisioning by fisheries will be discussed in light of seabird distributions in space and time and seabird bio-energetic requirements.

Changes in Harbor Seal Population Dynamics in Aialik Bay

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During the past three decades, numbers of harbor seal pups (*Phoca vitulina richardsi*) in Aialik Bay, a tidewater glacial fjord in southcentral Alaska, diminished by about 90%. Similar declines were observed near Kodiak Island. Although numbers of pups have increased near Kodiak Island since 1994, numbers of pups in Aialik Bay pups did not begin increasing until 2003. Coincident with the population recovery near Kodiak Island was a shift to earlier parturition dates. During the decline, field observations in Aialik Bay documented maximum numbers of pups on 6/18/1979 (256 pups), 6/13/80 (358 pups) and 6/11/81 (235 pups). Since 2002 harbor seals near Aialik and Pedersen glaciers have been monitored using remotely controlled video cameras. During this time period maximum numbers of pups were counted on 6/14/02 (38 pups), 6/7/03 (45 pups), 6/1/04 (59 pups), and 6/1/05 (53 pups). Delayed timing of parturition in harbor seals has been associated with poor condition of females during late summer and with population age structures favoring older females. Harbor seal populations can be affected by bottom-up (food) and top-down (predation) influences where bottom-up factors can affect both condition and survival while top down factors primarily affect survival. In Aialik Bay, stabilization of counts occurred after 1989, a time when the AT1 killer whale pod, known to feed on harbor seals in Aialik Bay, diminished in numbers by 50%. Improved foraging in late summer 2003 was associated with prolonged haulout in 2003 and higher numbers of pup in 2004. Increased numbers of pups in 2003- 2005 also corresponds with the period of sexual maturation of seals born after the 1998 PDO shift. Data from Aialik Bay and adjacent areas suggest both bottom-up and top-down mechanisms may be involved in the decline and recovery of seals and distinguishing the contributions of these effects will be difficult.

Studying Killer Whale Predation in the Field: a Sound Approach to Detecting Kills

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Killer whales are top predators in many coastal and oceanic ecosystems and are thus likely to play an important role in regulating marine mammal populations. Field studies investigating the energetic requirements and dietary preferences of mammal-eating killer whales have been compromised by our inability to consistently identify kills. In particular, attacks on smaller prey may be difficult to detect by conventional visual observation techniques alone. This leads to underestimates in capture rates and to biases in the perceived diet spectrum towards larger species that are more difficult to subdue. We conducted a 5-year study of the acoustic behaviour of mammal-eating killer whales in South-east Alaska to test whether acoustic monitoring can be used to detect killer whale attacks. Compared to fish-eating killer whales, we found that groups of mammal-hunters traveled in complete silence the great majority of the time. Vocal behaviour was limited to brief bouts while the animals were surface-active or were milling after a successful attack. The animals started vocalizing following 11 of the 12 confirmed kills of marine mammals and kills where typically followed by distinctive sounds generated by the killer whales breaking up the prey carcass. This shows that certain acoustic cues are consistently associated with predation events and can be used to document their occurrence. Our findings indicate that acoustic monitoring should be incorporated into field studies attempting to assess the prey capture rates of mammal-eating killer whales and the impact of their predation on marine mammal populations.

Estimating Sperm Whale Abundance with Bayesian Mark-recapture

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In 2003 to 2005, 44 sperm whales were photo identified along the oceanic shelf edge in the eastern Gulf of Alaska. Many of these whales have learned to remove sablefish off demersal, longline gear. The goal was to determine the abundance of these sperm whales, using a mark-recapture model. Mark-recapture methods often produce poor results when the recapture sample size is too small. In particular the estimated variance of the Chapman estimator for a single release, single recapture experiment tends to be so large, that the lower confidence limit is less than the known number of marked animals at the time of release, a nonsensical result. Bayesian methodology can be used to provide more realistic results through the use of prior information about population parameters. In this talk a Bayesian method is developed for estimating the marked proportion of the population for a single release single recapture experiment. The prior distribution of the marked proportion is modeled as a beta distribution. The likelihood of the data is modeled with a binomial distribution. The posterior distribution of the marked proportion is an updated beta distribution. An implied distribution for N is then derived. The population abundance is estimated as the median of this implied distribution for N. A Bayesian credible interval for N is found with numerical integration. This Bayesian method is then extended to multiple release, multiple recapture experiments. These results will be used as part of the North Pacific Research Board study (R0309) to help define the scope of the interactions between sperm whales and longline fishing vessels.

Seabird Avoidance Gear Alternatives in Alaska Longline Fisheries: Collaborative Research With Small Vessel Operators

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Where seabirds are present, commercial longline vessels in Alaska have the potential to catch seabirds in their gear, in particular, species of special concern such as the endangered short-tailed albatross. As a result, the National Marine Fisheries Service in conjunction with the US Fish and Wildlife Service (FWS) developed regulations requiring commercial fishermen to deploy bird deterrent devices while fishing. In 2003 and 2004, the Alaska Sea Grant Marine Advisory Program undertook a collaborative demonstration research project with funds provided by the USFWS to develop and document additional practical ways of reducing bird interactions with longline gear deployed by small vessels, and to evaluate better ways to deploy and comply with current deterrent regulations. We relied upon the ingenuity and cooperation of small vessel owners to accomplish these goals. We did not evaluate the methods for effectiveness in deterring seabirds; rather, we concerned ourselves with the logistical and economic practicalities of new and existing methods. Six projects were undertaken with halibut longline vessels whose homeports ranged from Southeast Alaska to Kodiak. Recommendations as a result of this project are: 1) consideration be given to testing seabird deterrence of lighter weight streamer lines, 2) if found effective, lighter weight streamer lines be constructed and distributed for free to small boat operators, 3) research on the use of integrated weight groundline on smaller vessels be continued, and 4) outreach efforts be undertaken to inform smaller vessel owner/operators about buoy line covering, davit designs and associated costs, and streamline deployment.

Using Quantitative Fatty Acid Signature Analysis (QFASA) to Estimate Diet in Young Steller Sea Lions (SSL) in Prince William Sound, Alaska

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When weaning occurs and what prey species young SSL depend on are important questions in investigating the decline of SSL populations in Alaska. We employed QFASA to investigate these questions in young (2.5-48.0 month old) SSL in Prince William Sound (PWS). We used 207 blubber biopsy samples, 21 undigested milk samples, and a previously published fatty acid (FA) prey database from PWS (26 species) to estimate diet. QFASA requires that prey species be differentiated based on their FA signature. While this has previously been determined for PWS prey, we sought to determine whether milk samples as a whole (despite within-female variability from diet) could be differentiated from prey species. Milk samples were clearly distinguished from all other prey items using discriminate function analysis with 93% accuracy. To further investigate the differentiation of milk, we constructed 4 mixed-prey diets, each differing in the proportion of milk (range: 0-100%), and analyzed the ability of QFASA to estimate a simulated diet. Milk was underestimated by 18, 8 and 3% in simulation diets containing 100, 50 and 10% milk, respectively. Other components of the simulated diet (herring, pollock, salmon, and sand lance) were generally well-estimated and no milk was estimated for the simulation diet containing 0% milk. QFASA also requires calibration factors to account for FA metabolism within the predator. We used two sets of calibration factors: 1) those generated from captive SSL fed herring and 2) those generated from grey seal pups fed milk. Using SSL calibration factors, estimated diets of young SSL were dominated by herring, shrimp, sand lance, milk and squid. However, milk was approximately 8% of the diet across all ages. When modeled using the grey seal pup calibrations, milk, herring, eulachon, squid and salmon dominated, with milk showing a significant negative correlation (Pearson co-efficient=-0.331, $p<0.001$) with age. The results suggest that QFASA can be used to determine the proportion of milk in the diet of individual Steller sea lions, however, it will be important to determine how best to account for FA metabolism when diets contain a mixture of high fat milk and low fat fish species.

Remote Monitoring of Vital Rates in Harbor Seals (*Phoca vitulina*)

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Harbor seals (*Phoca vitulina*) have declined in parts of Alaska, while seal populations in other areas of the state remained stable or increased. Genetic data indicate that movements of individuals between areas cannot explain the declines. Fluctuations in population abundance can be evaluated by estimating survival and reproduction, and quantifying effects of proximate factors on those vital rates. In 2003 we initiated long-term vital rates studies in Prince William Sound (PWS) where seals numbers have declined by >65% (- 3.1%/yr 1990-2004). Thus far 122 seals in PWS have received subcutaneous VHF transmitters (Telonics IMP-300-L) duty-cycled for 5 years of battery life. At the time of capture we collect samples to assess age, genetics, body condition and health, diet, endocrinology profiles, disease and contaminant exposure. Long-term vital rates data from VHF implants, paired with data on diet and health of individuals, permits an assessment of what variables may differentiate between seals that survive and reproduce and those that do not, potentially elucidating factors contributing to declines of seals in those areas. In summer 2005, with funding from NPRB, we established six land-based dataloggers at multiple haulout sites to continuously monitor presence/absence of radio-tagged individuals and transmit those data via a geostationary operational environmental satellite (GOES). Initial problems with ambient electronic interference resulted in an unacceptably high level of false positive signals, identified by incorrect pulse rates or transmission times. Equipment modifications reduced the recording of false positives. Detection of seals radio-tagged in 2005 was high (92.7%) but datalogger resight (signal detection) of seals tagged in 2003 and 2004 was extremely low (27.3% and 10.4%, respectively). It is unlikely that all of these censored (undetected) signals are reflective of mortality rate. Herein we examine frequency of false-positive GOES data and discuss plans for ground-truthing and improving quality of data collected via remote monitoring.

Community-based Harvest Monitoring of Subsistence Harvest of Harbor Seals and Steller Sea Lions

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For the past twelve years the Alaska Native Harbor Seal Commission, in cooperation with the Alaska Department of Fish & Game Division of Subsistence, has collected information on the subsistence harvest of Harbor Seals and Steller sea lions annually. The data is collected through face-to-face interviews with hunters conducted by local research assistants in each community. The data collected include the total number of animals harvested (including struck and lost), the sex and approximate age of the animals harvested, and the timing of the hunt. The information is used by the National Marine Fisheries Service to document the number of animals harvested for subsistence in their stock assessment reports. It is also available to the public and may be used by Alaska Natives and/ or agencies to make better informed resource management decisions. The 2004 surveys included a question aimed at collecting traditional ecological knowledge. Respondents were asked about their perception of marine mammal population trends over the past 5 years. These traditional knowledge questions will be incorporated into the harvest monitoring surveys as the need for information related to a specific research project or community concern arises.

Do Food and Predators Play Inseparable Roles in the Decline of Prince William Sound Harbor Seals?

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Researchers generally have asked whether diminished resource abundance or increased predation have been major contributors to the declines of harbor seals and Steller sea lions in the Gulf of Alaska. An alternative possibility, however, is that resources and predators have inseparable effects on survival and reproduction. My talk will describe how my colleagues and I have integrated field studies and computer simulations in the search for synergistic effects of resources and predators on the harbor seal population of Prince William Sound. In addition to surveying our empirical data on the foraging ecology of harbor seals in Prince William Sound, I will address two related questions. Can declines in fish abundance indirectly increase predation rates on seals? And, given our huge ignorance of subsurface predator ecology, can we use the observed behaviour of seals to infer unmeasured characteristics of potential predators such as killer whales and sleeper sharks?

Harbor Seal (*Phoca vitulina*) -- Kayak Interactions in Pederson Lake, Kenai Fjords National Park

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Tourism is the fastest growing industry in Alaska and worldwide. Marine and ecotourism are expanding at the highest rates; assessments of the impacts of tourist activities on wildlife and the ecosystems are lacking. Kenai Fjords National Park was established in 1980 and has increased in popularity for both large vessel tours and kayakers. Harbor seals (*Phoca vitulina*) have experienced over an eighty percent decline in Aialik Bay during the past 25 years. Since 2002, a network of remote cameras has been used near Aialik and Pedersen glaciers to monitor number of seals and their responses to vessels. In the summer of 2005 an in-depth study on the impacts of kayaks in Pedersen Lake was initiated after increasing numbers of kayaks were observed in this secluded haulout. The objectives of this study are to: 1) quantify whether seal activity level increases in the presence of kayaks, 2) compare inter-annual variation in behavior and disturbances, 3) relate seal reactions to kayaker actions and 4) develop recommendations to help kayakers minimize disturbance. Kayak interactions and seal behavior were recorded during the molt from July through September via the remotely controlled video cameras system and by direct field observation. Number of kayaks observed in Pederson Lake increased from 7 in 2003 to 86 in 2005. In 2005, seals abandoned their haulout during 56% of the kayak interactions. Field observations indicate increased levels of harbor seal activity (alertness and abandoning ice) in the presence of kayaks ($P<0.001$). Further field observations will be conducted in 2006.

A Quality Assurance and Quality Control Program (QA/QC) for Lipid Extraction and Gas Chromatographic Analysis for Fatty Acids (FA): an Interlaboratory Study

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Collaborating groups have collected prey and blubber samples for fatty acid signature analysis to be used to model the diet of juvenile Steller Sea Lions (SSL) throughout their Alaskan range using quantitative fatty acid signature analysis (QFASA). Since these groups are analyzing the samples using different analytical laboratories it is essential that a uniform QA/QC program be in place to allow data sets to be merged for QFASA and to assure comparison of uniform data. As an initial assessment of the variability in lipid content and fatty acid analysis, all participating laboratories (n=7) agreed to analyze a specific certified sample purchased from the National Institute of Standards and Technology (NIST SRM 1946). Each laboratory then analyzed the samples and reported the data using their standard operating procedures. The seven participating laboratories conducted 3 to 5 replicate analysis of NIST SRM 1946. The certified compositional analysis supplied by NIST served as the control. The most significant discrepancy between laboratories is the suite of FA being identified by each lab. The number of FA identified as fatty acid methyl esters (FAME) and quantified ranged from 24 - 81 while NIST reported 28. Four laboratories reported over 65 FA while three reported less than 33. This result is especially significant in application of the QFASA model. The total extractable fat content reported averaged 9.92 ± 0.97% (n = 26) compared to 10.17 ± 0.48% reported by NIST. The FA quantitative results both among and between laboratories and when compared to the NIST certified levels were quite reliable with absolute differences ranging from 2.5% low for 18:1ω9 (29.51 vs. 31.16%) to 27% high for C20:0 (0.14 vs. 0.11%) when compared to NIST and variances between laboratories of 2.7% and 21% for 18:1ω9 and C20:0 respectively. These observations suggest a high degree of reliability of the quantitative data among laboratories but the limited range of FA reported from some laboratories places potential limitations of the data to the application of the QFASA model.

Tsaa Tl'ooni, "Tlingit Seal Hunter"

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'Respect the resource, be patient, be careful, be aware of the weather, take only what you need, share your harvest, and be thankful' are some of the underlying principles that the Tlingit of Southeast Alaska use to guide their harvest and use of Harbor Seals. Seal hunting by Alaska Natives is guided by long held and deeply respected protocols that govern all aspects of marine mammal and human interaction. The hunting, processing, and use of Harbor Seal derived products are 'part of a well developed cultural system of harvesting and processing techniques, ecological knowledge, social conventions, ethics, and beliefs' (Wolfe 1994:1). The Alaska Department of Fish and Game (ADFG), Division of Subsistence and Alaska Native organizations have worked together in a cooperative effort for over twenty years to document local knowledge. This poster will summarize interviews and surveys done in the early 1990s by Division staff in 16 Southeast communities. Selections from the following ADF&G publications were used to compile the information for this poster: Whiskers! Multicultural Multimedia Database for Alaska Marine Mammals (Mishler 1999); Ecology, Harvest, and Use of Harbor Seals and Sea Lions; Interview Materials from Alaska Native Hunters (Haynes & Wolf 1999); and Tlingit Seal Hunting (Wolfe 1994). Tlingit seal hunters are taught to respect, balance, and share, regulate, and pass on the values that guide the code of conduct that governs seal harvesting.

Distribution and Abundance of Juvenile Kittlitz's Murrelets in Kachemak Bay, Alaska, 2004-2005

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Kittlitz's murrelets (*Brachyramphus brevirostris*) are small alcids found only in waters of Alaska and Siberia. In Alaska, their population declined by >80-90%, and they became a candidate for ESA listing in 2004. Because they associate with glaciers, climate change may affect their prey or foraging habitat as glaciers recede. Their nests can not be monitored like other seabirds, and since few juveniles have been observed at sea, reproductive failure has been proposed as one reason for their decline. Our study is developing a protocol for at-sea monitoring of Kittlitz's, and will examine evidence of reproduction. During August of 2004 and 2005, we used small boats and strip transects to survey Kittlitz's in Kachemak Bay, Alaska (n = 23 days/year). We recorded 17 juveniles in 2004, but only 3 in 2005. Juvenile densities peaked on 8-10 August, with the highest daily density of 0.37 birds/km^2 in 2004. Most juveniles were in the inner bay, which is more highly stratified than the outer bay, and also where adults concentrated. Although numbers were low, the ratio of juveniles to adults were comparable to that of the more abundant marbled murrelet (B. marmoratus). Mean juvenile:adult ratio in the inner bay was 0.065, indicating that Kittlitz's can fledge chicks in the Kachemak area. The near absence of juveniles in 2005, however, suggests that in some years Kittlitz's have high nesting failure, or do not breed. Possible explanations for the annual differences are (1) normal fluctuations in reproductive success (boom and bust years), (2) poor conditions in 2005, which was preceded by an anomalously warm winter and spring, or (3) a need for improved identification of juveniles. The latter will require more 'birds in hand' for age confirmation. We will continue this study in 2006, and will increase efforts to capture juveniles.

Non-Invasive Monitoring of Testosterone in an Endangered Species, the Steller Sea Lion (*Eumetopias jubatus*)

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Inherent difficulties exist in obtaining blood samples for hormonal analysis from large free-ranging marine mammals. The use of feces as a medium offers a unique opportunity to provide an approximation of an animal's circulating concentration of hormones through non-invasive methods. In this study, an adult captive male Steller sea lion housed under ambient conditions at the Alaska SeaLife Center (Seward, AK) was monitored for both fecal and serum testosterone concentrations from May 2002 to June 2003. The objective of the investigation was to determine if the use of feces was applicable to monitoring testosterone for Steller sea lions (Eumetopias jubatus). A commercially available radio-immunoassay was validated for fecal testosterone in this species. Serum testosterone concentrations ranged from 0.07-1.74 ng/ml. Fecal testosterone values ranged from undetectable levels to 80.2 ng/g dry weight. Changes in serum testosterone were closely tracked by fecal testosterone, exhibiting a similar temporal trend in concentration patterns. In addition, fecal samples collected from the male Steller sea lion from January 2002 through December 2004 were analyzed. Samples were divided into seasons by the breeding (March to August) and non-breeding (September to March) seasons of the free-ranging population. Despite the captive state of the animal, fecal concentrations were significantly higher during the breeding season than non-breeding season ($p < 0.001$). These data support the use of feces as a reliable medium for non-invasive monitoring of testosterone for this endangered species. This method eliminates handling stress and allows for a viable alternative in sample collection when serum may not be possible to obtain.

Are Killer Whales Affecting the Recovery of Steller Sea Lions? Assessing Evidence in Kenai Fjords, Alaska

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The behavioral and predatory patterns of Gulf of Alaska transient (GAT) killer whales were studied between 2000 and 2005 using remote video and vessel-based observations near the Chiswell Island Steller sea lion rookery and in the broader Kenai Fjords region of the northern Gulf of Alaska. GAT killer whales were observed on 118 days and the median group size was 2 (range: 1-9). Nine predatory events were observed from vessels and an additional 16 were inferred from remote video studies; all involved Steller sea lions. Observed predation was consistent with the lowest published estimates of killer whale energetic requirements. GAT killer whales spent a large proportion (45%) of their time resting which may be a strategy for conserving energy. Low estimates of the proportion of the local population of sea lions consumed by GAT killer whales ranged from 4% to 8% over the years 2002 through 2005 but were not significantly different between years. Predation on sea lion pups at the Chiswell Island rookery was greatest during years when a single killer whale was foraging alone and when a 1.5 year old calf was being trained to kill. Older age-classes of sea lions were observed and presumed to be taken at other times when killer whales were foraging in groups. Our study suggests that GAT killer whales could be partially responsible for inhibiting the recovery of Steller sea lions in the Gulf of Alaska. Remote video studies will continue to monitor presence and predation by killer whales at the Chiswell Island Steller sea lion rookery. Additionally, satellite tags are being developed for attachment to GAT killer whales to assess their movement patterns when and where research vessels and remote video cameras are unable to track them.

Declines in Harbor Seal Numbers in Glacier Bay National Park, Alaska

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Glacier Bay National Park had one of the largest breeding aggregations of harbor seals in Alaska, and it is functionally the only marine reserve for harbor seals in Alaska. Yet, numbers of seals in Glacier Bay are declining rapidly, perhaps as an extension of the population declines that began in the Gulf of Alaska. Understanding why harbor seals are declining in a large area where they are more protected from human activities than anywhere else in Alaska may clarify their minimal habitat needs. We analyzed counts of seals from 1992 to 2002 from Johns Hopkins Inlet, a tidewater glacial fjord, from 559 counts over 191 days in June and and August, and aerial surveys of all terrestrial haulouts in Glacier Bay from 45 different days. We estimated population trends using models that controlled for environmental and observer-related factors. In 1992, 6,200 seals were counted on icebergs in a tidewater glacial fjord and at terrestrial sites; by 2002 only 2,550 seals were counted at these same haulouts. Numbers of non-pups in the glacial fjord declined by 6.6%/yr (-39%/8 yr) in June and by 9.6%/yr (-63%/11 yr) in August and at all other haulouts by 14.5%/yr (-75%/10 yrs) during August. In the glacial fjord the number of pups remained steady from 1994-1999 and made up an increasing proportion of seals counted (5.4%/yr), and the proportion of pups peaked at 34-36%. The rapid declines do not appear to be due to changes in seal behavior or redistribution. The declines reinforce genetic evidence that harbor seals in Glacier Bay are demographically isolated from other populations and indicate that the three current management stocks need to be redefined. Changes in Glacier Bay's ecosystem and population demographic data from the glacial fjord suggest that inter-specific competition and predation are likely factors in the declines.

Variability in Organochlorine Contamination in Both Blood and Blubber over Time in Captive Stellers Sea Lions (*Eumetopias jubatus*)

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Three adult captive Stellers sea lions (two females and one male) housed at the Alaska SeaLife Center in Seward, Alaska were temporally sampled for organochlorine contaminants over approximately a two year period (March 2001 to March 2003). Samples were analyzed in both blood and blubber. In blood for all three animals (n = 69), sumPCBs (wet weight) ranged from 1.10 to 17.00 ng/g and averaged 4.08 ± 0.27 ng/g. SumPCBs (lipid weight) ranged from 215.56 to 53,125.00 ng/g and averaged 10,378.01 ± 835.34 ng/g. SumDDTs (wet weight) ranged from 0.70 to 16.91 ng/g and averaged 3.52 ± 0.27 ng/g. SumDDTs (lipid weight) ranged from 2030.46 to 14,503.26 ng/g and averaged 5446.72 ± 297.64 ng/g. In blubber for all three animals (n = 19), sumPCBs (wet weight) ranged from 14.00 to 2800.00 ng/g and averaged 1087.16 ± 210.68 ng/g. SumPCBs (lipid weight) ranged from 517.86 to 38,659.79 ng/g and averaged 6379.06 ± 2100.49 ng/g. SumDDTs (wet weight) ranged from 22.00 to 3371.00 ng/g and averaged 1323.25 ± 246.64 ng/g. SumDDTs (lipid weight) ranged from 6804.19 to 19,268.79 ng/g and averaged 16,013.59 ± 676.38 ng/g. Concentrations in blood for all three animals were similar and followed a seasonal pattern with levels higher in late fall and lower in the early spring. Concentrations in blubber were similar for the females and followed a similar trend with noted variability but the male was considerably lower and declined over the study period. The way in which concentrations of organochlorine contaminants change over time in Stellers sea lions indicates that while blubber levels may vary, blood levels are more consistent between sexes and change with season which is likely associated to metabolization of blubber stores for various physiological needs.

Muscle Biochemistry of Nursing Harbor Seal (*Phoca vitulina*) Pups

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Harbor seal (*Phoca vitulina*) pups begin swimming almost immediately after birth, although dive performance lags that of adults for several months due, in part, to the pups' lower body oxygen stores. Blood and muscle are the main tissue oxygen stores, and recent studies in pinnipeds have suggested that muscle development begins during the lactation period, perhaps in response to developmental cues and muscle activity. As muscles develop to support breath hold diving activity, we predict that there would be a shift in their biochemical profile to reflect an increase in ability to support sustained aerobic metabolism. Changes expected are an increase in myoglobin concentration [Mb], higher densities of slow-oxidative muscle fibers, as indicated by increased levels of aerobic enzymes such as citrate synthase (CS) and β-hydroxyacyl CoA dehydrogenase (HOAD), and decreased levels of anaerobic enzymes such as lactate dehydrogenase (LDH). To examine muscle development in harbor seals, muscle biopsies were collected from the longissmus dorsii of known-age pups (n=65) and adult females (n=16) from the St. Lawrence River estuary in Quebec, Canada throughout the four-week nursing period during May-July of 2000-2002. Myoglobin concentration and enzyme levels were determined for the pups, and compared to those determined for adult females. Pup [Mb] were found to increase linearly from early to late lactation, but remained 59% lower than adult [Mb] at weaning (2.4 ± 0.2 vs. 5.9 ± 0.7 g/100g wet tissue). The levels of CS, HOAD, and LDH were determined in pup muscle tissue and compared to the enzymatic profiles of the adult tissue. The results of this study suggest that while the pup's muscles are becoming more aerobically poised during the nursing period, they are not fully developed at weaning. Future research will include determining muscle fiber types, mitochondrial densities, and capillary densities using transmission electron and light microscopy.

Samples from Subsistence: Harbor Seal Biosampling Program

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Following the Exxon-Valdez Oil Spill in 1989, Alaska Natives in communities impacted by the spill expressed interest in monitoring the harbor seal populations they depended on for subsistence. In 1996, the Alaska Native Harbor Seal Commission was awarded EVOS funds to initiate its harbor seal biosampling program. Through this program people from Alaska Native communities in areas affected by the oil spill were trained to collect biological samples from seals hunted for subsistence. In 1999, additional funds were secured through the North Pacific Research Board to expand the program statewide. Over 150 biosampling technicians have been certified from across Alaska. These technicians have collected samples from over 500 harbor seals statewide. The samples are archived at the University of Alaska Museum and are available for loan to researchers. Samples collected by the ANHSC biosampling program are routinely used by scientists from state and federal agencies and private research institutions to study the health of Alaska harbor seal populations. Biosampling technicians have the opportunity to contribute their traditional ecological knowledge with each sample they submit to provide Western scientists with additional insight. The Alaska Native Harbor Seal Commission communicates the results of all research to Alaska Native communities and facilitates collaboration between Western scientists and Alaska Natives.

Disease and Health Monitoring in Juvenile Steller Sea Lions (*Eumetopias jubatus*) Held in Temporary Captivity

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In August 2003, the Alaska SeaLife Center implemented a new research program focusing on free-ranging juvenile Steller sea lions (*Eumetopias jubatus*) from the endangered western stock. This project provides the ability to study wild animals for up to three months in a specialized quarantine facility, after which time the animals are returned to the wild. A major objective of this program is a comprehensive health and disease monitoring protocol which was developed to evaluate health and disease at admission and release, as well as for comparison to free-ranging control juvenile Steller sea lions (SSL) captured from the same geographical location. Serum was collected at capture from 20 transient juvenile SSL (age 1-2 years) along with 10 free-ranging juvenile SSL and has been tested for exposure to typical marine mammal infectious diseases. Serum was also tested at release from the transient juvenile SSL. All samples tested to date have shown no evidence of exposure to *Brucella* spp., morbillivirus or *Toxoplasma gondii* and animals in temporary captivity showed no increase in exposure to Leptospira spp. or phocine herpesvirus-1. Tracheal mucous and feces were collected opportunistically to evaluate parasite load. Nasal, rectal, preputial and vaginal swabs were screened for both normal and potentially pathogenic bacteria. Additional sensitivity testing was performed on E. coli isolates cultured from rectal swabs to assess whether antibiotic resistance had developed over the course of temporary captivity. These isolates have shown no resistance upon admission or release to 12 commonly used antibiotics. In summary, these results show that Steller sea lions held in temporary captivity for up to three months remained healthy and did not show evidence of exposure to disease or develop antibiotic resistance that could place free-ranging animals at risk for disease following their release.

Using Longline Fishing Vessels as Research Platforms to Assess the Population Structure, Acoustic Behavior and Feeding Ecology of Sperm Whales in the Gulf of Alaska

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In the Gulf of Alaska, depredation of demersal sablefish (*Anoplopoma fimbria*) longline fishing gear by sperm whales (*Physeter macrocephalus*) has occurred since at least the mid 1970s. In 1995, with the implementation of IFQ, the season extended to 8 months. This allowed more opportunity for whales to depredate longline gear and reports of depredation increased. No sperm whales were seriously injured but economic loss to the fleet has occurred. Beginning in 2003, the North Pacific Research Board funded a collaborative study among fishermen, scientists and managers to collect quantitative data on longline depredation. The goal of the study is to determine the mechanics of the depredation, characterize the whales involved, and to recommend changes in fishing behavior to reduce depredation. Typically, one to seven whales were found near fishing vessels during the haul. Genetic results determined the whales were male and 44 sperm whales were photo-identified. The median of the 2005 posterior distribution for sperm whales present in the study area is 90 whales with a 95% Bayesian credible interval of (65, 128). Data analyzed from seven fishermen's logbooks resulted in 124 sets monitored for whale presence and evidence of depredation. Whales were present near vessels one-third of the time and, of these sets, 71% had evidence of depredation. Whales were seen at the start of the haul 15%, and joined during the haul 30%, of the time. Whales joining the haul was not independent of depredation (Fisher's Exact Test, p=.0004) indicating when whales join the haul depredation is likely. Statistically significant decreases (about 3%) in CPUE (T-test, p=.023) were found when whales were present and/or there was evidence of depredation. Depredation was lowest in March and highest during mid summer. This initial phase proved successful in monitoring sperm whales near fishing vessels and evaluating the magnitude of the depredation.

Observations of Sperm Whale Longline Depredation in the Gulf of Alaska

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Historical whaling records indicate that sperm whales off southeast Alaska incorporate fish into their diets, particularly black cod (*Anoploploma fimbria*). Since 1995 this fact has become relevant to fisheries concerns in the form of increased depredation encounters between longline fishermen and at least 44 individual sperm whales. Since 2002 the SE Alaska Sperm Whale Avoidance Project (SEASWAP) has been studying this phenomenon using fishermen reports, photo-ID, and biopsies. Since 2004 autonomous recorders have been mounted on longline deployments to detect and track sperm whale acoustic activity, whenever fishing vessels were present and absent. By using acoustic multipath the range and depths of foraging whales can be determined from a single hydrophone. Findings to date indicate that whenever fishing vessels are absent, sperm whales are naturally foraging at mid-depth in the water column (e.g. 250 m in 500 m deep water), and that their dive cycle durations are similar to those reported in other areas. Whenever animals are around fishing vessels, however, the dive cycles are typically much shorter (e.g. 15 minutes or less) and position fixes on vocally active animals tend to be much shallower (e.g. 50 m). There is increasing evidence that distinctive acoustic cues made by hauling longline vessels attract the animals to longline activity, whenever the animals are less than 10 nautical miles range from the site. These cues do not seem to be associated with sounds made by specialized longline equipment, but rather relate to how the vessel is handled during a longline haul. Based on these observations, the SEASWAP effort is transitioning from observations to hypothesis testing of four lowcost strategies for reducing depredation. These include the increased use of 'circle hauls', deployment of decoy anchorlines, passive acoustic monitoring from fishing vessels, and slightly modified fishing gear that uses shortened gangions with acoustically-reflective surfaces.

Validation Studies of Blubber Quantitative Fatty Acid Signature Analysis (QFASA) with Captive Steller Sea Lions (*Eumetopias jubatus*)

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Reliable estimates of diets of marine mammals are vital for understanding their role in the ecosystem, but current quantification methods are often imprecise and biased. QFASA has been developed to estimate the species composition of marine mammal diets from the fatty acid (FA) signatures of their blubber and that of their potential prey. We conducted captive feeding studies (1-20 months each) on seven juvenile female Steller sea lions (SSL) to evaluate QFASA's ability to identify known diets and to provide information on FA turnover time, deposition, and FA calibration coefficient (FA-CC) data required for QFASA. For each animal, 4-9 sequential full-depth blubber biopsies (n=56) were collected mid-flank, following periods of controlled diet, including 1-12 week pulses of salmon, capelin, eulachon, pollock, pilchard or Atka mackerel, or 35-63 days of a consistent multi-species diet. Fish FA signatures varied among the 12 prey species tested (FA mean CV=0.83, range 0.2-3.7, n=515). Within prey species, CVs averaged 0.35 (range=0.19-0.45). Low variability (CV=0.18) was observed in 10 SSL FA-CC calculations (n=5 SSL) where herring diets exceeded 200 days. We subsequently ran QFASA using a mean SSL FA-CC and a new subset of 39 fatty acids. QFASA tracked 63% of eight long-term (>1 month) single species diet switches, performing best for animals on strict herring diets prior to the diet switch. Predictions of short-term and multi-species diet switches correctly identified herring as a major diet contributor, and also certain new diet items, but results were inconsistent, particularly in discerning between herring and small shoaling prey (e.g., capelin, pollock, squid). Species identification depended on the modeling parameters used; thus further optimization is required to reduce species misidentification levels. Sigmoidal decreases in the proportion of herring predicted by QFASA in 3 long-term diet switches showed that 90% of the FAs in blubber turned over within 3-4 months.

Fatty Acid and Stable Isotope Signatures Reveal Annual, Seasonal, and Age-Related Variability in Tufted Puffin Diets

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We propose that tufted puffins (*Fratercula cirrhata*) may serve as valuable biological indicators of prey availability, providing information on the effects of climate-driven changes in oceanographic conditions on prey assemblages in the North Pacific. Using stable isotope and fatty acid signature analysis, our primary objective is to relate variability in diet composition to reproductive success, chick growth rates and current oceanographic conditions; data come from adult and nestling tufted puffins breeding on a small island in Chiniak Bay, Kodiak, AK. To date, we have determined fatty acid profiles of adipose tissue sampled from 104 adults and 38 nestlings captured during three time periods in 2003 and 2004; pre-incubation (n=30), late-incubation (n=36), and late chick-rearing (n=38 adults and 38 nestlings). Discriminant analysis using the 14 most abundant fatty acids classified individuals with >90% accuracy and indicated that the diet of adults shifted across seasons and differed from nestlings. We measured concentrations of $\delta^{15}N$ and $\delta^{13}C$ in whole blood samples drawn from 78 adult and 59 nestlings in 2003 and 2004. Stable isotopes of Nitrogen indicated a seasonal trophic shift in adult diet: adults consumed primarily invertebrates prior to egg-laying, but gradually transitioned to a higher trophic-level diet during chick-rearing. Inter-annual variability in stable isotope and fatty acid signatures was much lower than seasonal variability indicating that reproductive stage may influence foraging strategies. Alternatively, a variable diet may reflect seasonal fluctuations in prey availability. Reproductive success did not differ between years. However, mass at fledging and lipid content of nestling diets were both lower in 2004. We propose that in years where high quality forage fish is not readily available to chick-rearing adults, condition of fledging-age nestlings may be compromised.

Gulf of Alaska - Integrated Ecosystem Observing Systems and Sensors

Monday, 23 January 2006: 4:30 - 6:15 PM

Session Chair and Poster Review: Mark Johnson

TALKS

Speaker	Title
Mark Johnson	The Alaska Ocean Observing System
Carl Schoch	A Demonstration of the Alaska Ocean Observing System in Prince William Sound
Yi Chao	Development of a Regional Ocean Modeling System (ROMS) for Real-Time Forecasting in Prince William Sound and Adjacent Alaska Coastal Waters
Stephen Okkonen	Monitoring Seasonal Changes in Prince William Sound Circulation
James Bodkin	Long Term Monitoring of Nearshore Habitats in the Gulf of Alaska: Why and How?
Sonia Batten	Relevance of the Continuous Plankton Recorder (CPR) Survey Results to Alaskan Fisheries Resource Issues
K. David Hyrenbach	Basin-wide Seabird Distributions Across the Sub-Arctic North Pacific (2002-2005): Seasonal and Interannual Variability

POSTERS

First Author	Title
Ross Mulllins	Tackling the Post-IERP Problem: PWSFRAP as prototype
Sheryl Salasky	Youth Area Watch Students Map and Survey Mineral Creek State Park
Marilyn Sigman	Community Involvement in Coastal Monitoring
David Welch	Applications of the Pacific Ocean Shelf Tracking System (POST): A Permanent Continental-Scale Acoustic Tracking Array for Fisheries Research & Ocean Observation

The Alaska Ocean Observing System

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AOOS is developing three integrated and geographically diverse Regional Coastal and Ocean Observing Systems (RCOOSs) for Alaska in the Gulf of Alaska, Bering Sea/Aleutian Islands and the Arctic with a pilot project established in Prince William Sound. Creating an integrated ocean observing system in Alaska is a unique challenge because Alaska's marine system is larger than the combined marine systems in the rest of the United States, has extensive marine oil and gas reserves essential to the nation, and includes one the most productive and valuable (~$1.5 billion in 2003) marine fisheries in the world. No other observing system in the United States has such climate extremes, significant geographic distances, and limited infrastructure. The AOOS mission is to create an integrated network of observations that provides easily accessible information about the past, current and future states (physical, chemical and biological) of Alaska's oceans and coastal marine waters and resources. To this, we have created at the University of Alaska Fairbanks a Data Management and Modeling and Analysis Group to develop, display and archive products from observations and models that will include surface and three-dimensional current velocities, significant wave heights, information products for search and rescue, oil spill response, coastal erosion mitigation (such as wave models and storm surge forecasts), and other needs developed through stakeholder participation. Our goals for this meeting are to introduce our web-based system for data access and display, solicit feedback from interested users on how to improve data products and access, and seek new collaborations with groups and individuals who can provide data to help make AOOS a complete source for marine information in Alaska.

A Demonstration of the Alaska Ocean Observing System in Prince William Sound

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The Oil Spill Recovery Institute (OSRI) and its partner organizations conduct research in Prince William Sound to enable detection and prediction of oil-spill related impacts and subsequent recovery. This mission led to the development of a regional atmospheric circulation model coupled to an ocean circulation model. The modeling program is now rapidly evolving to integrate with the Alaska Ocean Observing System (AOOS) and to take better advantage of real-time data streams from satellites, weather stations, and an enhanced observational oceanography program consisting of permanent moored buoys and seasonal hydrographic transects. There are two primary goals of the observing system in Prince William Sound. The first is to combine long-term monitoring with short-term hypothesis-driven process studies to understand mechanisms underlying the dynamics between the major coastal current (the Alaska Coastal Current) and the fauna and flora of the Pacific Ocean. Of particular interest is the development of a more comprehensive understanding of mechanisms that cause ecological variability. Understanding the circulation and the patterns of water exchange will provide a better scientific foundation for addressing fisheries and ecosystem management needs related to long term oceanic and climatic variability. The second goal is to provide information to the major user groups in PWS including the coastal communities, oil and gas transportation industry (tanker traffic and oil spill response), air taxis, commercial fishermen, recreational and commercial boaters, and Coast Guard search and rescue operations. For example, the high spatial resolution wind, wave and ocean current products will provide improved forecasts to recreational and commercial vessel and aircraft operators, and enhance the safety of oil tanker traffic in PWS. The newly developed and/or improved physical and ecological forecast products will enable resources managers to make better management decisions on food supply, predation, and human activities such as commercial and recreational fishing.

Development of a Regional Ocean Modeling System (ROMS) for Real-Time Forecasting in Prince William Sound and Adjacent Alaska Coastal Waters

Yi Chao, J. Farrara, Z. Li, P. Li, Q. Vu, X. Wang, H. Zhang, J. C. McWilliams, and X. Capet
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As part of the Prince William Sound Ocean Observing System (PWSOOS), the development of a Regional Ocean Modeling System (ROMS) will be described. The goal is to develop an operational modeling, data assimilation and forecasting system that can deliver both the physical and biological data products in real-time to research and application users. These data products include 3-dimensional ocean circulation fields (temperature, salinity and current), tides including both sea level and current, and lower trophic level ecosystem parameters. ROMS solves the primitive equations under the hydrostatic and Boussinesq approximations. ROMS is discretized in coastline- and terrain-following curvilinear coordinates. The major new features of the ROMS implementation for PWSOOS include the 3- dimensional variational (3DVAR) data assimilation method, a Pacific basin-scale ROMS that provides the needed boundary conditions for the PWSOOS ROMS configuration. We anticipate that the proposed PWSOOS ROMS forecasting system will be operational by 2007 during the proposed field experiment. Both in situ and satellite observations will be assimilated into this PWSOOS ROMS in real-time. Forced with the real-time forecast of the RAMS (Regional Atmospheric Modeling System) atmospheric fields, the PWSOOS 3D ocean circulation and tide can be predicted in real-time. The information and data products will be made available to both research and applications users in real-time through user-friendly interfaces.

Monitoring Seasonal Changes in Prince William Sound Circulation

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Non-tidal circulation within Prince William Sound changes from a wind-driven system during the winter to a buoyancy-driven system during the summer. Along-shore winter winds promote coastal convergence and sea level setup at the coast in the Gulf of Alaska. An along-shore current results. Because Prince William Sound is not fully enclosed, the along-shore current is somewhat constrained to flow into the Sound through Hinchinbrook Entrance and out of the Sound through Montague Strait. During summer, winds are weak and do not promote coastal convergence. However, large volumes of freshwater are discharged into the Gulf of Alaska and Prince William Sound from the surrounding coastal mountain watersheds. Copper River discharge flowing across Hinchinbrook Entrance, in conjunction with the coastal freshwater discharges within Prince William Sound effectively establishes a ring of freshwater around the central Sound. A buoyancy-driven, counterclockwise gyre in the central Sound results. These seasonal changes in circulation are illustrated by observations acquired by instrument platforms and hydrographic surveys of the Prince William Sound Ocean Observing System.

Long Term Monitoring of Nearshore Habitats in the Gulf of Alaska: Why and How?

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It is widely accepted that long-term monitoring of resources is of critical importance in detecting change, assigning cause, and taking actions to ameliorate human impacts. Because of the uncertainties surrounding the potential causes of future change, or the magnitudes of those changes, it is often difficult to envision how monitoring data can be used to provide specific benefits to conservation and restoration, overall ecosystem health, and socioeconomic conditions. However, it is a near certainty that changes will occur in the Gulf of Alaska in the decades to come, and that at least some of those changes will be adverse and caused by human activities. We provide three examples from marine ecosystems that illustrate how a long-term monitoring program can lead to early detection, regulatory action, a reduction in the extent of adverse environmental impacts, and a reduction in associated socioeconomic costs. With the intent of providing information necessary to meet the goals of the EVOS Restoration and Gulf Ecosystem Monitoring programs and the National Park Service Vital Signs program we have developed a long term monitoring protocol inclusive of nearshore habitats along Prince William Sound, Kenai/Lower Cook Inlet, Katmai, and Kodiak coasts. The protocol includes: 1) Synoptic sampling of physical and biological parameters (e.g. shoreline geomorphology and eelgrass cover); 2) Intensive sampling of a variety of specified biological and physical parameters (e.g. abundance and productivity of intertidal organisms, and selected birds and marine mammals), 3) Sampling of a smaller suite of selected biological and physical parameters (e.g. the abundance, growth, and contaminant levels in mussels and clams), and 4) Conduct of shorter-term studies aimed at identifying important processes regulating or causing changes within the nearshore.

Relevance of the Continuous Plankton Recorder (CPR) Survey Results to Alaskan Fisheries Resource Issues

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Previous presentations have focused on the time series of CPR data that has been collected with EVOS and NPRB support. Two examples currently being investigated that consider the role of eddies will be presented here that have implications for Alaska's commercial fisheries:

- Samples on a seasonal transect between 150°W and 175°W (the centre of the Alaska Gyre to the deep waters of the southern Bering Sea) were processed for euphausiid abundances. Our expectation, based on initial observations, was that there would be a negative correlation between water depth and euphausiid biomass in both the Gulf of Alaska and Bering Sea, so that highest biomass would be found in shallowest water, i.e. over the Aleutian shelf. While this held true for the Bering Sea, it was not the case in the Gulf of Alaska - in the fall and winter the highest biomass of euphausiids in the Gulf of Alaska were over the deep waters of the Aleutian trench. We speculate that eddies from the Alaskan Stream are responsible for this distribution and comment on the relationship between juvenile salmon and euphausiid distribution patterns.

- Recruitment is a key factor in determining the strength of commercial stocks of decapods such as Tanner, snow and Dungeness crab. One mechanism which may contribute to the dispersal of larvae is the anti-cyclonic eddies that form along the eastern continental margin of the northeast Pacific. These eddies contain shelf water and as they move offshore, planktonic organisms are shed and become subjected to surface wind-driven currents instead. CPR samples in which Decapoda had been recorded were re-examined and over 40 species/taxa were identified. Different species showed different distributions; *Chionoecetes* spp. larvae (Tanner/snow crab) for example were found mainly on the Alaskan shelf, but were also recorded from deeper waters in the Gulf of Alaska, presumably transported in eddies. A simulation of ocean surface currents was applied to examine the possible influence on plankton distributions and showed that large-scale westerly movements across the northern Gulf of Alaska are possible and may be a potential mechanism for the spread of shelf species throughout the region.

Basin-wide Seabird Distributions Across the Subarctic North Pacific (2002-2005): Seasonal and Interannual Variability

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In 2002, we initiated a multi-year monitoring program to survey marine bird and mammal communities from British Columbia (Canada) to Hokkaido (Japan), using the bulk-cargo carrier *Skaubryn* as a platform of opportunity. This project seeks to document spatial gradients in uppertrophic predator assemblages, as well as temporal fluctuations in community structure across the sub-arctic North Pacific Ocean and the southern Bering Sea. We first developed standardized survey techniques using pilot data collected during the summer and fall of 2002. Using these standardized protocols, we have completed nine more surveys since the summer of 2002. Herein, we summarize the seasonal (spring, summer, fall) and interannual (2002 - 2005) distribution patterns of the numerically dominant marine bird and mammal species along a standardized 7,500 km transect. Our replicate surveys have documented clear spatial gradients in faunal distributions, with a particularly striking east to west segregation of three shearwater species: Sooty Shearwaters (*Puffinus griseus*) dominate off BC and in the Gulf of Alaska, Short-tailed Shearwaters (*Puffinus tenuirostris*) are numerically dominant in the Southern Bering Sea, and Streaked Shearwaters (*Calonectris leucomelas*) are most numerous in the Kuroshio - Oyashio current. We have also documented seasonal changes associated with latitudinal shifts of sub-tropical and sub-arctic species, and east-west migration of sub-arctic species (Northern Fulmar *Fulmarus glacialis*, Black-legged Kittiwake *Rissa tridactyla*, Least Auklets *Aethia pusilla*) from Alaskan breeding colonies to distant wintering grounds. This novel synoptic perspective of seabird distributions across the North Pacific underscores the value of cargo vessels as platforms of opportunity. In particular, standardized regional comparisons are required to characterize the response of far-ranging upper-trophic predators and North Pacific marine ecosystems to environmental variability over basinwide scales.

Tackling the Post-IERP Problem: PWSFRAP as Prototype

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In 2005, the North Pacific Research Board (NPRB) and the National Research Council published a science plan whose centerpiece is the "Integrated Ecosystem Research Program" (IERP). The IERP is a significant and explicit refinement of prior formulations (e.g., 10-year duration, interdisciplinary, no single-factor analyses, stakeholder inclusion, prediction-based objectives and assessments). In 1993, the Prince William Sound Fisheries Ecosystem Planning Group (PWSFERPG) and the Exxon Valdez Oil Spill Trustee Council published the Sound Ecosystem Assessment (SEA) Science Plan. Driven by economic urgency and scientific necessity, the authors took a loose collection of contemporary ideas and capabilities and produced one of the first IERPs (then called "ecosystem approach"). Despite the lessons of a dozen years, both plans share a fatal flaw --- neither includes a contingency plan for success. The five-year SEA plan, based on a $20 million investment in research findings, capacity building, and region-specific scientific expertise, said nothing about year six. The new NPRB plan, suggesting a ten-year IERP with a $10 million investment in similar asset development, says nothing about year eleven. At the same moment in March 1999 when the highly-tuned, interdisciplinary, program-funded, SEA collaboration ceased to exist, the founders of the future Prince William Sound Fisheries Research Applications and Planning (PWSFRAP) met, set aside despair over forthcoming losses, and set about minimizing those losses, seeing the original motivating problems solved, and finding new applications as a means to economic viability. This poster describes PWSFRAP, its approach, lessons learned, and an outlook for the future. The first lesson is acknowledgement that post-IERP outcomes are stakeholder responsibilities, the second that useful outcomes require help. The poster argues for inclusion of the post-IERP problem in the current public dialogue regarding IERP and spill restoration and for its inclusion in statehood anniversary retrospectives.

Youth Area Watch Students Map and Survey Mineral Creek State Park

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The Valdez Youth Area Watch group continues the ongoing project of mapping and surveying the Mineral Creek State Park. The purpose of this project is to gather information regarding the species in this area for the Alaska Department of Fish and Game and the local Parks and Recreation Community, because of the interest to further develop this area. Our group had the opportunity to look at a number of different plans that The City of Valdez Planning and Zoning Commission had created, and we used the earlier observations and data to evaluate the effects each individual plan had on the ecosystem. We are using G.P.S. to map the various ecological zones and note the locations of bald eagle nesting sites, bear trails, and anadromous streams. We also conduct random and maximum density counts on the intertidal life in the Mineral Creek area with the aid of mud-core and quadrat sampling. Maximum density counts were conducted on barnacles and mussels present in April 2005. By taking the count in 3 different designated quadrants, we averaged the maximum density of barnacles (760) and mussels (83). We also took the random density, again designating 3 quadrants and averaging the random densities of barnacles (130) and mussels (49). The number of eagle nests in the area (2) was also recorded, as were the G.P.S. locations. After observing the activity of the nests concerning the use of them by eagles, we evaluated the effects that the plans for the Mineral Creek State Park had on these nests.

Community Involvement in Coastal Monitoring

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Citizen observations along Alaska's shoreline can provide the means for scientists to extend the spatial and temporal depth of specific datasets and for residents of coastal communities to contribute and communicate observations related to the status of specific populations and environmental conditions that may signal significant environmental changes related to resources upon which they depend for their livelihood or recreation. A community involvement plan has been completed for GEM Nearshore Monitoring with the following objectives:

- Inform community members about GEM ecosystem-scale research and monitoring
- Engage community members in key elements of decision-making, including selection of long-term monitoring sites of community interest
- Encourage and support community participation in sampling during program development and implementation of full-scale sampling
- Provide opportunities for community members, scientists, and natural resource managers to share data and information on a user-friendly website.

The Kachemak Bay CoastWalk program is being developed into the Gulf of Alaska CoastWatch program with data collection protocols aligned with GEM protocols and a database integrated with the Kachemak Bay Research Reserve GIS. Dean's recent review of CoastWalk legacy data will be used to refine quantitative data collection and provide different levels of participation tiered to different skill levels and expertise of the observers. Methods have been developed for collecting data on patterns of human use, marine invertebrate selected birds (live), dead birds and marine mammals (including collection of sea otter skulls), relative abundance of seaweed and seagrass, and geo-referencing specific types of data such as novel floatable debris (e.g., rubber duckies) evidence of shoreline erosion or deposition, and accumulations of trash or marine debris. Future work will adapt methods for collecting data on the abundance and density of marine invertebrates and seaweed indicator species from the LiMPETS citizen monitoring program in use in West Coast NOAA Marine Sanctuaries.

Applications of the Pacific Ocean Shelf Tracking System (POST): A Permanent Continental-Scale Acoustic Tracking Array for Fisheries Research & Ocean Observation

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The Census of Marine Life is helping to develop POST, a permanent continental-scale tracking array for the west coast of North America. 2004-05 was a two year field demonstration, and used six 20km long listening lines and several thousand acoustically tagged juvenile salmon (12-15 cm long). Detection rates for individual fish crossing 20 km long acoustic lines in the ocean was 91% in 2004, and rose to 96% in 2005. This increase represents a doubling of detection efficiency, from missing 1 fish in 11 to missing 1 fish in 20. Our results demonstrate striking differences in marine migration pathways and survival between different populations of the same salmon species, as well as between species and that these differences are directly measurable. In subsequent years we plan to include additional oceanographic sensors to provide detailed data on changes in bottom temperature, salinity, and currents for the entire west coast of North America as part of a single, seamless and permanent ocean observing array. This would describe how the oceanography of the west coast changes at a level of detail far beyond what is currently possible. Such data could be directly meshed with the fish movement & survival data to describe how animals move relative to changes in the three dimensional structure of the ocean that they migrate through. The development of POST promises a radical change in how marine science can be conducted in continental shelf and slope regions. It is now possible to contemplate direct in situ experiments of how different groups of marine fish respond (movement rates, survival) after 'treatment' (e.g. sea lice burden or El Niño/La Niña years) or to measure seasonal movements of individual stocks of fish of all species, not just salmon. This will change marine fisheries science from a discipline based on a very limited observational capacity to one based on direct experiment.

Exxon Valdez Oil Spill Restoration Process

Monday, 23 January 2006: 7:30 - 9:00 PM

POSTERS

First Author	Title
Joe Banta	Prince William Sound / Exxon Valdez Oil Spill Region Project Catalog
William Driskell	From Tankers to Tissues- Oil Degradation in Prince William Sound
Edward Glazier	Social and Economic Assessment of Major Oil Spill Litigation Settlement
Bonita Nelson	The Hydrocarbon Database- Long term Data in a Changing World
Riki Ott	Crude Oil and Human Health: The Legacy of the *Exxon Valdez* Oil Spill
Richard Thorne	Impacts of EVOS on Herring That Were Unknown at the Time of the Settlement

Prince William Sound/Exxon Valdez Oil Spill Region Project Catalog

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In 2004, the Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) began an annual publication of a project catalog for research sites. The catalog covers research projects in the Prince William Sound RCAC/Exxon Valdez Oil Spill region. Catalogs for 2004 and 2005 can be found at (http://www.pwsrcac.org/resources/catalog.html). Through an outreach process to various research and funding organizations, projects are identified and their locations plotted on interactive web-based maps in an effort to represent all the research that is currently being conducted in the region. The goals for the catalog include providing a central location to identify active or proposed projects in the PWSRCAC/ EVOS region and encouraging the coordination of research projects and the sharing of project information and resources. The catalog can also provide easy access to project information for the general public. The catalog is now entering its third year and the Prince William Sound Regional Citizens' Advisory Council and the North Pacific Research Board (NPRB) are working together to provide all project information through the NPRB website.

From Tankers to Tissues - Oil Degradation in Prince William Sound

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Crude oil in Prince William Sound (PWS) comes from three primary sources: 1) Monterey oil released from Valdez storage tanks in the 1964 earthquake, 2) the Exxon Valdez oil spill (EVOS) of Alaska North Slope (ANS) crude in 1989, and 3) treated ballast water from the Alyeska Marine Terminal in Port Valdez. Monterey oil currently appears as small splotches of asphalt on upper intertidal rocks in sporadic locations throughout the Sound. EVOS oil still resides in small quantities buried in several PWS beaches. Treated ballast water (~11 million gallons/day) containing very low-level amounts of weathered ANS crude oil, is discharged daily into Port Valdez. Fixed-location mussel monitoring has detected no significant discharge events beyond Port Valdez. But outside of PWS, a persistent background oil-like PAH signal occurs essentially unaltered in the sediments from upstream of the Copper River through Shelikof Strait.

Social and Economic Assessment of Major Oil Spill Litigation Settlement

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This paper describes the nature and status of the research and monitoring project titled, 'Social and Economic Assessment of Major Oil Spill Litigation Settlement.' The effort is being undertaken for the U.S. Department of the Interior, Minerals Management Service Alaska OCS Region. The overarching goal of the project is to contribute to the base of knowledge needed by public officials for balanced decision-making in the development and transportation of oil resources in the federal waters of Alaska and elsewhere in the coastal zone of the United States. A longitudinal case study approach has been employed to examine social and economic aspects of Exxon Valdez Oil Spill (EVOS) litigation and settlement processes and outcomes. The human geographic focus is Kodiak Island Borough, but related aspects of oil spills that have occurred elsewhere in Alaska are also being examined. Data regarding social, economic, and demographic trends and conditions in the study areas have been compiled and will serve as means for analyzing litigation settlement and related social processes vis-a-vis other events and processes occurring in the region during the period in question. This will require a second phase of data collection and monitoring following pending large-scale settlement. The paper describes the research design and economic and demographic models that have been developed for the study, and the litigation-related context and constraints that unavoidably affect the timing of the final analysis.

The Hydrocarbon Database- Long term Data in a Changing World

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The Exxon Valdez Oil Spill Trustee Council Hydrocarbon Database is the collection of hydrocarbon sample and analysis information collected since the beginning of the spill. The data has been collected from a variety of investigators, projects and agencies. This database has maintained integrity throughout changes in data managers, software changes and users and provides a useful model for establishing and maintaining long term data sets.

Crude Oil and Human Health: The Legacy of the Exxon Valdez Oil Spill

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Thirteen years after the 1989 Exxon Valdez Oil Spill (EVOS), we started an investigation to determine if this spill and subsequent 1989 cleanup affected the health of cleanup workers. We conducted a literature review for environmental pollutants present during the cleanup, including crude oil, crude oil mist, and crude oil aerosols (PAHs or polycyclic aromatic hydrocarbons); diesel fumes, and select dispersants, bioremediation products, and other cleanup chemicals. Known acute and chronic health effects are discussed. Available health and medical records from the State of Alaska (1,771 claims filed), Exxon (6,722 reported cases of Upper Respiratory Infections), and two toxic tort lawsuits show that workers reported acute symptoms identical to the potential symptoms listed in the literature review. Acute symptoms included respiratory problems and possible central nervous system (CNS) problems. A synthesis of available documents, including court records, congressional hearings, state records, and federal reports revealed that Exxon's worker safety program failed to adequately protect worker health. A 2003 survey of former EVOS cleanup workers, conducted independently through the Yale Medical School, found significantly higher self-reported chronic symptoms, including respiratory problems, CNS problems, and chemical sensitivities. Environmental medical doctors now recognize the 'petrochemical problem' - public health effects from low levels of exposure to PAHs. In 1999, the U.S. EPA listed 22 PAHs in crude oil on its list of persistent, bioaccumulative, toxic pollutants. Our findings indicate that the crude oil and chemicals present during the 1989 cleanup were hazardous to human health; that workers were likely exposed to dangerous levels of dangerous chemicals; and that workers likely developed acute and chronic symptoms from exposure to crude oil and chemicals present during the cleanup. The hazardous effects of PAHs to human health are particularly relevant to discussions of long-term harm to wildlife from the EVOS.

Impacts of EVOS on Herring That Were Unknown at the Time of the Settlement

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At the time of the Settlement in 1991, the Prince William Sound herring stock was not considered to be injured. In fact, the age-structured model used to manage the fishery estimated the population status in 1991 to be in excess of 100,000 mt. However, so few fish returned to spawn in 1993 that the commercial fishery was cancelled, and a late 1993 assessment estimated the actual population abundance at only 17,000 mt. For the next several years, investigations focused on why the population collapsed in 1993, with disease factors a leading hypothesis. However, recent evidence suggests that the population did not collapse in 1993; it actually began a substantial decline in 1989, coincident with the oil spill, and that decline persisted from 1989 to 1994. The evidence is based on a reconstruction of the population abundance using a combination of acoustic assessment and aerial surveys of miles of herring spawn. A pattern of persistent decline from 1989 to 1994 is also supported by abundance trends of several major predators of herring, including Steller sea lions. Further evidence can be found in a comparison of the estimates from the age structured model with those of the reconstruction. Both methods are in excellent agreement from 1980 to 1988, then sharply diverge from 1989 to 1994. The most logical explanation is a change in natural mortality in 1989 that caused the age structured model to overestimate herring abundance. Also subsequent to the Settlement is the documentation that herring rise to the surface each night to refill their swim bladders. This behavior provides a mechanism for direct contact between herring and surface toxicants from an oil spill. The intense and well-documented natural predation on herring would result in increased natural mortality under any circumstances where the health of the herring is impaired.

Marine Eco-Regions of Alaska

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At large spatial scales, Alaska marine waters are thought to include four Large Marine Ecosystems (LMEs): the Gulf of Alaska (GOA), Eastern Bering Sea (EBS), Chukchi Sea and Beaufort Sea. However, the boundaries assigned to these systems are somewhat arbitrary and based largely on continental features. Yes, the GOA is oceanographically distinct and geographically isolated from the EBS, but the Aleutian Archipelago is usually placed in the EBS, even though the south side of the chain is bathed in Alaska Stream waters from the GOA. Similarly, the southern Chukchi is arguably an extension of the northern EBS (or vice-versa) in terms of oceanography and biology, but is treated separately because the narrow Bering Strait offers a convenient geographic boundary for division of the two LMEs.

We can consider marine ecosystems of Alaska in a different way. For example, terrestrial ecosystems of Alaska have been categorized into "domains" (n=2) and "provinces" (n=15) based on climate, bio-geographic commonalities and dominant ecosystem processes. No such attempt has yet been made to delineate the marine ecosystems of Alaska. It is widely recognized, however, that there are sub-regions within the LMEs that can be characterized by their similarities in oceanography and biology, and these meso-scale "eco-regions" often cross LME boundaries. Using the known distribution of biological indicators such as seabirds, mammals, fish and plankton, and considering topographic and oceanographic features, we can identify at least 25 marine eco-regions in Alaska. Delineating these eco-regions is more than an academic exercise: fish and wildlife forage and reproduce at the intermediate spatial scales of eco-regions, and travel among contiguous eco-regions during migration. In order to be efficient, conservation and management efforts should operate at the same spatial scales and with some recognition of eco-region boundaries.

Bering Sea & Aleutian Islands - Climate & Oceanography

Tuesday, 24 January 2006: 8:30 - 9:45 AM

Session Chair and Poster Review: James Overland

TALKS

Speaker	Title
James Overland	A Major Climate/ecosystem Shift Observed in the Northern Bering Sea
Phyllis Stabeno	Spatial and Temporal Variability over the Eastern Bering Sea Shelf
Gleb Panteleev	Estimates of Summer Transport of the Kamchatka Current as a Variational Inverse of Hydrographic and Surface Drifter Data.
Katherine Hedstrom	Multi-Decadal Coupled Sea-Ice/Ocean Numerical Simulations of the Bering Sea
Haoguo Hu	Modeling the Bering Sea Circulation and Thermodynamic Characteristics Using an Coupled Ice-Ocean Model (CIOM)

POSTERS

First Author	Title
Igor Belkin	Bering Sea Frontal Pattern and its Variability
Douglas Dasher	Aleutian Islands, Alaska, Coastal Environmental Monitoring Assessment Program (EMAP): Sample Site Selection Methodology

A Major Climate/Ecosystem Shift Observed in the Northern Bering Sea

James Overland, Jacqueline M. Grebmeier, Sue E. Moore, Ed V. Farley, Eddy C. Carmack, L.W. Cooper, K E. Frey, J.H, Helle, F.A. McLaughlin, S. Lyn McNutt, and Phyllis Stabeno
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Based on new multi-disciplinary observations it appears that the ice-dominated Arctic shelf ecosystem of the northern Bering Sea, which favored benthic communities and bottom feeding sea ducks and marine mammals, is giving way to one more dominated by pelagic fish communities that was previously limited to the southeastern Bering Sea. Beginning in the late 1990s changes include: decreased benthic productivity southwest of St. Lawrence Island, decreased foraging range of gray whales in the Chirikov Basin north of St. Lawrence Island, increased pink salmon abundance, and changes in behavior of walrus in response to the replacement of stable pan- and pack-ice with brash and thin ice as noted by Native hunters. Continuation of such changes will clearly impact both subsistence harvests and commercial fisheries. Proximate causal factors are reduction in sea ice concentration and increased southerly wind anomalies during spring. These wind anomalies in turn are associated with a new Arctic climate pattern, with low pressure over Eurasia and high pressure over the North American Arctic. This new pattern differs from the two dominate hemispheric climate patterns for 1950-1999: the Arctic Oscillation and the Pacific North American pattern. The existence of a new pattern makes it more uncertain what climate state will follow the present period of strong warming in the Bering Sea. Although a shift back to cold climate conditions is possible due to large climate variability in high latitudes, the northern Bering Sea is part of a larger climate system and thus likely to follow Arctic-wide patterns of diminished sea ice cover. It is difficult to envision rapid removal of the heat already gained by the ocean in recent years in response to diminished sea ice concentration.

Spatial and Temporal Variability over the Eastern Bering Sea Shelf

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In May and in September/October 2005, a hydrographic survey was done along the 70-m isobath from southwest of St. Lawrence Island (M8: 62N, 173W) south to M2 (57N, 164W). Temperature, salinity, nutrients, fluorescence, chlorophyll and oxygen were measured at each of ~55 hydrographic stations. In addition, four long-term biophysical moorings (M2, M4, M5 and M8) were deployed in April and recovered in September/October 2005. Each mooring was designed to measure temperature, salinity, fluorescence, nitrate and currents. The hydrographic surveys reveal spatial scales of variability and the moorings reveal temporal scales. Maximum ice extent occurred around April 11, with ice present over much of the north-central shelf. The southern shelf was ice free. Sea ice strongly influenced the temperature, salinity, nutrients and structure of the water column throughout the summer. In spring, there was a sharp shift in temperature, salinity and nutrients at the location of maximum ice extent. As a result of the melting ice over the northern shelf, the water column was colder and fresher than over the southern shelf. The northern shelf was also more strongly stratified than the southeastern shelf. In addition, the spring phytoplankton bloom had already occurred over the northern shelf as evidenced by nitrate drawdown and significant chlorophyll accumulation at the bottom of water column. The differences in nutrients were also striking. Over the north-central shelf nitrate is depleted in upper layer, while in bottom the highest nutrients were observed. There were still significant nutrients over the southern shelf throughout the water column. It is evident from the fall survey that many of the physical differences persisted through the summer. As expected, depth integrated temperatures were higher in the south than in the north, while the north-central shelf is fresher than the southern shelf. Salinity stratification dominates in north, while temperature stratification dominates in south.

Estimates of Summer Transport of the Kamchatka Current as a Variational Inverse of Hydrographic and Surface Drifter Data

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Quasi-stationary summer Bering Sea circulation is reconstructed through assimilation of hydrographic and atmospheric climatologies, transport estimates through the Bering Strait, and surface drifter data into non-linear primitive equation model. Two numerical experiments were fulfilled. In experiment A we assimilated all available observations and derive the optimized state of the Bering Sea circulation. The obtained temperature, salinity and velocity fields provide the best fit to the data and satisfy the dynamical and kinematic constraints of the ocean circulation model. Our results indicate the splitting of the Kamchatka Current in the vicinity of the Shirshov Ridge. This branching is in agreement with independent ARGO drifter observations. It was also found, that the transport of the Kamchatka Current gradually increases downstream from 14 Sv in the Olyutorsky Gulf to the 24 Sv in the Kamchatka Strait. In experiment B we did not assimilate the surface drifter data, but instead, we took into account the transport estimate of 12 Sv through the Kamchatka Strait. This outflow estimate is derived from a number of publications implementing the dynamical method calculations. The obtained velocity fields reveals strong disagreement with the satellite tracked surface and subsurface (ARGO) drifters. Our results indicate the necessity of a more detailed study of the inflow/outflow transport through the southern boundary of the Bering Sea. Obtaining the optimal climate state of the Bering Sea is a necessary step in the development of the data assimilation system in the region. We will present the example of the now- and fore-cast of the circulation in the Bering Sea based on our results. We will also discuss the features of the future and short range forecast system data assimilation in Bering Sea.

Multi-Decadal Coupled Sea-Ice/Ocean Numerical Simulations of the Bering Sea

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A coupled, regional sea-ice/ocean model has been developed to examine the interannual to interdecadal variability of circulation, sea-ice extent, thickness and concentration within the Bering Sea for the period 1958-2000. In particular, we examine the variability induced by El Nino and the warm/cool phase in the Northeast Pacific, and identify the dominant physical terms (e.g. incoming shortwave radiation, sensible heat flux, advection of sea ice) leading to this variability. Our coupled model is based on the Regional Ocean Modeling System (ROMS), implemented at 10 km resolution for a Northeast Pacific domain, which includes the Gulf of Alaska and the Bering Sea. The regional model is embedded in a lower resolution basin-scale model, which is used to generate the large-scale signals and provides both boundary and initial conditions for the Bering Sea via one-away nesting. Ice dynamics are based on the efficient elastic-viscous-plastic rheology of Hunke and Dukowicz (1997), ice thermodynamics are based upon Mellor and Kantha (1989) and include a three level ice layer, a snow layer, and a molecular sublayer at the ice/ocean interface. Atmospheric forcing is derived from CCSM reanalysis fluxes. Regional model results for recent years are compared with satellite derived products based upon Pathfinder SSM/I and sea surface temperature.

Modeling the Bering Sea Circulation and Thermodynamic Characteristics Using an Coupled Ice-Ocean Model (CIOM)

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With our wave mixing parameterization is considered, the circulation and tidal current in the Bering Sea are investigated simultaneously using an regional CIOM based on Princeton Ocean Model. The model simulated the observed major circulation patterns and vertical temperature structure. The temperature of upper and bottom layers tends to be uniform due to the mixing of wave and tides, respectively, which are the main dynamical mechanism to form thermocl``ine. The simulated M2 and K1 co-tidal charts are consistent with previous studies. The result shows the western boundary Kamchatka Current flows along the western side of the basin; the Aleutian North Slope Current flows along the northern Aleutian Islands; the Bering Slope Current is evident northwestward along the 1000 m isobaths; the Bering Sea shelf current is northward. All these features from simulations are consistent with available observations. The simulated annual cycle of ice edge and ice thickness are consistent with available observation.

Bering Sea Frontal Pattern and its Variability

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Oceanic fronts of the Bering Sea are of primary importance to the sea's ecosystem. Notwithstanding decades of research, the Bering Sea frontal pattern remains poorly studied. Some fronts have just been newly-described from satellite data (Belkin and Cornillon, 2005). Since most studies were focused on the southeastern Bering Sea shelf, a comprehensive picture of the entire sea's frontal pattern is still lacking. In this presentation, such a balanced description is attempted. Seasonal, inter-annual and long-term variability of fronts and along-front currents, as well as of cross-frontal exchange, are fundamental physical determinants of habitats adjacent to respective fronts. These modes of frontal variability and their relations to the observed variability of the coupled ocean-sea ice-river runoff-atmosphere system and the ongoing climate change of the Bering Sea region are described, compared and discussed.

Aleutian Islands, Alaska, Coastal Environmental Monitoring Assessment Program (EMAP): Sample Site Selection Methodology

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Alaska's coastal marine shoreline of approximately 45,000 miles constitutes more than 50% of the total United States coastline. The surface area of coastal bays and estuaries in Alaska is 33,211 square miles, almost three times the estuarine area of the contiguous 48 states. Under the Clean Water Act (CWA) Sections 303(d) and 305(b), Alaska has the responsibility to report and identify causes and sources of water quality impairment by 'characterizing all the waters in Alaska'. This could be accomplished by taking a census of all the coastal waters in Alaska, but this is impracticable due to budgetary and logistical concerns. A practical, cost effective alternative to conducting a census to characterize all of Alaska's coastal waters is to implement a probabilistic survey sampling method. Implementation of the EPA Environmental Monitoring and Assessment Program (EMAP) generalized random tessellation stratified spatially-balanced survey (GRTS) design for an assessment of the nearshore marine environment in the Aleutian Islands will be discussed. This sampling design methodology provides for accurate estimates, with uncertainties, for various indicators and stressors over the entire population of interest within the Aleutian nearshore region. This type of survey design is an important tool to help resource managers, elected officials and the public see the 'big picture' for large regions, with known statistical confidence, and to report on the status and to assess trends in Alaska's aquatic ecological resources.

Bering Sea & Aleutian Islands - Lower Trophic Levels

Tuesday, 24 January 2006: 10:15 - 11:15 AM

Session Chair and Poster Review: George Hunt

TALKS

Speaker	Title
George Hunt	Bering Ecosystem Study (BEST)
Kohei Mizobata	Biochemical Enhancement Related to Mesoscale Eddies in the Bering Sea Green Belt
Jeffrey Napp	Regulation of Zooplankton Standing Stock and Production in the Southeast Bering Sea: Top-down v. Bottom-up Control and Recent Climate-Related Declines in a Subarctic Ecosystem
Lisa Eisner	Variations in Physical and Biological Oceanography and Forage Fish (Juvenile Salmon and Age-0 Pollock) Distributions During Fall in the Eastern Bering Sea

POSTERS

First Author	Title
Mark Benfield	Semi-automated Processing of Bering Sea Zooplankton Samples Using ZOOIMAGE Software
Clara Deal	An Ecosystem Model Study of Plankton and Nutrient Dynamics in the Bering Sea Shelf with a Focus on the Nitrogen Budget and Water Column Nitrification
Lawrence Schaufler	Fatty Acid Composition of Mesozooplankton from the Bering Sea

Bering Ecosystem Study (BEST)

George Hunt, Ben Fitzhugh, and David Hyrenbach
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The goal of the Bering Ecosystem Study (BEST) Program is to develop a fundamental understanding of how climate change will affect the marine ecosystems of the eastern Bering Sea, the continued use of its resources, and the economic, social and cultural sustainability of the people who depend on it. BEST was conceived as an integrated, collaborative, interdisciplinary study of the eastern Bering Sea shelf between the Alaska Peninsula and St. Lawrence Island. It is anticipated that fieldwork will occur in 2007, 2008 and 2009, with 2010 as a year for synthesis and write-up. Cruises are anticipated to start in mid-March and conclude at the end of June, with an icebreaker working the study area from 15 March through 22 May, and an ice-strengthened vessel from 26 April through 30 June of each year. The focus of the fieldwork planned for 2007-2009 is to understand the role of changing sea-ice conditions on the chemical, physical, and biological characteristics of the ecosystem and human resource use activities is the most urgent research priority of the BEST Program. An important component of BEST focuses on social science issues, and was developed in collaboration with Alaskan Native Community participation. During the next several years, many organizations and programs in addition to BEST will be investigating the eastern Bering Sea and the effects of climate variability on its resources and people. It is expected that, through close cooperation and integration of effort, a much stronger program will emerge than could have been sustained by any one agency alone.

Biochemical Enhancement Related to Mesoscale Eddies in the Bering Sea Green Belt

Kohei Mizobata, Jia Wang, and Sei-ichi Saitoh
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This study investigated the Bering Slope Current (BSC) eddy field, the primary production and the shelf-slope exchange during 1998-2002, using a 3-D ocean general circulation model and satellite multi-sensor remote sensing. The eddy simulation revealed, 1) the fluctuation of eddy field is resulted from BSC-bathymetry interaction and baroclinic instability, and 2) high eddy activity induces the increase in on-/off- shore flux along the shelf break. While the eddy activity is high during summer, the influence of the wind field on the eddy activity is small because of low wind speed (about 2~3ms-1). In 1999, a La Nina year (indicating weak Aleutian Low in winter), the altimeter analysis shows the stable eddy field and low primary production over the Bering Sea basin and along the Gulf of Alaska. In 2002, an El Nino year (indicating strong Aleutian Low in winter), however, high eddy activity field and primary production emerged around Aleutian Passes, and over the Bering Sea Basin. The variability of eddy kinetic energy over the Bering Sea Basin is affected by the inflow of North Pacific water through Aleutian Passes. These results indicate that the eddy field and the primary production over the Bering Sea basin tend to be changed by the climatic forcing through the inflow from Aleutian Passes.

Regulation of Zooplankton Standing Stock and Production in the Southeast Bering Sea: Top-down v. Bottom-up Control and Recent Climate-related Declines in a Subarctic Ecosystem

Jeffrey Napp, G.L. Hunt, Jr., S.E. Moore, C.T. Baier, and N. Shiga
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The eastern Bering Sea ecosystem is an ecotone, straddling the Subarctic and Arctic biogeographic provinces. High standing stocks of zooplankton in the southeastern Bering Sea are responsible, in part, for the high production of commercial living marine resources. The Bering Sea ecosystem has demonstrated rapid responses to past climate variability, and bottom-up forcing has a strong role in the structure and function of eastern Bering Sea ecosystems. Recently, warming of eastern Bering Sea waters has been accompanied by a decrease in summer zooplankton biomass in all four regions examined (the basin, and the outer, middle, and inner shelf waters). The decrease in biomass is due, in part, to a decrease in the copepod, *Calanus marshallae*, although this does not explain the decline in zooplankton biomass in all four regions. We examined the possibility that top-down control might be an important factor in the decline of summer zooplankton biomass, and found that, potentially, in aggregate, zooplankton predators could consume more than 400% of the standing stock, and 460% of the annual production of zooplankton, thus indicating the strong possibility of top-down control. Estimates of percent removal by individual planktivorous predators range from 1% (seabirds) to greater than 100% (fishes). Lack of sufficient zooplankton prey may force some predators to shift to alternate prey, or to shift the location of their foraging (e.g. fin whales, *Balaenoptera physalus*). The Oscillating Control Hypothesis, one construct for interpreting forcing of the Bering Sea ecosystem, is revisited based on these new findings.

Variations in Physical and Biological Oceanography and Forage Fish (Juvenile Salmon and Age-0 Pollock) Distributions During Fall in the Eastern Bering Sea

Lisa Eisner, Kristin D. Cieciel, Mary D. Courtney, Edward V. Farley, Angela Middleton, James M. Murphy, John Pohl, and John H. Helle
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Surveys were conducted during fall 2000-2005 on the eastern Bering Sea shelf, as part of a multi-year international research program, Bering-Aleutian Salmon International Survey (BASIS). Stations were spaced 15-30 km apart between 54°N and 68°N from inshore (30 m depth contour) to the shelf break, although spatial coverage varied from year to year. Forage fish were captured with a surface net trawl, zooplankton data were collected with oblique bongo tows and oceanographic data were obtained from conductivity-temperature-depth (CTD) vertical profiles and laboratory analyses of discrete water samples. Oceanographic variables include temperature, salinity, nutrients, phytoplankton size structure and biomass (based on chlorophyll a size fractionation). Inter-annual variations in water mass properties, phytoplankton and zooplankton characteristics and distributions of forage fish (primarily juvenile salmon and age-0 pollock) are compared over the southern and northern shelf and across frontal regions. A long-term goal of our research is to characterize inter-annual and spatial variations in these shelf ecosystems during fall. Our results will be used to monitor the effects of climate variations on fisheries and lower trophic level ecology in the eastern Bering Sea.

Semi-automated Processing of Bering Sea Zooplankton Samples Using ZOOIMAGE Software

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Conventional methods for enumerating and measuring zooplankton samples consist of: randomly dividing the sample into representative fractions (splitting); separation of the contents of the split into taxonomic groups of interest; and measurement of subsamples of each taxonomic group to estimate size-frequency distributions. This approach is time-consuming and imposes a considerable lag between sample collection and interpretation of the results. New techniques such as silhouette photography can produce a 1:1 photographic contact print of the contents of a split, which can then be scanned at high resolution to produce an image that can then be enumerated and measured using interactive Matlab software. This approach is still time consuming but has the advantages of easier and more accurate estimation of lengths and production of a digital record of the contents of the sample. The development of new semi-automated image analysis software called ZOOIMAGE represents a further advance in processing technology. This software allows a silhouette image or a direct scan of the sample contents to be counted and measured by the software. With the aid of a set of taxonomically classified images identified by a human expert, the software can be trained to automatically classify the contents of new plankton samples. We present a comparative example of the time required to process, and accuracy of results from Bering Sea zooplankton samples collected with a Multinet sampler as part of an NPRB-funded study.

An Ecosystem Model Study of Plankton and Nutrient Dynamics in the Bering Sea Shelf with a Focus on the Nitrogen Budget and Water Column Nitrification

Clara Deal, M. Jin, J. Wang, and T. Whitledge
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High nutrient levels support high primary production in the Bering Sea, one of the world's most productive marine ecosystems. To investigate the role water column nitrification in primary production on seasonal to annual time scales, we applied a one-dimensional physical model coupled to a one-dimensional biological model to time series data from the NOAA-Pacific Marine Environmental Laboratory (PMEL) M2 mooring site. The physical model includes a 2° level turbulence model with wind mixing, thermal stratification and tidal forcing introduced to improve tidal mixing. The biological model contains nine compartments: phytoplankton (diatoms, flagellates), nutrients (nitrate-nitrite, ammonium, dissolved silicon), zooplankton (small copepods, large copepods, microzooplankton) and detritus. Model results show summer storm events replenish nitrate in the mixed layer by bringing nitrate from below to the surface resulting in enhanced chlorophyll concentrations. An evaluation of nitrification using the model supports the hypothesis that increases in late-summer nitrate concentrations observed in the southeastern Bering Sea bottom waters are due to conversion of ammonium to nitrate (nitrification) and agrees well with previously estimated nitrate replenishment rates of 20-30% based on observations. The results of this study suggest that models of primary productivity in the southeastern Bering Sea need to include nitrification, potentially the source of up to ~28% of the springtime water column nitrate, which would support ~20% of the May to mid-September primary production.

Fatty Acid Composition of Mesozooplankton From The Bering Sea

Lawrence Schaufler and Jeff Napp
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Fatty acids are often used to trace trophic relations among species occupying the lowest levels of food webs. However, application of these methods to the Bering Sea and north Pacific is constrained by the limited availability of fatty acid data describing the mesozooplankton commonly found in these regions. We present fatty acid and alcohol compositions of mesoplankton including euphausiids, copepods, decapods, pteropods, and other taxa commonly found in the Bering Sea. Differences in the fatty acid compositions detected among the species examined suggest species-specific differences in the degree of carnivory and herbivory. Moreover, fatty acid compositions reveal differences among species with respect to their dependence on diatom and dinoflagellate energy sources. Examination of the fatty alcohols comprising copepod waxes indicates a number of markers that may be useful in discriminating the presence of *N. cristatus* and *C. marshallae* from *E. bungii* in the lipids of their predators. These data provide a basis for understanding fatty acid sources in upper trophic levels and therefore support future efforts aimed at tracing the nutritional dependencies of species occupying higher trophic levels.

Tuesday, January 24: Lunch Keynote Address

The 'Alaska Tsunami' Research Project: Education and Public Outreach (EPO) by High School Students Investigating Regional Marine Resource Issues

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The Alaska regional National Ocean Sciences Bowl (NOSB) competition, known as the Alaska Tsunami Bowl, is unique among the 25 regional competitions nationwide in that a research project is included in determining the team that represents Alaska in the national competition. Students from 21 different high schools in 17 communities have addressed regionally important marine resource issues by researching the science, management, and socioeconomic factors involved. Through this process, students work as a team, interviewing local managers, users, and community leaders. They prepare both a written research paper and an oral presentation before an audience of scientific judges and other high school students, teachers, and parents in Seward. Topics during the past three years included contaminants, climate change, and ecosystem management. As the video clips and student presentations will show, the perks of this EPO approach are that:

- Students attack research projects from 'outside the box', resulting in meaningful results that surprise researchers and resource managers.
- Teams have opportunities to present their research projects beyond the Alaska Tsunami competition, and in several cases have been instrumental in local and statewide changes.
- Because of the oral presentation requirement, teams practice their presentation before their classmates, parents, and local contacts. This greatly expands the educational value of their work.
- High school students get to know researchers and managers as real people involved with and interested in their projects and perspectives.

Bering Sea & Aleutian Islands - Fish & Fish Habitat

Tuesday, 24 January 2006: 11:15 AM - 2:30 PM

Session Chair and Poster Review: Chris Rooper

TALKS

Speaker	Title
Chris Rooper	Determining Juvenile Pacific Ocean Perch Habitat in the Eastern Aleutian Islands
Toshihide Hamazaki	Analyses of Bering Sea Bottom Trawl Surveys in Norton Sound: Absence of Regime Shift Effect on Epifauna and Demersal Fishes.
Gerald Hoff	Nursery Grounds of the Alaska Skate
Tim Loher	Investigating Declining Halibut (*Hippoglossus stenolepis*) Abundance in the Pribilof Islands: Is Temperature Important?
Christian Zimmerman	Estuarine Ecology of Juvenile Chum Salmon in Kuskokwim Bay, Alaska
Shigehiko Urawa	NPAFC International Cooperative Research Designates the Distribution of Asian and North American Chum Salmon Stocks in the Bering Sea and North Pacific Ocean
Gunnar Knapp	An Overview of Alaska Pollock Markets

POSTERS

First Author	Title
Matthew Berman	Spatial Fisheries Values in the North Pacific
M. Elizabeth Conners	Results of the Pacific Cod Local Depletion Study
David Ebert	Age, Growth, and Reproduction of Four Alaskan Softnose Skates (Chondrichthyes: Rajiformes: Arhynchobatidae: *Bathyraja*)
Jared Guthridge	The Effect of Temperature on Hatch Time for Atka Mackerel
Scott Johnson	Shallow Nearshore Fishes of Alaska: an Online Atlas
Douglas Kinzey	Multispecies Modeling of Three Commercial Fish Species in the Aleutians
Mandy Lindeberg	Bering Sea Forage Fish: Do They Use the Shallow Nearshore?
Susanne McDermott	Reproductive Biology of Atka Mackerel
Sara Miller	Feasibility of Estimating Movement Within a Spatially-Explicit Stock Assessment Model of Eastern Bering Sea Walleye Pollock (*Theragra chalcogramma*)
Jane Reid	The Integration of Alaskan Surficial Seabed Characteristics Using the usSEABED Knowledge System

Bering Sea & Aleutian Islands - Fish & Fish Habitat

POSTERS (continued)

First Author	Title
Haixue Shen	Interaction Between Commercial Fishing and Walleye Pollock in Eastern Bering Sea
Sandra Parker Stetter	Survey Strategies for Assessment of Bering Sea Forage Species
Bradley Stevens	Embryo Development and Morphometry in the Blue King Crab *Paralithodes platypus* Studied by Image and Cluster Analysis
Naoki Tojo	Environmental Cues for Herring Spawning Timing in Northern Bristol Bay

Determining Juvenile Pacific Ocean Perch Habitat in the Eastern Aleutian Islands

Chris Rooper, Mark Zimmermann, and Jennifer Boldt
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Juvenile Pacific ocean perch (POP) habitat use was examined at three sites near Samalga Pass in the Aleutian Islands during this study. The goals of this research are to assess the ecological value of differing habitats to juvenile POP by mapping study areas using multibeam and sidescan sonar, modeling relationships between juvenile rockfish abundance and habitat characteristics, and linking the habitat to juvenile POP abundance and condition. We used a combination of underwater video and acoustic methods to classify seafloor habitats and developed a statistical methodology for prediction of habitat types based on acoustic data. Fish habitat use was estimated using a combination of underwater video observations and bottom trawls which also collected individuals for laboratory analysis. Seafloor habitats ranged from featureless sand areas to hard bottom substrates that were almost entirely covered in benthic invertebrates (sponges and corals). Juvenile POP were most abundant in complex habitats (predominantly boulder fields), where fish condition was the lowest. There was substantial variability in the zooplankton biomass, water column structure and habitat types available between two of the study areas, which may account for observed variability in POP abundance and condition.

Analyses of Bering Sea Bottom Trawl Surveys in Norton Sound: Absence of Regime Shift Effect on Epifauna and Demersal Fishes

Toshihide Hamazaki, Lowell Fair, Leslie Watson, and Elisabeth Brennan
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This study retrospectively examined evidence of the effects of ocean climate regime shifts on epifauna and demersal fishes of Norton Sound, Alaska, northeast Bering Sea, collected by triennial bottom-trawl surveys from 1976 to 2002. Throughout the period, benthic fauna was dominated by sea stars (48.78%), followed by cods (5.19%), flatfishes (5.15%), sculpins (15.7%), and crabs (2.6%). From 1976 to 2002, the CPUE index of total species increased exponentially (4.5% yr^{-1}) by three fold with some declines in 1991 and 1999. The increase was also observed in sea stars (5.1% yr^{-1}), flatfishes (6.1% yr^{-1}), and crabs (2.5% yr^{-1}). However, trends of cods and sculpins were mixed. Regression analysis showed the CPUE index of total species positively correlated with survey years and bottom water temperature. However, when bottom water temperature was independently regressed, it was not significant. Those measurements indicate regime shifts brought biomass increases of Norton Sound epifauna and demersal fishes.

Nursery Grounds of the Alaska Skate

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Nursery grounds for the Alaska Skate *Bathyraja parmifera* were identified in the south eastern Bering Sea. Through seasonal sampling, biological and physical aspects of the nursery grounds were studied. The nursery site was relatively small in area (~5 nm^2) and was active year round. All sampling periods showed high densities of viable eggs and sexually mature males and female skates present. Although actively reproducing year round, there were two distinct pulses of reproductive activity in summer and winter months. Egg depositional cycles were estimated to last several months and embryo development times may be greater than 1 year. Predation on young skates was evident at two levels. Eggs are prey upon in early development by an unknown gastropod species, and newly hatched juveniles are consumed by Pacific cod and Pacific halibut. The reproduction cycle and development time of embryos, sources of mortality to juvenile and embryonic skates, and direction of future research will be discussed.

Investigating Declining Halibut (*Hippoglossus stenolepis*) Abundance in the Pribilof Islands: Is Temperature Important?

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Halibut catches around the Pribilof Islands in the southeast Bering Sea have declined markedly during the present decade, with harvest shortfalls amounting to >50% of combined harvest quotas since 2003. Harvest shortfalls of this magnitude can have serious consequences for the local community that relies upon the halibut fishery to provide both food and a major input to the local economy. Declines in both harvest and CPUE have led to speculation regarding underlying causes, including the possibility of fishery-induced local depletion. In addition to local harvest, changing environmental conditions might also be a factor determining either abundance or catchability of local stock components. In particular, halibut conduct an annual onshore-offshore spawning migration with Pribilof Canyon representing the area's most important slope spawning ground. Fish typically move from slope-to-shelf in spring and depart shallow water at the onset of winter. Regional ocean conditions that influence their movement may alter residence time within the shallows or cause them to use alternate migratory pathways to move between the slope and shallow feeding habitat. The goal of the present study is to better understand relationships between water temperature and halibut abundance on both intra- and inter-annual time scales, in order to understand how climate variability might influence local fisheries that operate close to their home ports. In 2002, a pilot study was initiated to determine the feasibility of deploying temperature loggers on commercial gear in order to monitor temperatures experienced by the fleet and correlate them with catch. In 2003, with financial assistance from NPRB, the study was expanded. In 2003 and 2004, data were obtained from over total 450 commercial longline sets, providing information on nearshore summertime temperature variability and allowing for preliminary analysis of the potential effects on catch.

Estuarine Ecology of Juvenile Chum Salmon in Kuskokwim Bay, Alaska

Christian Zimmerman, Nicola Hillgruber, Sean E. Burril, and Lewis Haldorson,
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Estuaries may function as important nurseries for juvenile chum salmon *(Oncorhynchus keta)*; however, little is known about this early life stage, particularly in Western Alaska. Here we present results on timing of out-migration, distribution, feeding, and condition of chum salmon juveniles in 2003 and 2004 in Kuskokwim Bay. Juveniles were sampled on a station grid from June through August in 2003, and from May through June in 2004. In the lab, juvenile diet was determined and average energy density was measured. Otolith microstructure and microchemistry was used to estimate duration of marine residence. In 2003, proportionate abundance of chum salmon decreased from 7.7% of the total catch in June to 0.1% in July. No juvenile chum salmon were caught in August of 2003. Mean fork length (FL) increased from 49.2 mm (n = 56, SD = 3.895) in June to 55.8 mm (n = 3, SD = 6.028) in July of 2003. In 2004, proportionate abundance of juvenile chum increased from 0.3% in May to 47.8% in June and mean FL increased from 38.3 mm (n = 11, SD = 2.490) in May to 51.3 mm (n = 808, SD = 4.516) in June. Density of juvenile chum salmon was highest closest to the river mouth, with out-migrating juveniles following the main river channels and the eastern shore of Kuskokwim Bay. Energy density of juvenile chum salmon in 2003 declined from 4751.49 cal/g (n=61, SD=115.37) in June to 4709.45 cal/g (n=3, SD=30.08) in July. In 2004, juvenile chum salmon energy density was 5200.43 cal/g (n=77, SD=176.25) in May, but declined seasonally. Small copepods and dipterans comprised the majority of juvenile chum salmon prey items, comprising 95.5% and 3.7% of the overall diet in 2003 and 91.9% and 4.6% in 2004. The large abundance of dipterans in the diet of juvenile chum salmon, particularly in fish caught close to the river mouth, suggests feeding at the water surface. Using a bioenergetics model, we will assess the growth potential of juvenile chum salmon in Kuskokwim Bay.

NPAFC International Cooperative Research Designates the Distribution of Asian and North American Chum Salmon Stocks in the Bering Sea and North Pacific Ocean

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The North Pacific Anadromous Fish Commission (NPAFC) was established to promote the conservation of anadromous Pacific salmon stocks in the ocean. One of its principal activities is international cooperative research by member countries (Canada, Japan, Korea, Russia, and USA). Various salmon stocks originating in fresh waters of Asia and North America intermingle in common feeding grounds in the North Pacific Ocean and adjacent seas. A better understanding of salmon community structure will encourage their sustainable conservation in the ocean ecosystems. Thus the NPAFC cooperative research on the genetic stock identification (GSI) to determine the distribution and migration of sockeye and chum salmon in the Bering Sea is ongoing with a financial support from the North Pacific Research Board (NPRB Project #R0303). Chum salmon is a major pelagic fish species in the North Pacific ecosystems. The stock-specific ocean distribution of chum salmon was estimated by GSI. Analysis of allozyme variation (20 loci) was used to determine the stock origins of mixture of fish caught by trawl operations of research vessel in the Bering Sea and North Pacific Ocean from early August to mid September 2003. The GSI-estimates combined with catch data (CPUE) indicated that the ocean distribution patterns of immature chum salmon were different among regional stocks. The Japanese stock was distributed in the central Bering Sea. The distribution of the Russian stock was similar to the distribution of Japanese chum salmon, but also spread into the North Pacific Ocean. Northwestern Alaska stocks including fall chum salmon from the Yukon River were distributed mainly in southern waters of the western Gulf of Alaska. The Alaska Peninsula/Kodiak stock was widely distributed in the Bering Sea and North Pacific Ocean, extending to 175°E. The Southeast (SE) Alaska/North BC stock appeared in the northern Gulf of Alaska and southern Bering Sea. The distribution of the South BC/Washington stock was similar with that of SE Alaska/North BC stock, but extended to northern waters in the Bering Sea. The ocean distribution and migration patterns of salmon stocks may be affected by various factors such as abundance of food organisms, interactions within or between species, ocean conditions (water temperature, salinity, depth, current etc.), timing and location of spawning, and winter habitats.

An Overview of Alaska Pollock Markets

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Alaska's pollock resources support an industry worth hundreds of millions of dollars in annual first wholesale value of production. This value and the economic success of the industry is driven not only by pollock harvests but also by world markets for the products made from Alaska pollock. This presentation provides an overview of markets for Alaska pollock, based on reports prepared for the Pollock Conservation Cooperative Research Center and the North Pacific Fishery Management Council. Alaska pollock markets are complex. Three major products account for most of the first wholesale value: fillets, surimi and roe. Pollock fillets are sold primarily in the U.S. and European markets, while surimi and roe are sold primarily in Asian markets, particularly Japan. Markets for each product are very different and experience different trends over time in world demand, competing sources of supply, and prices. Alaska pollock products compete with production from harvests in Russian waters, much of which is processed in China. Russian pollock resources have declined significantly in recent years, helping to strengthen markets for Alaska products. Alaska pollock fillets also compete with other whitefish fillets (increasingly including farmed tilapia) and surimi produced from a number of other species.

Spatial Fisheries Values in the North Pacific

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We develop methods to estimate the spatial and temporal variation in economic value of groundfish fisheries in the U.S. waters of the North Pacific. The research addresses two related objectives: (1) enable valuation of groundfish fisheries at spatial scales relevant to management decisions on marine protected areas; (2) explicitly link spatial and temporal variability of fisheries values to observable environmental variables. The research proceeds in two stages: First, we undertake statistical analyses to associate biomass surveys and fisheries catch per unit of effort (CPUE) with environmental variables at a detailed spatial scale (ca. 3km grid) and short time step (ca. 1 wk). Environmental variables include bathymetry, remotely sensed observations on physical and biological oceanography, and numerically modeled output. Second, we derive spatial values from econometric analyses that predict the location and intensity of fisheries effort over time as a function of modeled CPUE and spatial cost factors. The research has a direct application to decisions on marine protected areas, providing the ability to estimate opportunity costs to fisheries of boundary changes, and the variability of opportunity costs over time of spatial fisheries closures. It also provides a method to project spatial fishery effects of climate variability and change, as well as a step toward dynamic spatial modeling of linked fisheries and ecosystems.

Results of the Pacific Cod Local Depletion Study

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The Fisheries Interaction Team at the Alaska Fisheries Science Center has completed three years of a field experiment on localized depletion of Pacific cod in the heavily-fished region of the southeast Bering Sea. The study was designed to determine if intensive trawl fishing for cod creates a localized depletion in fish abundance that could adversely affect prey availability for endangered Steller sea lions. The experiment uses a before-after, treatment-control type design to compare the seasonal rate of change in cod abundance within the Cape Sarichef no-trawl zone to the rate of change in the adjacent heavily-trawled area. In each of the three years, the non-parametric statistical test has overwhelmingly indicated no difference between sites in the trawled and untrawled areas (p-values of 0.86 to 0.98). Power of the 2003 test was low due to small sample size, but power calculations indicate that the experiments in 2004 and 2005 would have been able to detect a reduction in the average catch of the trawled zone in the range of 20-30%. The concept of localized depletion is strongly dependent on assumed spatial and temporal scale. The experiment looked for an effect based on assumptions that fishing effects would be evident within 5 nmi of the removal and persist for at least several weeks. The observed results indicate that actual fishing effects occur at different spatial and temporal scales. The results of concurrent tagging and biological studies suggest that the cod stocks in the study area are highly mobile over time scales shorter than two weeks. In order for a fishery to produce persistent localized depletion, the target pool of fish must be static over an extended time period. Our work in 'cod alley' leads us to believe that this assumption is not valid for Pacific cod, at least in this region.

Age, Growth, and Reproduction of Four Alaskan Softnose Skates (Chondrichthyes: Rajiformes: Arhynchobatidae: *Bathyraja*)

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In Alaska, skates are taken in large numbers as bycatch in groundfish fisheries, with an estimated 30,552 metric tons caught in 2002. Additionally, a directed fishery for skates has emerged in the Gulf of Alaska. Given the large available biomass of skates and the need for alternative fishery targets and better bycatch utilization, Alaskan skates are likely to be increasingly targeted. Because many elasmobranchs, including skates, have life history characteristics that make them especially vulnerable to fishing (e.g. slow growth, large size at maturity, low fecundity), it is extremely important to harvest these species with caution. A lack of life history information on Alaskan skates, however, severely limits the potential for effective management. To address this knowledge gap, the age, growth, and reproductive biology of four common bathyrajid species are being determined. Field sampling is taking place in the Eastern Bering Sea and Gulf of Alaska. To date, 701 *Bathyraja aleutica*, 382 *B. interrupta*, 268 *B. minispinosa*, and 134 *B. taranetzi* have been sampled during survey cruises. Vertebral centra, caudal thorns and reproductive tracts have been collected from these specimens. Successful completion of this project will provide fishery scientists and resource managers with critical biological information for effective management of four common Alaskan skate species. Establishing species-specific regulations and/or quotas as fisheries are being developed is necessary to ensure sustainability of these potentially susceptible batoids.

The Effect of Temperature on Hatch Time for Atka Mackerel

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Atka mackerel (*Pleurogrammus monopterygius*) inhabit the southern Bering Sea and northern Pacific Ocean, ranging from Asia to North America. Because they support an annual multimillion dollar commercial trawl fishery and are an intricate part of the marine ecosystem, a better understanding of Atka mackerel reproductive ecology is needed to establish more reliable management of this species. The objective of this study was to determine the time from fertilization until hatching at different constant temperatures comparable to those observed in situ. Fertilized eggs were collected from captive Atka mackerel, transferred into closed-system incubation tanks, sub sampled at regular intervals, and preserved in Stockard's solution. Spawning events were video recorded to determine time zero. A total of 11 egg batches spawned in 2004 and 9 spawned in 2005 were used for incubation experiments. Incubation regimes were set at temperatures of 10, 7, 5, and 4°C. Duration from spawning to first hatching was a function of incubation temperature, with first hatching occurring at 43.5 days (10°C), 64.7 days (7°C), 84 days (5°C), and 100.7 days (4°C) after fertilization. The collected data will be used to describe a complete embryonic developmental series for Atka mackerel. A detailed description of the embryonic development with regard to temperature will allow the assessment of age of eggs in situ. As a consequence it will be possible to estimate spawning and hatching dates and the extent of the spawning season, thus providing critical information for better stock assessment and management of Atka mackerel in Alaskan waters.

Shallow Nearshore Fishes of Alaska: an Online Atlas

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We have developed an online atlas on the distribution and habitat use of 87 fish species captured in shallow nearshore (<5 m deep, <20 m from shore) waters of Alaska. Regions sampled include southeastern Alaska, the Aleutian Islands, and the Arctic. Fish were captured with a beach seine at 47 locations from 1998 to 2005. Habitats sampled included soft bottoms with eelgrass, cobble beaches with understory kelps, steep bedrock outcroppings, and sand or gravel beaches with no rooted vegetation. A total of 643 seine hauls yielded 517,632 fish. Based on total catch, the three most abundant species were walleye pollock, Pacific sand lance, and Pacific herring. Total fish catch by habitat type was 182,342 in eelgrass, 154,566 in kelp, 118,565 in bedrock outcroppings, and 62,159 in bare (no rooted vegetation) sites. Juveniles dominated the catch of all species captured; mean size of walleye pollock, sand lance, and herring was <100 mm fork length. Distribution patterns were evident for many species; for example, in southeastern Alaska, crescent gunnel were widely distributed, whereas kelp perch were confined to southern waters, and black rockfish to more outside coastal waters. Nearshore waters support a diverse and abundant community of fishes, many of commercial importance. This online atlas provides valuable information on the distribution and habitat of nearshore fishes and allows scientists and managers to query species, habitat, and site data over wide spatial scales in Alaska.

Multispecies Modeling of Three Commercial Fish Species in the Aleutians

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Age-structured models of fish populations that interact as predators and prey have generally been based on variants of multispecies VPA, or involved deterministic time series of predators as 'forcing functions' external to the prey dynamics. We present a multispecies extension to the statistical catch-at-age paradigm in which data on diet composition are used formally to estimate the parameters determining predation. The model is an extension of the one currently used to assess some of the fish stocks in the North Pacific region by the AFSC. Our multispecies catch-at-age model is applied to Pacific cod, walleye pollock and Atka mackerel on the Aleutian shelf. The interactions among these species are important to clarify because these three species support the largest Aleutian fisheries, and are also key components of the food web supporting species such as Steller sea lions. We compare the estimates of natural mortality from models that incorporate diet data with the natural mortalities from single-species assessments that do not.

Bering Sea Forage Fish: Do They Use the Shallow Nearshore?

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Nearshore waters of the Bering Sea provide habitat for several forage fish species that are important in the diet of marine mammals, sea birds, and other fishes. In June 2005, we sampled shallow nearshore waters (<5 m deep) of the Bering Sea with a beach seine to estimate forage fish distribution and relative abundance. Three habitat types were sampled: non-vegetated sandy substrate, vegetated cobble substrate, and vegetated bedrock substrate. A total of 70 sites were seined on Akutan, Akun, and Unalaska Islands. Total catch was 84,077 fish representing 27 species. Catches varied widely from no fish to over 15,000 fish per seine haul. Pacific sand lance was the dominant forage fish species captured - approximately 35,000 were caught - and they occurred in 60% of all seine hauls. Mean size of sand lance captured was 106 mm fork length (FL). Other commonly captured forage fish were young-of-the-year Pacific sandfish (mean FL = 36 mm) and young-of-the year-gadids (mean FL = 31 mm). Catch per seine haul (all fish species) was 1,170 fish in non-vegetated sandy substrate sites, 1,648 fish in vegetated cobble sites, and 98 fish in vegetated bedrock substrate sites. Most sand lance (98%) were caught in non-vegetated sandy substrate sites, and most sandfish (96%) and gadids (97%) were caught in vegetated cobble substrate sites. Although we caught forage fish in shallow nearshore waters in June, use of the nearshore by forage fish in other seasons and other areas of the Bering Sea is unknown.

Reproductive Biology of Atka Mackerel

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The reproductive ecology of Atka mackerel was funded as NPRB project 522. This talk will give an overview of the 4 different studies currently conducted within this project. Atka mackerel reproductive stages were analyzed with respect to their spatial and temporal distribution. Atka mackerel are batch spawners that spawn over an extended period along the Aleutian chain in high current areas. Atka mackerel exhibit a complex small scale distribution of mature and immature fish within local populations. The relationship of spawning locations and fishing areas were explored and it appears that Atka mackerel spawn mostly within the trawl exclusion zones at our study sites, indicating that the exclusion zones might be de facto marine protected areas for Atka mackerel. Atka mackerel length and age at maturity were examined for three consecutive years (2002-2004) as a separate part of the study. Age at maturity varied little over year and area, whereas length at maturity varied by area and year. This was contributed to yearclass size and varying length at age by area. Atka mackerel embryos were incubated at different temperatures at the Alaska SeaLife Center to allow the construction of developmental series. This information is essential since egg development at low temperatures in deeper waters could extend the spawning season dramatically and influence distribution patterns. Preliminary results from the 2005 spawning season will be discussed. A genetic study was conducted investigating egg cannibalism and mating strategies. Parentage of cannibalized egg clutches was determined. Preliminary results show that the total number of parents contributing to a clutch ranged from two to seven. Most cannibals were excluded as possible parents of clutches they had consumed; however one male cannibalized his own offspring.

Feasibility of Estimating Movement Within a Spatially-explicit Stock Assessment Model of Eastern Bering Sea Walleye Pollock (*Theragra chalcogramma*)

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Currently the stock assessment for walleye pollock (*Theragra chalcogramma*) in the eastern Bering Sea (EBS) has no spatial component, although there is much interest in pollock distribution and abundance at smaller spatial scales. Because both feeding and spawning movements dominate the seasonal spatial distribution dynamics of pollock, the fishery could differentially affect fishing mortality and abundance spatially. In order to eventually advance the EBS pollock stock assessment by including spatial structure, we first investigate the statistical feasibility of estimating movement parameters of EBS pollock from a mark-recapture experiment. The first experimental design examined was a Petersen experiment, involving a single release event of tagged fish (from a research operation) and a single recapture event (from samples of the commercial catch). We found that it is feasible to tag and recapture a sufficient number of fish for estimating abundance. Based on a previous field study, the maximum number of pollock that can be tagged is 240,000 per vessel (4,000/day with a 2 month tagging season). For the entire population of age 1+ pollock, less than 5% of the harvest would need to be examined for tags at a level of precision 1-alpha=0.95, an accuracy of A=10%, and use of a single tagging vessel for two months For an older population of age 3+ pollock, less than 5% of the harvest would need to be examined for tags. The second experimental design examined was the Darroch method for estimating movement parameters between two strata, the northwest and southeast areas of the EBS. Marking and recapture sample sizes were allocated between the two strata either evenly, proportionally to the bottom trawl survey estimates, or proportionally to the commercial catch. We found that estimation of movement can be done with confidence, if the movement is not random and the total sample size requirements follow Robson and Regier's (1964) method for an accuracy level of 10%. All allocations for sample size between the two strata gave similar results.

The Integration of Alaskan Surficial Seabed Characteristics Using the usSEABED Knowledge System

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Few marine researchers doubt the need for uniform, integrated, digital information about surficial seafloor sediment and rocky bottom character and distributions, to aid in the mapping of habitats, the search for marine resources, and the analysis of Quaternary history. In a perfect world, some research group (or a coalition of groups) would fund a uniform study of the U.S. Exclusive Economic Zone (USEEZ) to support these studies, and a group of dedicated researchers would spend years analyzing and synthesizing the data gathered by a host of ships' crews. In a practical world, many researchers have performed excellent, albeit small-scale, studies of areas that, in total, essentially cover the U.S. continental shelves. However, these studies have not yet been used to create a broad, integrated analysis of the seafloor due to different methodologies and seemingly overwhelming task of compiling the hundreds of reports and datasets that cover the USEEZ. The USGS and its collaborators are compiling and integrating seabed observations and analyses from these reports and datasets to create usSEABED (http://walrus.wr.usgs.gov/usseabed), an integrated, uniform knowledge system based on the information integration system, dbSEABED (http://instaar.colorado.edu/~jenkinsc/dbseabed). usSEABED holds point data for texture, statistical values, numeric values for descriptive data, and selected geochemical and geophysical parameters, including (as of 2005), more than 200,000 sites for the lower 48 states. In Alaska, we are presently working to include the abundance of data collected by the USGS, the National Ocean Service, the US Navy, and universities, oil companies, and other federal agencies, totaling tens to hundreds of thousands of data points, into usSEABED. For this symposium, we present the work-in-progress for usSEABED in Alaska, seek further useable data and partners for usSEABED, and show some of the ways usSEABED data are being used elsewhere in the US. We hope that usSEABED will provide an ongoing data source and data repository to aid the marine science community's understanding of seafloor character, processes, and resources.

Interaction Between Commercial Fishing and Walleye Pollock in Eastern Bering Sea

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Walleye pollock (*Theragra chalcogramma*) is the main prey species of Steller sea lions (*Eumetopias jubatus*). Great concerns existed over potential biological interactions between Steller sea lions and commercial fishing following the reclassification of the western population of sea lions as endangered under terms of the ESA in 1997. The goal of this study is to reveal if commercial fishing changes the aggregation pattern of Eastern Bering Sea (EBS) walleye pollock, thereby affecting predation opportunity for Seller sea lion. Here we used the hydroacoustic data collected from fishing vessels equipped with Simrad ES 60 split-beam echosounders operating at 38 kHz. By using Echoview 3.0, several energetic and morphological descriptors of the walleye pollock schools were evaluated to better understand whether significant differences exist at the scale of the fish aggregations occurred in response to fishing. Variograms were also used to describe the spatial structure of walleye pollock. Study results will be presented in meeting.

Survey Strategies for Assessment of Bering Sea Forage Species

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Remote sensing and direct sampling technologies were used to examine the distribution, species composition, and ecological role of nektonic organisms within Bering Sea nearshore, continental shelf, and slope habitats. Sampling technologies used in our integrated survey included acoustics (splitbeam echosounders), optics (LIDAR, ZOOVIS, ROV), jig, and nets (midwater trawl, MultiNet, bongo, seine). We were interested in evaluating methods for assessing distribution, abundance, and life history characteristics of forage species including myctophids, bathylagids, Pacific sandlance, and Pacific sandfish. We completed nearshore and continental shelf/slope surveys in the southeastern Bering Sea near Unalaska, Akutan, and Akun Islands between June 8 and 22, 2005. Completed samples included 488 km of acoustic transects, 23,125 km of optic (aerial) measurements, 24 continental shelf/slope sampling stations, and 18 nearshore sampling stations. Preliminary results suggest that pelagic nekton are patchy in continental shelf and slope habitats and that spatial and temporal distributional variance was species- and region-dependent. LIDAR and aerial observations suggest that marine mammals and birds are closely associated with high-density fish or invertebrate patches. Challenges associated with integrating an assessment survey with a multi-trophic sampling program are not trivial.

Embryo Development and Morphometry in the Blue King Crab *Paralithodes platypus* Studied by Image and Cluster Analysis

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Despite the value of Bering Sea crab fisheries, embryonic development has been described for few commercial species, and no standard exists for defining developmental stages. This study examines the embryonic development of the blue king crab, Paralithodes platypus, from the Pribilof Islands in the eastern Bering Sea. Fertilized embryos were removed at various intervals throughout their development. Digital photographs of embryos were made with a compound microscope and analyzed using a commercial image analysis system. Seven morphometric parameters were measured (total area, yolk area, embryo length and width, average diameter, eye length and width) and four indices were calculated (percent yolk, ellipticity, elongation, and circularity). First divisions were not apparent until day 4, after which divisions occurred daily until the blastopore appeared at day 28. A 'V'-shaped embryo became apparent on day 114, followed by rapid appendage development. The eyes became pigmented by day 192. Hatching occurred from day 381 to day 409, and required at least 33 days to complete. Embryo area declined from an initial value of 0.95 mm^2 on day 1 to 0.83 mm^2 on day 72, then increased to 1.28 mm^2 on day 388. Growth of all characters reached a plateau between days 240 and 353, and then increased rapidly until day 395. Developmental stages were defined both visually, and by using cluster analysis of select embryo measurements. Both methods resulted in an optimum selection of 12 stages. Visual methods were better at defining early changes, but morphometric measurements were better at defining middle and later stages. Application of morphometric analysis techniques may lead to improved understanding of crustacean embryogenesis and enable studies of subtle effects associated with environmental influences. The technique also has applications in the aquaculture industry.

Environmental Cues for Herring Spawning Timing in Northern Bristol Bay

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Spawning timing of Pacific herring (*Clupea pallasi*) typically varies by ±1 week interannually in northern Bristol Bay. Herring sac-roe fisheries in this region depend on availability of herring with mature roe, which are available during limited fishing opportunities at the start of the spawning season. To reduce risks of foregone harvests associated with unexpectedly early spawning or additional operating costs associated with premature mobilization for unexpectedly late spawning, accurate prediction models were developed. Relationships between herring spawning and environmental variables were investigated in intensive spatio-temporal analyses using ArcGIS, principal components analysis, and multiple regressions. Environment conditions in spring (March and April) were significantly correlated with the arrival and spawning timing of herring in northern Bristol Bay in May. Regression analyses detected significant relationships between both spawning timing and school arrival dates and combinations of environmental variables (air-sea-ice variables at the migration corridor, environmental control variables at the coastal spawning sites, and those variables at wintering ground ($P < 0.001$ $r^2 \sim 0.70$). The April variables showed most significant statistical relationships. The main effects of climate-driven thermal dynamics on pre-spawning herring physiology and behavior occur in offshore winter-spring habitats during maturation and migration and in inshore habitats in northern Bristol Bay during final maturation just prior to spawning.

Bering Sea & Aleutian Islands - Seabirds

Tuesday, 24 January 2006: 2:30 - 4:15 PM

Session Chair and Poster Review: David Roseneau

TALKS

Speaker	Title
David Roseneau	Expanding the Seabird Tissue Archival and Monitoring Project (STAMP) in the North Pacific
Paul Becker	Expanding the Seabird Tissue Archival and Monitoring Project (STAMP) in the North Pacific: Interim Analytical Results
Ian C. Rose	Seabird Diet and Nesting Success: Indicators of Ocean Conditions in the Northern Bering Sea
Shiway Wang	Foraging Patterns of Northern Fulmars (*Fulmarus glacialis*) in Alaska Inferred from Fatty Acid Signature Analysis
Stephani Zador	Integrating Data to Assess the Risk of Short-tailed Albatrosses Interacting with Trawlers in the North Pacific

POSTERS

First Author	Title
Paul Becker	Applying Statistical Power Analysis to the Design of a Long-term Environmental Monitoring and Banking Program: Chemical Contaminants and the Seabird Tissue Archival and Monitoring Project (STAMP)
Paul Becker	Banking and Use of Seabird Eggs from the Seabird Tissue Archival and Monitoring Project (STAMP)
Paul Becker	Distribution and Speciation of Mercury and Organotin Compounds in Seabird Eggs from Colonies in the Alaskan Coastal Ecosystem
Ellen Lance	Ecological Implications of Fisheries-Based Economic Development in Nelson Lagoon: Steller's Eider (*Polysticta stelleri*) Critical Habitat.
Robert Suryan	Satellite Tracking Albatrosses In Alaska: Preliminary Results of the 2005 Field Season
Stacy Vander Pol	Contaminants in Seabird Eggs: Seabird Tissue Archival and Monitoring Project (STAMP)

Expanding the Seabird Tissue Archival and Monitoring Project (STAMP) in the North Pacific

David Roseneau, Paul R. Becker, Steven J. Christopher, Glenn K. Chen, Rusty D. Day, Michael B. Ellisor, David Point, Rebecca S. Pugh, Kristin S. Simac, Stacy S. Vander Pol, and Geoffrey S. York
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Seabird eggs have been used to monitor temporal and spatial changes in anthropogenic contaminants in many parts of the world. Collecting, processing, and cryogenically banking eggs using established protocols provides reliable, high quality sources of material for real-time analyses of current contaminants of interest and retrospective studies of new analytes of interest in future years. In 1999, the U.S. Fish and Wildlife Service's Alaska Maritime National Wildlife Refuge implemented the Seabird Tissue Archival and Monitoring Project (STAMP) in collaboration with the U.S. Geological Survey Biological Resources Division (USGS-BRD), the National Institute of Standards and Technology (NIST), and the University of Alaska Museum of the North (UAMN). This long-term (100 year) effort was originally designed to monitor geographic and temporal trends in contaminants at seabird colonies on and near refuge lands using murre and kittiwake eggs. After the Bureau of Indian Affairs Alaska Region Subsistence Branch (BIA-ARSB) became a partner in 2004, the project's geographic scope expanded and gull eggs were added to the work. Public participation in the study has increased substantially over the last few years because of increasing interest in contaminants in rural subsistence diets. Currently, residents from 18 communities have collected murre and gull eggs using collecting kits, protocols, and permits supplied by the project (eggs from these birds are regionally important subsistence food sources). Background information on the geographic extent of the work, community involvement, outreach, coordination with international environmental specimen banks, and the NPRB's current role in the study is provided here.

Expanding the Seabird Tissue Archival and Monitoring Project (STAMP) in the North Pacific: Interim Analytical Results

Paul Becker, Stacy S. Vander Pol, Rusty D. Day, David Point, Steven J. Christopher, Kristin S. Simac, Michael B. Ellisor, Rebecca S. Pugh, Geoffrey S. York, Glenn K. Chen, and David G. Roseneau
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Seabird eggs have been used to monitor temporal and spatial changes in anthropogenic contaminants in many parts of the world. The Seabird Tissue Archival and Monitoring Project (STAMP) is a long-term, collaborative, Alaska-wide effort by the U.S. Fish and Wildlife Services Alaska Maritime National Wildlife Refuge, the U.S. Geological Survey's Biological Resources Division, the Bureau of Indian Affairs Alaska Region Subsistence Branch, and the National Institute of Standards and Technology to monitor long-term trends in environmental contaminants using seabird eggs. STAMP collects, processes, and cryogenically banks seabird eggs throughout Alaska using established protocols that provide reliable, high quality sources of material for real-time analyses of current contaminants of interest and retrospective studies of new analytes of interest in future years. Seabird species were selected for study based on an attempt to (1) include different trophic levels, (2) provide good geographic coverage in Alaska (arctic to subarctic), (3) enhance comparisons with similar studies of seabirds in other regions of the northern hemisphere, and (4) provide data that would be useful regarding issues on contaminants in subsistence diets. Seabirds presently being addressed by STAMP include two species of murres (common murre, *Uria aalge*, and thick-billed murre, *U. lomvia*) two species of gulls (glaucous gull, *Larus hyperboreus*, and glaucous-winged gull, *L. glaucescens*), and black-legged kittiwakes (*Rissa tridactyla*). Interim analytical results suggest broad-scale geographic and temporal patterns in Alaska and species-specific differences that may be related to food web characteristics, habitat utilization, and contaminant transport characteristics. Information on these patterns is presented here.

Seabird Diet and Nesting Success: Indicators of Ocean Conditions in the Northern Bering Sea

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A warming trend is changing the Bering Sea ecosystem, causing increased sea surface temperatures and reduced sea ice cover since the early 1990's. Models suggest that these changes will alter current dynamics and prey availability to upper trophic level consumers, including seabirds. To better understand how seabird productivity would be affected by potential changes in oceanography, we studied seabirds nesting on St. Lawrence Island, Alaska, during 2000-2004; the two most abundant planktivores in the region, least auklets (*Aethia pusilla*) and crested auklets (*A. cristatella*), as well as three species of piscivorous seabirds. We investigated the relationships among (1) Bering Strait flow rates, (2) taxonomic composition of seabird diets, and (3) nesting success. The large, oceanic copepod *Neocalanus cristatus*, a high-quality prey type for both planktivorous species, was more prevalent in the diet in years of higher flow rates during the breeding season. The smaller neritic copepod *Calanus marshallae* was more prevalent in auklet diets in years of weaker flow. The presence of smaller prey types in the diet may signal the relatively low availability of larger, oceanic prey types (i.e., *Neocalanus* copepods). In piscivore diets, the low incidence of Pacific sand lance (*Ammodytes hexapterus*) was associated with low flows and low nesting success. Arctic cod, a major prey type in previous studies of piscivorous seabirds in the region, was nearly absent from the diet in all years. Our study supports the use of seabird diet composition as an indicator of ocean conditions and a factor influencing reproductive success in these abundant avian predators.

Foraging Patterns of Northern Fulmars (*Fulmarus glacialis*) in Alaska Inferred from Fatty Acid Signature Analysis

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Diets of northern fulmars (*Fulmarus glacialis*) in the North Pacific are poorly known, and thus relationships of fulmars to supporting food webs and their potential sensitivity to ecosystem variability, such as that driven by a changing climate, also are uncertain. We employed a new technique, fatty acid signature analysis, to examine dietary differences and similarities among fulmars at three colonies located in distinct oceanographic settings in Alaska: Bering Sea, Aleutian Islands and Western Gulf of Alaska. Fatty acid composition of adipose tissue and stomach oils from adults and chicks were determined. We predicted that 1) signatures of adipose tissue and stomach oils would differ because the time scale each depot reflects differ and/or because adipose tissue fatty acids may be influenced by predator metabolism, while stomach oil fatty acids may be influenced by differential uptake; 2) fulmar diets would differ between colonies located in distinct oceanographic settings, which create unique habitats for prey assemblages; 3) diets would differ temporally (seasonally and inter-annually) within colonies because of variability in the physical environment resulting in variation of prey fatty acid signatures; and 4) diets of adult fulmars and their chicks would be similar because they feed by regurgitation. We found that fatty acid signatures of adipose tissue were significantly different than those of stomach oil; there were conspicuous spatial and temporal differences in adipose tissue signatures; but diets of adults may differ from those of chicks.

Integrating Data to Assess the Risk of Short-tailed Albatrosses Interacting with Trawlers in the North Pacific

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In 2000, NOAA-Fisheries concluded that fisheries using trawl gear were likely to adversely affect short-tailed albatrosses (*Phoebastria albatrus*). A biological opinion completed in 2003 on the effects of the total allowable catch setting process to the endangered short-tailed albatrosses included as a requirement that NOAA-Fisheries continue to work on ways to assess albatross interaction with trawl gear. Our goal was to integrate available data sets to determine the risk of lethal and non-lethal short-tailed albatross interactions with boats working in the groundfish trawl fishery. We compiled information about short-tailed albatross distribution and attraction to fishing vessels from federal agencies, universities, and grey and peer-reviewed literature. We used data provided by the NOAA Groundfish Observer Program and Regional Catch Accounting System to analyze trawling activity. Our analysis explores the relative risk of interaction among components of the trawl fishery including location, time of year, gear type, and processing mode.

Applying Statistical Power Analysis to the Design of a Long-term Environmental Monitoring and Banking Program: Chemical Contaminants and the Seabird Tissue Archival and Monitoring Project (STAMP)

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The Seabird Tissue Archival and Monitoring Project (STAMP) is a long-term, collaborative, Alaska-wide effort by the U.S. Fish and Wildlife Service's Alaska Maritime National Wildlife Refuge, the U.S. Geological Survey's Biological Resources Division, the Bureau of Indian Affairs Alaska Region Subsistence Branch, and the National Institute of Standards and Technology to monitor long-term trends in environmental contaminants using seabird eggs. The design of a monitoring and specimen banking program plays a major role in whether the data produced performs its intended purpose; to detect real trends, or to detect the absence of a trend, if one does not exist. Eggs collected annually by STAMP are cryogenically banked at the Marine Environmental Specimen Bank in Charleston, South Carolina. The statistical power of contaminant data generated on these banked eggs was analyzed to evaluate the performance of collecting and banking efforts and to provide guidance on potential refinement of the current methodology. The power to detect geographic trends among three regions was calculated for six contaminant classes and for different scenarios of sample size and the magnitude of inter-regional differences. Differences in resolution among specific compounds were observed based on their intra-regional variability. The statistical power of these data for detecting long-term temporal trends was also evaluated. Data from two years of sampling at one index location are used to model the effects of within-year and between- year sampling and analytical error on the magnitude of change that may be detectable over several years of monitoring effort. Based on current collections of 10 eggs per year and depending on the rate of change in levels of these contaminants in the environment, current estimates of the time required to detect a linear trend range from 5 to 22 years. Increasing sample sizes increased the statistical power when temporal changes were slow. However for some contaminants, there was negligible benefit in increasing sample size. These statistical analyses are currently based on the available data, and will be repeated as measurements for additional time points and colonies become available.

Banking and Use of Seabird Eggs from the Seabird Tissue Archival and Monitoring Project (STAMP)

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The Seabird Tissue Archival and Monitoring Project (STAMP) is a long-term, collaborative, Alaska-wide effort by the U.S. Fish and Wildlife Service's Alaska Maritime National Wildlife Refuge (USFWS/AMNWR), the U.S. Geological Survey's Biological Resources Division (USGS/BRD), the Bureau of Indian Affairs Alaska Region Subsistence Branch, and the National Institute of Standards and Technology (NIST) to monitor long-term trends in environmental contaminants using seabird eggs. STAMP includes banking of eggs as well as real-time chemical analyses. Through 2005, 893 egg clutches have been banked from five seabird species (common murre [*Uria aalge*], thick-billed murre [*U. lomvia*], black-legged kittiwake [*Rissa tridactyla*], glaucous gull [*Larus hyperboreus*], and glaucous-winged gull [*L. glaucescens*]). A murre egg control material has also been created through this banking effort to provide a matrix and concentration specific reference material. To date, polychlorinated biphenyl congener (PCB), organochlorine pesticide, and mercury analyses have shown geographical differences in contaminant levels between the Gulf of Alaska and Bering Sea, species differences between common and thick-billed murres, and geographical and temporal variations.

Distribution and Speciation of Mercury and Organotin Compounds in Seabird Eggs from Colonies in the Alaskan Coastal Ecosystem

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The cryogenic banking of environmental specimens for retrospective analysis is an important resource in environmental monitoring programs and for both present and future research on emerging contaminants. Recent studies by the Seabird Tissue Archival and Monitoring Project (STAMP) have demonstrated that eggs from selected Alaskan colonies are good candidates to establish baseline values for persistent organic pollutants (POPs) and total mercury. However, detailed information on organometallic species, such as organotin compounds and methylmercury is still needed. Recent analytical procedures developed at the National Institute of Standards and Technology (NIST) were applied to document the concentrations of organotin contaminants and methylmercury in eggs from several colonies that have been cryogenically banked by STAMP at the Marine Environmental Specimen Bank in Charleston, South Carolina. Eggs from four coastal Alaskan common murre (*Uria aalge*) and glaucous-winged gull (*Larus glaucescens*) colonies were analyzed. Three butyltin species (mono-, di-, and tri-butyltin) were found in all of the analyzed eggs. Comparisons between the deep diving fish-eating common murres and glaucous-winged gulls (scavengers/intertidal foragers/surface fish-eaters) highlights specific patterns of tri-butyltin levels, the relative amount of breakdown products (mono- and di-butyltin), and the lipid content of the eggs. These patterns suggest the possible influence of feeding pathways and/or different abilities for metabolizing this class of compounds. Methylmercury accounted for 80-90% of total mercury. Common murre eggs from the Gulf of Alaska contained higher levels of methylmercury than common murres eggs from the Bering and Chukchi seas. These geographical patterns were not seen in the glaucous-winged gull eggs, the concentrations of methylmercury being similar in analyzed eggs of this species from all three regions.

Ecological Implications of Fisheries-Based Economic Development in Nelson Lagoon: Steller's Eider (*Polysticta stelleri*) Critical Habitat

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We are investigating levels of petroleum hydrocarbons in Nelson Lagoon, a shallow body of water that supports a diverse array of marine and terrestrial life, located on the north side of the Alaska Peninsula. Species that inhabit Nelson Lagoon include the Emperor goose (*Chen canagica*); Bar-tailed godwit (*Limosa lapponica*), southwest Alaska sea otter (*Enhydra lutris kenyoni*) and Steller's eider (*Polysticta stelleri*). Populations of many of these species are declining; indeed, the southwest Alaska sea otter and Steller's eider are listed as threatened under the Endangered Species Act. Currently, the Village of Nelson Lagoon is a subsistence community that is economically sustained by a small salmon fishery. Over the next 10 years, the Village population is expected to grow by 20% in conjunction with the expansion of the bulk fuel facility and construction of a multi-species seafood processing plant. Increasing industrial activity raises the risk that levels of petroleum hydrocarbons, harmful to those species that feed, rest and breed in and along the shores, will enter the lagoon. To document baseline concentrations of petroleum based contaminants in the Lagoon, we are monitoring hydrocarbons in Nelson Lagoon using passive water sampling devices, sediments and blue mussels (*Mytilus trossulus*). Two years of monitoring will provide information on current levels of petroleum pollution, and will provide a benchmark to predict and monitor impacts and changes with proposed community development. The data collection for the second and final field season has been completed, and we are awaiting the results from laboratory analyses.

Satellite Tracking Albatrosses In Alaska: Preliminary Results Of The 2005 Field Season

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We are conducting a multi-species, satellite tracking study of North Pacific albatrosses during the non-breeding period (June to September), when they are most common in Alaskan waters. Our goal is to compare the marine habitat use of all three species of albatrosses in Alaska and the spatial and temporal interactions with commercial fisheries. In August 2005 (the first of two field seasons) we conducted a cruise to capture albatrosses in Seguam Pass and along the continental shelf break south of Amlia Island, Aleutian Islands, Alaska. Of the albatrosses we encountered, Black-footed (BFAL) were most common and far more abundant than Laysan (LAAL) or short-tailed (STAL) albatrosses. Sightings of STAL were the most rare, averaging 2.7 sightings per day (range = 0-8) with an average group size of 2 individuals (range = 1-8). In total, we captured 26 BFAL, 14 LAAL, and 2 STAL and, from these, collected blood and feather samples for contaminant, population genetic, and diet studies. Of these individuals, we attached satellite transmitters to 10 BFAL, 10 LAAL, and 2 STAL. Transmitter deployment durations ranged from 13 to 106 days (mean = 44.5 days, SD = 20.5). In general, STAL remained nearest the Aleutian Island archipelago, followed by LAAL, which ranged a bit further south and north of the Islands. BFAL ranged much more widely, with some birds traveling into the Gulf of Alaska, British Columbia, and the transition domain between Alaska and Hawaii. Surprisingly, none of the birds made extensive movements north into the Bering Sea, as has been observed with STAL during previous tracking efforts. These preliminary data demonstrate inter-species differences in the movement patterns and habitat use of North Pacific albatrosses during the non-breeding season. This also highlights differences among species in potential interactions with commercial fisheries that vary among regions.

Contaminants in Seabird Eggs: Seabird Tissue Archival and Monitoring Project (STAMP)

Stacy S. Vander Pol, Paul R. Becker, Rusty D. Day, Steven J. Christopher, Michael B. Ellisor, Rebecca S. Pugh, David G. Roseneau, Kristin S. Simac, Geoffrey S. York, and Glenn K. Chen
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The Seabird Tissue Archival and Monitoring Project (STAMP) is a long-term, collaborative, Alaska-wide effort by the U.S. Fish and Wildlife Service's Alaska Maritime National Wildlife Refuge (USFWS/AMNWR), the U.S. Geological Survey's Biological Resources Division (USGS/BRD), the Bureau of Indian Affairs Alaska Region Subsistence Branch, and the National Institute of Standards and Technology (NIST) to monitor long-term trends in environmental contaminants using seabird eggs. Many Alaskan native communities have partnered with STAMP to collect eggs. This hand-out poster was created for display in native communities to provide initial project results. Differences in contaminant levels between Gulf of Alaska and Bering Sea colonies and between common murres (*Uria aalge*) and thick-billed murres (*U. lomvia*) are highlighted. Murre egg values are shown to be generally lower than in other regions, and based on current contaminant levels, are currently not a human health concern.

Bering Sea & Aleutian Islands - Marine Mammals

Tuesday, 24 January 2006: 4:15 - 6:00 PM

Session Chair and Poster Review: Michael Cameron

TALKS

Speaker	Title
Michael Cameron	Ribbon Seal Habitat Selection and Seasonal Movements
Sara Iverson	Consequences of Fur Seal Foraging Strategies (COFFS): Relationships to Opposing Population Trends and Reproductive Performance in the Bering Sea
Alexander Burdin	Sea Otter Survey on the Commander Islands in 2005.
Lance Barrett-Lennard	The Role of Transient Killer Whales in Structuring Marine Mammal Communities in the Aleutian Islands: Insights from Predation Hotspots.
Craig Matkin	Ecotypic Variation and Predatory Behavior of Killer Whales in the Eastern Aleutians
Paul Wade	Use of Chemical Profiles in Assessing the Feeding Ecology of Alaska Killer Whales

POSTERS

First Author	Title
Vladimir Burkanov	Steller Sea Lion and Northern Fur Seal Surveys in Kuril Islands (Russia), 2005
Douglas Burn	Update on the Sea Otter Decline in Southwest Alaska
Angela Doroff	A Comparison of Indices of Sea Otter Health and Condition Between the Declining Southwest Population in Alaska and the Stable Commander Islands Population in Russia in 2004-05
Pamela Lestenkof	Fine Scale Foraging Behavior of Female Northern Fur Seals (*Callorhinus ursinus*)
Lisa Munger	Passive Acoustic Research on North Pacific Right Whales (*Eubalaena japonica*) in Alaskan Waters
Andrew Trites	Northern Fur Seals: Are They Nutritionally Stressed?
Vanessa von Biela	Differences in Age at First Reproduction and Reproductive Rates of Northern Sea Otters (*Enhydra lutris kenyoni*) in Alaska

Ribbon Seal Habitat Selection and Seasonal Movements

Michael Cameron, John L. Bengtson, Peter L. Boveng, Vladimir N. Burkanov, Brent S. Stewart, A. Trukhin
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The distribution of ribbon seals (*Histriophoca fasciata*) during the breeding season is largely confined to the marginal sea ice zones of the Bering Sea and the Sea of Okhotsk. However, until recently, very little has been known of ribbon seals' whereabouts and behavior during the non-breeding season, particularly during summer and autumn in ice-free areas. The scant information that has been available on this topic comes from incidental catches in fishing gear near Japan and in the central North Pacific, and occasional sightings in the Bering and Chukchi Seas. We present the first information on ribbon seal habitat selection and seasonal movements obtained by satellite tracking. Ten ribbon seals were captured on ice in late spring along the central coast of the eastern Kamchatka Peninsula, Russia. Satellite-linked Data Recorders (SDRs) were attached to the seals to document their movements during the post-molting and breeding period. Most seals dispersed southeast into ice-free areas soon after they were tagged. Several seals traveled into the North Pacific and foraged south of the western and central Aleutian Islands. Most dives were less than 150 m (perhaps to the seafloor) when over the continental shelf, but deepened to over 500 m as seals moved into offshore waters, where they evidently foraged in mesopelagic communities. These data indicate that these apagophilic seals spend a substantial part of their lives in ice-free ocean habitats notwithstanding their seasonal dependence on sea ice habitats for breeding and molting. Nevertheless, under rapidly-changing sea ice patterns, ribbon seals may be particularly vulnerable to climatic change. Evaluating ribbon seals' habitat selection and seasonal movements with respect to physical and biological environmental variables provides insight into the seals' potential responses to climate change such as redistribution of populations, diminished vital rates, and altered ecological interactions due to shifting mesopelagic communities.

Consequences of Fur Seal Foraging Strategies (COFFS): Relationships to Opposing Population Trends and Reproductive Performance in the Bering Sea

Sara Iverson, Alan M. Springer, Rolf R. Ream, Alison Banks, Jeremy Sterling, Brian S. Fadely, Rod Towell, and Jim Thomason
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Northern fur seals (*Callorhinus ursinus*) have declined by two-thirds in the North Pacific (NP) since the 1950s. While abundance during the breeding season (Jul-Oct) at the Pribilof Islands on the continental shelf of the eastern Bering Sea continues to fall, it has increased exponentially at Bogoslof Island in the deep ocean basin of the eastern Aleutians. Fur seals are also highly migratory, spending 8 months/year far south in the NP. Is the overall population decline due to fisheries, climate change and bottom-up forcing, or is it predation? Does the problem lie in the Bering Sea, reflecting consequences of summer foraging strategies, or elsewhere in the NP, reflecting consequences of winter foraging strategies? To answer these questions, we are undertaking a multi-year study examining consequences of maternal winter-summer foraging strategies and diets on milk output, pup growth, and productivity at St. Paul I. (SP, Pribilofs) and Bogoslof. Results from the first year indicate that on SP, females at parturition (39.9 kg, n=20) were slightly but significantly heavier than those on Bogoslof (36.8 kg, n=20, P=0.048). Although birth mass of their pups did not differ between locations (6.0 vs 5.8 kg, respectively), pup mass gain (and therefore milk intake) during the 6-9d perinatal period was greater at SP than Bogoslof (P=0.014). However, following the perinatal period, females on SP foraged within 300 km from the rookery and trips averaged 6.5d, while at Bogoslof, females foraged within 130 km and trips lasted only 2.4d. Consequently, pup mass gain from Jul-Oct at Bogoslof was almost twice that at SP (P<0.001), such that near-weaning pups were heavier (14.9 kg) and likely fatter than those at SP (11.9 kg), with possibly a higher probability for survival. The contrasting female foraging strategies and consequences may be related to the divergent population trajectories in the shelf and basin habitats.

Sea Otter Survey on the Commander Islands in 2005

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Based on aerial and skiff survey conducted by US FWS and USGS thought the last decade, sea otter population across the Aleutian Islands was dramatically declined (Doroff et al, 2003; Estes et al, 2005). But in comparison with Aleutian chain, on the west-most end of it, on the Commander Islands (Bering and Medny) sea otter demonstrate stable trend to population growth. In 2005 complete sea otter skiff survey on the Commander Islands (Kamchatka, Russia) was conducted twice, on Bering Island: 2-3 June and 28-29 June, and on Medny Island: 24-25 June and 15-16 July. For each survey track, the location of all sea otter groups were geographically recorded using GIS applications, group composition, sea otter number, distance from the shore line and water depth in each location where sea otter groups were present. All sea otter groups located close to the shore, at depths about 10 -15 m, group sizes varied from 2 to 300 animals. Total sea otter number on the Commander Islands was 6109 (including 1346 pups) and birth rate for both islands was 20%. Kelp beds around both islands were very weak, relatively dense kelp fields were recorded on the northern part of Bering Island. According to sea otter surveys for the last 150 years at the Commander Islands, the number of sea otters observed at the Commander Archipelago this year is at its highest ever recorded. Some hypotheses of the reason of stabilization and growth of sea otter population on the Commander Islands will be discussed.

The Role of Transient Killer Whales in Structuring Marine Mammal Communities in the Aleutian Islands: Insights from Predation Hotspots

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The role of killer whale predation in structuring marine mammal communities in the Aleutian archipelago has attracted much scientific interest in recent years but is still poorly understood. Although estimates of killer whale abundance have improved greatly in recent years, progress is hampered by difficulties acquiring predation observations over a vast area with challenging weather conditions. The most efficient approach in our opinion is to conduct intensive observations in times and places where prey species are predictable and aggregated, on the assumption that most predation mortality occurs in such 'hotspots'. As an example, we present findings from three field seasons at False Pass during the gray whale migration. Transient killer whales were observed on an almost daily basis in all three years. Groups sizes were up to 40--much larger than in other areas. On 18 occasions we observed groups of killer whales that for several days remained at, or returned to, locations of 10-24 fathoms marked by oil sheens indicative of sunken marine mammal carcasses. Fragments of floating blubber were retrieved on 14 of these occasions; mitochondrial DNA analysis indicated that all were from gray whales. On six occasions we obtained evidence that the carcasses were young-of-the-year calves, and in no cases was there evidence that adult gray whales or any other prey species were killed. Based on attendance periods and the number of killer whales present (114) we estimated that 25-50% of the blubber of each calf was consumed. Our results combined with preliminary data from other areas where gray whales appear particularly vulnerable to predation, suggest that between 15-35% of the annual calf production of the eastern gray whale population is killed by killer whales. We advocate a similar hotspot approach to estimating minimum predation rates of fur seals and Steller sea lions.

Ecotypic Variation and Predatory Behavior of Killer Whales in the Eastern Aleutians

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In a three year study of killer whales in the Eastern Aleutians three ecotypes were identified acoustically and genetically. Residents were most abundant in summer (Unimak Pass to Umnak Island) when an estimated 1200 animals of an expanding population use the area at least occasionally, but not necessarily annually. Transients were most abundant during the spring grey whale migration (Unimak I./False Pass) with 114 individuals identified over two years. Only six of these individuals were photographed during summer when an additional 51 transient individuals were identified. The offshore ecotype was encountered only once when 54 individuals were identified; most were matched with individuals photographed in other North Pacific regions. Transients were the only whales observed consuming marine mammals. In the spring Unimak I./False Pass area all 18 kills and harassments observed were of gray whales. During the summer surveys from Unimak Pass to Umnak I., northern fur seals were the most frequently sighted pinniped and the most important prey with five kills (42% of total kills and harassments observed), followed by Dall's porpoise with three harassments (25%), minke whale with two kills (17%), and Steller sea lions with one kill (8.3%) and one humpback whale harassment (8.3%). In more recent work around the Bogoslof Island Steller sea lion and fur seal rookeries, only northern fur seals were taken by killer whales. The Dall's porpoise and single humpback whale events were harassments, and not successful kills. We found no evidence that Steller sea lions are a preferred prey; estimates of predation rates are similar to those found in long-term studies in southeastern Alaska; a region where sea lions have not declined. Although humpback calves arriving from wintering areas show scarring from killer whales, predation on the feeding grounds appears minimal. Grey whales, however, are very important seasonal prey and minke whales, despite their low densities, may be taken regularly.

Use of Chemical Profiles in Assessing the Feeding Ecology of Alaska Killer Whales

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Tissue samples of killer whales collected through 2004 were analyzed for fatty acids, persistent organic pollutants, and stable isotopes to examine feeding ecology. As expected, fatty acid and stable isotope values for transient mammal-eating whales and resident fish-eating whales were consistent with their known dietary preferences. For transients, POP values showed an 'Alaskan signature' (low ΣDDTs / ΣPCBs, as well as high Σchlordanes / ΣPCBs), also found in Alaskan marine mammal prey such as Steller sea lions and fur seals. Given the persistence of POPs in marine mammals, this suggests that Alaska transients forage exclusively in Alaskan waters. Carbon and nitrogen stable isotope ratios suggest it is unlikely that Steller sea lions represent a substantial proportion of the overall diet for Eastern Aleutian Island (EAI) transients. The $\delta^{15}N$ ratio was much higher in Steller sea lions (17.5 ± 0.2) than was predicted for EAI transient prey ($\delta^{15}N$ = 14.1) using a linear additive prey model. Thus, alternative prey species with low $\delta^{15}N$ ratios must be consumed in relatively large proportions by the EAI transients to result in the nitrogen ratio measured for EAI transients. This conclusion agrees with field observations of EAI transients, which were observed to be preying exclusively on gray whales in May, and observations later in the summer consisted of predation on northern fur seals (58%) minke whales (28%) and Steller sea lions (14%). Giving equal weight to these two observed seasonal diets the predicted carbon and nitrogen stable isotope values (^{13}C = -15.9 ± 0.6, $\delta^{15}N$ = 18.2 ± 0.4) were very nearly equal to those measured for EAI transients (^{13}C = -16.2 ± 0.5, $\delta^{15}N$ = 18.0 ± 0.8). Thus, at least in spring and summer, EAI transient killer whales likely prey on a number of different marine mammal species, with seasonal preferences.

Steller Sea Lion and Northern Fur Seal Surveys in Kuril Islands (Russia), 2005

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All known Steller sea lion sites at 26 islands of the Kuril chain were surveyed at least once during June-July 2005. Four of five major rookeries were surveyed daily by observers stationed at field camps on the islands throughout the breeding season. At most locations, animals were counted from high elevations on land. Steller sea lion pups were counted on all rookeries between July 4 and 10 by the spook method whereby two counters walk through the rookery while non-pup animals are chased into the water. Non-pup northern fur seals were counted on haulouts only while pups were counted only on rookeries in early August 2005 with a method similar to Steller sea lion pup counts. In total, 5,725 non-pup sea lions and 2,366 pups were counted in the Kuril Islands in 2005. Compared with a previous survey in 2003, the non-pup number increased by 7.1% while pups went up by 10.5%. The five year (2001-2005) trend in abundance non-pup sea lions is +14.7% total (or +3.5% per year). For pups, it was almost twice as high (+27.5% total or +6.1% per year). The majority of pups (97.5%) were born on five main rookeries where 66% of total non-pup population was counted in 2005.

Northern fur seals form two rookeries on Lovushki and Srednego islands situated in the central part of the Kuril range. These populations have not been surveyed for 17 years. In total, 28,692 alive newborn pups were counted in 2005, 56.0% higher than the previous maximum number of pups recorded in 1978, and 108.0% higher than a similar previous pup count in 1988. Three northern fur seal haul sites were discovered during the survey, where over 1,200 males hauled out. Populations of both species have been growing on the Kuril Islands for the past 5 years. Northern fur seal pup production reached the maximum historical level ever recorded in the Kuril Islands.

Update on the Sea Otter Decline in Southwest Alaska

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On August 9, 2005, the U.S. Fish and Wildlife Service (USFWS) listed the southwest Alaska Distinct Population Segment of the northern sea otter as threatened under the Endangered Species Act (ESA). This population has declined in abundance overall by more than 50% in the past 20 years; with some areas within southwest Alaska declining by over 90% during this time period. Critical habitat was not determinable at the time of the final listing rule. The USFWS is in the process of forming a recovery team to develop a recovery plan for this population. We anticipate that the recovery plan will include recommendations for continued population monitoring, research into threats to recovery, and conservation actions that may help mitigate these threats. Ongoing USFWS activities in southwest Alaska include aerial and skiff surveys that indicate the decline is continuing throughout much of the region. The USFWS has also been working with the U.S. Geological Survey and the Alaska SeaLife Center to conduct live-capture studies for sea otter health, condition, and disease screening in the Commander Islands, Russia, the Aleutian archipelago, Shumagin Islands, and Kodiak archipelago.

A Comparison of Indices of Sea Otter Health and Condition Between the Declining Southwest Population in Alaska and the Stable Commander Islands Population in Russia in 2004-05

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Since the mid 1980's, sea otter (*Enydra lutris kenyoni*) abundance has declined as much as 90% over major portions of southwest Alaska. Because of the significance of this region to the species as a whole, the U. S. Fish and Wildlife Service listed the southwest distinct population segment of the northern sea otter as threatened under the Endangered Species Act. In the Aleutians the leading hypothesis regarding the cause of the population decline has been predation, however, data on survival, health, and condition for other regions within the area of decline are lacking. In 2004 and 2005, we captured sea otters in the eastern Aleutians and Kodiak archipelago (n=87) to assess indices of health and condition and contrast these data with animals captured on Bering Island, Russia (n=58) where no population declines have been observed. We evaluated hematological values (RBC, complete WBC, Hgb, Hct, MCV, MCH, MCHC), serum biochemical values, exposure to marine and terrestrial pathogens, teeth for age determination, and weight and length measures to assess condition relative to hematologic and serum biochemical values in these animals. Sample analysis to date suggests hematological values did not differ from published ranges. Sea otters were in good condition at the time of sampling and serology studies showed a prevalence for phocine distemper, 70/78 (titres ranged from 1:8-1:32) and 14/78 tested positive for canine distemper (titres ranged from 1:8-1:16); all ages appeared to have equal exposure. There were no positive results for exposure to either phocine or canine distemper in the samples from Bering Island. Exposure to herpes increased with age and only adult sea otters were positive for protozoal or leptospirosis spp. exposure. Of the samples analyzed, 4% and 14% tested positive for *Toxoplasma gondii* and *Sarcosystis neurona*, respectively in SW Alaska; 5.7% of adults had exposure to *T. gondii* from Bering Island. There was no indication of exposure to calicivirus present in either study area. Further analyses are required to interpret whether the documented exposure to these various pathogens may play a role in structuring the SW sea otter population in Alaska

Fine Scale Foraging Behavior of Female Northern Fur Seals (*Callorhinus ursinus*)

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The decline of the Pribilof Island population of northern fur seals (*Callorhinus ursinus*) since the late 1970s is not well understood. It has been speculated that changes in prey availability due to competition with commercial fisheries may be contributing to their decline and/or impeding their recovery. Previous studies have successfully used radio and satellite telemetry to identify movement patterns and at sea locations of fur seals - however, the resolution of data has been too coarse to identify critical foraging habitat and assess the spatial overlap with fisheries in the eastern Bering Sea. Our objectives were to use the newly-developed dead reckoning technology to determine the three-dimensional pelagic habitat and foraging behavior of northern fur seals on a finer spatial scale and at a higher resolution than is currently available. Five lactating fur seals were tracked from St. Paul Island from July to October 2005. Each animal was equipped with a VHF radio transmitter, Argos satellite tag and a Driesen & Kern dead reckoner tag. We obtained detailed records of fur seal diving patterns and used them to describe how foraging patterns vary with month and topography. These results provide a better understanding of fur seal foraging behavior and will ultimately provide an improved assessment of critical habitat and the degree of overlap with fisheries. Studying fur seal foraging behavior at a fine scale is a necessary step towards addressing the question of potential interactions between northern fur seals and commercial fisheries operating in the vicinity of the Pribilof Islands.

Passive Acoustic Research on North Pacific Right Whales (*Eubalaena japonica*) in Alaskan Waters

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We used temporary and long-term passive acoustic recorders to provide information on critically endangered North Pacific right whales (*Eubalaena japonica*) in the Bering Sea and western Gulf of Alaska. We deployed DIrectional Frequency Analysis and Ranging (DIFAR) sonobuoys during vessel-based cetacean surveys in Alaska in summers of 2002 and 2004 to detect calling right whales and guide the ship to within visual sighting range. The most common right whale call type (75%, n = 385) was an upswept tonal call, on average from 88 Hz to 159 Hz and 0.82 s in duration. Real-time call detection and directional bearings guided the vessel to right whales at unprecedented ranges (up to 100 km) and enabled researchers to conduct more detailed studies. We also deployed autonomous, seafloor-mounted hydrophones in three study areas: the southeast Bering Sea (SEBS) middle-shelf (50-100m depth) in 2000-2002 and 2004-2005, the SEBS outer shelf/shelf break (>100 m) in 2004-2005, and the western Gulf of Alaska (GoA) in 2003. The seafloor packages recorded continuously at an effective bandwidth encompassing the most common North Pacific right whale calls. Automated detection software was configured to detect upswept calls, and detections were reviewed by an analyst, who also browsed data surrounding positive detections to find additional calls. In the southeast Bering Sea middle-shelf region, right whale calls were detected as early as May and as late as November, and detection distances were commonly in the tens of kilometers. Right whales called on fewer days in early summer, whereas the highest calling rates and number of days with calls were recorded in late summer and early fall. Right whale calls occurred in bouts lasting usually less than 10 minutes and separated by tens of minutes to days. No right whale calls were detected in recordings from the Bering shelf break or western GoA; however, acoustic propagation in these regions is likely more limited than that observed on the Bering middle-shelf, and right whale calls have been detected during other studies in the western GoA.

Northern Fur Seals: Are They Nutritionally Stressed?

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The Pribilof Islands' population of northern fur seals has declined by over 70% since the mid-1950s. Over-hunting of adult females can explain most of the decline that occurred through the 1960s. However, the decline that has occurred since the late 1970s has not been explained. Measures of the nutritional status of mammalian populations include changes in body size, newborn mortality, and duration of foraging trips. We compared body lengths of fur seals we took in recent subsistence harvests (1995-2005) with records of body size archived during the historic commercial harvests (1915-1983). We found that average lengths of fur seals decreased from the early 1900s to the mid-1940s as the population increased and approached carrying capacity. However, body lengths increased through the 1950s and 1960s while the population was being reduced by hunting. Measurements taken since 1995 indicate that fur seals (which now number only 30% of their former abundance) have again experienced stunted growth comparable to when the population was last at carrying capacity in the 1940s and 1950s. Other measures of the nutritional status of northern fur seals indicate that foraging trips by lactating females were shorter, that mortality of pups on shore was lower, and that pups were bigger during the 1980s and 1990s compared to the 1970s. All told, the available data suggest that lactating females were able to obtain adequate nutrition in the Bering Sea during summer, but that juvenile fur seals (from weaning to 3 years of age) had difficulty obtaining sufficient resources. Whether the nutritional stress they appear to have experienced was associated with inadequate quantities or qualities of prey is unknown - nor is it yet clear whether it occurred in the Bering Sea during the fall, or out in the open Pacific during winter and spring.

Differences in Age at First Reproduction and Reproductive Rates of Northern Sea Otters (*Enhydra lutris kenyoni*) in Alaska

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Life history theory predicts that populations experiencing different environmental conditions such as resource availability and/or predation rates will have different reproduction and survival rates. Therefore the examination of variation in these parameters should provide insight into the external forces shaping population trajectory in areas such as southwest Alaska, where sea otter populations have declined over 75% since 1992. To determine if age at first reproduction (AFR) and reproductive rates (RR) for northern sea otters (*Enhydra lutris kenyoni*) varies between populations and if variability can be used to interpret differences in resource availability and predation, we examined reproductive tracts from declining populations in southwest (n=21), stable populations in south-central (n=44) and southeast Alaska (n=25) over the past decade (1994-2005) and from otters in stable populations in the Aleutian Islands (1967-1971, n=1155). AFR and RR were determined by examining ovaries for evidence of current and past pregnancy. The average AFR for recent south-central Alaskan populations was significantly lower (3.06 ± 0.48 years, 95%CI; n=27) when compared to Aleutian otters from 1967-71 (4.29 ± 0.27 years; n=692) and AFR in southwest and southeast Alaska is early as well. Reproductive rates of mature females (>5 years) were highest in recent southwest (75%, n=8) and southeast Alaskan samples (88%, n=8) and lower in recent south-central (71%, n=17) and past Aleutian samples (73%, n=757). Why Alaskan sea otters are currently reproducing at a younger age, and in some regions reproducing more often, than otters in the Aleutians during the late 1960's is unclear, but indicates modern sea otters may be experiencing increased predation pressure or relaxed food limitations as compared to otters when populations were at equilibrium in the Aleutians approximately 40 years ago. Predictive models that define relations between population status and reproductive parameters should provide explicit tests among competing hypotheses related to causes for change in the status of populations.

Bering Sea & Aleutian Islands - Integrated Ecosystem Observing Systems

Tuesday, 24 January 2006

POSTERS

First Author	Title
Reid Brewer	Lessons learned from the *Selendang Ayu* oil spill
Allen Macklin	IT Tools for Alaska: Federated North Pacific Marine Ecosystem Metadatabase

Lessons Learned from the M/V *Selendang Ayu* Oil Spill

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From 16-20 August 2005, Unalaska, Alaska played host to researchers, government and contract agencies and community members in the first ever Aleutian Life Forum (ALF). ALF is meant to be an annual conference whose mission is to celebrate and encourage understanding of the diversity of life in the Aleutians. In response to the recent M/V *Selendang Ayu* oil spill, the focus of this year's ALF was a day of speakers discussing the effects of oil on wildlife, the effects of oil on fisheries, and the effects of oil on communities. Over the 3 day period, 33 speakers presented their roles in the oil spill and discussed the lessons learned in a round-table format. The goal of ALF is to open communication channels between researchers and community members. This year's forum proved to be a wonderful success in both inter-agency communication and encouraging the participation and input of local community members.

IT Tools for Alaska: Federated North Pacific Marine Ecosystem Metadatabase

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Alaska is a focus of marine research for many countries of the Pacific Rim. This project broadens the availability of international research results to researchers, managers, planners and analysts. The aim is a "federation" of North Pacific Marine Science Organization (PICES) member countries' Oceanographic Data Centers through a central clearinghouse. Because of this federation, an Internet user will be able to discover information about North Pacific marine ecosystems in a single search across metadata holdings of all federation members. In 2005, the prototype merger of the Korea Oceanographic Data Center and the North Pacific Ecosystem Metadatabase was realized through the NSDI FGDC Clearinghouse, a site offering searches against nearly 400 separate geospatial databases. In the coming months, Japanese and Russian marine ecosystem information systems will join the federation.

Ocean Policy, Resource Management & Governance

Tuesday, 24 January 2006: 7:30 - 9:00 PM

POSTERS

First Author	Title
Alicia Bishop	Designation of Critical Habitat under the Endangered Species Act for Marine Mammals in the US EEZ: Evolution of Designation Criteria Based on Recent Litigation
Sarah Kruse	Socioeconomic Baseline Information for the Pribilof Islands

Designation of Critical Habitat under the Endangered Species Act for Marine Mammals in the US EEZ: Evolution of Designation Criteria Based on Recent Litigation

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This project critically analyzes the process of designating critical habitat (CH) under the Endangered Species Act (ESA) for marine mammals in the US EEZ. When dealing with such a complex and controversial topic, it is imperative that the National Marine Fisheries Service (NMFS) acts consistently between regions when making future CH designations. Based on recent court decisions and inconsistencies between the Agencies' interpretations, it is often difficult to decipher which provisions of CH designation under the ESA to follow. I intend to evaluate the suite of recent lawsuits that establish the legal framework for CH designation. A certain amount of ambiguity remains over what constitutes the essential criteria for CH designation. By examining existing designations of CH for Steller sea lions and North Pacific right whales, and evaluating the criteria used to justify these designations, inconsistencies can be determined as well as recognizing those essential scientific features necessary for a successful CH framework. The goal is to define those features essential for CH designation and determine how these features vary amongst marine mammals with differing life histories in order to provide explicit guidance to NMFS for designating CH in a timely, efficient, and legally defensible manner.

Socioeconomic Baseline Information for the Pribilof Islands

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Ecotrust is in the process of creating a baseline profile of the Pribilof Islands. The purpose of this project is to collect, compile, and analyze relevant socioeconomic information for the island communities to support evaluation, monitoring, and prediction of (a) the value of commercial fisheries to the islands and the region, (b) the social impacts of changes in fisheries management, (c) the potential for local economic development, (d) the role of subsistence activities in relation to environmental, economic, and social health. We present methods and preliminary results from this project. Typically, socioeconomic information has not been at the forefront of data gathering efforts in fishery management, and is frequently only available at comparatively coarse spatial, temporal and thematic resolutions. In collaboration with the Pribilof Islands Collaborative (PIC), Ecotrust identified socioeconomic data gaps that, if filled, would help the PIC and others plan for and mitigate eventual fishery management measures, and enhance the local stewardship of marine resources. This project utilizes both quantitative data, including fishery dependent and independent data, and qualitative data, relying on the traditional ecological knowledge of Pribilof Islands' residents. A recently completed on-island survey provides both new statistics and significant insight into how residents of both islands view life in their communities and the surrounding marine environment. This project is atypical in that it focuses proactively on research questions and information needs identified by PIC stakeholders, rather than retroactively gathering what data are available to fulfill regulatory requirements for socioeconomic impact assessments. By conducting this research in close collaboration with the island communities, and recognizing the contribution of local knowledge to the understanding of the various values associated with marine resources found around the islands, the project will be able to examine impacts and interconnectedness of the environment, the economy and community well-being in the Pribilof Islands.

Arctic Ocean - Climate, Oceanography, & Lower Trophic Levels

Wednesday, 25 January 2006: 8:30 - 9:45 AM

Session Chair and Poster Review: Ignatius Rigor

TALKS

Speaker	Title
Ignatius Rigor	An Outlook for Summer Sea Ice North of Alaska
Meibing Jin	Development of Coupled Ice-Ocean Ecosystem and Application to the Ice-Core Data in Land-Fast Ice Offshore Barrow
Jia Wang	The Response of Arctic Sea Ice to the Winter Atmospheric Dipole Anomaly (DA)
David Musgrave	Surface Currents from HF Radar in the Beaufort Sea

POSTERS

First Author	Title
Lawson Brigham	Arctic Marine Shipping Assessment (2005-2008) of the Arctic Council
Yi Chao	An Initial Demonstration of the Arctic Cybercast for Ocean and Ice Monitoring
Kohei Mizobata	Summer Chlorophyll Distributions Related to the Runoff-Ocean-Ice Interaction in the Beaufort/Chukchi Sea
Ignatius Rigor	The International Arctic Buoy Programme (IABP) - A Cornerstone of the Arctic Ocean Observing System
Jia Wang	Downscaling Ice-Ocean Characteristics in the Beaufort-Chukchi Seas Simulated by an IARC-Coupled Ice-Ocean Model (CIOM)

An Outlook for Summer Sea Ice North of Alaska

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The extent of arctic sea ice during summer has declined to record minima during the past decade. Five of the lowest minima in the last 100 years were observed during this period, and a new record minimum was set in September 2005. These changes have a profound impact on many other aspects of Arctic and global climate, ecology, and society. For example, many plant and animal species have been migrating further north, and the lack of sea ice during summer makes the Arctic Ocean, or more pertinently, the Chukchi and Beaufort seas north of Alaska, more accessible for navigation. Can we predict these minima? These minima may be attributed to global warming (e.g. the Arctic Climate Impacts Assessment Report 2004), but this decline may also be attributed to a change in the wind driven circulation of Arctic sea ice. In a series of papers, we showed that the prior winter Arctic Oscillation (AO) conditions explained most of the trends in summer sea ice extent in the Eurasian sector of the Arctic Ocean, while in the Alaskan sector the recent extreme minima may be due to the drift of younger, thinner ice towards the Alaskan coast during the recent predominance of high to moderate AO conditions. In this presentation, we plan to show some of the observed changes in Arctic climate, and relate these changes to the North Atlantic / Arctic Oscillation. We will also show how these relationships (correlations) may help us explain our long-term (1900- present) SAT and sea ice extent records. And finally we will show how these relationships may be used to improve our operational capability to predict Arctic sea ice conditions on weekly to seasonal time scales.

Development of Coupled Ice-ocean Ecosystem and Application to the Ice-Core Data in Land Fast Ice Offshore Barrow

Meibing Jin, Clara J. Deal, Jia Wang, Kyung-Hoon Shin, Nori Tanaka, Terry E.Whitledge, Sang Heon Lee, and Rolf R. Gradinger
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Based on biophysical ice core data collected in the landfast ice off Barrow in 2002 and 2003, a 1-D ice-ocean ecosystem model was developed to determine the factors controlling the bottom ice algal community. The oceanic ecosystem submodel has been successfully applied the NOAA/PMEL mooring 2 in the southeastern Bering Sea, and was coupled with the new sea ice ecosystem submodel by the transport through water-ice interface. The data and model results revealed a three-stage ice algal bloom: 1) onset and early slow growth stage before middle March, when growth is limited by light; 2) fast growth stage with increased light and sufficient nutrients; 3) decline stage after late May as ice algae are flushed out of the ice bottom. The stages 2 and 3 are either separated by a transition period as in 2002 or directly connected by ice melting as in 2003 when in situ light and nutrient enrichment experiments showed only light limitations. The modeled net primary production of ice algae (NPPAi) from March to June are 1.2 and 1.7g C/m^2 for 2002 and 2003, respectively, within the range of previous observations. Model sensitivity studies found that overall NPPAi increased almost proportionally to the initial nutrient concentrations in the water column. A phytoplankton bloom (if it occurs like in 2002) would compete with ice algae for nutrients and lead to reduced NPPAi. About 45% of the NPPAi was exported to the shallow benthos. Our future plan is to apply the coupled ice-ocean model to the Bering Sea shelf.

The Response of Arctic Sea Ice to the Winter Atmospheric Dipole Anomaly (DA)

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Using a coupled ocean-sea ice model (CIOM) in the pan-Arctic and North Atlantic Ocean, we investigate the dynamic response of the winter sea ice motion to an atmospheric circulation anomaly- Dipole Anomaly (DA). The dipole anomaly is the second-leading mode of monthly mean SLP north of 70°N during the winter season (Jan - Mar), accounting for 13% of the variance. One of its two anomaly centers is over the ocean southeast of Greenland; the other is situated over northern Eurasia and the Siberian marginal seas. Due to the dipole anomaly's strong meridionality, it becomes an important forcing to drive anomalous sea ice export out of the Arctic Basin into the Barents Sea and Nordic Seas. When the dipole anomaly remains in its positive phases, negative SLP anomalies appear in northern Eurasia and the Siberian marginal seas with the concurrent positive SLP over the northern American and Greenland region. The spatial patterns of sea ice are identified in response to the DA using CIOM-simulated results and the International Arctic Buoy Programme dataset (IABP, 1979-1998). There exist positive sea ice anomalies in the Nordic Seas and the Barents Sea due to the positive sea ice export from the Arctic Basin. As a result, sea ice thickness is reduced in the Arctic Ocean. Sea ice import from the Laptev Sea and the East Siberian Sea into the Arctic Basin is enhanced. An opposite scenario occurs during the negative phase of the DA. Sea ice observations are used to confirm the new finding, which differs from the impact due to the Arctic Oscillation (AO).

Arctic Ocean - Climate, Oceanography, and Lower Trophic Levels

Surface Currents from HF Radar in the Beaufort Sea

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In June 2005, the University of Alaska Fairbanks SALMON Project and CODAR Ocean Sensors embarked on a program to study the spatial and temporal variability of surface currents in the Beaufort Sea using high frequency Doppler radar, under sponsorship of the Minerals Management Service, the National Ocean and Atmospheric Administration, and the National Oceanographic Partnership Program. This HF radar system, manufactured by CODAR Ocean Sensors, is unique because the operating frequency can be remotely switched between 12 and 25 MHz depending on the wavefield, required resolution and coverage. Initial examination of the data indicates that the currents are in the direction of the wind. More complicated patterns of flow occur during shifts in wind direction. The radar is able to map ocean surface currents during periods of partial ice coverage and the ice can be located with the radar to within the resolution of the radar.

Arctic Marine Shipping Assessment (2005-2008) of the Arctic Council

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The results of the Arctic Climate Impact Assessment (ACIA) provided the impetus to the Arctic Council to develop and approve an Arctic Marine Strategic Plan in 2004. The Arctic Council Ministers in November 2004 also requested that PAME (Protection of the Arctic Marine Environment Working Group) conduct a comprehensive Arctic marine shipping assessment (AMSA) with Canada, Finland and the United States as lead countries. Russia, Norway, Denmark/Greenland, and Iceland also are key Arctic nations with significant Arctic marine shipping interests who will play significant roles within AMSA. The Arctic Council has acted because the Arctic sea ice cover, as documented by ACIA, is undergoing an unprecedented transformation (sea ice thinning, extent reduction, and a reduction in the area of multi-year ice in the central Arctic Ocean). The ACIA sea ice simulations for the 21st century also indicate increasing ice-free areas and suggest plausible increases in marine access throughout the Arctic Ocean. The lead countries, under PAME, are to work closely with the Permanent Participants and all working groups of the Arctic Council during the three-year assessment. AMSA's initial task will be to conduct an inventory/survey of Arctic shipping or marine activity; shipping is defined very broadly in AMSA to include all possible ship activities and types (including fishing vessels). The Arctic coastal states will be responsible for providing this baseline survey information for calendar year 2004. The completed survey will represent an historic total (and distribution) of ships that are using the Arctic Ocean at the beginning of the 21st century. The results of ACIA (primarily sea ice changes) will be coupled with regional economic analyses of marine shipping to determine plausible scenarios for levels of marine activity in 2020 and 2050. AMSA will assess the current (2004) and future (2020 and 2050) social, economic, and environmental impacts of these activities on Arctic communities, large marine ecosystems (LMEs), and all Arctic coastal seas. The final AMSA effort will be development of a suite of strategic directions and recommendations for the Arctic Council member states, all Arctic stakeholders, and the global maritime community.

An Initial Demonstration of the Arctic Cybercast for Ocean and Ice Monitoring

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An Arctic integrated information system that combines satellite geophysical products together with environmental data from surface measurement networks is necessary for monitoring ocean and ice. This system is important because: (1) a general user may not have the expertise to interpret and produce geophysical parameters for direct uses in research and operational applications, (2) the integrated system allows a user to have direct access to relevant data from both satellite and surface measurements, and (3) a user may not have all complex imaging and plotting software necessary to visually the results immediately. Furthermore, the timely dissemination of Arctic information through the Internet to researchers, mariners, local residents, policy planners, and decision makers is important to both scientific studies and operational applications. We present a systematic demonstration of the Arctic Cybercast, an information system for ocean and sea ice monitoring. This initial demonstration component of the Arctic Cybercast will cover large regions from the Aleutian area, throughout the Bering Sea, to the Chukchi Sea and part of the East Siberian Sea and the Beaufort Sea. Ocean surface wind vector and sea ice distribution are derived daily from data acquired by the SeaWinds Scatterometer on the QuikSCAT Satellite (QSCAT). QSCAT satellite data have been collected continuously for more than 6 years so far since July 1999. The QSCAT Mission is extended for up to four more years and thus a decadal dataset is possible. QSCAT has an outer swath of 1800 km for vertical polarization and an inner swath of 1400 km for horizontal polarization with a footprint of 25 km^2. These large swaths cover the Arctic two times per day around 6:20 am and pm. Multiple azimuth measurements are used to determine both wind speed and wind direction over ice-free ocean surfaces. Scatterometer algorithms are developed and implemented to identify and map sea ice classes and melt/freeze conditions of sea ice. In the demonstration, wind field and sea ice classes are presented in daily images via the Internet with the capability to select a particular date forward or backward in time and to animate the daily images. Results, from the 2004 fall season throughout the winter to the 2005 spring transition, from this demonstration system reveal the dynamics and the close interactions between ice, ocean, and atmospheric forcing. Rapid advance and retreat of sea ice extent are observed with associated phases of northerly and southerly winds. Results also show an appearance of large melt areas on sea ice as southerly winds force warm air advection from lower latitudes. Melting sea ice is highly resistant and causes significant delay and costs in U.S Coast Guard icebreaking operations. We plan to implement the near-real-time (within 2 to 3 hours delay) capability for operational use. This is an initial demonstration and further developments for the Arctic Cybercast together with nowcast and forecast models are necessary.

Summer Chlorophyll Distributions Related to the Runoff-Ocean-Ice Interaction in the Beaufort/Chukchi Sea

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The biogeochemical cycling related to sea ice and the circulation in the Beaufort Sea and the Chukchi Sea is investigated due to its high primary productivity. In this study, the variability of chlorophyll-a (chl-a), sea surface temperature (SST) and sea ice motion in the Beaufort Sea and the Chukchi Sea was investigated using remote sensed data. We employed the NASA/GSFC SeaWiFS Chla, the NASA/JPL AVHRR pathfinder SST Version.5 and NSIDC DMSP/SSM-I Sea ice concentration from September 1997 to December 2004. In the Chukchi Sea, SST and chl-a patterns usually show that an increase in the inflow through the Bering Strait and the outspread of the phytoplankton distributions from July to September. Relatively high SST (about 5 degree C) was also found from the Bering Strait to the Herald Canyon and similar pattern was revealed in chl-a maps in summer. Over the estuary of the Mackenzie River, solar heating is evident in every summer. In particular, wide-spreading high SST (more than 6-8 degree C) and the offshore propagation of high chl-a (2-4 mg m^{-3}) to the north wind ridge were revealed in the summer of 1998, when the maximum sea ice retreat was recorded. This high SST was only situated over the Canadian shelf. Thus the local heating may be due to river runoff. In the summer (July-September), high chl-a tends to appear over the Beaufort/Chukchi Sea, when sea ice is close to the coast. The offshore displacement of sea ice leads the low chl-a over the open ocean. Mesoscale eddies and surface current, however, sometimes bring high productive waters to the low chl-a region. These results indicate that surface circulation pattern is similar to subsurface flow of shallow subsurface temperature maximum, and that the three dimensional upper ocean circulation associated with runoff-ocean-ice interaction needs to be resolved in order to examine the lower trophic level ecosystem in these areas.

The International Arctic Buoy Programme (IABP) - a Cornerstone of the Arctic Ocean Observing System

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The Arctic has undergone dramatic changes in weather, climate and environment. For example, atmospheric pressure has decreased, surface air temperatures (SAT) have increased, and the clockwise circulation of sea ice and the ocean has weakened. It should be noted that these and many other observed changes in Arctic climate were first observed or explained using data from the International Arctic Buoy Programme (IABP, http://iabp.apl.washington.edu). The observations from the IABP have been essential for:

1. Monitoring Arctic and global climate change
2. Forecasting weather and sea ice conditions
3. Forcing, assimilation and validation of global weather and climate models
4. Validation of satellite data.

As of 2004, over 500 papers have been written using the observations collected by the IABP. The observations from IABP have been one of the cornerstones for environmental forecasting and studies of climate and climate change. The IABP is also evolving to better support the operational and research requirements of the community. For example, the IABP has been deploying buoys which not only measure SLP and SAT, but also ocean currents, temperatures and salinity. Other buoys have been enhanced to measure the ice mass balance (IMB) using thermistor strings and pingers aimed at the top and bottom of the sea ice. These stations provide critical atmospheric, ice, and upper ocean hydrographic measurements that cannot be obtained by other means. The Arctic and global climate system is changing. These changes threaten our native cultures and ecosystems, but may also provide economic and social opportunities. In order to understand and respond to these changes, we need to sustain our current observational systems, and for the Arctic, the IABP provides the longest continuing record of observations for the Arctic Ocean.

Downscaling Ice-Ocean Characteristics in the Beaufort-Chukchi Seas Simulated by an IARC Coupled Ice-Ocean Model (CIOM)

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We applied an IARC regional CIOM (Coupled Ice-Ocean Model) based on POM to simulate the downscaling ice and ocean processes with a 4-km resolution. The Beaufort CIOM was nested to the CCSR/NIES/FRCGC high-resolution (1/6 x 1/4 degrees) global coupled atmosphere-sea ice-ocean model. Atmospheric forcing data were derived from the NCEP reanalysis. Simulation of seasonal cycle was conducted. In the Chukchi Sea, the Bering inflow separates into three branches: the first main branch flows along the Alaska's coast that is the Alaska Coastal Current (ACC); the second branch flows northward and turns to the right, joining the ACC along the Beaufort coast; and the third branch flows toward the Northwind Ridge. The Beaufort Gyre is well reproduced, superimposed by numerous mesoscale eddies, with anticyclones outnumbering cyclones. We also investigated downscaling sea ice dynamics, such as sea ice ridging, rafting, leads and landfast ice, which are not resolved in the previous coarse resolution model. This approach combining the global model for the 20th century climate simulation with the regional downscaling/nesting simulation helps understanding of both large-scale sea ice variability and small-scale sea ice dynamics. Sea ice breaks up offshore piece by piece with landfast ice untouched along the Beaufort Sea coast. Sea ice cracks from pack ice with irregular shapes due to 1) complex ocean circulation, coastal current, and mesoscale eddies, 2) multi-category sea ice dynamics, and 3) complex and high-resolution geometry and topography. Sea ice ridging, rafting, and openings/leads can be well reproduced in sea ice thickness and concentration. Model validation using in situ observations, satellite measurements, and historical datasets is underway.

Arctic Ocean - Living Marine Resources

Wednesday, 25 January 2006: 10:15 AM - 12:00 PM

Session Chair and Poster Review: Brendan Kelly

TALKS

Speaker	Title
Brendan Kelly	Movements and Population Genetics of Ice-Associated Seals
Lori Quakenbush	Ice Seal Biomonitoring in the Bering-Chukchi Sea Region
Bodil Bluhm	Chukchi Sea Food Web Structure and Epibenthic Community Composition
Stephen Murphy	Evaluating Variation in Abundance of Arctic Cisco in the Colville River Using Existing Scientific Information and Traditional Knowledge from Subsistence Fishers
Carin Ashjian	Environmental Variability, Bowhead Whale Distributions, and Iñupiat Subsistence Whaling - Preliminary Results of a 2005 Late Summer Field Program
Sue Moore	Gray Whales as Sentinels of Alaskan Ecosystem Variability
Stephen Braund	Synthesis: Three Decades of Research on Socioeconomic Effects Related to Offshore Petroleum Development in Coastal Alaska

POSTERS

First Author	Title
Bodil Bluhm	Arctic Ocean Diversity, a Census of Marine Life Project
Michael Cameron	Diving Behavior, Habitat Use, and Movements of Bearded Seal (*Erignathus barbatus*) Pups in the Bering and the Chukchi Seas.
Catherine Mecklenburg	Fishes of the Northern Bering Sea and Chukchi Sea: Results of RUSALCA 2004 Trawling and Retrospective Search of Museum Vouchers

Movements and Population Genetics of Ice-Associated Seals

Brendan Kelly, J.R. Moran, B.J. Swanson, S. K. Sell, P. L. Boveng, and R. D. Snyder
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Sea ice has been important in the evolution of pinnipeds, and predictable snow and ice cover is critical to the successful reproduction, molting, foraging, and predator avoidance of several species. Changes in the timing and extent of ice and snow cover pose immediate threats, especially to seals in the Arctic Ocean where the effects of climate change are amplified. As key components of that ecosystem, their population responses to climate change will have broad ramifications. Changes in ice and snow conditions have been heterogeneous across the Arctic basin, and the effects on seals are likely to vary on regional scales. Forecasting the effects on ice-associated seals will require knowledge, currently lacking, of the population structure. We have reported inter annual fidelity to breeding sites which suggests that ringed seals, a strongly ice-associated species, are philopatric and may exist in numerous demographically isolated populations vulnerable to local extinctions. In April and May 2005, we attached satellite-linked transmitters to 11 ringed seals and two bearded seals captured in their Chukchi Sea breeding sites. The seals remained within small breeding home ranges until the ice broke free from shore on 7 July 2005. In July - September, they followed the ice edge north and east ranging as far as 950 km from their capture sites. In October, as the shorefast ice began to reform, six of the ringed seals and one of the bearded seals returned to the locations at which they were captured the previous spring. Locations of the other tagged seals in October were unknown. Whether fidelity to breeding sites indicates philopatry will be determined by analysis of patterns of heterozygosity. We have extracted and amplified DNA collected at five breeding sites in the Beaufort and Chukchi seas and have begun analyzing population structure using mtDNA and micro satellite markers.

Ice Seal Biomonitoring in the Bering-Chukchi Sea Region

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Ringed (*Phoca hispida*), bearded (*Erignathus barbatus*), spotted (*P. largha*), and ribbon (*P. fasciata*) seals are the four species of Alaska's seals collectively called ice seals. They are important to the subarctic and Arctic marine ecosystems and the subsistence culture of coastal Alaska Natives. There are concerns regarding the status and availability of ice seals due to changes occurring in the Bering and Chukchi Seas, including changes in the thickness, persistence, and distribution of sea ice, increasing concentrations of contaminants, and large volume fish removals. Little is known about the biology and ecology of ice seals and population estimates for ice seals are not available and not easily attainable due to their wide distribution in remote, ice-covered waters. Large decreases in abundance are likely to go undetected until low numbers affect subsistence harvests. Essential baseline information on the status of ice seals and on the marine ecosystem itself can be obtained from a monitoring program developed in conjunction with the annual subsistence harvest. We are working with eight coastal communities in the Bering-Chukchi region (Barrow, Point Hope, Diomede, Shishmaref, Nome, Gambell, Savoonga, and Hooper Bay) to collect seal tissues for age, contaminants, stock structure, diet, productivity, and body condition. Preliminary data on contaminants show that Alaska seals have lower levels of organochlorines (e.g., PCB, DDT, HCH) and potentially toxic metals (e.g., lead, mercury, cadmium) than seals from other regions of the Arctic. Preliminary data using mitochondrial DNA has not shown any stock structure in our samples from the harvest of bearded, ringed, or ribbon seals. Comparisons of diet, productivity, and body condition will be made with data collected during 1960-1980 from the same locations once we have acquired adequate sample sizes.

Chukchi Sea Food Web Structure and Epibenthic Community Composition

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Chukchi Sea food web structure and epibenthic community composition were studied at 17 stations in the Chukchi Sea as part of the Russian-American Long-Term Census of the Arctic (RUSALCA). Trawl hauls were analyzed for epibenthic megafaunal community composition; plankton hauls and benthic grab and trawl samples were processed for carbon and nitrogen stable isotope analysis to elucidate food web structure. Megafaunal species richness ranged from 18 to 53 per station. Mollusks and crustaceans were major contributors to overall species richness with 42 and 33 species, respectively, out of a total of 184 species. Gross abundance and biomass estimates ranged from 800-40,000 individuals per 1000 square meters and 1.6-69 kg wet weight per 1000 square meters, respectively. Multi-dimensional scaling techniques, based on species relative abundances, grouped the stations primarily by substrate type. Coupling between pelagic particulate organic matter (POM) as the food source and benthic consumers was tighter at stations under nutrient rich Anadyr Water (AW) conditions than at nutrient poor Alaska Coastal Current (ACC) locations. POM was isotopically enriched in the highly productive AW-influence region compared to the less productive eastern Chukchi Sea (ACC). Benthic fauna in the western Chukchi Sea AW conditions was tightly linked to pelagic primary production while benthic organisms in ACC locations were separated from the POM food source by 1-2 trophic levels (TL), resulting in comparatively longer food webs in ACC locations (3-4 TL) than in AW locations (2-3 TL).

Evaluating Variation in Abundance of Arctic Cisco in the Colville River Using Existing Scientific Information and Traditional Knowledge from Subsistence Fishers

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Low harvest levels of Arctic cisco (*Coregonus autumnalis*) in the Colville River fishery in several recent years have raised concerns about the population status of this important subsistence resource. The Minerals Management Service commissioned this study in response to those concerns and designed it so that both existing scientific data and traditional knowledge would be used to analyze annual variation in harvest rates. Ten residents from the Iñupiat village of Nuiqsut were selected to form a Panel of Local Experts, who will contribute traditional knowledge, review study results, and write an independent report detailing their views of the process and their confidence in the findings of the study. Three meetings have been held in Nuiqsut to date, and at least two more are planned in the coming months. We currently are conducting statistical analyses of over 20 years of data on subsistence and commercial harvests of Arctic cisco on the Colville delta, movements and abundance of juvenile and adult Arctic cisco in the Prudhoe Bay region, and long-term data on weather, oceanographic conditions, and industrial development in the region. To separate the effects of human activities and natural environmental variation on Arctic cisco populations, we first are analyzing long-term data sets on Arctic cisco abundance and regional environmental conditions that may influence fish populations. Results to date indicate that ~70% of the annual variation in abundance of juvenile Arctic cisco in the central Beaufort region can be explained by wind conditions during summer and that harvest rates from the Colville River 5-6 years later are highly correlated with this juvenile recruitment to the region. We next will analyze residual variation in the context of human activity, including offshore oil and gas exploration and development.

Environmental Variability, Bowhead Whale Distributions, and Iñupiat Subsistence Whaling - Preliminary Results of a 2005 Late Summer Field Program

Carin Ashjian, P. Alatalo, R. G. Campbell, J. C. George, A. Hartz, J. Manker, S. E. Moore, S. R. Okkonen, B. F. Sherr, E. B. Sherr
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The annual migration of bowhead whales (*Balaena mysticetus*) past Barrow, Alaska has provided subsistence hunting opportunities to Native whalers for centuries. Bowheads regularly feed near Barrow, most commonly in autumn, thus it is hypothesized that aggregations of their zooplankton prey (e.g., copepods, euphausiids) occur there recurrently. As part of a larger project investigating the response of this complex environment-whale-human system to climate variability, we conducted a field sampling program from mid-August to mid-September on the narrow continental shelf near Barrow to investigate the biological and physical mechanisms of plankton aggregation. Sampling was conducted from the R/V *Annika Marie* on seven transects across the shelf from near-shore to the ~150 m isobath. High spatial resolution profiles of temperature, salinity, fluorescence, optical backscatter, and C-DOM were collected using an Acrobat undulating towed vehicle on the outbound leg of each transect. On the inbound leg, discrete sampling for chlorophyll a, phytoplankton and microzooplankton abundance and composition, nutrients, and zooplankton abundance and composition was conducted in distinct water types or across frontal boundaries, identified from hydrographic and biological profiles. The distributions of cetaceans , particularly bowhead whales, was documented using aerial surveys. Distinct hydrographic and biological-chemical regions were located across the shelf that may contribute to the formation of bowhead whale prey aggregations.

Gray Whales as Sentinels of Alaskan Ecosystem Variability

Sue Moore, Kathleen M. Stafford, Kate M. Wynne, Jacqueline M. Grebmeier, David J. Rugh, Wayne L. Perryman and James E. Overland
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A compilation of recent evidence suggests that the annual migratory cycle of the Eastern North Pacific (ENP) population of gray whales (*Eschrichtius robustus*), between summer feeding areas offshore Alaska and wintering areas offshore Mexico, may be changing. Collectively, we have shown that

- gray whale calls were detected in the Beaufort Sea northeast of Barrow, Alaska throughout winter 2004;
- since 1999, gray whales have been observed feeding throughout the year southeast of Kodiak, Alaska;
- benthic community structure and productivity has declined in the northern Bering Sea (Chirikov Basin), concomitant with an apparent abandonment of the central basin by feeding gray whales;
- a one-week shift (delay) in southbound migratory timing offshore central California followed the 1977-78 regime shift in the North Pacific; and
- calving rates are positively correlated with the length of time feeding grounds in the northern Bering and Chukchi seas remain ice free.

Furthermore, the stranding of hundreds of gray whales in 1999 and 2000 closely followed the 1997-98 El Niño and were possibly related to marine ecosystem alterations associated with that event. These observations suggest that ENP gray whales may be sentinels of ecosystem variability throughout their range, including feeding areas offshore of Alaska. Conceptual models indicate that the record retreats and extreme inter-annual variability of sea ice cover in northern Alaskan seas may precipitate a shift from a benthic to a pelagic-dominated marine community structure. Our observations, coupled with a 30-year record of ENP gray whale population dynamics and the fact that each whale can sample large areas annually, suggest that gray whales may be a key sentinel species tracking marine ecosystem change from the top down.

Synthesis: Three Decades of Research on Socioeconomic Effects Related to Offshore Petroleum Development in Coastal Alaska

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This book synthesizes three decades of research related to the potential socioeconomic effects of offshore oil development on the peoples of Alaska. Between 1975 and 2004 in Alaska, the Minerals Management Service through its Economic Studies Program funded 167 technical and nine special social and economic reports. This book, comprised of 11 integrated chapters by independent authors, synthesizes and makes accessible this major body of research. The book fills a void in the literature related to offshore oil and gas development and its effects on the state, coastal communities, and people of Alaska living in development areas. The book includes an economic history of Alaska, discussions of the potential effects of offshore oil development at the state and community levels, a synthesis of the MMS sociocultural research, an overview of subsistence in Alaska, an analysis of the effects of oil development on North Slope Iñupiat subsistence activities, and discussions on the subsistence and community effects of the Exxon Valdez Oil Spill. The book also contains a description of the federal offshore leases, including maps of the offshore leasing areas, lease locations, and exploratory wells that have been drilled as well as a description of the revenue generated from offshore development. The editors plan to include the 176 MMS technical and special reports in electronic .pdf format.

Arctic Ocean Diversity, a Census of Marine Life Project

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The Arctic climate is changing at a tremendous rate. Current knowledge indicates that the Arctic seas hold a multitude of unique life forms adapted to the extremes of that environment; these species contribute to the biogeochemical cycles in the Arctic. Ongoing change makes solid baselines on the diversity of life in the major three realms of the Arctic seas (sea ice, water column and sea floor) an urgent issue, if we are to evaluate impacts of this change. The Arctic Ocean Diversity (ArcOD) project is part of the Census of Marine Life (www.coml.org) program and began in 2004. ArcOD is a pan-Arctic effort to inventory biodiversity in the three major realms of the Arctic: sea ice, water column, and sea floor - from the shallow shelves to the deeps basins. Objectives of ArcOD include synthesizing Arctic biodiversity data in the Ocean Biogeographic Information System (www.iobis.org), processing existing samples to higher taxonomic resolution and conducting fieldwork in areas of taxonomic and geographic gaps. Efforts addressing all three objectives are ongoing. This poster will present the concept and structure of the ArcOD project.

Diving Behavior, Habitat Use, and Movements of Bearded Seal (*Erignathus barbatus*) Pups in the Bering and the Chukchi Seas

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Bearded seals (*Erignathus barbatus*), an important Alaska Native subsistence resource, live and pup in pack ice habitat that may be significantly affected by climate change. Almost no recent research has been conducted on bearded seals in Alaska and no data exist on their seasonal movements, habitat use, or diving behavior. In a cooperative effort between scientists and subsistence hunters, in October 2004, two female young-of-the-year bearded seals were captured and instrumented with satellite-linked dive recorders (SDRs) in Kotzebue Sound. An additional seven female, and eight male, young-of-the-year bearded seals were captured and instrumented in 2005. These 17 bearded seals are the first to be instrumented with SDRs in Alaska. Bearded seals are benthic foragers, so we analyzed the amount of time seals spent near the sea floor, presumably foraging. Location data were plotted and linked to local bathymetry using standard GIS techniques. Dive data were analyzed to determine whether benthic foraging time varied between individuals or in relation to bathymetry or time of day. Preliminary results from animals tagged in 2004 indicated that most dives last from 4 to 6 minutes. The amount of time spent near the bottom varied between individuals and with time of day. Most seals spent almost half of their total time near the sea floor. Some of the seals have occupied areas as far north as Wainwright, AK, as far south as St. Lawrence Is., AK and west past the Gulf of Anadyr, Russia. Information on their seasonal movements and diving behavior will be used to identify important habitats and to improve census techniques.

Fishes of the Northern Bering Sea and Chukchi Sea: Results of RUSALCA 2004 Trawling and Retrospective Search of Museum Vouchers

Catherine Mecklenburg, David L. Stein, Boris A. Sheiko, Natalia V. Chernova, and T. Anthony Mecklenburg
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This presentation gives results of the marine fish component of the 2004-2005 program of the Russian-American Long-term Census of the Arctic (RUSALCA). Our team sampled primarily the benthic fishes on the August 2004 RUSALCA cruise to Bering Strait and the Chukchi Sea (using the RV Professor Khromov, homeport Vladivostok). To determine and document the present western Arctic fish baseline, we created a database of reliable, mostly personally confirmed, museum records of western Arctic and northern Bering Sea marine fishes. Most of the records had not previously been evaluated and synthesized. At present the database is populated with almost 2,000 museum lots from seven museums, and we continue to update and expand the database as a long-term effort. Our updated list of fishes known to occur in the region includes several extensions and revisions of known range. Problems with identifying fish as they bear on accuracy of the historical record are also highlighted, including species with unresolved taxonomy and species which are frequently misidentified because of their similarity to other species.