# Alaska Marine Science Symposium

## Showcasing Ocean Research in the Arctic Ocean, Bering Sea, and Gulf of Alaska

## January 19–23, 2009

**Hotel Captain Cook**
**Anchorage, Alaska**

**Sponsored by:**

Alaska Department of Fish and Game
Alaska Ocean Observing System
Alaska Pacific University
Alaska Sea Grant
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*Exxon Valdez* Oil Spill Trustee Council
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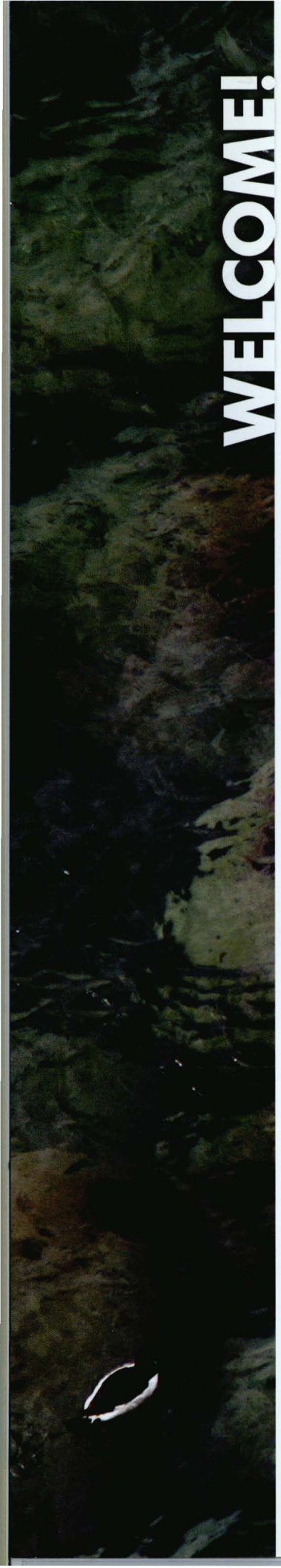
North Pacific Fishery Management Council
North Pacific Research Board
Oil Spill Recovery Institute
Pollock Conservation Cooperative Research Center
Prince William Sound Science Center
University of Alaska Fairbanks
US Arctic Research Commission
US Fish and Wildlife Service
USGS Alaska Science Center

**See the full schedule on pages 14–15.**

**www.alaskamarinescience.org**




# Welcome to the 2009 Alaska Marine Science Symposium

Started in 2002, the Symposium has provided opportunities for scientists from Alaska, the Pacific Northwest, the Nation, and beyond to inform each other about their research activities in the marine regions off Alaska.

## Colleagues, students and mentors connect

The Symposium allows researchers to re-connect with old colleagues and meet new ones. It's also an opportunity for students in marine science to connect with mentors and meet the authors of the literature that they have been studying as part of their own work.

## Free registration thanks to generous support

Word continues to spread about the Symposium's reputation as a gathering place to share innovative ocean research in Alaska's seas. The ongoing support of the Symposium's many sponsors has allowed registration to remain free of charge for all who wish to attend. Please see the back cover for the full list of sponsors.

## Thank you to the Organizing Committee

The Symposium would not be possible without the annual help of volunteers who find the time to fit in planning meetings, poster and workshop coordination, online and on-site registration, and other duties among their regular tasks.

*Nancy Bird—Prince William Sound Science Center and Oil Spill Recovery Institute*

*Catherine Boerner—Exxon Valdez Oil Spill Trustee Council*

*Kurt Byers—Alaska Sea Grant*

*David Christie—Alaska Sea Grant*

*Leslie Cornick—Alaska Pacific University*

*Nora Deans—North Pacific Research Board*

*Carrie Eischens—North Pacific Research Board*

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*Warren Horowitz—Minerals Management Service*

*Igor Katrayev—North Pacific Research Board*

*JoEllen Lottsfeldt—Exxon Valdez Oil Spill Trustee Council*

*Molly McCammon—Alaska Ocean Observing System*

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## Monday, January 19

8:00 am — Conference registration begins, Lobby Level, Hotel Captain Cook

### Workshops and Concurrent Meetings

*8:00 am–noon* — ***NPRB Ecosystem Modeling Committee and Bering Sea Project modelers meeting***
*Invitation only. Location: Club Room 1, 10th Floor.*

*8:00 am–1:30 pm* — ***Communicating Ocean Science Workshop***
*Location: Fore Deck Ballroom. See page 12 for workshop details.*

*8:00 am–1:30 pm* — ***AOOS Prince William Sound Field Experiment Principal Investigator meeting***
*Location: Quarter Deck, 10th Floor. See page 12 for workshop details.*

*8:00 am–5:00 pm* — ***Patch Dynamics meeting for BEST-BSIERP Bering Sea Project investigators***
*Invitation only. Location: Offsite at NPRB Offices, 1007 W 3rd Avenue, Suite 100.*

*1:30–5:00 pm* — ***BEST-BSIERP Bering Sea Project Group 5 Synthesis Meeting***
*Invitation only. Location: Club Room 2, 10th Floor.*

## Monday Afternoon, January 19

# Gulf of Alaska Plenary Session

### Discovery Ballroom

**1:30–1:45 pm, Welcoming Remarks by Clarence Pautzke, North Pacific Research Board**

**1:45–2:15** — **Keynote: Craig O'Connor, NOAA Office of the General Counsel**
**20 Years After EVOS: The Legacy of Research, Monitoring, and Restoration**

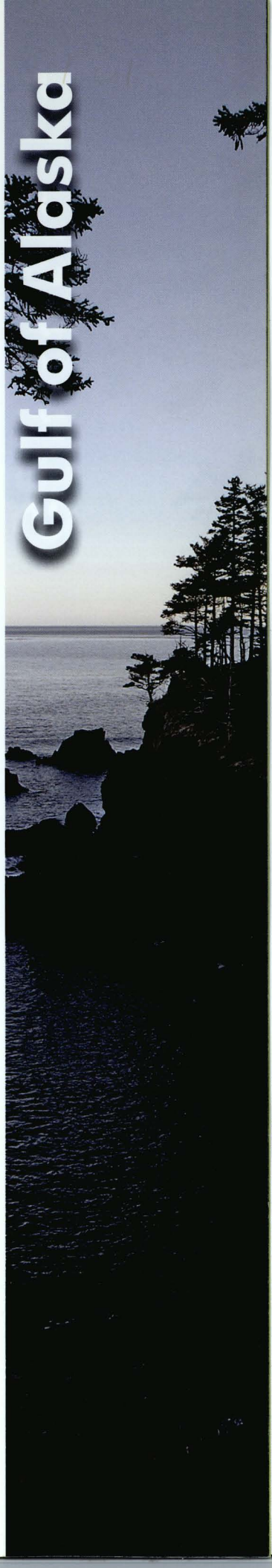
March 24, 2009 marks 20 years since the *Exxon Valdez* ran aground, spilling 11 million gallons of crude oil into the pristine waters of Prince William Sound and the North Gulf Coast of Alaska, causing one of the worst environmental disasters in the history of the U.S. In 1994, the *Exxon Valdez* Oil Spill Trustee Council was formed to restore Prince William Sound and the Gulf of Alaska to the "healthy, productive, world-renowned ecosystem" that existed before the spill. At the directive of Congress, the Trustee Council dedicated nearly 60 percent of available settlement funds to habitat protection and acquisition considered essential for the well-being of species injured by the oil spill. The magnitude of the *Exxon Valdez* oil spill, the extent of shoreline contamination, and evident high mortality of wildlife, prompted an evaluation of impacts of unprecedented scope and duration. Through the Trustee Council, hundreds of peer reviewed research, monitoring and general restoration projects have been funded resulting in a leap in knowledge about the marine environment.

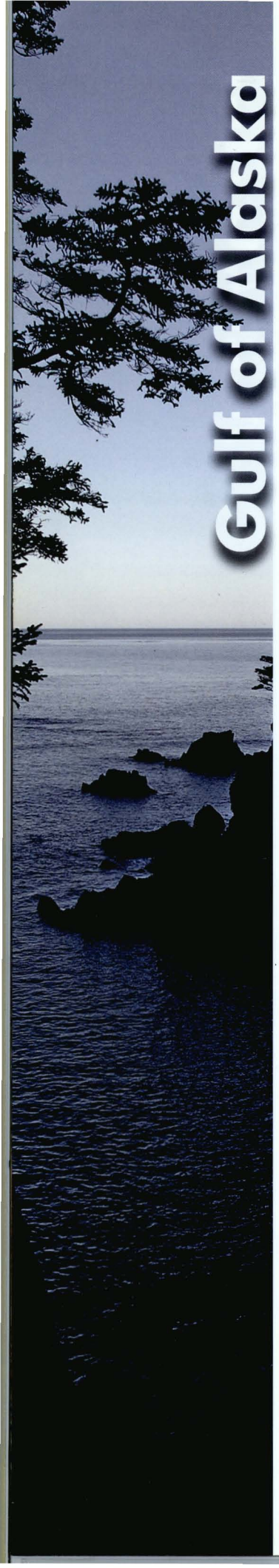
**Session Chair: Molly McCammon, Alaska Ocean Observing System**

### Session 1 — Climate and Oceanography

*2:15–2:30 pm* ..... ***Markus Janout:*** Temperature controlling processes and the recent cooling in the northern Gulf of Alaska
***(student presentation and 2008 NPRB Graduate Student Research Award winner)***

*2:30–2:45 pm* ..... ***Wieslaw Maslowski:*** Effects of mesoscale eddies on the flow of the Alaskan stream






## Session 2 — Ecosystem Perspectives

**2:45–3:00 pm** ..... ***Ian Hartwell:*** Sediment quality triad assessment in Kachemak Bay: characterization of soft bottom benthic habitats and contaminant bioeffects assessment

**3:00–3:15 pm** ..... ***James Bodkin:*** Using trophic cascades to develop ecosystem-based recovery criteria for threatened sea otters in Alaska

3:15–3:30 pm..... BREAK: Enjoy refreshments in the Discovery Ballroom

**3:30–3:45 pm** ..... ***Richard Thorne:*** Biological forcing by combinations of dominant prey and predators on juvenile pink salmon survival in the Prince William Sound ecosystem

## Session 3 — Lower Trophic Levels

**3:45–4:00 pm** ..... ***Nora Foster:*** Evaluating a potential relict Arctic invertebrate and algal community on the west side of Cook Inlet

**4:00–4:15 pm** ..... ***Amy Blanchard:*** Long-term investigation of benthic communities in Port Valdez, Alaska 1971–2007

**4:15–4:30 pm** ..... ***Elizabeth Atwood:*** Influence of mesoscale eddies on ichthyoplankton assemblages in the Gulf of Alaska ***(student presentation and 2008 NPRB Graduate Student Research Award winner)***

## Session 4 — Fish and Fish Habitat

**4:30–4:45 pm** ..... ***Terry Quinn:*** Failure of population recovery in relation to disease for Pacific herring in Prince William Sound

**4:45–5:00 pm** ..... ***Sarah Hinckley:*** Modeling spawning-nursery connectivity of walleye pollock between the Gulf of Alaska and the Bering Sea: toward an understanding of stock structure and recruitment

## Monday Evening Events

**5:30–7:00 pm** — ***Poster Reception: Gulf of Alaska Research, Lower Lobby***
***View posters, meet other Symposium participants, and enjoy refreshments.***

## Tuesday Morning, January 20

8:00 am Conference registration continues, Lobby Level

# Gulf of Alaska Plenary Session

### Continued, Discovery Ballroom

Morning Session Chair:
Robert Spies, Alaska SeaLife Center

### Session 4 Fish and Fish Habitat, continued

*8:00–8:15 am* ..... ***Russ Hopcroft:*** Oceanographic conditions along the northern Gulf of Alaska's Seward Line, 1997–2008

*8:15–8:30 am* ..... ***Joe Bizzarro:*** Diet and trophic ecology of skates in the Gulf of Alaska

*8:30–8:45 am* ..... ***Lorenz Hauser:*** Genetic population structure in Pacific cod: evidence for limited dispersal and isolated fjord populations

*8:45–9:00 am* ..... ***Cliff Ryer:*** Ampharetid worm turf: an essential character of juvenile flatfish habitat in Kodiak nurseries

*9:00–9:15 am* ..... ***Marlin Cox:*** Phase angle as a new independent condition index for fish

### Session 5 Seabirds

*9:15–9:30 am* ..... ***Julia Parrish:*** On death and dying: post breeding, cumulative, and wreck signals in Alaskan beached bird surveys

*9:30–9:45 am* ..... ***Veronica Padula:*** Health assessment of marbled murrelets in Port Snettisham, Southeast Alaska

*9:45–10:00 am* ..... ***John Piatt:*** Competitive coexistence and scale-dependent ecological segregation of *Brachyramphus* murrelets in a glacial-marine ecosystem

10:00–10:30 am ..... BREAK: Enjoy refreshments in the Discovery Ballroom

### Session 6 Marine Mammals

*10:30–10:45 am* ..... ***Jason Herreman:*** Evidence of bottom-up control of diet driven by top-down processes in a declining harbor seal population ***(student presentation)***

*10:45–11:00 am* ..... ***Lorrie Rea:*** Percent total body lipid content increases in Steller sea lion pups during the first year of life in a similar pattern to other otariid species

*11:00–11:15 am* ..... ***Markus Horning:*** Chronicle of a death re-told: quantifying predation on juvenile Steller sea lions in the Gulf of Alaska

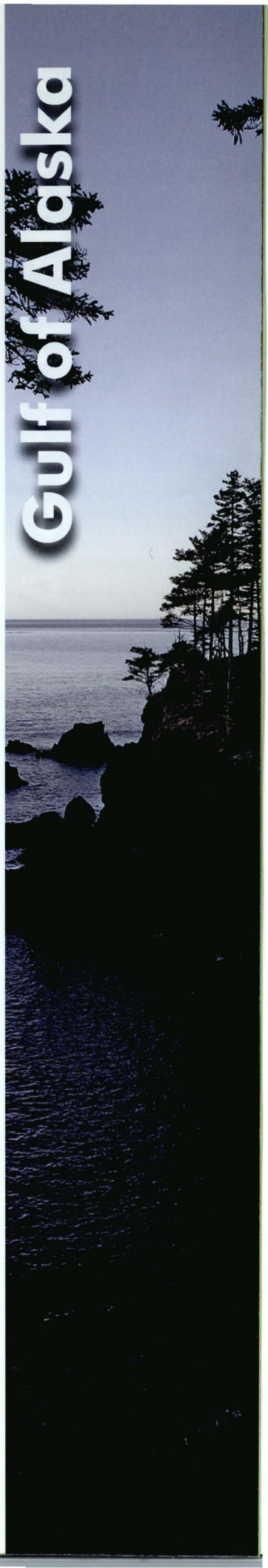
*11:15–11:30 am* ..... ***Craig Matkin:*** Ongoing population-level impacts on killer whales 18 years after EVOS

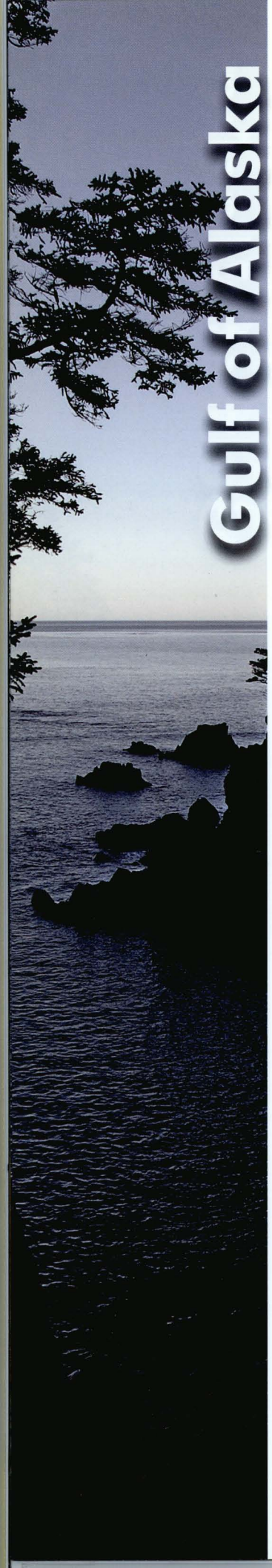
### Session 7 Humans

*11:30–11:45 am* ..... ***Courtney Carothers:*** Privatizing the right to fish: challenges to livelihood and community in Kodiak

*11:45 am–noon* ..... ***William Simeone:*** Subsistence harvests and local knowledge of rockfish in four Alaskan communities

**noon–1:30 pm** **LUNCH: President Barack Obama's Inauguration Speech (delayed video) Discovery Ballroom**






## Tuesday Afternoon, January 20

### Workshops and Concurrent Meetings

*1:30–5:00 pm* — ***BEST-BSIERP Bering Sea Project Principal Investigators Meeting***
***Invitation only. Location: Quarter Deck, 10th Floor.***

*8:00 am–5:00 pm* — ***Bowhead Whale Feeding Ecology***
***Invitation only. Location: Voyager Room, Lower Lobby.***

# Pacific Herring Research

## Discovery Ballroom

**Special Workshop hosted by the *Exxon Valdez* Oil Spill Trustee Council**
**Session Chair: Jennifer Schorr, EVOS Trustee Council. Facilitator: Jeep Rice, NOAA Fisheries**

Herring populations in Alaska are struggling in some regions such as Prince William Sound and Lynn Canal, yet are robust in others. Commercially fished populations have been monitored for decades, but ecosystem-level research has been minimal or absent. Renewed interest in herring population health has stimulated a significant amount of research in the past few years. This workshop reports new research findings on Pacific herring ranging from genetics to predation, from habitat to population monitoring, and from energetics and disease to modeling.

*1:35–1:55 pm*..... ***Richard Thorne:*** What has 16 years of acoustic surveys taught us about herring, EVOS and the Prince William Sound ecosystem?

*1:55–2:15 pm*..... ***Peter-John Hulson:*** Comparison of Pacific herring in Prince William Sound and Sitka Sound

*2:15–2:35 pm*..... ***Jodi Harney:*** Insight into herring spawning habitat using ShoreZone coastal mapping data in Prince William Sound

*2:35–2:55 pm*..... ***Janice Straley:*** Year-round presence of humpback whales in Alaskan waters and the impact on herring

*2:55–3:15 pm*..... ***John Moran:*** Humpback whales exert top-down control on Prince William Sound herring

3:15–3:30 pm..... BREAK: Enjoy refreshments in the Discovery Ballroom

*3:30–3:50 pm*..... ***Johanna Vollenweider:*** Do energy limitations cause overwinter mortality of young-of-the-year and juvenile Pacific herring?

*3:50–4:10 pm*..... ***Ron Heintz:*** Seasonal flux in the energy and proximate composition of maturing Pacific herring

*4:10–4:30 pm*..... ***Paul Hershberger:*** Virus shedding from herring after exposure to viral hemorrhagic septicemia virus

*4:30–4:50 pm*..... ***Tom Kline:*** Prince William Sound herring forage contingency

*4:50–5:10 pm*..... ***Dale Kiefer:*** Modeling the bi-stable state of herring in Prince William Sound

*5:10–5:30 pm*..... ***Discussion***

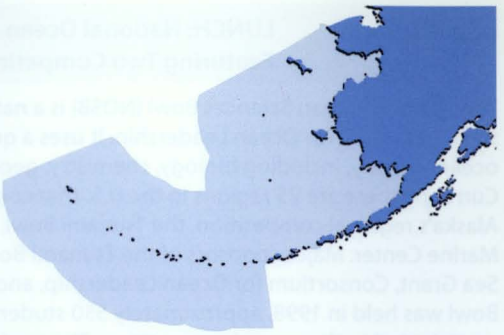
### Tuesday Evening Events

*5:30–7:00 pm* — ***Poster Reception: Bering Sea/Aleutian Islands Research, Lower Lobby***
***View posters, meet other Symposium participants, and enjoy refreshments.***

*7:00–9:00 pm* — ***Alaska Climate Change Initiatives Workshop***
***Location: Fore Deck. See page 12 for workshop details.***

*7:00–9:00 pm* — ***BEST-BSIERP Bering Sea Project Science Advisory Board Meeting***
***Invitation only. Location: Club Room 1, 10th Floor.***

# Bering Sea and Aleutian Islands Plenary Session



## Discovery Ballroom

**Morning Session Chair: Kris Holderied, NOAA Kasitsna Bay Laboratory**

**8:00–8:30 Keynote: Mike Sigler, BEST-BSIERP Bering Sea Project**
**Understanding Ecosystem Processes in the Bering Sea: Headlines for 2008**

The North Pacific Research Board and the National Science Foundation are supporting a comprehensive, $52 million study of the eastern Bering Sea ecosystem from 2007–2012. Ninety-four federal, state, university, and private institution scientists are studying everything from atmospheric forcing and physical oceanography to humans and communities, including the attendant economic and social impacts of a changing ecosystem. In 2008, the study began its first year of complete field programs with at-sea sampling from February through September. New headlines on progress being made are arriving weekly and will be reported here.

### Session 1 Climate and Oceanography

*8:30–8:45 am*..... ***Nick Bond:*** Expected changes in the climate forcing of Alaskan waters in late summer/early fall

*8:45–9:00 am*..... ***Phyllis Stabeno:*** A decoupling of 2008 sea-ice extent between the Arctic and Bering Sea

*9:00–9:15 am*..... ***Muyin Wang:*** Sea ice over the Bering Sea: the past, present and future

*9:15–9:30 am*..... ***Tom Weingartner:*** A satellite-tracked drifter perspective of the nearshore Bering Sea: science and outreach

*9:30–9:45 am*..... ***Emily Davenport:*** Phosphate cycling in Bering Sea sediments ***(student presentation)***

### Session 2 Ecosystem Perspectives

*9:45–10:00 am*..... ***Puneeta Naik:*** Particulate absorption properties along four transects on the southeastern Bering Sea shelf ***(student presentation)***

10:00–10:30 am ..... BREAK: Enjoy refreshments in the Discovery Ballroom

*10:30–10:45 am*..... ***Lee Cooper:*** Progression of the spring bloom in the northern Bering Sea and transmission of particulates to the sea floor

*10:45–11:00 am* ..... ***Jerry McCormick-Ray:*** Geographic variation of benthic macrofauna: Bering Sea, May–June 2006

### Session 3 Lower Trophic Levels

*11:00–11:15 am*..... ***Meibing Jin:*** Response of lower trophic level production to long-term climate change in the southeastern Bering Sea

*11:15–11:30 am* ..... ***Jeff Napp:*** Recent trends in eastern Bering Sea zooplankton: data and confessions

*11:30–11:45 am*..... ***Sandra Parker-Stetter:*** Evaluating acoustics for squid assessment in the Bering Sea

*11:45 am–noon* ..... ***Mary Hunsicker:*** A three-tiered approach for evaluating the predatory role of the commander squid in the eastern Bering Sea
***(student presentation and 2008 NPRB Graduate Student Research Award winner)***

**noon–1:30 pm** **LUNCH: National Ocean Sciences Bowl Demonstration Featuring Two Competing Local High School Teams**

The National Ocean Sciences Bowl (NOSB) is a national, high-school science competition managed by the Consortium for Ocean Leadership. It uses a quiz-bowl format to test students on their knowledge of oceanography, including biology, chemistry, geology, geography, social science, technology, and physics. Currently there are 25 regions in the U.S. that compete in the NOSB, each with their own regional competition. Alaska's regional competition, the Tsunami Bowl, is held each February in Seward, hosted by UAF's Seward Marine Center. Major sponsors of the Tsunami Bowl include UAF School of Fisheries and Ocean Sciences, Alaska Sea Grant, Consortium for Ocean Leadership, and the University of Alaska Southeast. Since the first Tsunami Bowl was held in 1998, approximately 550 students from more than 30 schools throughout Alaska have participated in the annual competition. The goal of NOSB is to increase knowledge of the ocean among high school students and, ultimately, magnify the public understanding of ocean research.

**Afternoon Session Chair: Leslie Cornick, Alaska Pacific University**

## Session 4 Fish and Fish Habitat

*1:30–1:45 pm* ..... ***Sarah Hinckley:*** New information about connectivity: relationships between larval release and potential settlement areas for snow crab in the Bering Sea

*1:45–2:00 pm* ..... ***Stewart Grant:*** Contrasting genetic population structures and responses to ice-age variability in north Pacific pollock and Pacific cod

*2:00–2:15 pm* ..... ***Carwyn Hammond:*** Estimating unobserved mortality rates of Bering Sea crabs due to encounters with trawls on the seafloor ***(student presentation)***

*2:15–2:30 pm* ..... ***Andrew Seitz:*** Behavior of satellite-tagged Pacific halibut in the Bering Sea/Aleutian Islands region and its biological implications

*2:30–2:45 pm* ..... ***Patrick Ressler:*** Trends in walleye pollock and euphausiid abundance on the Bering Sea shelf since 2004

*2:45–3:00 pm* ..... ***Craig Rose:*** Modifications of trawl sweeps to reduce epifauna damage by Bering Sea flatfish fisheries

*3:00–3:15 pm* ..... ***Jim Ianelli:*** Opportunistic temperature-at-depth recorders on Bering Sea pollock trawls to evaluate linkages between location-specific temperatures and pollock, salmon, and other species

3:15–3:45 pm ..... BREAK: Enjoy refreshments in the Discovery Ballroom

*3:45–4:00 pm* ..... ***Anne Hollowed:*** Biogeography of forage fishes in the Bering Sea

*4:00–4:15 pm* ..... ***Dongwha Sohn:*** Distribution and connectivity between spawning and settling locations of Greenland halibut in the Bering Sea ***(student presentation)***

## Session 5 Seabirds

*4:15–4:30 pm* ..... ***Martin Renner:*** The roles of fisheries, climate and seascape on the distribution of northern fulmars

*4:30–4:45 pm* ..... ***Robert Suryan:*** Safeguarding short-tailed albatrosses by reestablishing a third breeding colony: condition, post-fledging survival, and migration of artificially- vs. naturally-reared chicks

*4:45–5:00 pm* ..... ***Ine Dorresteijn:*** Stable isotopes in diets of planktivorous auklets indicate low trophic level responses to climate variability ***(student presentation)***

*5:00–5:15 pm* ..... ***Ian Jones:*** Covariation between North Pacific climate and auklet demographic parameters at three western Aleutian islands during 1990–2008

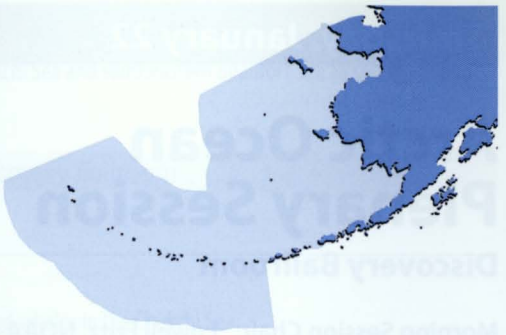
## Wednesday Evening Events

*5:30–7:00 pm* ***Poster Reception: Arctic Ocean Research, Lower Lobby***
***View posters, meet other Symposium participants, and enjoy refreshments.***

*7:00–9:00 pm* ***Fish Identification Workshop for Alaskan Murres***
***Location: Whitby Room, Lower Lobby. See page 12 for workshop details.***

*7:00–9:00 pm* ***BEST-BSIERP Bering Sea Project SAB and Advisory Group Joint Meeting***
***Invitation only. Location: Club Room 1, 10th Floor.***

# Bering Sea and Aleutian Islands Plenary Session



## Continued, Discovery Ballroom

Session Chair: Lowell Fritz, NOAA-NMFS Alaska Fisheries Science Center

### Session 6 Marine Mammals

*8:15–8:30 am* ..... ***Greg O'Corry-Crowe:*** Fishing for population structure in North Pacific seals: challenges, pitfalls and solutions

*8:30–8:45 am* ..... ***Peter Boveng:*** Ribbon seals and their relationship with sea ice in the Bering Sea

*8:45–9:00 am* ..... ***Paul Olivier:*** Insights into the foraging behavior of Steller sea lions using an animal-borne video and data recorder ***(student presentation)***

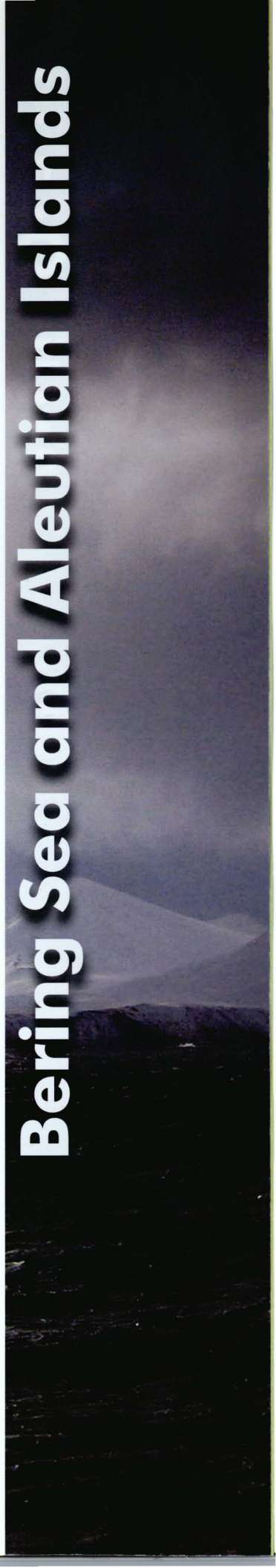
*9:00–9:15 am* ..... ***Mary-Anne Lea:*** Lunar and seasonal influences on the migratory diving behavior of northern fur seal pups

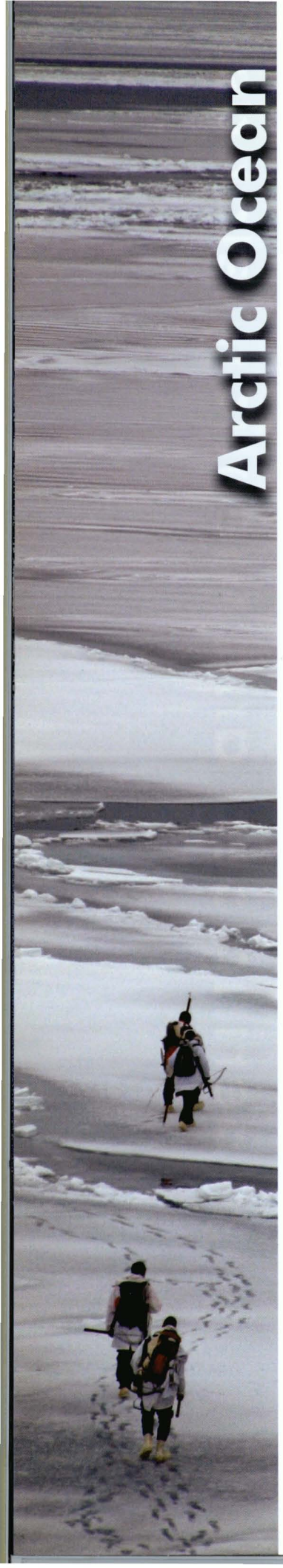
*9:15–9:30 am* ..... ***Kelly Newman:*** Temporal and spatial vocal patterns of killer whales at the Pribilof Islands ***(student presentation)***

*9:30–9:45 am* ..... ***David Mellinger:*** Passive acoustic detection of right, fin and humpback whales in the eastern Bering Sea

9:45–10:00 am..... BREAK: Enjoy refreshments in the Discovery Ballroom

Bering Sea and Aleutian Islands Plenary ends. Arctic Ocean Plenary (see next page) begins at 10:00am.






## Thursday, January 22

# Arctic Ocean Plenary Session

### Discovery Ballroom

**Morning Session Chair: Lowell Fritz, NOAA-NMFS Alaska Fisheries Science Center**

*10:00–10:10 am* ..... ***Craig George,*** North Slope Borough: Dedication to Arnold Brower, Sr.

**10:10–10:30 am** **KEYNOTE Richard Feely**
**Ocean Acidification**

## Session 1 Climate and Oceanography

*10:30–10:45 am* ..... ***Carleton Ray:*** Impact of diminished sea ice on marine mammals and indigenous hunters of Beringia

*10:45–11:00 am* ..... ***Jim Overland:*** What do we learn about the future Arctic from the summer 2008 sea ice minimum?

*11:00–11:15 am* ..... ***Gleb Panteleev:*** Re-analysis of the Arctic ocean: case study for the Chukchi and East Siberian Seas

*11:15–11:30 am* ..... ***Jia Wang:*** Is the dipole anomaly a major driver to record lows in Arctic summer sea ice extent?

*11:30–11:45 am* ..... ***Natalia Donoho:*** Tides, tidal currents, and sea level trends in Alaska: co-ops activities and data sources

*11:45 am–noon* ..... ***Aixue Hu:*** Role of Bering Strait in the thermohaline circulation's response to freshwater forcing under present day and LGM conditions

**noon–1:30 pm** **LUNCH: POLAR PALOOZA**
**Stories from a Changing Planet**

POLAR PALOOZA's "Stories from a Changing Planet" science road show has taken polar researchers and Alaskan Natives to some 25 science centers and natural history museums across America. Sponsored by NSF and NASA, "Stories…" features a changing "cast" of 35 scientists as presenters, original high-definition video, and authentic artifacts such as ancient ice cores, Extreme Cold Weather gear, and fossils revealing Earth's past climate. Evaluation shows positive reactions to audiences meeting actual researchers and the use of dramatic production techniques. Project Director Geoff Haines-Styles offers an overview (using fast-paced video and survey data) as a model for future national education and outreach projects, and answers questions.

**Afternoon Session Chair: Ana Sirovic, Alaska Pacific University**

## Session 2 Ecosystem Perspectives

*1:30–1:45 pm* ..... ***Carrie Parris:*** Advanced monitoring initiative: Arctic coastal data mining and assessment project

*1:45–2:00 pm* ..... ***Brian Hunt:*** Zooplankton biogeography as a measure of oceanographic change in Canada Basin

## Session 3 Fish and Fish Habitat

*2:00–2:15 pm* ..... ***Sarah Mincks:*** Epibenthic megafauna in the northern Bering and Chukchi seas: environmental influences on community structure

*2:15–2:30 pm* ..... ***Elizabeth Loggerwell:*** Beaufort Sea survey: geographic and historical comparisons

*2:30–2:45 pm* ..... ***Jennifer Nielsen:*** Arctic cisco genetics and otolith micro chemistry

## Session 4 Seabirds

*2:45-3:00 pm*..... ***Steffen Oppel:*** Importance of the eastern Chukchi Sea and southeastern Beaufort Sea as spring staging areas for king and common eiders

3:00–3:30 pm..... BREAK: Enjoy refreshments in the Discovery Ballroom

## Session 5 Marine Mammals

*3:30–3:45 pm*..... ***Lori Quakenbush:*** Fall movements of bowhead whales in the Chukchi Sea

*3:45–4:00 pm*..... ***Julien Delarue:*** A year-long acoustic monitoring program of bowhead whales in the Chukchi Sea

*4:00–4:15 pm*..... ***Bruce Martin:*** Ambient noise in the Chukchi Sea, July 2007–July 2008

*4:15–4:30 pm*..... ***Lisanne Aerts:*** Sounds from an offshore oil production island and bowhead whale call characteristics

*4:30–4:45 pm*..... ***Marjo Laurinolli:*** Study of walrus distribution in the Chukchi Sea using passive acoustics

*4:45–5:00 pm*..... ***Brendan Cummings:*** The polar bear, a warming Arctic, and the Endangered Species Act: the role of wildlife law in responding to climate change

**Arctic Ocean Plenary Ends. Closing Remarks.**

# Friday, January 23

## Workshops

*8:00 am–5:00 pm* ***Arctic Science Planning Workshop***
*Location: Fore Deck. See page 13 for workshop details.*

*8:00 am–noon* ***Steller Sea Lion Research Coordination Workshop***
*Invitation only. Location: Voyager Room, Lower Lobby.*

*9:00 am–noon* ***Metadata Workshop***
*Location: Endeavour Room, Lower Lobby. See page 13 for workshop details.*

# Workshop Descriptions

## Monday, January 19

### 8 am–1:30 pm Communicating Ocean Science

**Location** Fore Deck Ballroom, Lobby Level

**Leader** Nora Deans (North Pacific Research Board)

Meet other communicators and educators to share ideas for communicating ocean science to national, regional and local audiences. We welcome scientists, educators, writers, editors, media and others interested in sharing research results with diverse audiences to join us for lively discussion.

### 8 am–1:30 pm AOOS Prince William Sound Field Experiment Investigator Meeting

**Location** Quarter Deck, 10th Floor

**Leader** G. Carl Schoch (Alaska Ocean Observing System)

The Alaska Ocean Observing System (Anchorage) and the Oil Spill Recovery Institute (Cordova) are co-sponsoring a field experiment between April and August of 2009 to evaluate regional forecast models for wind, waves and ocean circulation in Prince William Sound. This will be an end-to-end demonstration of the Alaska Ocean Observing System in 2009, from observations to models to their direct application by users. Investigators will use field measurement s to evaluate predictions of regional forecast models, and are using this workshop to further coordinate next summer's activities.

## Tuesday, January 20

### 7–9:00 pm Alaska Climate Change Initiatives

**Location** Fore Deck Ballroom, Lobby Level

**Leaders** Anne Hollowed (NOAA), Douglas Vincent-Lang (State of Alaska)

We will discuss the latest developments on NOAA's proposed National Climate Services Center; the State of Alaska Sub-Cabinet on Climate Change and Research Needs, and the ICES-PICES climate change initiative.

## Wednesday, January 21

### 7–9:00 pm Fish Identification Workshop for Alaskan Murres

**Location** Whitby Room, Lower Lobby

**Leaders** Mayumi Arimitsu (USGS), Rosana Paredes (Oregon State University)

The focus of this workshop is to train field biologists on the identification of common prey species of seabirds in the Gulf of Alaska and Bering Sea. Special emphasis will pertain to Thick-billed Murre bill-loads for chick provisioning. Topics will include an overview of prey items, basic characteristics of major groups, tips for identification on a glance, and hands on activities for practice. Participants are encouraged to bring their own binoculars.

## Friday, January 23

### 8 am–5 pm Arctic Science Planning Workshop

**Location** Fore Deck Ballroom, Lobby Level

**Leader** Molly McCammon (Alaska Ocean Observing System)

Alaska's Arctic is seeing increased activity due to the recent U.S. Outer Continental Shelf oil and gas lease sale and the increasing retreat of sea ice and consequent lengthening of the ice-free season. Warming ocean temperatures may result in a northward shift of fish, bird and marine mammal species and other impacts on marine ecosystems. Polar bears have been listed as Threatened under the Endangered Species Act. The Alaska Ocean Observing System, the North Pacific Research Board, Minerals Management Service and other Federal and state agencies, the North Slope and Northwest Arctic boroughs, and industry including Shell Oil, Conoco-Phillips and British Petroleum are all interested in increased ocean and marine resource monitoring in the Beaufort and Chukchi seas.

MMS, the oil and gas industry, and the National Science Foundation have planned significant research and monitoring programs for the open water season of 2009. Due to the location's remoteness and harsh weather, any research and monitoring activity in this region is extremely expensive. Furthering collaborative efforts in this region would help maximize the value of the dollars spent. For longer-term activities, we could look to the model adopted by other regions in the U.S., such as Chesapeake Bay, San Francisco Bay, Southern California Bight, and Puget Sound to join forces and collaborate to develop a more comprehensive monitoring and assessment program, in which each organization focuses on projects that fulfill their goals, yet fit into a larger plan through which resulting data can be shared and integrated among the participants.

The purpose of this workshop is to follow up on an initial Collaboration Roundtable, held in early summer 2008. Participants will share plans for future research and monitoring activities in the Beaufort and Chukchi Seas, and will further explore opportunities for coordination and collaboration.

### 9 am–noon Making Your Data More Valuable by Creating Standardized Metadata

**Location** Endeavour Room, Lower Lobby

**Leader** Vivian Hutchison (USGS)

Laptops are desired but not required, as participants can share laptops and will receive a copy of the Metavist software. At the conclusion, participants will know about:

- the value of metadata for geospatial and biological information,
- the Federal Geographic Data Committee (FGDC) Metadata Standard,
- how to use and submit records to a clearinghouse,
- the variety of tools available for metadata creation,
- ways to implement a metadata program in their own organization, and
- how to create a record using Metavist software.

Each participant will also receive a CD containing all of the workshop materials.

# Symposium Events at a Glance

| | Monday<br>January 19 | | Tuesday<br>January 20 | | Wednesday<br>January 21 |
|---|---|---|---|---|---|
| Morning<br>8:00–10:00 | Communicating Ocean Science Workshop, Fore Deck, 8:00 am–1:30 pm (page 12)<br><br>AOOS Prince William Sound Field Experiment Investigator meeting, Quarter Deck, 8:00 am–1:30 pm (page 12)<br><br>BEST-BSIERP Bering Sea Project Patch Dynamics meeting, NPRB Offices, 8:00 am–noon (invitation only; continues after lunch) | | GULF OF ALASKA PLENARY SESSION CONTINUES, Discovery Ballroom, 8:00 am–noon (page 5)<br>*Fish + Fish Habitat*<br>*Seabirds*<br>*Marine Mammals*<br>*Humans* | Bowhead Whale Feeding Ecology Workshop, Voyager Room, 8:00 am–noon (invitation only; continues after lunch) | BERING SEA/ALEUTIAN ISLANDS PLENARY SESSION BEGINS, Discovery Ballroom, 8:00 am–noon (page 7)<br>*Climate + Oceanography*<br>*Ecosystem Perspectives*<br>*Lower Trophic Levels* |
| 10:00–noon | NPRB Ecosystem Modeling Committee and BEST-BSIERP Bering Sea Project modelers meeting, Club Room 1, 8:00 am–noon (invitation only) | | | | |
| Lunch<br>noon–1:30 | on your own | | LUNCH: PROVIDED. President Barack Obama's Inauguration Speech (delayed video), Discovery Ballroom | | LUNCH: PROVIDED. National Ocean Sciences Bowl Demonstration |
| Afternoon<br>1:30–5:00 | Symposium Welcome, Discovery Ballroom<br><br>Keynote Address: *Exxon Valdez* Oil Spill 20th Anniversary<br><br>GULF OF ALASKA PLENARY SESSION BEGINS, Discovery Ballroom, 2:15–5:00 pm (pages 3–4)<br>*Climate + Oceanography*<br>*Ecosystem Perspectives*<br>*Lower Trophic Levels*<br>*Fish + Fish Habitat* | BEST-BSIERP Bering Sea Project Patch Dynamics meeting continues, NPRB Offices, 1:30–5:00 pm (invitation only)<br><br>BEST-BSIERP Bering Sea Project Group 5 Synthesis meeting, Club Room 2, 1:30–5:00 pm (invitation only) | EVOS PACIFIC HERRING SPECIAL WORKSHOP, Discovery Ballroom, 1:30–5:30 pm (page 6) | Bowhead Whale Feeding Ecology Workshop continues, Voyager Room, 1:30–5:00 pm (invitation only)<br><br>BEST-BSIERP Bering Sea Project Investigators meeting, Quarter Deck, 1:30–5:00 pm (invitation only)<br><br>Gulf of Alaska posters come down; Bering Sea and Arctic posters go up, Lower Lobby | BERING SEA/ALEUTIAN ISLANDS PLENARY SESSION CONTINUES, Discovery Ballroom, 1:30–5:00 pm (page 8)<br>*Fish + Fish Habitat*<br>*Seabirds* |
| Evening<br>5:30–7:00 | Poster Reception: Gulf of Alaska Research, 5:30–7:00 pm, Lower Lobby | | Poster Reception: Bering Sea/Aleutian Islands Research, 5:30–7:00 pm, Lower Lobby | | Poster Reception: Arctic Ocean Research, 5:30–7 pm, Lower Lobby |
| 7:00–9:00 | | | BEST-BSIERP Bering Sea Project SAB meeting, Club Room 1, 7–9:00 pm (invitation only) | Alaska Climate Change Initiatives: NOAA's proposed National Climate Services; the State of Alaska Sub-Cabinet on Climate Change and Research Needs, and ICES-PICES climate change initiative, Fore Deck, 7–9:00 pn (page 12) | Fish ID Workshop, Whitby Room, 7–9:00 pm (page 12)<br><br>BEST-BSIERP Bering Sea Project SAB & Advisory Group joint meeting, Club Room 1, 7–9:00 pm (invitation only) |

# Schedule at a Glance

| Thursday January 22 | Friday January 23 | | | |
|---|---|---|---|---|
| BERING SEA/ALEUTIAN ISLANDS PLENARY SESSION CONTINUES, Discovery Ballroom, 8–10:00 am (page 9)<br>*Marine Mammals* | Arctic Science Planning Workshop, Fore Deck, 8:00 am–noon (page 13; continues after lunch) | Steller Sea Lion Research Coordination workshop, Voyager Room, 8:00 am–5:00 pm (invitation only) | | Morning 8:00–10:00 |
| | | | Metadata Workshop, Endeavour Room, 9:00 am–noon (page 13) | |
| ARCTIC OCEAN PLENARY SESSION BEGINS, Discovery Ballroom, 10:00 am–noon (pages 10–11)<br>*Climate + Oceanography*<br>*Ecosystem Perspectives* | | | | 10:00–noon |
| LUNCH: PROVIDED. Polar Palooza! | LUNCH: PROVIDED (for Arctic workshop registrants only) | | | Lunch noon–1:30 |
| | | | Pollock Conservation Cooperative Research Center Advisory Board Annual meeting, NPRB Offices, 1–5:00 pm (continues on Saturday, Jan. 24) | |
| ARCTIC OCEAN PLENARY SESSION CONTINUES, Discovery Ballroom, 1:30–5:00 pm (pages 10–11)<br>*Ecosystem Perspectives, cont.*<br>*Fish + Fish Habitat*<br>*Seabirds*<br>*Marine Mammals* | Arctic Science Planning Workshop continues, Fore Deck, 1:30–5:00 pm (page 13) | | | Afternoon 1:30–5:00 |
| | | | | Evening 5:30–7:00 |
| | | | | 7:00–9:00 |

# Symposium Sponsors

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- US Arctic Research Commission
- US Fish and Wildlife Service
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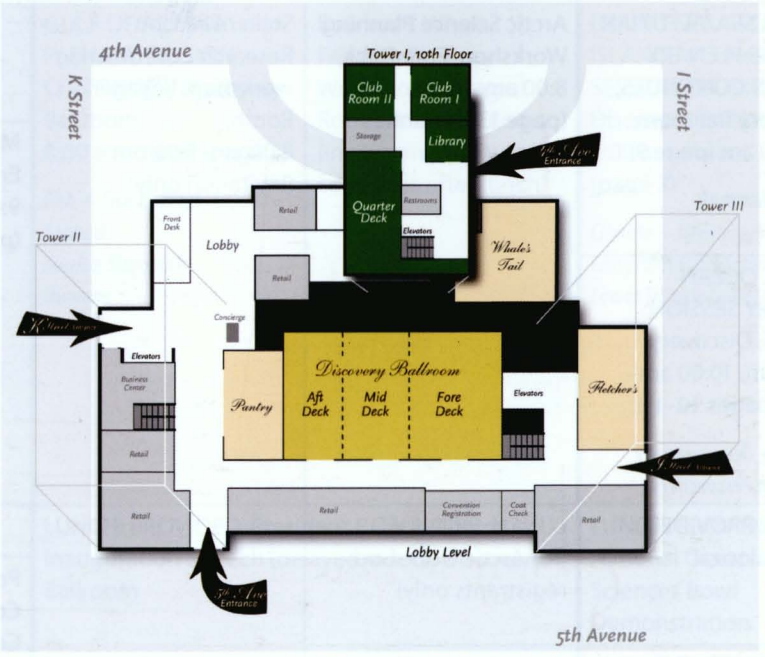
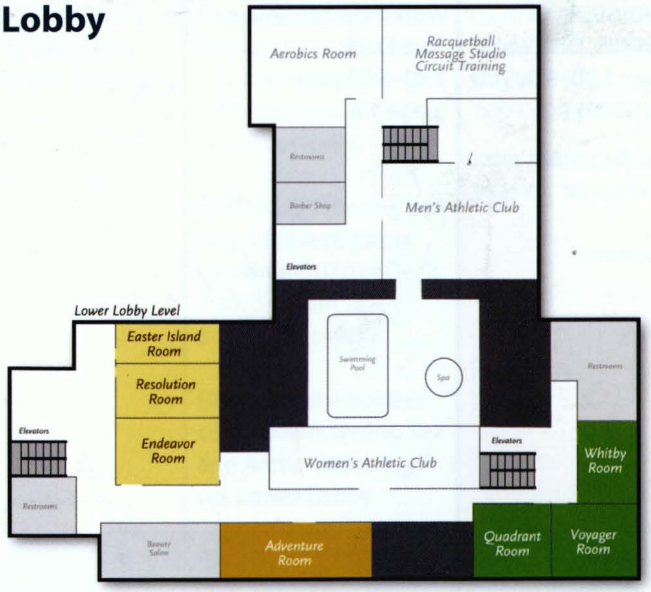
# Captain Cook Hotel Meeting Rooms

## Lobby Level




## Lower Lobby

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# Alaska Marine Science Symposium

## Showcasing Ocean Research in the Arctic Ocean, Bering Sea, and Gulf of Alaska

## January 19–23, 2009

**Hotel Captain Cook**
**Anchorage, Alaska**

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# Marine Science in Alaska: 2009 Symposium
# Book of Abstracts

- Monday 19 January
- **Gulf of Alaska**
  - **Morning** Welcome
  - **Afternoon** Climate, Oceanography, Ecosystem Perspectives, Lower Trophic Levels & Fish and Fish Habitat
  - **Evening** Poster Reception

- Tuesday 20 January
- **Gulf of Alaska**
  - **Morning** Fish and Fish Habitat, Seabirds, Mammals & Humans
  - **Afternoon** Prince William Sound Herring Workshop
  - **Evening.** Poster Reception

- Wednesday 21 January
- **Bering Sea and Aleutian Islands**
  - **Keynote Address** – Michael Sigler

*Understanding Ecosystem Processes in the Bering Sea BEST-BSIERP 2008 Headlines*

  - **Morning** Climate and Oceanography, Ecosystem Perspectives & Lower Trophic Levels
  - **Afternoon** Fish and Fish Habitat & Seabirds
  - **Evening** Poster Reception

- Thursday 22 January
- **Bering Sea and Aleutian Islands**
  - **Morning 1** Mammals
- **Arctic**
  - **Keynote Address** – G Carleton Ray

*Impact of Diminished Sea Ice on Marine Mammals and Indigenous Hunters of Beringia*

  - **Morning 2** Climate and Oceanography & Ecosystem Perspectives
  - **Keynote Address** – Richard Feely

*Tribute to Arnold Brower Sr*

  - **Afternoon** Ecosystem Perspectives, Fish and Fish Habitat, Seabirds & Mammals

# Gulf of Alaska
## Climate and Oceanography, Ecosystem Perspectives, Lower Trophic Levels & Fish and Fish Habitat

Monday 19 January 2009
2 15 – 5 00 PM
**Session Chair Molly McCammon**
**Alaska Ocean Observing System**

TALKS

| **Speaker** | **Title** |
|---|---|
| Markus A Janout * | Temperature controlling processes and the recent cooling in the northern Gulf of Alaska |
| Wieslaw Maslowski | Effects of mesoscale eddies on the flow of the Alaskan Stream |
| S Ian Hartwell | Sediment Quality Triad Assessment in the Kachemak Bay Characterization of Soft Bottom Benthic Habitats and Contaminant Bioeffects Assessment |
| James L Bodkin | Using Trophic Cascades to Develop Ecosystem-Based Recovery Criteria for Threatened Sea Otters in Alaska |
| Richard E Thorne | Biological Forcing by Combinations of Dominant Prey and Predators on Juvenile Pink Salmon Survival in the Prince William Sound Ecosystem |
| Russell R Hopcroft | Oceanographic conditions along the northern Gulf of Alaska□s Seward Line, 1997-2008 |
| Nora R Foster | Evaluating a Potential Relict Arctic Invertebrate and Algal Community on the West Side of Cook Inlet |
| Amy L Blanchard | Long-term Investigation of Benthic Communities in Port Valdez, Alaska 1971-2007 |
| Elizabeth C Atwood * | Influence of mesoscale eddies on ichthyoplankton assemblages in the Gulf of Alaska |
| Terrance J Quinn | Failure of Population Recovery in Relation to Disease for Pacific Herring in Prince William Sound |
| * Student Presentation | |

**Temperature controlling processes and the recent cooling in the northern Gulf of Alaska**

**Markus Janout**, University of Alaska Fairbanks, Janout@sfos uaf edu
Russell R Hopcroft, University of Alaska, hopcroft@ims uaf edu
Kenneth O Coyle, University of Alaska Fairbanks, coyle@ims uaf edu
Thomas J Weingartner, University of Alaska Fairbanks, weingart@ims uaf edu

In spring 2007, oceanic temperatures throughout the water column in the northern Gulf of Alaska (GOA) were the lowest since the early 1970s, and remained below normal through 2008 Stratification was weak due to higher surface and lower near-bottom salinity, likely associated with delayed spring snowmelt In particular, the 0-100m temperatures along the Seward Line remained below normal, whereas >100m temperatures were more variable, due to salt stratification Atmospheric and oceanographic data confirm that salinity (as a function of coastal freshwater runoff) is a controlling parameter for deep mixing and the vertical extent of winter-cooled surface waters Salinity structure is therefore critical for the physical environment of the GOA ecosystem Evidently, the recent cooling caused delays in the onset and development of (at least) primary and secondary producers

We present oceanographic observations from the 2007 and 2008 cooling years in comparison with long term trends at the coastal GOA station GAK1 and further investigate the temperature controlling processes along the Seward Line In particular, we focus on the contribution of along-shore advection to the northern GOA heat and freshwater budget and on cross-shelf gradients in atmospheric heat fluxes

Student Presentation

**Effects of mesoscale eddies on the flow of the Alaskan Stream**

**Wieslaw Maslowski,** Naval Postgraduate School, maslowsk@nps edu
Richardo Roman, Naval Postgraduate SchoolOceanography, rroman@nps edu
Jaclyn Clement Kinney, Naval Postgraduate School, jlclemen@nps edu

Using a high-resolution, pan-Arctic ice-ocean model forced with realistic atmospheric data, we examine the mean transport and temporal and spatial variability within the Alaskan Stream Model results are analyzed and compared with observations, including satellite altimetry and CTD measurements The mean net transport of the Alaskan Stream is found to be between 34 and 44 Sv, intensifying downstream Mesoscale eddies are found to periodically move along the path of the Alaskan Stream and alter the mean position of the typically westward-flowing current However, the strength of the current is not reduced as an anticyclonic eddy passes a point along the path Instead, there appears to be an offshore (or southward) shift in the current velocity core Stationary measurement instruments may not be able to detect this shift in position over the slope if their southernmost location does not coincide with the current shift due to an eddy This may result in recording of a weakened or sometimes reversed flow Finally, we examine and demonstrate that modeled eddies within the Alaskan Stream have dominant effect on northward transport and variability through the eastern and central Aleutian Island passes

**Sediment Quality Triad Assessment in the Kachemak Bay Characterization of Soft Bottom Benthic Habitats and Contaminant Bioeffects Assessment**

**S Ian Hartwell**, NOAA, ian hartwell@noaa gov
Dennis Apeti, NOAA, dennis apeti@noaa gov
Kimani Kimbrough, NOAA, Kimani Kimbrough@noaa gov
W Edward Johnson, NOAA, ed johnson@noaa gov

The goal of this project was to assess benthic habitat conditions and evaluate whether contaminants may influence biodiversity and productivity in inner Kachemak Bay The northern portion of the Bay was sub-divided into four intertidal and subtidal sampling strata based on geophysical and hydrodynamic properties An additional stratum was established within Homer Harbor In the summer of 2007, sediment was synoptically sampled in a stratified random statistical design for physical characterization, comprehensive chemical analyses, benthic macroinvertebrate community, toxicity bioassays, and basic water quality Data is being analyzed in the NOAA NS&T sediment quality triad framework for ecosystem assessment Chemical analyses reveal a virtually pristine environment in the open bay Relative to the bay, Homer Harbor has elevated levels of PAHs indicative of fuel spills and combustion by-products Tri-butyl tin residues are also elevated in the harbor Chlorinated pesticides and PCBs were slightly elevated in Homer Harbor, but all concentrations were at low levels Metals concentrations were generally low, but in harbor sediments Zn, Cr, and Cu approached threshold biological effect levels Infaunal assessment showed diverse assemblages with abundances greater than 3,000 animals/$m^2$ in all but a few locations Diversity and abundance show a gradient from lower in the east to higher in the west areas of the bay, which reflects the influence of summer water quality from glacial meltwater entering the bay from the Fox and Bradley Rivers The intertidal and subtidal communities contain a core species assemblage common to both, plus mutually exclusive groups of species found in each The benthic assemblage in Homer Harbor is distinct from areas outside the harbor Significant toxicity was observed in two locations, one of which may be an artifact of harsh sediment characteristics (dense clay) Overall, the shallow habitats in Kachemak Bay appear to be largely unaffected by chemical contamination These data can serve as a comprehensive baseline to assess potential spills, relative condition of neighboring areas, and to assess habitat condition as the region is developed over time This project is coordinated with sampling in deeper areas of the bay and Cook Inlet in collaboration with CIRCAC

## Using Trophic Cascades to Develop Ecosystem-Based Recovery Criteria for Threatened Sea Otters in Alaska

**James L Bodkin**, USGS, james_bodkin@usgs gov
James A Estes, University of California, Santa Cruz, jestes@cats ucsc edu
M T Tinker, USGS, tinker@biology ucsc edu

For species or populations listed under the Endangered Species Act, delisting criteria normally are based on demographic measures such as abundance and rates of population change This approach seeks to maintain enough individuals over a sufficiently large area to assure a low risk of future extinction and requires often difficult to obtain population data More importantly, such demographically-based delisting criteria may be insufficient to insure restored ecological function, which is an important consideration for species that are both depleted and known to exert strong influence in structuring their ecosystem We explore this issue for sea otters as a keystone species in maintaining kelp forest ecosystems The collapse of sea otter populations in the Aleutian archipelago late in the 20th century disrupted the otter/sea urchin/kelp trophic cascade, thus causing coastal reefs to transition from productive kelp forests, to deforested urchin barrens Surveys of sea otters and their associated rocky reef habitats at 30 islands before and after the decline demonstrated that the system nearly always exists in one of two phase states (kelp-dominated or deforested) and that each state is highly predictable based on sea otter density We use these data to establish a best-fit functional relationship between otter density and phase-state configuration A resampling analysis of the rocky reef survey data further demonstrates that phase state can be characterized with a high level of confidence with relatively little field effort Our analyses indicate that phase state is an informative and sensitive measure of sea otter population status and ecosystem function and should augment traditional, demographically-based metrics as delisting criteria for this species The use of ecosystem-based criteria will have application in recovery planning where relations between species densities and ecosystem state are well defined

## Biological Forcing by Combinations of Dominant Prey and Predators on Juvenile Pink Salmon Survival in the Prince William Sound Ecosystem

**Richard E Thorne**, Prince William Sound Science Center, rthorne@pwssc org

We synoptically monitored both spring zooplankton and pelagic fish abundance in Prince William Sound, Alaska, from 2000 to 2006 Our objective was to investigate the hypothesis that the dominant pelagic fishes, walleye pollock (*Theragra chalcogramma*) and Pacific herring (*Clupea pallasi*), switched from planktivorous to piscivorous feeding when densities of large-bodied copepods (genus *Neocalanus*) were low, causing reductions in the survival of juvenile pink salmon (*Oncorhynchus gorbuscha*) During the first five years of our observations, large copepod abundance and pink salmon survival were both higher during even years than odd years As expected from the prey-switching hypothesis, piscivorous fishes exhibited a significant, progressive inshore movement during the odd years of poorer nursery conditions In addition, the pink salmon returns per large copepod in the nursery year increased over the five-year period, corresponding to a significant decline in walleye pollock abundance However, in the last two years of this study it became apparent that another mechanism was operating on the survival of pink salmon fry A dominant two-year cycle emerged from the data While a two-year cycle is characteristic of wild stocks of pink salmon, it had not previously been observed in the hatchery-dominated PWS pink salmon We present data that predation by the adult pink salmon, which return along the same path as the fry outmigration, is probably the driving mechanism over the last two years of the study The complex and varying forcing functions present a challenge to pink salmon forecasting, and possibly to all ecosystem research

## Oceanographic conditions along the northern Gulf of Alaska's Seward Line, 1997-2008

**Russell R Hopcroft**, University of Alaska, hopcroft@ims uaf edu
Kenneth O Coyle, University of Alaska Fairbanks, coyle@ims uaf edu
Thomas J Weingartner, University of Alaska Fairbanks, weingart@ims uaf edu
Terry E Whitledge, University of Alaska Fairbanks, terry@ims uaf edu

The Seward Line in the Northern Gulf of Alaska has been the focus of multidisciplinary sampling for the past 11 years Here we report on the observations of physical oceanography, nutrients, phytoplankton, and zooplankton over that period In particular, we discuss the biological conditions during 2007 and 2008 when spring temperatures have been lower than observed over the past decade During both years, the spring bloom was delayed, as was the development of the zooplankton community dependant upon it Under these conditions some key zooplankton species have done better than average, while others have not Specifically, biomass during May of the key copepod species *Neocalanus plumchrus/flemingeri* was lower than average in 2007 Implications to higher trophic levels will be discussed Notably, 2008 returns of pink salmon released in 2007 showed low survival compared to other years

## Evaluating a Potential Relict Arctic Invertebrate and Algal Community on the West Side of Cook Inlet

**Nora R Foster**, University of Alaska, swamprat@mosquitonet com
Dennis C Lees, Littoral Ecological & Environmental Services, dennislees@earthlink net
Sandra C Lindstrom, University of British Columbia, sandracl@interchange ubc ca

This work represents an effort to describe in greater detail than previously known the anomalous occurrences of Arctic epifaunal invertebrates and algae along the western side of Cook Inlet in an area of interest for industrial development To address questions of Arctic-affiliated algae and invertebrates, we reviewed previous biological assessments, examined specimens, and considered the geological history and other factors that may explain the disjunct occurrences We reviewed the distributions of 723 species of marine invertebrates and 175 algae of Cook Inlet and 66 species from the Arctic algae species from both sides of Cook Inlet, Prince William Sound and Point Barrow Sixty-eight invertebrates have distributions that include the west side of Cook Inlet and the Arctic

For the invertebrates, we employed two types of multivariate analyses on bryozoa and mollusks (two phyla for which good distributional data and identifications are available) to view relationships among regions and taxa The distribution of seaweeds in the northeast Pacific and in was Cook Inlet was analyzed to consider what relationship might exist between species occurring the Cook Inlet and in the Arctic, using existing algae databases, and as yet unpublished molecular data

Given their potential isolation, these western Cook Inlet populations could be at risk of significant habitat perturbation and may prove to be sensitive indicators of climate change or other ecological shifts Plans to develop a large industrial port in the vicinity of Iliamna and Iniskin bays presents a risk the construction and operation of such a port could threaten populations Monitoring their distributions and abundance could provide insight into changes in marine flora and fauna with changing physical oceanographic conditions On the other hand, the persistence of these species in spite of their restricted distributions, relative to the prevailing currents, raises some interesting questions about their reproductive mechanisms and strategies

## Long-term Investigation of Benthic Communities in Port Valdez, Alaska 1971-2007

**Arny L Blanchard**, University of Alaska Fairbanks, arnyb@ims uaf edu
Howard M Feder, University of Alaska Fairbanks, feder@ims uaf edu
Hilary K Nichols, University of Alaska Fairbanks, hilaryknichols@gmail com
Carrie L Parris, University of Alaska Fairbanks, belben@sfos uaf edu

Long-term studies (1971 to 2007) of the marine environment in Port Valdez, Alaska, have demonstrated large change over time with human activities contributing substantially to small and ecosystem-level changes in the fjord Sampling of benthic invertebrates at sites in Port Valdez was initiated in 1971 and modified in 1989 to address effects of treated ballast-water discharges on benthic communities at the marine oil terminal A retrospective analysis was performed to determine the important scales of factors contributing to spatial and temporal variability in the benthos Overall, the 1964 earthquake in Prince William Sound, deposition of glacial sediments, and returns of adult hatchery salmon appear to have the largest influences on faunal communities in the fjord At small scales (< 2 km), measurable effects from anthropogenic stressors include discharges of ground fish wastes from a fish processing plant and treated ballast waters at the marine oil terminal Infaunal communities affected by fish wastes were dominated by the opportunistic polychaete Capitella capitata Interactions between vessel traffic and fish waste deposition resulted in delayed recovery of fauna from the deposition of dredged sediments Assessments of sediments adjacent to the oil terminal indicate subtle, long-term alterations of fauna at low hydrocarbon concentrations Fauna sensitive to hydrocarbons include the polychaetes Galathowenia oculata and Melinna cristata and a cumacean Eudorella emarginata These fauna declined in abundance at 100 to 300 ng g-1 PAH in sediments Overall, biological communities Port Valdez have experienced substantial temporal variability with natural and anthropogenic stressors contributing to measurable local and ecosystem-level adjustments of fauna The results of the long-term investigations in Port Valdez have implications for understanding effects from anthropogenic stressors and long-term variability in benthic systems throughout Alaskan waters

**Influence of mesoscale eddies on ichthyoplankton assemblages in the Gulf of Alaska**

**Elizabeth Catherine Atwood**, University of Washington, Seattle, eatwood@u washington edu
John K Horne, University of Washington, Seattle, jhorne@u washington edu
Janet Duffy-Anderson, NOAA/NMFS/AFSC, janet duffy-anderson@noaa gov
Carol Ladd, NOAA/PMEL/AFSC, carol ladd@noaa gov

Ichthyoplankton trajectories through the environment determine growth rates and survival Individual paths are influenced by both local and large scale oceanographic conditions Coastal origin, mesoscale eddies (cir 100 km diameter) propagating westward across the continental shelf are a strong mechanism of cross-shelf water exchange and influence nutrient, chlorophyll, and zooplankton densities Despite the prevalence of eddies in the Gulf of Alaska, the importance of entrainment on ichthyoplankton diversity, survival, and growth has not been quantified Evidence for larval fish entrainment was examined using oblique bongo tows from a cruise undertaken in 2005 This cruise focused on the physical and biological characteristics of three eastern Gulf of Alaska mesoscale eddies Haida, Sitka, and Yakutat Using hierarchical cluster analysis, a southern group was identified consisting of fish species found in lower eastern Pacific waters This group was also identified in Non-Metric Multidimensional Scaling (NMDS) and multivariate tests (Mantel, Multi-Response Permutation Procedure) Regression of species richness as a function of distance from eddy center showed an inverse relationship (gamma error structure, inverse link function, $p = 0\ 00025$), attributed to converging flow toward the eddy centers Advection of fish larvae from coastal to slope waters may reduce survival and subsequent recruitment of commercially important shelf species

Student Presentation

## Failure of Population Recovery in Relation to Disease for Pacific Herring in Prince William Sound

Gary D Marty, University of California, gdmarty@ucdavis edu
Peter-John F Hulson, University of Alaska Fairbanks, p hulson@uaf edu
Sara E Miller, University of Alaska Fairbanks, S Miller@uaf edu
**Terrance J Quinn**, University of Alaska Fairbanks, terry quinn@uaf edu
Steve D Moffitt, Alaska Department of Fish and Game, steve moffitt@alaska gov
Richard A Merizon, Alaska Dept of Fish and Game, richard merizon@alaska gov

Rapid declines in wild fish populations are often associated with disease, but the role of disease in prolonged depression of fish populations is poorly understood Three pathogens are commonly associated with disease of marine fish the mesomycetozoean Ichthyophonus hoferi, filamentous bacteria (*Tenacibaculum maritimum*), and viral hemorrhagic septicemia virus (VHSV) We show that following a severe 1993 disease outbreak in the Pacific herring (*Clupea pallasi*) population of Prince William Sound, Alaska, U S A , population recovery has been impaired by epidemics that have cycled through the adult population about every 4 years Comprehensive epidemiological study from 1994 through 2002 resulted in time series of two disease indices related to these parhogens The series were augmented to 2006 using data from two lesions skin ulcers (associated with filamentous bacteria) and white foci in the heart (associated with *I hoferi*) collected by field biologists from 2003 through 2006 The time series indicated that decreasing severity of epidemics of filamentous bacteria and VHSV in 1993/1994 and 1998 were replaced by epidemics of I hoferi that peaked in 2001 and 2005 The impact of disease on population abundance was quantified by updating an age-structured assessment model with data from 2001 through 2006 The best model scenario modeled mortality as a function of the filamentous-bacteria/VHSV index for ages 3 4 with the total prevalence of I hoferi for all ages From 1993 through 2006, estimated natural mortality was significantly greater than background natural mortality of 0 25 The overall pattern in estimated age 3 recruitment was a strong pulse every four years (1983, 1987, 1991) and then persistently low numbers after 1992 However, projections from the model showed that the low recruitment after 1992 was sufficient for population recovery if the effect of disease had not been present This study shows that disease information can be used to explain and predict changes in populations that have confounded traditional fisheries assessment

# Gulf of Alaska
## Fish and Fish Habitat, Seabirds, Marine Mammals & Humans

Tuesday 20 January 2009
8 00 AM – Noon
**Session Chair Robert Spies**
**Alaska SeaLife Center**

TALKS

| Speaker | Title |
|---|---|
| Sarah Hinckley | Modeling spawning-nursery connectivity of walleye pollock between the Gulf of Alaska and the Bering Sea Toward an understanding of stock structure and recruitment |
| Joseph J Bizzarro | Diet and trophic ecology of skates in the Gulf of Alaska (*Raja* and *Bathyraja* spp ) |
| Lorenz Hauser | Genetic population structure in Pacific cod, *Gadus macrocephalus* evidence for limited dispersal and isolated fjord populations |
| Clifford H Ryer | Ampharetid worm turf an essential character of juvenile flatfish habitat in Kodiak nurseries |
| Marlin Keith Cox | Phase angle as a new independent condition index for fish |
| Julia K Parrish | On death and dying coast breeding, cumulative, and wreck signals in Alaskan beached bird surveys |
| Veronica Marie Padula | Health Assessment of Marbled Murrelets in Port Snettisham, Southeast Alaska |
| John F Piatt | Competitive Coexistence and Scale-Dependent Ecological Segregation of *Brachyramphus* Murrelets in a Glacial-Marine Ecosystem |
| Jason K Herreman * | Evidence of bottom-up control of diet driven by top-down processes in a declining harbor seal (*Phoca vitulina richardsi*) population |
| Lorrie D Rea | Percent total body lipid content increases in Steller sea lion (*Eumetopias jubatus*) pups during the first year of life in a similar pattern to other otariid species |
| Markus Horning | Chronicle of a death re-told quantifying predation on juvenile Steller sea lions in the Gulf of Alaska |
| Craig O Matkin | Ongoing population-level impacts on killer whales 18 years after the Exxon Valdez oil spill |
| Courtney Carothers | Privatizing the Right to Fish Challenges to Livelihood and Community in Kodiak, Alaska |
| William E Simeone | Subsistence Harvests and Local Knowledge of Rockfish *Sebastes* in four Alaskan Communities |
| *** Student Presentation** | |

**Modeling spawning-nursery connectivity of walleye pollock between the Gulf of Alaska and the Bering Sea Toward an understanding of stock structure and recruitment**

**Sarah Hinckley**, Alaska Fisheries Science Center, Sarah Hinckley@noaa gov
Carolina Parada, University of Washington, carolina parada@noaa gov
John K Horne, University of Washington, jhorne@u washington edu
Bernard Megrey, Alaska Fisheries Science Center, Bern Megrey@noaa gov
Martin Dorn, Alaska Fisheries Science Center, martin dorn@noaa gov
Albert J Hermann, University of Washington, albert j hermann@noaa gov

We developed and used a coupled biophysical model to simulate the physical environment and the early life history of walleye pollock (*Theragra chalcogramma*) in the Gulf of Alaska (GOA) The overall goal of the modeling work has been to understand processes that influence walleye pollock recruitment, and how recruitment may fluctuate as climate changes As part of this main goal, we have tried to illuminate aspects of the population structure of walleye pollock in the North Pacific by providing a picture of relationships between spawning locations and nursery areas GOA and Bering Sea (BS) walleye pollock are presently managed as a separate populations Is this management scheme justified? Spawning pollock are now found in several different locations in the GOA, especially since the historical population spawning in Shelikof Strait has declined Where do the fish from these different spawning locations go? Part of our ultimate goals with this work is to use our biophysical model to derive a model-based index of recruitment to aid managers of walleye pollock In order to do this, we must answer these questions about stock structure and connectivity In this project, we adapted and developed a biophysical simulation model to examine some of these questions, and to aid in the development of a potential recruitment forecasting index for GOA walleye pollock This application consists of a coupled model set a three dimensional model of the physical environment, including currents, salinities, and temperatures, and an individual-based model of mechanisms affecting growth and survival of young walleye pollock as they move through the environment We present the modeling application we developed, validation exercises, and the results of simulation experiments that shed light on the complex relationship between spawning areas in the GOA, and the different nursery areas This work has resulted in increased insight into possible connections of walleye pollock within the GOA and between the GOA and the BS

## Diet and trophic ecology of skates in the Gulf of Alaska (*Raja* and *Bathyraja spp*)

**Joseph J Bizzarro**, Moss Landing Marine Laboratories, jbizzarro@mlml calstate edu
David A Ebert, Moss Landing Marine Laboratories, debert@mlml calstate edu
Simon B Brown, Moss Landing Marine Laboratories, sbrown@mlml calstate edu
Mariah D Boyle, Moss Landing Marine Laboratories, mboyle@mlml calstate edu
Gregor M Cailliet, Moss Landing Marine Laboratories, cailliet@mlml calstate edu

The Aleutian (*Bathyraja aleutica*), Bering (*B interrupta*), big (*Raja binoculata*), and longnose (*R rhina*) skates are common groundfishes occurring throughout the outer continental shelf and upper slope of the Gulf of Alaska The diets and trophic levels of these skates were determined and compared intra and interspecifically to elucidate their ecological roles in the Gulf of Alaska ecosystem Specimens were collected from fishery independent trawl surveys of the Alaska Department of Fish and Game and National Marine Fisheries Service conducted in the western Gulf during May-September, 2005-2007 All species were determined to be secondary consumers with trophic levels ranging from 3 58 3 69 Decapod crustaceans were the primary prey items in the diets of all skates Among decapods, shrimps dominated the diets of all species but *R binoculata*, which consumed primarily brachyuran crabs Interannual dietary differences were noted for *B aleutica* and *B interrupta* In both cases, euphausiids comprised a much greater proportion of the diet during 2007, and the contribution of shrimps was relatively less substantial The diets of *B aleutica, B interrupta* (during 2006), and *R rhina* were quite similar, consisting primarily of shrimps with crabs and fishes of secondary importance Diet compositions differed significantly for all additional interspecific comparisons Skates appeared to be generalists, consuming locally abundant invertebrates and fishes, including several commercially important taxa (e g pandalid shrimps, tanner crabs, gadids, flatfishes) As common benthic predators and competitors with other groundfishes, the studied skate assemblage may play an influential role in trophic dynamics and regulation of demersal marine communities in the Gulf of Alaska

## Genetic population structure in Pacific cod, *Gadus macrocephalus* evidence for limited dispersal and isolated fjord populations

**Lorenz Hauser**, University of Washington, lhauser@u washington edu
Kathryn M Cunningham, School of Aquatic and Fishery Sciences, kathrynmaja@gmail com
Ingrid Spies, NOAA, ingrid spies@noaa gov
Michael F Canino, NOAA, Mike Canino@noaa gov

Although the notion that exploited species should be managed at the population level can be traced back to seminal work more than a century ago, the practical implementation of such insight is still fraught with difficulties Especially in marine fishes, population boundaries are often ill-defined by environmental, biological or genetic discontinuities Nevertheless, there is strong evidence for limited dispersal within continuous populations in many marine species, resulting in stock structure highly relevant to management and conservation Here, we examined the genetic population structure of Pacific cod, *Gadus macrocephalus*, across much of its northeastern Pacific range Genetic divergence was highly correlated with geographic distance in an isolation-by-distance (IBD) pattern along the coastal northeast Pacific Ocean (~ 4000 km, $r^2$ = 0 83), extending from Washington State to the Aleutian Islands, and over smaller geographic distances for three locations in Alaska (~1700 km, $r^2$ = 0 56) Slopes of IBD regressions suggested average dispersal distance between birth and reproduction of less than 30km Exceptions to this pattern were found in samples taken from fjord environments in the Strait of Georgia (Canada) and Puget Sound (USA), where populations were isolated from coastal cod Our results refute the paradigm of broad scale genetic homogeneity and extensive gene flow in Pacific cod In common with other marine species, isolated stocks were found in some enclosed bays and may exist elsewhere, requiring identification and independent management Furthermore, although no clear stock boundaries could be identified in Pacific cod along the North American coast, effective dispersal is limited, and essentially self recruiting stocks are likely to exist on the northeast Pacific continental shelf Such stocks could be further resolved using recently developed genetic markers linked to expressed genes under diversifying selection, as currently underway in Atlantic cod and other species Such high differentiation markers could also be used to evaluate contemporary migration rates, investigate larval dispersal and estimate mixture proportions in mixed stock fisheries on summer feeding grounds

## Ampharetid Worm Turf An Essential Character of Juvenile Flatfish Habitat in Kodiak Nurseries

**Clifford H Ryer**, AFSC/NOAA, cliff ryer@noaa gov
Benjamin J Laurel, AFSC/NOAA, Ben Laurel@noaa gov
Brian A Knoth, AFSC/NOAA, brian knoth@noaa gov

The ampharetid polychaete *Pseudosabellides sibirica* is a bioengineering species controlling the distribution of juvenile flatfish in summer nurseries around Kodiak In some years the worm is absent, while in others so abundant that it forms a dense turf covering large swaths of the seafloor Juvenile flatfish, notably northern rock sole, aggregate where the worm are either sparse or patchy, but avoid the dense turf During the summer of 2008 a dense worm turf extended from a depth of 21 to 135m at Pillar Creek Cove, with juvenile flatfish aggregated along the shallow (inner) edge We tested the hypothesis that juvenile flatfish are unable to bury themselves in sediment stabilized by worm turf, reasoning that this would lead fish to avoid this habitat Video monitored microcosms containing single rock sole were place over bottom with and without worm turf Juvenile flatfish buried immediately in the sand treatment Fish were unable to bury in turf treatment and continuously moved about attempting to bury In a second manipulation, we tested the hypothesis that sparse/patchy worm tubes would render juvenile less vulnerable to predation Juvenile were tethered on the seafloor at depths transecting the worm turf Mortality generally increased with depth, but dropped significantly along the inner turf edge, where fish had aggregated These experiments suggest that predator avoidance is a principle factor controlling distribution of juvenile flatfish relative to ampharetid worm habitat, and that inter-annual changes in ampharetid abundance strongly influence the quality of juvenile nurseries

## Phase angle as a new independent condition index for fish

**Marlin Keith Cox**, Sitka Sound Science Center, marlinkcox@gmail com
Ron A Heintz, Alaska NOAA Fisheries, ron heintz@noaa gov

In this study, phase angle is presented as a new method to measure fish health and condition Conditional indices have historically been based on simple weight at length relationships, or costly, time consuming, analytical laboratory procedures that measure specific physiological parameters Here the authors present a new method to measure the condition of fish using phase angle values obtained by measuring the bioelectrical impedance (resistance and reactance) of fish Phase angle is introduced to bridge the simplicity of a quick field based measurement with the specificity of laboratory analysis by directly measuring extra- and intra-cellular water movement which is indicative of an organism s conditional status Phase angle was measured in six species of fish during different relative conditional periods (e g fed vs starved, wild vs hatchery, winter vs spring, and post-mortem) Phase angle was reflective of different conditional states with phase angles < 15° being indicative of fish in poor condition while phase angles > 15° indicated fish were in better condition Phase angle also decreased with time in post mortem fish due to cell membrane degradation and subsequent water movements from intra- to extra-cellular (interstitial) spaces

## On death and dying coast breeding, cumulative, and wreck signals in Alaskan beached bird surveys

**Julia K Parrish**, University of Washington, jparrish@u washington edu
Jane E Dolliver, University of Washington, dolliver@u washington edu
Kathryn A Litle, University of Washington, kalitle@u washington edu

The Coastal Observation and Seabird Survey Team (COASST) is a beached bird monitoring program that trains citizens to survey beaches monthly and collect data in a standardized, rigorous manner Data are used to create a baseline against which a variety of factors, including anthropogenic factors, can be assessed Since its inception in 1999, COASST has grown to over 500 people surveying about 300 sites, including over 60 sites and participants in Alaska We examined three types of beached bird data post breeding signals typical of temperate and sub-arctic beached bird programs, cumulative annual encounter rates, and incidents and intensity of mass stranding (or wrecks) Unlike all established beached bird survey programs in temperate and sub-arctic regions, including COASST lower 48, COASST Alaska data indicate a distinct lack of post-breeding mortality throughout all regions in the state Instead, encounter rates peak during the breeding season For abundant migrating species, exemplified by Northern Fulmars, post-breeding mortality appears to be confined (at least as expressed by beach-cast birds) through fall months along CCS (California Current System) sites, and varies extensively on an annual basis Cumulatively over the geographic range of the program, encounter rates are highest on the exposed, low inclination, west-facing beaches of the northern CCS, with a peak along the Oregon coastline With the exception of select sites in the Bering Sea and the Aleutian islands, Alaskan encounter rates most closely resemble the extremely low values of the inside waters of greater Puget Sound Wreck signals are infrequent, but available data from both COASST Alaska, COASST lower 48, and other temperate and sub-arctic bird programs suggest Alaska wrecks are both rare and severe, and include both local and migrant species Taken together, these data suggest that the patterns of deposition of both breeding and migrant species is unique in Alaska, and may represent differences in use of nearshore coastal ecosystems, local physical forcing, and the annual cycle, timing, and geographic pattern of post-breeding migration

## Health Assessment of Marbled Murrelets in Port Snettisham, Southeast Alaska

**Veronica Marie Padula**, University of Alaska Anchorage/University of Alaska Fairbanks, vmp2011@gmail com
Scott Newman, Food and Agriculture Organization of the United Nations, Scott Newman@fao org
Kim Nelson, Oregon State University, nelsonsk@onid oregonstate edu
Trevor Bruce Haynes, University of Alaska Fairbanks, 88sunday88@gmail com
Carolyn Cray, University of Miami Miller School of Medicine, CCray@med miami edu

Marine ecosystem conservation relies on a thorough understanding of the biology, health, and ecology of threatened populations Information about seabirds is an essential part of marine ecosystem conservation As top predators, seabirds accumulate nutrients and toxins from their prey and the environment in their blood and tissues, which is reflected in their hematological and clinical chemistry parameters Consequently, seabird health reflects the health of their ecosystem However, seabird population health must be monitored over time in order to track changes The first step in the monitoring process is to collect baseline data to compare to other regions or future studies in the same region Here, we provide baseline health reference intervals for the Marbled Murrelet (*Brachyramphus marmoratus*) in an area previously unstudied We analyzed blood samples from 101 murrelets and report hematological and clinical chemistry values for Port Snettisham, Southeast Alaska from 2005 to 2007 These baseline health reference intervals were then compared to values from murrelets from Año Nuevo Bay, California (sampled from 1997-2000) Results suggested that murrelets sampled in 2006 were in poorer physical condition compared to 2005 and 2007 birds Anomalous environmental conditions, such as low temperatures and heavy rains, during the 2006 spring may have negatively impacted the murrelets physical condition Male hematological parameters were not significantly different from females (for 2006 and 2007), however calcium was significantly larger in females ($P < 0.0001$), likely caused by sex specific physiological changes during breeding Overall, murrelets from Southeast Alaska appear to be in relatively good physical condition, and found that murrelets from California showed signs of depressed health relative to the Alaska population However, Alaska murrelets were sampled at a time when no obvious health threats were of concern, and thus establishes baseline health parameters in a murrelet population unaffected by complicating factors In the future, potential threats to murrelet health in Port Snettisham include compromised water quality, contaminated prey items due to oil pollution, cruise ship discharges, and discharges from industry, and changes in prey availability and abundance

## Competative Coexistence and Scale-Dependent Ecological Segregation of Brachyramphus Murrelets in a Glacial-Marine Ecosystem

**John F Piatt**, USGS Alaska Science Center, jpiatt@usgs gov

Among congeneric seabird species that coexist, the closely-related Kittlitz's Murrelet (KIMU, *B brevirostris*) and Marbled Murrelet (MAMU, *B marmoratus*) have high potential for competitive interactions In Alaska, KIMU and MAMU are almost the same size (~8% difference in mass), eat the same prey (e g , capelin, sand lance) and forage in the same manner At basin and regional scales, their distributions overlap extensively and both species are most abundant in sheltered waters of northern SE Alaska to Prince William Sound To assess potential for competition at finer scales, we examined at-sea spatial distribution of both species with respect to the physical (e g , temperature, turbidity) and biological (e g , plankton, fish) environment of Glacier Bay in SE Alaska At increasing (from 2 to 32 km) spatial scales, we calculated correlations between murrelet densities and 27 habitat variables, and applied regression tree analysis to assess the influence of each variable on murrelet abundance Analyses revealed areas of Glacier Bay where neither species foraged, areas where KIMU were common but MAMU were not, and vice-versa At the largest spatial scale, the distribution of both species was influenced most by prey abundance At small to moderate scales, prey abundance followed by glacially-influenced physical variables strongly influenced KIMU distribution, whereas physical features (e g , temperature, distance from glacier) influenced MAMU more strongly than prey At all scales, MAMU were correlated with 21 of 27 variables in a manner opposite to KIMU, revealing markedly different inter-specific approaches to use of food and space resources in Glacier Bay

**Evidence of bottom-up control of diet driven by top-down processes in a declining harbor seal (*Phoca vitulina richardsi*) population**

**Jason K Herreman**, Univeristy of Wyoming, jkherreman@hotmail com
Gail M Blundell, Alaska Department of Fish and Game, gail blundell@alaska gov
Merav Ben-David, University of Wyoming, bendavid@uwyo edu

Two mechanisms of population control dominate most biological systems, bottom-up and top-down regulation It is possible however, that top-down mediation may lead to bottom-up control of a population if predators simultaneously compete for the same prey Harbor seals (*Phoca vitulina richardsi*) in Glacier Bay (GB) and Prince William Sound (PWS), Alaska have declined drastically since the 1970's, with PWS recently stabilizing and GB continuing to decline Hypotheses for the declines include both bottom-up and top-down processes We hypothesized that increased competition and predation risk by other predators is causing harbor seals in GB to forage on lower quality prey We used a combination of prey remains and isotope analyses to compare seal diets in these areas Seal diets in GB and PWS varied spatially and temporally due to changes in resource availability and sexual segregation Adults showed clear divergence in diet during specific times of year in both areas Sexual segregation of diet in GB was most prevalent during spring and fall, while segregation was greatest during late summer in PWS Diet of seals in PWS showed annual variation not found in GB, likely following prey cycles In GB during the summer, all seals switched to a diet of more intertidal/demersal species of lower fat content such as rockfish and sculpin This switch coincided with an increase in competitors and predators entering GB The change in diet combined with high estimates of emigrants out of GB, suggest that increased competition and risk of predation may contribute to overall population declines

Student Presentation

## Percent Total Body Lipid Content Increases in Steller Sea Lion (*Eumetopias jubatus*) Pups During the First Year of Life in a Similar Pattern to other Otariid Species

**Lorrie D Rea**, Alaska Department of Fish and Game, lorrie rea@alaska gov
Kenneth W Pitcher, Alaska Department of Fish and Game, kwpitcher@yahoo com
Sean D Farley, Alaska Department of Fish and Game, sean farley@alaska gov
Julie P Richmond, Alaska Department of Fish and Game, Julie Richmond@UCONN EDU
Wendy S Dunlap-Harding, Alaska Department of Fish and Game, WDunlap@dfg ca gov

Although several studies have suggested that early-lactation Steller sea lion (SSL) pups (birth to 6 weeks of age) are healthy and well nourished, there has been continued concern that if mothers were nutritionally stressed they may not be able to fully support larger, mid- or late-lactation pups, possibly leading to decreased survivorship of juveniles This study estimated the percent total body lipid content (TBL) of 382 SSL pups (2 to 11 months of age) using the deuterium dilution technique to determine if poor body condition was evident in this species within the first year of development Samples were collected from pups captured in Southeast Alaska (SEA, n=135), Prince William Sound (PWS, n=160), Gulf of Alaska (GOA, n=25) and the Aleutian Islands (AL, n=62) between 1998 and 2008 Male pups were larger and slightly leaner than females in all regions, thus were considered separately Both male and female pups were smaller and leaner in SEA than in regions of the western population (PWS, GOA and AL) Mean TBL of male pups in AL increased significantly during the first year of development from 15 9 ± 5 0 % (mean ± SD) in early-lactation (2-3 months of age, n=9) to 32 4 ± 5 3 % in late-lactation (10-11 months of age, n=17, P=0 0000, F2,33=35 29) Similarly, mean TBL of female pups in AL increased from 23 5 ± 3 1 % in early-lactation (2-3 months of age, n=7) to 35 9 ± 5 2 % in late-lactation (10-11 months of age, n=11, P=0 0002, F3,29=9 46) Mean TBL contents of early-lactation SSL pups was similar to those values previously reported for California sea lions (*Zalophus californianus*) and Australian fur seals (*Arctocephalus pusillus*) of similar ages Additionally, mid- and late-lactation TBL contents of SSL pups fall within the range of values reported for Australian fur seals of similar ages This leads us to conclude that there is no evidence of poor body condition in western stock SSL pups during the first year of development

## Chronicle of a Death Re-Told Quantifying Predation on Juvenile Steller Sea Lions in the Gulf of Alaska

**Markus Horning**, Oregon State University, markus horning@oregonstate edu

Despite decades of studies, the endangered western DPS of Steller sea lions (*Eumetopias jubatus*) continues to decline for undetermined reasons Explicit evidence of mortality and underlying causes are essential yet difficult to obtain We present the first direct, preliminary measure of predation on western Steller sea lions from post-mortem satellite-linked transmissions by implanted monitors We propose a predator pit based conceptual framework for integrating predation and productivity on sea lion population trajectories

Twelve juvenile male Steller sea lions from Prince William Sound (PWS) were implanted with dual Life History Transmitters (LHX tags) between 2006-2008, and released in the Resurrection Bay, Kenai Fjords (KF) area In 4648 monitored days from 12 animals, data from four mortality events were received Within the limits of the small initial sample size, survival rate estimates derived from LHX returns were comparable to rates from re-sights of 143 juvenile males branded by the NMFS in PWS (L Fritz, pers comm) In conjunction with zero mortality observed during control studies this indicates that no mortalities were undetected or caused by our approach Of four datasets received, three were indicative of predation inferred from recorded temperature profiles, immediate onset of transmissions, and ancillary observational data The fourth dataset was inconclusive The only available direct measure of predation on any pinniped suggests predation as potentially the single greatest cause of mortality for juvenile Steller sea lions in the PWS-KF region Combining our records of 1 in 4 mortalities with available brand re-sight data, we estimate that that 58 5% (95% c i 49 6 65 3) of one cohort in PWS-KF are removed by predation during the first 6 years of life, and that 51 5% (42 7 59 6) of females may be consumed before primiparity High levels of juvenile predation, low abundance, near neutral population trajectory and proposed recent increases in juvenile survival suggest that the Western Steller sea lion may be situated in the refuge portion of a predator pit This suggests the need to integrate consumer and resource driven effects, and to determine spatially explicit vital and predation rates to accurately characterize near apex forcing in this changing ecosystem

**Ongoing population-level impacts on killer whales 18 years after the Exxon Valdez oil spill**

**Craig O Matkin**, NGOS, cmatkin@acsalaska net
Graeme Ellis, Pacific Biological Station, Graeme Ellis@dfo-mpo gc ca
Eva Saulitis, NGOS, saulitis@pobox xyz net
Peter Olesiuk, Pacific Biological Station, OlesiukP@pac dfo-mpo gc ca
Stanley D Rice, NOAA, jeep rice@noaa gov

Killer whales from resident AB pod and the AT1 transient population were photographed in oil after the 1989 Exxon Valdez oil spill, but preliminary damage assessments did not definitively link mortalities to the spill and could not evaluate recovery Since that time photo-identification methods were used to monitor 2 killer whale populations 5 years prior to and for 18 years after the spill Pre spill monitoring made it possible to accurately assess population changes following the spill The most commonly encountered resident pod, AB Pod, and the most frequently observed transient whales, the AT1 population, suffered losses of 33 and 41%, respectively, in the year following the spill Eighteen years after 1989, AB Pod had not recovered to pre-spill numbers Moreover, its rate of increase (1 6%/yr) was significantly less than that of all other resident pods (3 2%) which did not decline at the time of the spill The AT1 population, which lost 9 members following the spill, continued to decline and is now contains 7 individuals and is listed as depleted under the Marine Mammal Protection Act Although there may be other contributing factors, the loss of AT1 individuals, including reproductive-age females, accelerated the population s trajectory toward extinction The synchronous losses of unprecedented numbers of killer whales from 2 ecologically and genetically separate groups and the absence of other obvious perturbations strengthens the link between the mortalities and lack of recovery, and the Exxon Valdez oil spill and weakens any possible connection to other anthropogenic impacts Given the small numbers of individuals in these apex predator populations, their potential role in structuring ecological communities, and their cultural value to coastal residents, indigenous populations and visitors from around the world, the deaths in AB Pod and the impending extinction of the AT1 population represent losses of and damage to resources of international ecological and cultural significance

**Privatizing the Right to Fish Challenges to Livelihood and Community in Kodiak, Alaska**

**Courtney Carothers**, University of Alaska Fairbanks, carothers@sfos uaf edu

Increasingly economists and resource managers across the globe promote the privatization of fishing rights to achieve efficiency goals These processes of enclosure often generate profound impacts for marine-dependent communities This talk will examine the transformations brought about by privatization policies in remote Alutiiq fishing communities of the Kodiak Archipelago, Alaska Conclusions are based on twelve months of ethnographic research, a large-scale mail survey of Alaska halibut quota holders, and in-depth analysis of fisheries privatization discourses and policies I describe how privatization policies remake the relationship between fishing communities and the resources on which they depend constraining flexible, kin-based village fisheries and causing dramatic reductions in fisheries participation Mail survey results show clear relationships between market participation, attitudinal responses, and demographic variables A logit analysis suggests that fishermen with lower incomes and those that identify as Alaska Native are more likely to sell, and less likely to purchase fishing rights While reasons for declining participation are complex, fishermen identify the permit as an important social marker of change in their communities Social changes related to permitting and privatization, including the emergence of a lost generation with few ties to fishing, pose challenges for marine-dependent community sustainability

**Subsistence Harvests and Local Knowledge of Rockfish Sebastes in four Alaskan Communities**

Mike Turek, Alaska Department of Fish and Game, mike turek@alaska gov
**William E Simeone**, Alaska Department of Fish and Game, bill simeone@alaska gov

This paper describes the results of a study to estimate the subsistence harvest of rockfish, genus *Sebastes*, in Sitka Nanwalek, Port Graham, and Chenega Bay Rockfish have been used for subsistence purposes in Alaska for centuries, but changes in federal subsistence fishery regulations for Pacific halibut Hippoglossus stenolepis governing the use of longlines raised concerns that the incidental catch of rockfish was increasing Several years of data from surveys sent to all holders of Subsistence halibut registration certificates (SHARC) showed that most of the incidental harvest of rockfish occurred in Southeast Alaska (federal halibut regulatory area 2C), and Southcentral Alaska (federal halibut regulatory area 3A) A majority of the catches took place incidental to halibut fishing using rod and reel, except for Chenega Bay, where rockfish were targeted under state subsistence regulations Respondents described traditional methods for harvesting, and strategies to avoid rockfish while using longlines to catch halibut In the Southcentral Alaska communities, the most commonly harvested rockfish were pelagic black rockfish, known as black bass *S melanops*, and of unspecified black species In Sitka, non-pelagic Quillbacks *S maliger* were most commonly caught

# Gulf of Alaska
# Prince William Sound Pacific Herring Workshop

Tuesday 20 January 2009
1 35 – 5 10 PM
**Session Chair Jennifer Schorr**
***Exxon Valdez* Oil Spill Trustee Council**

TALKS

| **Speaker** | **Title** |
|---|---|
| Richard E Thorne | What has 16 years of acoustic surveys taught us about herring, EVOS and the Prince William Sound ecosystem? |
| Peter-John F Hulson * | Comparison of Pacific herring in Prince William Sound and Sitka Sound |
| Jodi N Harney | Insight into herring spawning habitat using ShoreZone coastal mapping data in Prince William Sound, Alaska |
| Janice Straley | Year Round Presence of Humpback Whales in Alaskan Waters and the Impact upon Pacific Herring |
| John R Moran | Humpback Whales Exert Top-Down Control on Prince William Sound Herring |
| Johanna Vollenweider | Do Energy Limitations Cause Overwinter Mortality of Young-of-the-Year and Juvenile Pacific herring (*Clupea pallasi*)? |
| Ron Heintz | Seasonal Flux in the Energy and Proximate Composition of Maturing Pacific Herring |
| Paul K Hershberger | Virus Shedding from Pacific Herring After Exposure to Viral Hemorrhagic Septicemia Virus (VHSV) |
| Thomas C Kline | Prince William Sound herring forage contingency |
| Dale A Kiefer | Modeling the Bi-Stable State of Herring in Prince William Sound |
| *** Student Presentation** | |

## What has 16 Years of Acoustic Surveys Taught Us About Herring, EVOS and the Prince William Sound Ecosystem?

**Richard E Thorne**, Prince William Sound Science Center, rthorne@pwssc org

Acoustic surveys of the adult herring biomass in Prince William Sound were initiated in 1993 following indications of a herring population crash The surveys have been conducted at least annually for 16 consecutive years and illustrate the advantages of a long and consistent time series of a dynamic biological variable The initial survey confirmed a population crash The acoustic estimates are positively correlated with an index of herring milt along beaches from aerial surveys that has been conducted by the Alaska Department of Fish and Game since 1973 This finding allows us to examine trends over the past 26 years It also provides evidence that the 1989 Exxon Valdez Oil Spill was a factor in the collapse The mile-days of milt index peaked in 1988, then declined over a six-year period rather than a one-year collapse in 1993 While the acoustic surveys provide critical and timely information for fisheries management, their greater value may be the documentation of the critical role of herring in the ecosystem Over the past decade there have been increasing efforts to incorporate juvenile herring as well as census of marine mammals and seabirds into the acoustic surveys Herring are a critical winter-period food resource for Steller sea lions The numbers of Steller sea lions in Prince William Sound are strongly correlated with herring abundance Herring declines after EVOS likely contributed to declines in the western stock during the 1990s Both herring abundance and Steller sea lion numbers in Prince William Sound declined between 80% and 90% in the 11 years after the spill Humpback whales are also an increasing factor in predation on herring and may be a primary reason for the current lack of herring population recovery Several seabirds and harbor seals also target both juvenile and adult herring The lack of recovery of certain seabird species is clearly related to the lack of herring recovery Herring success in the PWS ecosystem is likely a complex process involving interactions with walleye pollock, pink salmon and zooplankton production as well as marine mammal and seabird predation

## Comparison of Pacific herring in Prince William Sound and Sitka Sound

**Peter-John F Hulson**, University of Alaska, Fairbanks, p hulson@uaf edu
Terrance J Quinn, University of Alaska, Fairbanks, terry quinn@uaf edu
Brenda L Norcross, University of Alaska, Fairbanks, norcross@ims uaf edu
Gary D Marty, Animal Health Centre, Ministry of Agriculture and Lands, Gary Marty@gov bc ca

Pacific herring stocks in both Prince William Sound and Sitka Sound, Alaska, are managed through the use of Age-Structured Assessment models (ASA) ASA models for Pacific herring in Prince William Sound and Sitka Sound fit observations of commercial fishery catch, and fishery independent observations of spawning age composition, egg deposition, and mile-days of milt In this study, we compare observations, model structures, and model output between Pacific herring in these two regions The spawning age composition has been nearly identical between the two stocks, with the exception of the last decade Weight-at-age in the two stocks has been highly related since 1980 Recruitment of age-3 herring, estimated as parameters in both ASA models, indicate that low recruitment has persisted in the last 15 years in both populations Further, maturity is also comparable, and both ASA models point to a recent change in natural mortality or maturity However, the population indices and spawning biomass estimates are different in each stock, especially after the 1992-1993 disease outbreak in PWS The population size in PWS has remained at low levels since 1993 and the stock size in Sitka has been increasing in recent years

Student Presentation

## Insight into herring spawning habitat using ShoreZone coastal mapping data in Prince William Sound, Alaska

**Jodi N Harney**, Coastal and Ocean Resources Inc , jodi@coastalandoceans com
Mandy R Lindeberg, Alaska Fisheries Science Center, NOAA Fisheries,
Mandy_Lindeberg@noaa gov
Steve D Moffitt, Alaska Department of Fish and Game, steve_moffitt@fishgame state ak us
Kalen Morrow, Coastal and Ocean Resources Inc , kalen@coastalandoceans com

Herring are an integral part of food webs and marine ecosystems, utilizing a range of habitats during their complex life cycle Understanding the use of spawning habitat in Prince William Sound is important because the population has remained below the commercial fishery threshold for the last ten years

In this study, observations of herring spawn in Prince William Sound (ADF&G 1973-2007) are integrated with 5,585 km of ShoreZone coastal habitat mapping data recently completed for the region ShoreZone is a mapping and classification system that specializes in the collection and interpretation of aerial imagery of the intertidal zone and nearshore environment Its objective is to produce an integrated, searchable inventory of geomorphic and biologic features which can be used as a tool for science, education, and management

ArcGIS software is used to associate 3,476 spawning observations with adjacent alongshore segments (ShoreZone "units") and the habitat attributes mapped within those units Of the 1,374 km of shoreline associated with spawn occurrence in the last 35 years, the majority possess low-frequency observations of spawn ShoreZone units with the highest frequency of spawn observations (such as Tatitlek Narrows, Rocky Point at Galena Bay, and northern Montague Island) represent <2% of spawning shorelines (23 km) Along these high-frequency spawning shorelines, wave exposures are mapped predominantly as protected (60%) and semi-protected (33%) The most common coastal types are mixed sand and gravel beaches (55%), bedrock with sand and gravel beaches (24%), and estuaries (13%) Biological ShoreZone attributes mapped at these spawning hotspots are also summarized, including the presence of eelgrass and kelp These attributes are then used to identify other shorelines in the Sound that possess similar attributes

ShoreZone data can provide insight and tools to assist managers in Prince William Sound A resource map summarizing potential spawning habitat is produced in this study, as are maps of habitat attributes at spawning locations in selected heavily-oiled areas Similar studies may be achieved in Southeast Alaska and other areas where ShoreZone data exist

## Year Round Presence of Humpback Whales in Alaskan Waters and the Impact upon Pacific Herring

**Janice M Straley**, University of Alaska Southeast Sitka Campus, jmstraley@uas alaska edu

In the North Pacific, humpback whales winter in lower latitude breeding grounds of Mexico, Hawaii and Asia, and summer in higher latitude feeding grounds across the Pacific Rim However, humpback whales are present year round in Alaskan waters, and, because they are thought to be seasonal migrants, sightings during the summer are expected, but fall and winter sightings are perplexing Fall and winter sightings in higher latitudes are not without precedent Historical whaling data documented humpbacks in the fall and winter in Norway, Russia and Canada Currently, in Alaska, humpback whales are sighted in the fall and winter in coastal areas of the Gulf of Alaska It has been speculated that whales present in the fall and winter are part of a non-migrating population or perhaps constitute non-breeding (resting) females In southeastern Alaska, a longitudinal study on humpback whales began in the fall of 1979 This study documented the fall movement of whales into six areas as a seasonal response to herring schools moving in from open passages to overwinter in the deep, sheltered bays and sounds of southeastern Alaska Herring move into these sheltered areas when the surface waters become cooler and the turbulence from fall storms results in mixing of the water column to near-uniform temperature Whales are capitalizing on these overwintering herring, an energy-rich prey This study documented most whales eventually migrate, which takes a month, to the breeding grounds There were ten cases of whales overwintering because they were sighted often enough that two migrations could not have occurred These whales were mixed age and sex classes Whales feeding in the fall and winter may need additional energy reserves for migration, perhaps pregnant females or whales inexperienced in finding food This would influence the length of time spent on the feeding grounds creating a staggered migration pattern, with some whales leaving earlier and some later The duration on the feeding grounds may be longer in years when food resources are scarce In areas where herring populations are depressed, predation by humpback whales during the fall and winter could have a significant impact and be suppressing recovery

## Humpback Whales Exert Top-Down Control on Prince William Sound Herring

**John R Moran**, NOAA/NMFS/AFSC, Auke Bay Laboratories, john moran@noaa gov
Stanley D Rice, NOAA/NMFS/AFSC, Auke Bay Laboratories, jeep rice@noaa gov
Ron A Heintz, NOAA/NMFS/AFSC, Auke Bay Laboratories, ron heintz@noaa gov
Janice M Straley, University of Alaska Southeast, Sitka, jan straley@uas alaska edu
Terrance J Quinn, Juneau Center, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, terry quinn@uaf edu

Humpback whales (*Megaptera novaegliae*) have been observed feeding on large school schools of Pacific herring (*Clupea pallasii*) in the waters of Prince William Sound (PWS) during the fall and winter months It has been hypothesized that predation by whales may be preventing the PWS herring population from recovering to historic levels In 2007, to assess the impact of whales on herring, we conducted a three five day cruises to evaluate the abundance, residency, prey, and important feeding areas of humpback whales within PWS We found whales feeding on over-wintering herring in Sawmill Bay, Elrington Passage, Prince of Wales Passage, and Port Gravina Counts of 25 (September 2007), 81 (November 2007) and 59 (January 2008) whales, combined with photographic mark-recapture models resulted in a peak estimate of 165 whales occurring in late December These data were modeled to estimate 10,401 whale use days in PWS from 1 September 2007 through 28 February 2008 Based on a resting metabolic rate, the energetic requirements for these whales feeding exclusively on herring would account for the removal of 18-23% of the pre-winter herring biomass in PWS Field work for this project is continuing from the fall 2008 through the spring of 2009 To date, surveys of PWS yielded counts of 67(September) and112 (October) whales These numbers are higher than the surveys observed in 2007, indicating there may be more whales present in PWS than the previous one year of data documented or estimated

## Do Energy Limitations Cause Overwinter Mortality of Young-of-the-Year and Juvenile Pacific herring (*Clupea pallasi*)?

**Johanna J Vollenweider**, NOAA Fisheries, AK Fisheries Science Center,
Johanna Vollenweider@noaa gov
Ron A Heintz, NOAA Fisheries, AK Fisheries Science Center, ron heintz@noaa gov
Paul K Hershberger, USGS, phershberger@usgs gov

We examined overwinter energy expenditure of young-of-the-year (YOY) and juvenile Pacific herring (*Clupea pallasi*) using three Gulf of Alaska stocks (two declining populations - Prince William Sound (PWS) and Lynn Canal (LC), and a robust population - Sitka Sound (SS)) While causes underlying the declines remain elusive, it is likely their combined effects are reflected in energy dynamics We examined the potential for overwinter energy expenditures to cause size-selective mortality Collections of wild-caught fish were calibrated against fasting herring in controlled laboratory conditions subjected to multiple temperatures

YOY herring (mean fork length = 95mm) in PWS lost energy at a significantly higher rate over winter (-0 13 kJ/day) than SS fish (-0 03 kJ/day), and were considerably disadvantaged at the onset of spring Fasting YOY in lab studies depleted energy stores twice as fast as wild-caught YOY, suggesting that some winter foraging occurred to forestall energy loss Surprisingly, the frequency of prey remains in stomachs was significantly greater in PWS (62%) than SS (3%) Identifiable prey were primarily copepods and euphausiids

Juvenile herring (ages 1 and 2) (mean fork length = 166mm) also lost energy more rapidly in PWS (-0 96 kJ/day) than in SS (-0 80 kJ/day) or LC (-0 77 kJ/day) Juvenile herring foraged frequently in all stocks, with fish in SS and PWS foraging more frequently (58% and 56% in SS and PWS, respectively) than in LC (40%) Juvenile diet consisted of euphausiids, copepods and some pteropods

In summary, both YOY and juvenile herring lost energy over winter in PWS more rapidly than their Southeast Alaska counterparts Higher energetic demands observed in PWS may be a factor in their decline, perhaps caused by higher predation rates or disease Higher energy loss rates in PWS herring results in poor condition at the onset of spring YOY and juveniles must forage more intensely to obtain sufficient energy stores to survive the following winter If subsequent summer feeding is insufficient for compensatory growth and for accumulation of energy stores, winter mortality the following year is likely

## Seasonal Flux in the Energy and Proximate Composition of Maturing Pacific Herring

**Ron A Heintz**, NOAA AFSC, ron heintz@noaa gov
Johanna J Vollenweider, NOAA AFSC, Johanna Vollenweider@noaa gov
John P Hudson, NOAA AFSC, john hudson@noaa gov

Fisheries scientists often rely on fixed length fecundity relationships in order to predict recruitment in a given year However, significant interannual variation in availability of food suggests there should be variation in the amount of energy adults can invest in their offspring This problem is likely to be acute for species such as herring, which depend on energy reserves during the period prior to spawning We sampled herring from Lynn Canal, Alaska between September 2004 and September 2005 to understand how variation in food availability influences the amount of energy Pacific herring have to invest in reproduction Fish were located using hydroacoustics and sampled with gillnets Each month, except for April, May and July five female and five male herring were analyzed to determine their stomach fullness, energy, protein, lipid and moisture contents In addition, the proximate compositions of five ovaries from different females were sampled each month On average, whole fish lost approximately 50% of their energy content between September and March, consistent with observations of empty stomachs During the same period, ovaries increased in energy sevenfold The majority of the energy lost from whole herring came from lipid, which accounted for nearly 90% of the energy loss In contrast, most of the energy gain in the ovaries derived from protein, which accounted for more than 75% of the energy gain Herring therefore relied on stored lipid to meet metabolic demand and mobilized endogenous proteins to grow gonads The energy content of herring sampled in September 2005 was significantly less than that of September, 2004 Thus, poor reduced food availability during the summer of 2005 likely impacted the quantity and quality of gonadic tissue produced during the following winter

## Virus Shedding from Pacific Herring After Exposure to Viral Hemorrhagic Septicemia Virus (VHSV)

**Paul K Hershberger**, USGS, Western Fisheries Research Center, phershberger@usgs gov
Jacob L Gregg, USGS Western Fisheries Research Center, jgregg@usgs gov
Courtney A Grady, USGS, Western Fisheries Research Center, cgrady@usgs gov
Rachael M Collins, USGS, Western Fisheries Research Center, rcollins@usgs gov

Epizootics of viral hemorrhagic septicemia (VHS), accompanied with mortality and viral shedding from infected hosts, were initiated after waterborne exposure of specific pathogen-free Pacific herring to concentrations of VHSV as low as 40 pfu / mL Shed virus was first detected 4-5 days post-exposure, peaked in flow-through tanks after 6-10 days at 1,000 2,500 pfu / mL, and was no longer detected after 15-16 days post-exposure The onset and peak of viral shedding preceded those of host mortality by 2 days, and cumulative mortalities in treatment groups ranged between 81-100% after 21 d Calculated shedding rates peaked at 200 - 500 million pfu / fish / day and were based on water supply rates into the tanks, fish stocking densities, and detected titer of waterborne virus When extrapolated out to the population scale, the rapid onset and magnitude of viral shedding from infected individuals provide insight into mechanisms of VHSV transmission and disease initiation among free-ranging and confined populations of Pacific herring

## Prince William Sound herring forage contingency

**Thomas C Kline**, Prince William Sound Science Center, tkline@pwssc gen ak us

The Prince William Sound herring forage contingency project is assessing plankton energy content, sources, and taxonomic composition (see poster by RWC), relationships between herring energy content and plankton sources, and potential food source interactions with sympatric fishes We report here detailed analyses from 2007 and preliminary observations from 2008 that suggest a late bloom

Zooplankton content energy was assessed in terms of density with respect to water volume as a measure of habitat quality and in terms of energy density per unit mass as a measure of food quality PWS herring nursery bays were each quite different with respect to both parameters There was approximately one order of magnitude less energy available per unit volume of water in the fall compared to the spring, however, food quality was generally comparable Two of the bays had overall more energy per unit volume than the greater Sound or offshore in the Gulf

Stable isotope analysis (SIA) was used to assess herring plankton sources in relation to herring whole body energy content (WBEC) Center of the $^{13}C$ value distribution near -19 suggested that mostly PWS carbon was important for fall 2007 herring food webs, which contrasts with 2006 observations and some of those from the 1990's Whale Bay tended to have herring with higher WBEC as well as lower $^{13}C$ values that may have resulted from feeding on euphausiids SIA of juvenile pollock sympatric with herring provided a measure of dietary overlap Data were not inconsistent with predation on herring by a few of the pollock (these had higher $^{15}N$ values) March 2007 values of herring were similar to the values observed in November 2006, which is consistent with little feeding during winter, the intervening period Isotopic overlap between herring and pollock was much less in March compared to November Pollock shift to higher $^{13}C$ values typical of PWS carbon during the winter Food resources available to pollock in winter are apparently not available herring

## Modeling the Bi-Stable State of Herring in Prince William Sound

**Dale A Kiefer**, System Science Applications, kiefer@usc edu
Frank J O'Brien, System Science Applications, fjobrien@cox net
Evelyn D Brown, Flying Fish Ltd , husumbandb@embarqmail com

As part of our development of a population dynamics of herring in Prince William Sound, we have examined Alaska Fish and Game's Age Structure Analysis (ASA) Models for Prince William Sound As discussed in a second presentation at this symposium, the ASA time series for the population of adult herring and 3 year old recruitment display distinct patterns that have helped guide development of our model These patterns include the existence of bi-stable states for the adult populations and the existence between 1976 and 1992 of bi-modal distributions in recruitment We suggest that these patterns are an expression of the internal biological dynamics of the herring population In order to test this suggestion we will run our model of herring population dynamics to determine whether its predictions are consistent with output from the ASA model Our model, which will be run for the period from 1980 to 2005, predicts changes in the population of all stages of the herring s life cycle

We believe that our model contains formulations that match well the features that emerge from the ASA analysis The most significant component of the model is a nonlinear, density-dependent formulation of changes in the probability of survival at one or more stages in the herring s life history According to such a formulation, at a given stage thresholds in the density of population will drive large variations in survival If the density of individuals entering a given stage is below the threshold value, survival is low, and if the density exceeds the threshold, survival is high One or more of such bottlenecks can create both bi-stable states in population size and bimodal distributions in recruitment The system of equations also include formulations the spatial expansion and contraction of the herring s habitat with changes in the size of the adult population, differences in the reproductive success of 4 year old recruits and the older adults, and stochastic events such as the dramatic increase in herring recruitment that occurred in the mid-70s within the Gulf of Alaska

# Bering Sea and Aleutian Islands
## Climate and Oceanography, Ecosystem Perspectives & Lower Trophic Levels

Wednesday 21 January 2009
8 00 AM – Noon
**Session Chair Kris Holderied**
**NOAA Kasitsna Bay Laboratory**

TALKS

| Speaker | Title |
|---|---|
| **KEYNOTE**<br>**Michael Sigler** | **Understanding Ecosystem Processes in the Bering Sea**<br>**BEST-BSIERP 2008 Headlines** |
| Nicholas A Bond | Expected changes in the climate forcing of Alaskan waters in late summer/early fall |
| Phyllis J Stabeno | The Bering Sea in 2008 A decoupling of sea-ice extent between the Arctic and Bering Sea |
| Muyin Wang | Sea ice over Bering Sea the past, present and future |
| Thomas Weingartner | A satellite-tracked drifter perspective of the nearshore Bering Sea science and outreach |
| Emily S Davenport * | Phosphate cycling in Bering Sea sediments |
| Puneeta Naik * | Particulate Absorption Properties along four transects in the Southeastern Bering Sea Shelf |
| Lee W Cooper | Progression of the spring bloom in the northern Bering Sea and transmission of particulates to the sea floor |
| Jerry McCormick-Ray | Geographic Variation of Benthic Macrofauna Northern Bering Sea, May-June 2006 |
| Meibing Jin | Response of lower trophic level production to long-term climate change in the southeastern Bering Sea |
| Jeffrey M Napp | Recent Trends in eastern Bering Sea Zooplankton data and confessions |
| Sandra Parker-Stetter | Evaluating acoustics for squid assessment in the Bering Sea |
| Mary Elizabeth Hunsicker * | A three tier approach for evaluating the predatory role of the commander squid, *Berryteuthis magister*, in the eastern Bering Sea |
| *** Student Presentation** | |

**Understanding Ecosystem Processes in the Bering Sea BEST-BSIERP 2008 Headlines**

**Mike Sigler**, NOAA Alaska Fisheries Science Center, Mike Sigler@noaa gov
H Rodger Harvey, University of Maryland Center for Environmental Science,
harvey@cbl umces edu

The North Pacific Research Board and the National Science Foundation are supporting a comprehensive, $52 million study of the eastern Bering Sea ecosystem from 2007-2012 Ninety-four federal, state, university, and private institution scientists are linked through a vertically integrated process and modeling research program in the Bering Sea ranging from atmospheric forcing and physical oceanography to humans and communities-including the attendant economic and social impacts of a changing ecosystem In 2008, the study began it s first year of complete field programs with at-sea sampling from February through September Appropriate for its start the Bering Sea winter ice cover reached a 30-year high, and Alaska shivered through cold and wet through the spring and summer The principal ocean structure influencing marine processes in the Bering Sea is the cold pool (temperatures <2°C), which was extensive In a year of relatively low food availability, there was no overlap in foraging tracks between birds nesting on St Paul Island and St George Island for either kittiwakes or murres One kittiwake flew all the way to Bogoslof Island, even though it was raising a chick on St George Island Post-larval cod and pollock were less common everywhere except near the Pribilof Islands Measures showed that microzooplankton grazing removed ~84% of phytoplankton daily growth in SE Bering Sea during summer At-sea observers reported good numbers of fin and humpback whales Oceanography modeling (BESTMAS) simulated mooring (M2) temperatures agree reasonably well with observations Yup'ik elders express both humility and respect for the ocean, which they hold in high regard Chefornak elder John Eric stated, "It's no wonder that the ocean has the name imarpik [from imaq, "contents"] because it holds everything " New headlines on progress being made are arriving weekly and will be reported at our presentation

**Expected changes in the climate forcing of Alaskan waters in late summer/early fall**

**Nicholas A Bond**, University of Washington, nicholas bond@noaa gov
James E Overland, NOAA, james e overland@noaa gov
Muyin Wang, University of Washington, muyin wang@noaa gov

There is increasing evidence that the oceanographic conditions going into the fall season play an important role for the marine ecosystems of Alaska Our objective is to examine how these conditions are liable to evolve in association with global climate change We use the coupled atmosphere-ocean model simulations carried out for the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report, and protocols for using this model data that we have developed for marine ecosystem applications Our analysis is guided by recent results from the Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative (AYK-SSI), Bering-Aleutian Salmon International Surveys (BASIS) and Global Ocean Ecosystems Dynamics (GLOBEC) programs, among other research The specific parameters examined are linked to lower-trophic level productivity, and include the sea surface temperature (SST), wind mixing and cross-shelf Ekman transports for the Bering Sea, and the freshwater runoff and the downwelling component of the winds for the coastal Gulf of Alaska The climate models can simulate some of these parameters directly (e g , SST) while proxies are employed for other parameters (e g , runoff) We consider our technique to be a reasonable way to achieve an early indication of the likely changes in oceanographic conditions related to various marine populations It should be considered as complementary to direct simulations, in which climate scenarios are used to force regional ocean numerical models, which in turn are linked to biological models, i e , dynamical downscaling

**The Bering Sea in 2008 A decoupling of sea-ice extent between the Arctic and Bering Sea**

**Phyllis J Stabeno**, NOAA/PMEL, phyllis stabeno@noaa gov
Jeffrey M Napp, AFSC/NOAA, jeff napp@noaa gov
James E Overland, PMEL/NOAA, james e overland@noaa gov

Data collected during 2008, illustrate linkages between physics and biology, and provide a striking example of sea ice extent being determined more by dynamics within the Bering Sea than Arctic wide In 2008, the Bering Sea was remarkably cold, with sea-ice extent and duration over the southeastern shelf the greatest in three decades This contributed to the unusually cold, sea surface temperatures (<9 5°C) over the middle shelf during summer and the extensive cold pool covering much of the middle shelf Depth-averaged, summer temperatures at M2 remained below 5°C, compared to 8°C in 2005 The extensive ice over the eastern Bering Sea shelf occurred in spite of the fact that the previous summer, ice extent in the Arctic reached a historical low The low areal concentration of ice in Arctic resulted in a late freeze-up of the Chuckchi Sea (mid-December), but strong, frigid, northerly winds resulted in much of the eastern Bering shelf becoming ice covered by mid-January So, while the lack of ice in the Arctic delayed the arrival of ice in the Bering Sea, the maximum ice extent was determined by atmospheric forcing and the previous autumn s ocean temperatures Thermodynamics will force the northern Bering Sea to continue to be ice covered during winter Climate models, also, predict that even though the summer Arctic will be largely ice free by the middle of this century, the Bering Sea will have extensive sea ice over the northern shelf (north 60°N) each winter/spring Over the southern Bering Sea shelf, with its longer days and warmer ocean temperatures, there will be significantly less ice on average, but extreme years will occur where sea ice covers most of the southeastern shelf Ice extent will continue to be dominated by interannual and decadal variability These swings in ice extent and ocean temperatures have profound impacts on the Bering Sea ecosystem, as has been seen in last decade For instance, summer zooplankton abundance over the eastern shelf and slope, which was particularly low during the warm period (2001-2005), appears to be rebounding with the return of colder conditions in 2006 2008

**Sea ice over Bering Sea the past, present and future**

**Muyin Wang**, University of Washington, muyin wang@noaa gov
James E Overland, PMEL, james e overland@noaa gov

Sea ice represents a defining characteristic of the oceanographic environment in the shelf regions of the Bering Sea The seasonal advance and retreat of sea ice over the Bering Sea shelf influences not only the physical environment, but also represents a crucial determinant of ecosystem structure and function In this study we examine ice extent over the Bering Strait and east Bering shelf based on both the UK Hadley analysis and the IPCC AR4 climate model simulations in the past and projections for the future The projections of future sea ice conditions are based on models whose 20th century hindcasts were a reasonable match with observations The criteria used for selection process were the seasonality of sea ice extent in both the Northern Hemisphere as a whole, and winter maximum ice cover over the Bering Sea Our analysis of the model projections under the moderate IPCC A1B emissions scenario indicates that sea ice will continue to form in the northern portion of the Bering Sea, but that the ice free season will be longer due to a later freeze-up Uncertainties associated with projections are estimated under both A1B and A2 emission scenarios

**A satellite-tracked drifter perspective of the nearshore Bering Sea science and outreach**

**Thomas J Weingartner**, University of Alaska, weingart@ims uaf edu
Terry Reeve, University of Alaska Fairbanks, lftar@uaf edu
Seth Danielson, University of Alaska Fairbanks, seth@ims uaf edu
Warren Jones, Quinhagak Village Council, nvk@gmail org

The region inshore of the 30 m isobath on the Bering Sea shelf is a critical habitat for a variety of marine organisms and local communities It is also an important migratory corridor for a variety of fish and a circulation pathway that links the southeastern Bering Sea with Bering Strait and the Arctic Ocean Nevertheless, the inner shelf has received little scientific attention and many questions abound regarding circulation patterns, communication between the inner and middle shelf, and along-shore continuity of the flow In an effort to address these issues, we have and continue to use satellite-tracked drifters to elucidate the time-varying circulation on the inner shelf Our research efforts have engaged the residents of Mekoryuk (Nunivak Island in 2002) and Quinhagak (Kuskokwim Bay in 2008) who conduct the drifter deployments from their communities In September 2002 residents of Mekoryuk deployed 15 drifters north of Nunivak Island and, between June and September of 2008, residents of Quinhagak deployed 32 drifters, in clusters of 4 and at approximately 2-week intervals

Results to date indicate that in summer and early fall, nearshore waters tend to remain trapped to the coast and flow northward along the coast of western Alaska However, by October there is an extensive wind-forced, cross-shelf transport of relatively dilute, low-nitrate, nearshore waters onto the mid-shelf region Because the mean circulation on the middle shelf is sluggish these low-salinity waters may remain here through winter and spring These results suggest that inner shelf waters, with their low-nitrate concentrations may play an important role in establishing the nutrient reservoir over the middle shelf at the onset of the spring bloom The data also provide kinematical characterizations of the inner shelf flow that reflects the combined response to tides, winds, and coastal freshwater discharge Finally, our results demonstrate that inner shelf studies, which are inaccessible to most research vessels, can be conducted efficiently through collaborations with local communities

## Phosphate cycling in Bering Sea sediments

**Emily S Davenport**, Western Washington University, emilysdavenport@gmail com
David H Shull, Western Washington University, david shull@wwu edu
Allan H Devol, University of Washington, devol@ocean washington edu

Phosphate flux between marine sediments and bottom water is affected by rates of organic-matter oxidation, bioirrigation, and sorption processes We assessed the relative importance of these processes in sediments of the Bering Sea, a region where nutrient exchange between the broad shallow shelf and overlying water may influence water column productivity and where climate change appears to be causing a shift in ecosystem dynamics We directly measured phosphate flux using core incubations and we also measured rates of bioirrigation, sediment oxygen consumption, infaunal burrow densities, amorphous iron-hydroxide concentrations and phosphate sorption isotherms at each station The results indicate that processes controlling phosphate cycling vary among different regions of the Bering shelf On the middle shelf, phosphate flux positively co-varies with infaunal burrow densities whereas along the outer shelf it is dependent upon the rate of oxygen consumption and the concentration of amorphous iron hydroxides This variation in control of phosphate cycling suggests that these regions of the Bering Sea shelf will show differential responses to climate-driven ecosystem change

Student Presentation

## Particulate Absorption Properties along four transects in the Southeastern Bering Sea Shelf

**Puneeta Naik**, Louisiana State University, pnaik2@lsu edu
Eurico J D'Sa, Louisiana State University, ejdsa@lsu edu
Joaquim I Goes , Bigelow Laboratory for Ocean Sciences, jgoes@bigelow org
Helgado R Gomes, Bigelow Laboratory for Ocean Sciences, hgomes@bigelow org

Climatic trends of reducing sea ice cover and rising temperatures seen in the past decades in the southeastern Bering Sea have an effect on the sea ice-coupled spring phytoplankton bloom and thus on the phytoplankton production processes One of the governing factors in the formation of the bloom is the availability of light Absorption of light by phytoplankton populations is used in the prediction of oceanic primary production from light and pigment data It forms a major part of models for light penetration and light utilization by phytoplankton and can be used for retrieval of pigment concentrations and size structure Recently it has been argued that primary productivity in the ocean varies more closely with absorption by phytoplankton and not always with amount of chlorophyll-a Thus measurements of in situ particulate absorption, namely absorption by phytoplankton and non-algal particles (NAP) or detritus are important components in bio-optical models and only a few studies have been reported for the southeastern Bering Sea This study would attempt analyses of the absorption data from four transects along the southeastern Bering Sea collected during a cruise in July 2008 The absorption properties measured would reveal the spatial variations of the particulate fraction (phytoplankton and NAP) in response to hydrographic features Preliminary analysis of absorption by particulate matter (Phytoplankton plus NAP) are highly variable between the four transects (north to south along the shelf) as well as within transects (east to west across the shelf) The transects near the Kuskokwim River had higher particulate absorption as compared to other transects, also stations closest to the Kuskokwim River had higher NAP absorption as compared to stations away from the river along these transect The phytoplankton absorption did not show similar trend, however it was found to be higher at middle depths as compared to surface at some stations along transects corresponding to the chlorophyll maxima This indicates that phytoplankton absorption mostly follows variations in chlorophyll as expected These data would be studied with respect to hydrographic and biological data to further investigate the response of the absorption properties to these hydro-biological variables

Student Presentation

## Progression of the spring bloom in the northern Bering Sea and transmission of particulates to the sea floor

**Lee W Cooper**, University of Maryland Center for Environmental Science, cooper@cbl umces edu
Markus Janout, University of Alaska Fairbanks, Janout@sfos uaf edu
Karen E Frey, Clark University, kfrey@clarku edu
Rebecca S Pirtle-Levy, North Carolina State University, rspirtle@ncsu edu
Jacqueline M Grebmeier, University of Maryland Center for Envioronmental Science, jgrebmei@cbl umces edu
James R Lovvorn, Department of Zoology, lovvorn@uwyo edu

The benthos of the northern Bering Sea shelf is dominated by a world-class biomass of soft-bottom macrofauna as well as important epifaunal assemblages The likely basis for this high sustained benthic biomass is the intense spring bloom, but few observations are available that have followed the direct sedimentation of this rich organic material during the bloom peak in May MODIS satellite imagery, water column chlorophyll concentrations and surface sediment chlorophyll inventories were used to document the dynamics of sedimentation to the sea floor in both 2006 and 2007, as well as to compare observations with existing data from the spring bloom in 1994 An atmospherically-derived radionuclide, $^{7}$Be, that is deposited in surface sediments as ice cover retreats was used to supplement these observations, as were studies of light penetration and nutrient depletion in the water column as the bloom progressed Tight linkages among sea ice retreat, chlorophyll biomass, water mass structure and particulate sedimentation on the sea floor suggest that significant shifts in benthic ecosystem productivity and impacts on the associated benthic based food web can be expected with continued seasonal sea ice retreat in the northern Bering Sea Overall, chlorophyll biomass was significantly different in each of three years with ice-melt data (1994, 2006, 2007) despite similar ice retreat timing Repeat sampling shows that even within-season variation is large and blooms highly localized Water mass and nutrient variation, wind-mixing and late winter brine formation are among the potentially other variables that may also impact spring productivity in addition to the timing of ice retreat

## Geographic Variation of Benthic Macrofauna Northern Bering Sea, May-June 2006

**Jerry McCormick-Ray**, University of Virginia, cr@virginia edu
Richard M Warwick, Plymouth Marine Laboratory, rmw@pml ac uk

Benthic macrofauna play important ecosystem roles in the northern Bering Sea This study highlights the dominance, abundance, and distribution of 146 macro-benthic species identified from 86 stations, of which 23 stations were located north of St Lawrence Island and 63 (18 replicated) south of it Multivariate analyses show a strong correlation in species abundance with geographic location, and good species gradation with latitude Significant differences in species composition-abundance were observed between north and south stations ($p<0$ 1), but this separation breaks down when species were aggregated to family level For all soft sediment stations, both regions exhibited high variability in species composition-abundance, but northern stations exhibited greater variability For all 86 stations, most (99%) contained fewer than 5 dominant species (representing >50% total individuals) per station, many (75%) were dominated by 1-2 species, 7% had 4 dominant species, and one station from a hard bottom epifauna contained 20 species While most of the 146 species were rarely encountered, the characteristic soft sediment species displayed a distinct north and south difference (Average Dissimilarity 78 25), with the small bivalve *Ennucula tenuis* and unidentified polychaete species (Maldanidae) frequently dominating south stations (51% cum freq ), followed by the bivalves *Nuculana radiata* (14%) and *Macoma calcarea* (9%) (Average Similarity 35 86) In contrast, northern stations with soft sediment were frequently dominated by the bivalve *Macoma calcarea* (19%) followed by *Ennucula tenuis* (12%), unidentified amphipod species (Ampeliscidae) (10%), and unidentified polychaete species (Maldanidae) (10%) (Average Similarity 23 42) Stations with the most common bivalve genera (Macoma, Ennucula, Nuculana) were composed of individuals of a single age-class size some stations with Macoma and/or Ennucula contained only juveniles (<1cm, >10 individuals/station) and some contained all age sizes, but very few juveniles of Nuculana were found Results indicate that species composition, dominance, and abundance show a significant difference between stations located north and south of St Lawrence Island Varying macrofauna composition and bivalves of different size classes suggest a regional-scale benthos that is patchy, heterogeneous, and undergoing various degrees of recruitment

## Response of lower trophic level production to long-term climate change in the southeastern Bering Sea

**Meibing Jin**, University of Alaska Fairbanks, ffjm@uaf edu
Clara Deal, University of Alaska Fairbanks, deal@iarc uaf edu

The ecosystem in the Bering Sea has undergone profound changes in response to climate regime shifts in the past decades The lower tropic level production is assessed with a vertically 1-D coupled ice-ocean ecosystem model, which was applied to a NOAA/PMEL mooring from 1995 to 2005 The physical model is forced by sea surface winds, heat and salt fluxes, tides, and sea ice The biological model includes coupled pelagic and ice algae components Model results are validated well with daily mooring temperature, fluorometer and daily SeaWiFS chl a data There are two distinct ocean conditions and phytoplankton bloom patterns related to the Pacific Decadal Oscillation (PDO) index regimes with warmer temperature and later bloom of warm water phytoplankton species in PDO>1 years, and colder temperature and earlier bloom of cold water phytoplankton species in PDO<-1 years The phytoplankton production of different species experienced dramatic changes after the 1976 climate shift, but the total annual net primary production (NPP) remained flat over the past four decades under similar nutrients regulation Climate shift also affected the vertical distribution of lower trophic level production and energy flow to the upper ocean pelagic ecosystem or the benthic community There were a long-term PDO regime shift in 1976 and short-term PDO reversals in 1998 Phytoplankton biomass responded promptly to both short and long-term climate changes Zooplankton biomass responded to the long-term climate shift but less dramatically to the short-term one The model results captured the observed trends of zooplankton abundance changes from 1990s to 2004

## Recent Trends in eastern Bering Sea Zooplankton data and confessions

**Jeffrey M Napp**, NOAA Fisheries, jeff napp@noaa gov
Phyllis J Stabeno, NOAA -- Research, phyllis stabeno@noaa gov
George L Hunt, University of Washington, geohunt2@u washington edu
D Van Holliday, University of Rhode Island, University of Massachusetts, Dartmouth
van holliday@sbcglobal net

Recent trends in the climate and ocean conditions over the eastern Bering Sea have given us the opportunity to observe the response of mesozooplankton biomass and the abundance of selected zooplankton species to both warm and cold conditions During the years 2001 to 2005, summer mesozooplankton biomass declined in several domains over the southeastern shelf, while more recent data show an increase in biomass concomitant with the onset of cold conditions (2006, 2007) Is it that simple? This conclusion is derived from a summer survey that has varied somewhat in both collection time and place over the years How robust is this conclusion to the variations in time and space of sample collection? Highly resolved time series of temporal variability in zooplankton biomass are rare in this region One exception is a relatively new set of acoustically-determined biomass measurements at NOAA site M2 which can describe temporal variability during the summer at a single location Spatial variability has always been an impediment to assembly of time series Do we know the relevant critical or patch scales for zooplankton over the shelf? How many stations are necessary to characterize a shelf domain? If we are to answer the question of how changes in climate affect the ecosystem through lower trophic level processes, we must do a better job understanding the limits of the data we already posses as well as plan for efficient and economical sampling for the future Only then will we be able to address how climate affects the availability of prey for planktivorous fish, birds and mammals

## Evaluating acoustics for squid assessment in the Bering Sea

**Sandra Parker-Stetter**, University of Washington, slps@u washington edu
John K Horne, University of Washington, jhorne@u washington edu

Fishery-independent abundance estimates of squid biomass in the Bering Sea Aleutian Island ecosystem do not occur despite the importance of squid in marine mammal diets and the need to set squid bycatch limits for the walleye pollock fishery In 2006, squid bycatch by the pollock fleet surpassed the Total Allowable Catch (TAC) Industry cooperatives voluntarily left the Unimak Pass/Horseshoe region to avoid exceeding the squid Over Fishing Limit (OFL) This diversion of fishing effort circumvented a pollock fishery closure but underscores the need for a quantitative assessment of squid biomass to set appropriate TAC and OFL limits In August 2007 we conducted a pilot squid survey using multifrequency acoustics (38, 70, and 120 kHz echosounders) and midwater trawling (Gloria HiFlow pollock net) to examine the potential of acoustically discriminating squid from fish and zooplankton Nineteen candidate aggregations were sampled for species composition, target identification, and squid life history information Preliminary results suggest that a traditional multifrequency acoustic analysis approach, frequency differencing, holds promise for discriminating squid from co-occurring walleye pollock We are also evaluating metrics to describe the shape of squid backscatter distribution and are optimistic that recommendations from this work will be applicable to squid assessments

## A three tier approach for evaluating the predatory role of the commander squid, *Berryteuthis magister*, in the eastern Bering Sea

**Mary Elizabeth Hunsicker**, University of Washington, essing@u washington edu
Timothy E Essington, University of Washington, essing@u washington edu
Bryan Ishida, University of Washington, ishida@u washington edu

The eastern Bering Sea (EBS) is a highly productive region that supports some of the world s largest commercial fisheries and the production of species of conservation interest In recent decades, human activities and environmental conditions have induced changes in the abundance of several commercial fishes and marine mammals inhabiting this region It is recognized that indirect effects of fishing and other perturbations on the food web may have exacerbated shifts in the community structure, thus there is increased interest among scientists to gain better knowledge of the trophic linkages within this system Here, we combine stomach content and stable isotope analyses to evaluate the trophic ecology of the commander squid, *Berryteuthis magister*, in the EBS We also evaluate the potential a novel method for reconstructing the trophic history of *B magister* from isotope signatures laid down in their eye lens layers Our results show that there is an ontogenetic shift in prey composition of *B magister* and that fish occurred most often in the seasonal stomach contents Prey size spectra indicate that predation on fish is not influenced by size-related constraints while consumption of squid is a function of increasing predator body size Further, stable isotope analyses of seasonal squid samples show that the trophic position of *B magister* increases by approximately one trophic level over increasing body size and indicate that *B magister* is more likely to share prey resources with commercially valuable fishes than to prey upon them Lastly, isotope analyses of squid eye lenses suggest that this method may be a valuable tool for identifying the trophic history of individual *B magister* The trophic records of many individuals demonstrate an increase in trophic position with ontogeny However, the isotope signatures also indicate that the diet history of *B magister* is not identical among individuals and that the degree of variation may be season-dependent Together, these findings provide a foundation for further evaluation of the trophic dynamics of *B magister* and for exploring how fishing and changing environmental conditions may impact these dynamics

Student Presentation

# Bering Sea and Aleutian Islands
## Lower Trophic Levels, Fish and Fish Habitat & Seabirds

Wednesday 21 January 2009
1 30 – 5 00 PM
**Session Chair Leslie Cornick**
**Alaska Pacific University**

TALKS

| Speaker | Title |
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| Sarah Hinckley | New information about connectivity relationships between larval release and potential settlement areas for snow crab in the Bering Sea |
| W Stewart Grant | Contrasting genetic population structures and responses to ice-age variability in North Pacific pollock and Pacific cod |
| Carwyn F Hammond * | Estimating unobserved mortality rates of Bering Sea crabs due to encounters with trawls on the seafloor |
| Andrew C Seitz | Behavior of satellite tagged Pacific halibut in the Bering Sea/Aleutian Islands region and its biological implications |
| Patrick H Ressler | Trends in walleye pollock and euphausiid abundance on the Bering Sea shelf since 2004 |
| Craig S Rose | Modifications of trawl sweeps to reduce epifauna damage by Bering Sea flatfish fisheries |
| Anne B Hollowed | Biogeography of forage fishes in the Bering Sea |
| Dongwha Sohn * | Distribution and Connectivity between Spawning and Settling Locations of Greenland halibut (*Reinhardtius hippoglossoides*) in the Bering Sea |
| Martin Renner | The roles of fisheries, climate and seascape on the distribution of Northern Fulmars (*Fulmarus glacialis*) in the Bering Sea |
| Robert Suryan | Safeguarding Short-Tailed Albatrosses by Reestablishing a Third Breeding Colony Condition, Post-Fledging Survival, and Migration of Artificially- vs Naturally-Reared Chicks |
| Ine Dorresteijn * | Stable isotopes in diets of planktivorous auklets indicate low trophic level responses to climate variability |
| Ian Lawrence-Jones | Covariation between North Pacific climate and auklet demographic parameters at three western Aleutian islands during 1990-2008 |
| *** Student Presentation** | |

## New information about connectivity relationships between larval release and potential settlement areas for snow crab in the Bering Sea

Carolina Parada, University of Washington, carolina parada@noaa gov
Lobo Orensanz, Centro National Patagonico, lobo@cenpat edu ar
**Sarah Hinckley**, Alaska Fisheries Science Center, Sarah Hinckley@noaa gov
Billy Ernst, Universidad de Concepcion, biernst@udec cl
David Armstrong, University of Washington, davearm@u washington edu
Bernard Megrey, Alaska Fisheries Science Center, Bern Megrey@noaa gov
Jeffrey M Napp, Alaska Fisheries Science Center, jeff napp@noaa gov
Albert J Hermann, University of Washington, albert j hermann@noaa gov

Snow crab (*Chionoecetes opilio*) has supported one of the most lucrative fisheries in the eastern Bering Sea, but landings have declined to historically low levels The geographic range of reproductive females has retracted to the northwest, and larval hatching has shifted downstream of historical distribution areas of snow crab in the southeast Bering Sea There is concern about whether it is possible for the southeast shelf to be repopulated via larval advection to the south from the new spawning areas over the northwest shelf and slope A biophysical model was implemented to study larval transport and environmental effects to assess this question We also examined the general connectivity between areas of larval release and potential settlement in the Bering Sea Since our first connectivity analysis, reported on at last years Alaska Marine Science meeting, we have filled in previously missing years to our simulations, and have several new and interesting results A sector of the middle domain of the shelf to the east of the Pribilof Islands again shows consistent potential for larval retention, but reproductive females have virtually vanished there Larvae hatched to the north and northwest of the Pribilofs, particularly in the outer domain are likely to be advected away, except for those released to the south of St Matthew Island, where the new simulations indicate significant retention New information on areas of potential settlement related to temperature is presented Areas of settlement of modeled larvae match the distribution of the smallest juveniles caught by NMFS surveys (thought to be approximately 1 year old, and not to have moved significantly from initial settlement areas) well, adding confidence to model results No southward advection of larvae from northwestern release areas was found indicating that repopulation of the historical snow crab distributions in the southeastern parts of the Bering Sea via larval advection is unlikely

## Contrasting genetic population structures and responses to ice-age variability in North Pacific pollock and Pacific cod

**W Stewart Grant**, University of Alaska Anchorage, phylogeo@yahoo com
Michael F Canino, NOAA Fisheries, Mike Canino@noaa gov
Ingrid Spies, NOAA Fisheries, ingrid spies@noaa gov
Lorenz Hauser, University of Washington, lhauser@u washington edu

Populations of three phylogenetically related gadid fishes (cods) have historically supported large fisheries in the North Pacific and North Atlantic oceans and have been the focus of numerous population genetic studies Here we present new mitochondrial (mt) DNA data that provide insights into the population structures of these species and a novel perspective on how populations of these species responded to ice-age climate cycles Atlantic and Pacific cod show substantially subdivided population structures, often with isolation by distance between populations Homing to spawning areas, restricted migration, or both, may contribute to this structure Walleye pollock, on the other hand, show minimal population structure that may reflect high rates of migration or strong metapopulation effects of local extinctions and colonizations Bayesian skyline estimates of historical population sizes show substantially different patterns among species Pacific cod shows recent population growth in the center of its range, where ice-age ocean disturbances were greatest In contrast, populations of pollock show similar historical growth patterns across the North Pacific While all three species are closely phylogenetically related, small differences in life history patterns appear to have large effects on population structure and on responses to long-term climate changes

## Estimating unobserved mortality rates of Bering Sea crabs due to encounters with trawls on the seafloor

Craig Rose, Alaska Fisheries Science Center, craig rose@noaa gov
Allan Stoner, Alaska Fisheries Science Center, al stoner@noaa gov
Loveday Conquest, University of Washington, conquest@u washington edu
J Eric Munk, Alaska Fisheries Science Center, j eric munk@noaa gov, speaker
**Carwyn Hammond**, Alaska Fisheries Science Center / University of Washington, School of Aquatic and Fisheries Sciences, carwyn hammond@noaa gov

Management of Bering Sea crab and groundfish fisheries must account for unobserved mortality of crabs which encounter bottom trawls, but are not captured A new approach to predicting delayed mortality of injured crabs is to use a reflex action mortality predictor (RAMP), which establishes a relationship between mortality and reflex impairments Based on a pilot study in 2007 we have published RAMP curves for both *Chionoecetes bairdi* (Tanner crab) and *C opilio* (Snow crab) Additional data collected in 2008 allowed us to update the existing RAMPs, to more fully examine the effect of injury scores on RAMP, and to determine the best method for estimating overall mortality Preliminary results indicated that the additional measurements did not significantly alter the original relationship between expected mortality and reflex score In this application, the RAMP curves were used to predict unobserved mortality from observed proportions of reflex scores of *Chionoecetes* spp crabs captured after encounters with different parts of bottom trawl gear, i e footrope, wing/bridle, sweep and alternative types of footrope and sweep In addition to estimating mortality rates caused by each gear part, we tested whether the alternative footrope and sweep designs reduced the unobserved mortality rates of crab Preliminary results indicated that the alternative off-bottom sweep design does elicit lower mortality than that of the conventional on-bottom sweep

Student Presentation

## Behavior of satellite tagged Pacific halibut in the Bering Sea/Aleutian Islands region and its biological implications

**Andrew Seitz**, University of Alaska Fairbanks, aseitz@ims uaf edu
Tim Loher, International Pacific Halibut Commission, tim@iphc washington edu
Jennifer L Nielsen, U S Geological Survey, jlnielsen@usgs gov
Brenda L Norcross, University of Alaska Fairbanks, norcross@ims uaf edu

Currently, it is assumed that eastern Pacific halibut (*Hippoglossus stenolepis*) belong to a single, fully mixed population extending from California through the Bering Sea, in which adult fish disperse randomly throughout their range during their lifetime However, we hypothesize that Pacific halibut dispersal is more complex than currently assumed and is not spatially random To test this hypothesis, we studied seasonal dispersal and behavior of Pacific halibut in the Bering Sea and Aleutian Islands Pop-up Archival Transmitting tags attached to fish during the summer provided no evidence that Pacific halibut moved out of the Bering Sea and Aleutian Islands region into the Gulf of Alaska during the mid-winter spawning season, supporting the concept that this region may contain a separate spawning component of adult fish There was evidence for geographically localized groups of Pacific halibut along the Aleutian Island chain All of the fish tagged there displayed residency, with their movements possibly impeded by passes between islands Mid-winter aggregation areas of Pacific halibut are assumed to be spawning grounds, of which two were previously unidentified and extend its presumed spawning range ~1000 km west and ~600 km north of the nearest documented spawning area The summarized depth data transmitted via satellites was used to identify three general behaviour patterns including dispersal to the continental slope, continental shelf residency, and feeding site fidelity This behavior information may be used to refine some assumptions of Pacific halibut biology and ecology

## Trends in walleye pollock and euphausiid abundance on the Bering Sea shelf since 2004

**Patrick H Ressler**, NOAA Fisheries-Alaska Fisheries Science Center, Patrick Ressler@noaa gov
Alex De Robertis, NOAA Fisheries-Alaska Fisheries Science Center, alex derobertis@noaa gov,
Phyllis J Stabeno, NOAA-Office of Atmospheric Research, phyllis stabeno@noaa gov
Christopher Wilson, NOAA Fisheries-Alaska Fisheries Science Center,, Chris Wilson@noaa gov

Acoustic backscatter has been used to estimate the biomass and distribution of midwater walleye pollock (*Theragra chalcogramma*) in the eastern Bering Sea since 1977, using well-established survey methods More recently, backscatter data at several frequencies and zooplankton net sampling have been used to identify euphausiid aggregations (mostly *Thysanoessa inermis* and *T raschii*) during acoustic pollock surveys and compute an index of euphausiid biomass in terms acoustic backscatter per unit area This new information will allow the abundance and distribution of pollock to be compared with that of one of its most important prey Acoustic backscatter from pollock and euphausiids are compared from summer surveys in 2004, 2006, 2007, and 2008 Initial results suggest that euphausiid summertime abundance has increased as much as 3-fold on the Bering Sea shelf since 2004, while the abundance of pollock has declined by about half during the same time period This euphausiid abundance index may be a useful aid to understanding the dynamics of the pollock and euphausiid populations during changing environmental conditions in the Bering Sea Related work is underway that will enable conversion of the euphausiid abundance index to units of biomass based on euphausiid length and species composition information, as well as a species-specific euphausiid target strength model

**Modifications of trawl sweeps to reduce epifauna damage by Bering Sea flatfish fisheries**

**Craig Rose**, Alaska Fisheries Science Center, NOAA Fisheries, craig rose@noaa gov
Carwyn Hammond, Alaska Fisheries Science Center, NOAA Fisheries,
carwyn hammond@noaa gov
Scott McEntire, Alaska Fisheries Science Center, scott mcentire@noaa gov
John Gauvin, J Gauvin and Associates, gauvin@seanet com

The component of the Bering Sea shelf ecosystem most vulnerable to collateral damage by trawls is living structure, formed by sessile epifauna Bottom trawlers targeting flatfish in the eastern Bering Sea use long cables (sweeps) between the doors and the trawl nets to herd fish into the nets The area of seafloor passing under these cables during trawling is much larger than the area covered by the trawl nets themselves Conventional sweeps continuously contact the seafloor over nearly their entire length Because of the small size and flexible structure of sessile epifauna in these areas with sand/mud substrates, raising sweeps off of the seafloor could substantially reduce the total effects of trawling on these animals We examined the how inserting disks or bobbins at 10 m intervals, raising the remainder of sweep cables 5 10 cm above the seafloor, changed the effects of bottom trawl sweeps on animals that form living structure, sea whips (Halipteris willemoesi, basketstars (Gorgonocephalus eucnemis) and sponge (Halichondria sp ) We towed trawls with both conventional and modified sweeps along closely spaced parallel tracks A sled, equipped with both video and sonar imaging systems, was towed across the tracks after 1-2 days, and approximately one week, one month and one year The imaging sonar allowed identification of areas affected by each sweep section Video counts of damaged and undamaged animals within each affected swath and adjacent areas outside of the trawl tracks provided data to compare damage rates and recovery Sonar observations showed that, except for the disks themselves, the modified sweeps only contacted the seafloor at a few high points Damage rate differences between control areas and those covered by conventional sweeps and the relative reduction in damage rates due to sweep modifications were similar after the day, week and month periods Both of these contrasts increased after one year, indicating delayed mortality from the conventional sweeps and recovery in the swaths of the modified sweeps Since an associated study showed that the modified sweeps still effectively herd flatfish, their use could reduce the habitat effects of bottom trawling on the Bering Sea shelf

## Biogeography of forage fishes in the Bering Sea

**Anne Hollowed**, National Marine Fisheries Service, Anne Hollowed@noaa gov
Edward V Farley, National Marine Fisheries Service, ed farley@noaa gov
Patrick H Ressler, National Marine Fisheries Service, Patrick Ressler@noaa gov
Stan Kotwicki, National Marine Fisheries Service, stan kotwicki@noaa gov

Theoretical ecology suggests that competition between species and predator-prey interactions are modulated by the quality and quantity of suitable habitat In the ocean environment, shifts in ocean conditions can influence habitat boundaries and thus play a critical role in the spatial distribution and interaction between key species in the Bering Sea The Bering Sea Integrated Ecosystem Research Program (BSIERP) seeks to understand and forecast the impacts of climate change on the Bering Sea ecosystem One group of interrelated BSIERP field projects is designed to improve our ability to identify and map habitat boundaries for selected fish species This will provide information that can be used to forecast the implications of climate change on the Bering Sea ecosystem Here we provide a preliminary assessment of the summer and fall biogeography of forage fishes in the Bering Sea and its relationship to oceanographic features For the purposes of this study, forage fishes include age-0 and age-1 walleye pollock (*Theragra chalcogramma*) and capelin *(Mallotus villosus*) Preliminary results suggest that fish exhibit resource partitioning in the Bering Sea Temperature influences the latitudinal distribution of age-1 pollock Comparison of summer distribution of age-1 pollock along the outer shelf in six different years shows they occupy a core region north of the Pribilof Island in all years while occupation of southern and northern regions vary depending on ocean conditions This suggests that foraging hotspots may shift in response to climate change

## Distribution and Connectivity between Spawning and Settling Locations of Greenland halibut (*Reinhardtius hippoglossoides*) in the Bering Sea

**Dongwha Sohn**, Oregon State University, dsohn@coas oregonstate edu
Lorenzo Ciannelli, Oregon State University, lciannel@coas oregonstate edu
Janet Duffy-Anderson, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, janet duffy-anderson@noaa gov
Ann Matarese, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Ann Matarese@noaa gov
Kevin Bailey, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Kevin Bailey@noaa gov

We examine spatial distribution and connectivity between spawning and potential settling locations during the ontogeny of Greenland halibut (GH, *Reinhardtius hippoglossoides*) in the Bering Sea (BS) In the BS, recruitment of GH has been declining since the late 1970s, little is known about ecology and biology of GH during early life stages For the study, we utilized available GH historical data from the Alaska Fisheries Science Center Larval and pelagic juveniles data were extracted from the ichthyoplankton database from 1982- 2005 The data were collected using three different gear types, including 60cm Bongo nets, Modified Beam Trawl, and Multiple Opening/Closing Net Environmental Sampling System The distributions of GH larvae were analyzed separately with each gear type to eliminate difference in gear efficiency The settled juveniles (age-0s and age-1s) data were extracted from the Groundfish survey data using bottom trawl from 1982 to 2007 We found that GH have a long pelagic duration and are subject to extended drift pathways Larvae were found off the continental slope (below 500 m) Some larvae apparently enter the continental shelf zone from March to May through the Bering Canyon, while others are transported along the slope and onto the shelf through the Pribilof Canyon Vertical distribution of larvae suggests that GH hatch below 530 m, and buoyant larvae move up the water column The highest abundance of larvae was collected in the upper 45 m The nursery region of pelagic juveniles is over the middle shelf around the Pribilof Islands during summer Settlement location of age-0s is only found on the middle shelf around the St Matthew Island during summer, and Age-1s were mostly found on the outer shelf These distribution patterns indicate that larvae likely drift along the continental shelf edge, eventually crossing from the slope to the shelf to settle as age-0s Also, GH require specific location for settling and prefer different environmental conditions for their ontogenetic stages as they develop after settlement This study contributes to understanding settlement success and recruitment of GH as it may be associated with variability in Bering Slope Current during the long distance dispersal trajectory

Student Presentation

## The roles of fisheries, climate and seascape on the distribution of Northern Fulmars (*Fulmarus glacialis*) in the Bering Sea

**Martin Renner**, University of Washington, auklet@bigfoot com
Julia K Parrish, University of Washington, jparrish@u washington edu
John F Piatt, U S Geological Survey, john_piatt@usgs gov
G Vernon Byrd, Alaska Maritime National Wildlife Refuge, vernon_byrd@fws gov
Kathy A Kuletz, U S Fish and Wildlife Service, kathy_kuletz@fws gov
George L Hunt, University of Washington, geohunt2@u washington edu

Northern Fulmars are one of the most numerous species in the Bering Sea and susceptible to affects from both climate change and fishing activities In many parts of their range, the diet of Northern Fulmars has been supplemented greatly by offal discarded from industrial fisheries Since the establishment of the Exclusive Economic Zone and enactment of the Magnuson-Stevens Act in 1983, however, the discard of offal has been increasingly restricted by fishing regulations We examined data from the North Pacific Pelagic Seabird Database, supplemented by a substantial number of surveys added recently, to see whether this change in discards could have affected the distribution of fulmars in the Bering Sea We found that fulmars were more evenly distributed in the 1980s-2000s than in the 1970s We postulate that fulmars were more aggregated in association with fisheries during the 1970s, whereas today they are more dispersed, as would be expected if they had increased their reliance on natural prey Fulmars are also known to be sensitive to climate variability The Bering Sea experienced a major ecosystem regime shift in 1977 and lesser ecosystem changes during subsequent decades To examine climate effects on fulmars, we modeled fulmar densities against a suite of physical variables describing the seascape (e g bathymetry, SST, distance from the shelf), mostly derived from remote sensing The relationship of fulmar density and sea surface temperature was nonlinear When we compared the residuals of this model with the Pacific Decadal Oscillation (PDO) index we found a positive relationship between PDO and fulmar populations at sea (average for the Bering Sea $9\times10^6$ birds) that was strongest at a time lag of 5 years These results suggest that it may be possible to predict the effects of different climate change scenarios on fulmar populations in the Bering Sea A significantly positive population trend of the at-sea populations of fulmars suggests that if the reduction of offal discards had a negative impact on fulmar populations, it was overshadowed by other drivers, such as climate

## Safeguarding Short-Tailed Albatrosses by Reestablishing a Third Breeding Colony Condition, Post-Fledging Survival, and Migration of Artificially- vs Naturally-Reared Chicks

**Robert Suryan**, Oregon State University, rob suryan@oregonstate edu
Gregory Balogh, U S Fish and Wildlife Service, Greg_Balogh@fws gov
Tomohiro Deguchi, Yamashina Institute for Ornithology, deguchi@yamashina or jp
Judy Jacobs, U S Fish and Wildlife Service, judy_jacobs@fws gov
Kiyoaki Ozaki, Yamashina Institute for Ornithology, ozaki@yamashina or jp
Fumio Sato, Yamashina Institute for Ornithology, sato@yamashina or jp
Takao Baba, Yamashina Institute for Ornithology, Baba@yamashina or jp
Noboru Nakamura, Yamashina Institute for Ornithology, nakamura@yamashina or jp

Endangered Short-tailed albatross (*Phoebastria albatrus*) nest in Japan, but frequent waters of Alaska that are used extensively by commercial fisheries Although the population continues to increase and commercial fishing fleets in Alaska have taken admirable measures to avoid incidental take of this species, 85% of the breeding population still exists on one volcanically active island (Torishima) The other 15% of the population breeds on an island group that is under a tri-nation territorial dispute Reestablishment of a third breeding colony at a stable , historic site (Mukojima) is considered essential for delisting this endangered species and efforts began in 2006 to expedite colony establishment Pilot translocation and hand-rearing studies were conducted in 2006 with 10 Laysan albatross (*P immutabilis*) chicks in Hawaii and in 2007 with 10 black-footed albatross (*P nigripes*) chicks in Japan to refine techniques In 2008, the first, of an anticipated five, full-scale translocation and hand-rearing of 10 short-tailed albatross chicks was conducted These efforts provided a unique opportunity for experimental assessment of colony establishment efforts, which are critical for properly informing future resource managers facing similar conservation concerns

We compared development, health, post-fledging survival, and migration patterns between short-tailed albatross chicks hand-reared on Mukojima (experimental group) and those naturally-reared on Torishima (control group) Growth curves of hand-reared chicks (n =10) were all within the 95% confidence limits of naturally-reared chicks (n = 10) through fledging (flying from colony) All hand-reared chicks survived to fledge ( fledging success is unknown for naturally-reared chicks, but certainly < 100%) Based on satellite tracking data, post-fledging survival was 80% for both groups (n = 5 per group) At-sea behavior and migration patterns were mostly similar, although hand-reared birds took longer to begin sustained flight, traveled at a slightly greater daily rate, and more commonly occurred over continental shelf regions These preliminary results provide strong support for the overall success of the initial colony establishment efforts Furthermore, they contribute greatly to our knowledge of juvenile short-tailed albatross distribution in Alaskan waters, an age class for which we had little previous data, but has influenced fisheries management decisions in recent years

**Stable isotopes in diets of planktivorous auklets indicate low trophic level responses to climate variability**

**Ine Dorresteijn**, University of Alaska, Fairbanks, i dorresteijn@student uva nl
Alexander S Kitaysky, University of Alaska, Fairbanks, ffask@uaf edu
G Vernon Byrd, US Fish and Wildlife Service, vernon_byrd@fws gov

Diets of planktivorous auklets might indicate changes in the distribution and composition of zooplankton communities in the Bering Sea ecosystem We examined inter-annual (2003-2008) and intra-seasonal (June-August) dynamics of diet composition (as reflected in stable isotope $^{13}C$ and $^{15}N$ signatures of adult blood samples) of least auklets (Aethia pusilla) breeding at two colonies with distinct oceanographic conditions St George and St Paul, Pribilof Islands As expected based on the colony locations relative to the continental shelf-break, we found that diets of birds breeding on St Paul (continental shelf region) were enriched in $^{13}C$ and $^{15}N$ compared to those of birds breeding on St George (shelf-break region) We also found that physical oceanographic conditions (e g , cold and warm regimes determined by the timing of winter ice retreat and SSTs) determine both inter-annual and seasonal patterns of diet compositions at each colony On the inter-annual basis, enrichments of $^{13}C$ and $^{15}N$ signatures were observed on both colonies, which coincided with overall increasing trends in the duration of winter ice cover and declining SSTs in the Bering Sea during 2003-08 On the intra-seasonal basis, enrichments of $^{13}C$ and $^{15}N$ occurred at both colonies during warm years These intra-seasonal patterns were not consistent during cold years Observed inter-annual enrichments of $^{13}C$ and $^{15}N$ in least auklet diets in the Bering Sea shelf regions are probably associated with an increased productivity of the ecosystem during cold regimes Intra-seasonal changes in stable isotope signatures likely indicate differences in temporal and spatial interactions of oceanic and shelf water masses in the vicinity of Pribilofs, and may point to the origin (shelf or ocean basin) of zooplankton species available to foraging auklets

Student Presentation

## Covariation between North Pacific climate and auklet demographic parameters at three western Aleutian islands during 1990-2008

**Ian Lawrence Jones**, Memorial University of Newfoundland, iljones@mun ca
Alex Bond, Memorial University of Newfoundland, abond@mun ca
Jeff Williams, Alaska Maritime NWR, Jeff_Williams@fws gov
G Vernon Byrd, Alaska Maritime NWR, vernon_byrd@fws gov

We looked for covariation between demographic parameters (adult survival, breeding success and phenology) and North Pacific climate indices, for Least (*Aethia pusilla*) and Crested (*A cristatella*) auklets breeding at three western Aleutian Islands (Buldir, Kiska and Kasatochi) during 1990-2008, and for Whiskered Auklets (*A pygmaea*) at Buldir during 1992-2008 The three islands span a 600 km arc in the oceanic domain of the North Pacific at about 52° N latitude Because they prey mostly on calanoid copepods and euphausiids, auklets' trophic position is low compared to other seabirds and annual variation in survival and reproductive performance might be particularly driven by annual changes in ocean productivity driven by climate Auklet survival was measured by color-marking and resighting adults, with analysis using program MARK Productivity and phenology were quantified by monitoring breeding crevices If both survival and productivity were driven by indirect large-scale oceanographic phenomena that enhance ocean productivity then we would expect to see strong correlations between annual survival and productivity and we would expect to see similar trends across islands and species Kasatochi experienced a cataclysmic volcanic eruption on August 7, 2008, destroying the auklet colony site and all life on the island, along with our 2008 resighting data Adult survival rates varied by island and species, ALPI and NPI climate indices role were inconsistent, and Kiska varied more widely across years, perhaps due to density dependent processes acting at sea or rat predation on land Productivity varied by island and with the NPI climate index, with higher productivity occurring when mean air pressure was low Phenology varied consistently across islands with Buldir auklets laying earliest and Kiska latest (correlating positively with colony size), with little evidence of differences between years or covariation with climate Because foraging areas adjacent to the three islands have very different bathymetry and different ocean current structure, changing climate might have affected them differently Further, island-specific terrestrial factors (volcanism, earthquakes, gulls and rats) have likely muddied the picture Nevertheless, taken together, the results are generally consistent with the notion that large scale climate variability affects demographic parameters of planktivorous seabirds

# Bering Sea and Aleutian Islands
# Marine Mammals

Thursday 22 January 2009
8 00 – 9 30 AM
**Session Chair Lowell Fritz**
**NMFS Alaska Fisheries Science Center**

TALKS

| **Speaker** | **Title** |
|---|---|
| Greg M O'Corry-Crowe | Fishing for population structure in North Pacific seals challenges, pitfalls and solutions |
| Peter L Boveng | Ribbon Seals and their relationship with sea ice in the Bering Sea |
| Paul Olivier * | Insights into the foraging behavior of Steller sea lions using an animal-borne video and data recorder |
| Mary-Anne Lea | Lunar and seasonal influences on the migratory diving behavior of Northern fur seal pups |
| Kelly Ann Newman * | Temporal and Spatial Vocal Patterns of Killer Whales at the Pribilof Islands |
| David K Mellinger | Passive acoustic detection of right, fin and humpback whales in the eastern Bering Sea |
| *** Student Presentation** | |

**Fishing for population structure in North Pacific seals challenges, pitfalls and solutions**

**Greg M O'Corry-Crowe**, Harbor Branch Oceanographic Institute
Florida Atlantic University, gocorryc@hboi fau edu
Peter L Boveng, National Marine Fisheries Service, peter boveng@noaa gov
Gail M Blundell, Alaska Department of Fish and Game, gail blundell@alaska gov
Lori Quakenbush, Alaska Department of Fish and Game, Lori Quakenbush@alaska gov
Vladimir N Burkanov, National Oceanic and Atmospheric Administration, vburkanov@gmail com
Robert Small, Alaska Department of Fish and Game, bob_small@alaska gov

The analysis of population genetic structure traditionally consists of (A) testing explicit hypothesis, such as genetic differentiation among breeding groups, and (B) inference about what genetic heterogeneity means in terms of historical relationships or the level of contemporary gene flow or dispersal Both have proven difficult in several North Pacific seal species such that the analysis of population subdivision is often reduced to a fishing exercise driven primarily by sampling limitations, and often applying incorrect approaches, insufficient markers and inappropriate stratification regimes Drawing on extensive datasets of Pacific harbor seals (*Phoca vitulina*, n=1,449), spotted seals (*P largha*, n=244), bearded seals (*Erignathus barbatus*, n=160) and ribbon seals (*P fasciata*, n=33) for mtDNA and up to 16 microsatellite markers, we conducted a critical analysis of a broad array of approaches for investigating population subdivision Genetic differentiation was found in harbor, spotted and bearded seals at a number of spatial scales, indicative of restricted dispersal at range of temporal scales Five key findings affected our ability to reveal underlying patterns of dispersal and gene flow (1) Sampling regime Seals were often sampled opportunistically, e g on migration or during long-distance foraging trips, limiting our ability to characterize baseline populations (2) High mtDNA diversity (He0 92) in all species indicated large historical population sizes but severely limited statistical power in frequency-based analysis (3) Small sample size limited information content and increased uncertainty in parameter estimation (4) Recent common ancestry, asymmetric dispersal and changing population size indicated that equilibrium-based methods may not be appropriate (5) Most currently available analysis methods, including model-based clustering, gene frequency and coalescent-based methods, are informative only when there s substantial genetic differentiation, which was not always the case for the species investigated By contrast, individual-based analyses, including genotypic assignment tests and relatedness estimation were relatively assumption free and dealt with contemporary time frames relevant to management These approaches are yielding fresh insight into breeding and dispersal behavior in harbor seals in Alaska and need to be applied to other species Such methods, however, are sample intensive and require coordinated, directed sampling where the genetic research is integrated into broader ecological studies

## Ribbon Seals and their relationship with sea ice in the Bering Sea

**Peter L Boveng**, NOAA Fisheries, peter boveng@noaa gov
Shawn P Dahle, NOAA Fisheries, shawn dahle@noaa gov
Michael F Cameron, NOAA Fisheries, michael cameron@noaa gov
John L Bengtson, NOAA Fisheries, john bengtson@noaa gov
Erin E Moreland, NOAA Fisheries, Erin Moreland@noaa gov
Heather L Ziel, NOAA Fisheries, heather ziel@noaa gov

The ribbon seal (*Histriophoca fasciata*) is one of six species of true seals that are associated with ice in the Arctic and sub-Arctic seas Amid widespread concern about climate warming and loss of sea ice, alarms have been sounded for the fate of these species based on common-sense notions about their dependence on ice Information is sorely lacking for critical assessments of their conservation status and prognosis for survival Recent surveys and satellite telemetry studies have just begun to fill some of the gaps for ribbon seals in the Bering Sea Although historical population estimates are imprecise, comparison with a new estimate from aerial surveys in 2007 does not indicate that a major decline has occurred in the eastern Bering Sea Satellite-telemetry records have confirmed a widespread pelagic distribution of ribbon seals from July through November when they are not associated with sea ice The frequency and duration of hauling out on the sea ice, also recorded by satellite-telemetry, has provided new insights into the nature of ribbon seals dependence on the ice during March June when whelping, mating, and molting occur This new information, combined with previous natural history observations and data, as well as projections of future sea ice conditions, supports a qualitative assessment of ribbon seals prospects for survival through the middle of the 21st century

## Insights into the foraging behavior of Steller sea lions using an animal-borne video and data recorder

**Paul Olivier**, Texas A&M University, paul olivier@tamu edu
Russel D Andrews, University of Alaska Fairbanks and the
Alaska Sealife Center, russ_andrews@alaskasealife org
Don G Calkins, North Pacific Wildlife Consulting, LLC, don_calkins@northpacificwildlife com
Vladimir N Burkanov, National Marine Mammal Laboratory, NMFS, NOAA,
vladimir burkanov@noaa gov
Randall W Davis, Texas A&M University, davisr@tamug edu

In June 2008, we deployed three video and data recorders on lactating Steller sea lions (SSL, *Eumetopias jubatus*) in the Kuril Islands of Eastern Russia The objective of the project was to compile a more complete data set depicting the behavioral and environmental components of SSL ecology To accomplish this goal, instrument packages were outfitted with a small, head mounted video camera with a Global Positioning System (GPS) and back mounted digital video recorder, microprocessor and sensors for pressure (depth), swim speed, ambient temperature, and body position (pitch, roll and yaw) Preliminary results show no correlation between surface intervals and corresponding dive depths or dive durations suggesting that the animals were diving within their aerobic dive limit We recorded 7 5 hr of video which showed 66 prey encounters All except four encounters were with Atka mackerel (*Pleurogrammus monopterygius*) Three of the four non-mackerel encounters were with benthic sculpins, which the sea lions appeared to ignore The remaining non-mackerel encounter was a predation event on a pollock (*Theragra chalcogramma*) All but three predation events were benthic The remaining prey capture events (1 pollock and two mackerel) indicate back-light feeding where the animal dove to the bottom and then foraged while ascending using light from the surface to back-light the fish These results provide the first visual views of SSL predation behavior and indicate foraging tactics for an important prey species, the Atka mackerel This prey species exhibits diurnal migration behavior which makes it an easy target for SSL feeding at night as mackerel tend to sit on the sea floor between sunset and sunrise This is contrary to the hypothesis of Nichol et al (2002, MEPS 239 193) that SSL may take advantage of mackerel migrating into the water column during the day

Student Presentation

## Lunar and seasonal influences on the migratory diving behavior of Northern fur seal pups

**Mary-Anne Lea**, National Marine Mammal Laboratory, ma_lea@utas edu au
Devin Johnson, National Marine Mammal Laboratory, devin johnson@noaa gov
Rolf R Ream, National Marine Mammal Laboratory, rolf ream@noaa gov
Sharon Melin, National Marine Mammal Laboratory, sharon melin@noaa gov
Tom Gelatt, National Marine Mammal Laboratory, Tom Gelatt@noaa gov

The development of diving in pinniped neonates provides a valuable opportunity to examine the evolution of diving strategies and to differentiate between the influences of physiological constraints and environmental factors in determining foraging behaviour in naive animals The transition to nutritional independence is of particular importance as animals must learn to forage quickly after weaning or face starvation Recent work has indicated that the northern fur seal (*Callorhinus ursinus*) population at their largest rookery, St Paul Is , has declined by 25% (2002-2006), yet clear threats to recovery remain a mystery We investigated whether the foraging behaviour of fur seals in their first winter could illuminate differences between areas with increasing and decreasing trends that might help explain these threats

In this study, 64 pups from all North American breeding sites (St Paul, St George, Bogoslof and San Miguel islands) were equipped with satellite-dive recorders prior to weaning (mid-late November) and followed during their first 6 months at sea Six-hourly histograms of dive depth, duration and time at depth and at temperature were transmitted via satellite Prior to leaving natal sites pups dived shallowly to average depths of 4 1m for 27 3s Once departed, the inception of a diel pattern in diving occurred by the second month at sea with maximum nightly dive depths (36m) exceeding daytime dives (31 9m) This trend continued as daytime dives became shallower and less frequent and the majority of diving became restricted to night periods as days lengthened Simultaneously, the influence of lunar phase on diving behaviour became apparent During full moons pups dived to significantly greater depths than during other lunar phases, while during the new moon night diving tended to be shallower Diving behaviour varied considerably among pups from different rookeries particularly during the pre-departure period and the first month at sea, while diving capacity increased for both sexes during the first 6 months at sea Changes in mean dive depth during the winter/spring transition indicate pup diving behaviour is likely responsive to seasonal shifts in prey availability as pups near the Transition Zone Chlorophyll Front and coastal Pacific Northwest wintering areas

## Temporal and Spatial Vocal Patterns of Killer Whales at the Pribilof Islands

**Kelly Ann Newman**, University of Alaska Fairbanks, k newman@sfos uaf edu
Alan Springer, University of Alaska Fairbanks, ams@ims uaf edu
Craig O Matkin, North Gulk Oceanic Society, contact@whalesalaska org

Waters surrounding the Pribilof Islands are a foraging hot spot for mammal eating killer whales, which come there every summer to feed on abundant fur seals To delve into predator-prey interactions between killer whales and fur seals, we monitored killer whale visitation patterns in the vicinity of the islands using moored marine autonomous acoustic recorders One recorder was deployed near St Paul I for 21 days in June-July 2006, two were deployed near St Paul I for 60 days in June-August 2008 and two were deployed near St George I for 38 days in July-August 2008 Vocalization patterns were compared to ascertain temporal and geographic visitation patterns, predation behavior, and diurnal activity near fur seal rookeries We found matches of several call types between 2006 and 2008 at St Paul I , indicating the same groups of killer whales returned to the area There was one call match between St Paul I and St George I , but fewer calls were detected at St George I than St Paul I This could be due to the smaller number of fur seals at St George I , seasonal differences in killer whale visitation, or oceanographic conditions that affected call propagation and detection capabilities Vocalizations of whales at St Paul I were also compared to those from other regions in Alaska, and bore the closest structural resemblance to calls produced by whales recorded near False Pass, Alaska, another foraging hot spot in the southeastern Bering Sea

Student Presentation

**Passive acoustic detection of right, fin and humpback whales in the eastern Bering Sea**

**David K Mellinger**, Oregon State University, david mellinger@oregonstate edu
Kathleen Stafford, University of Washington, Stafford@apl washington edu
Sue E Moore, NOAA, sue moore@noaa gov
Sharon L Nieukirk, Oregon State University, Sharon Nieukirk@oregonstate edu
Sara L Heimlich, Oregon State University, Sara Heimlich@oregonstate edu
Phyllis J Stabeno, NOAA, phyllis stabeno@noaa gov

North Pacific right whales (*Eubalaena japonica*) are among the most endangered species of marine mammals, and describing their seasonal habitat use and distribution in the Bering Sea remains a high priority Fin (*Balaenoptera physalus*) and humpback (*Megaptera novaeangliae*) whales are the most common large whales in the Bering Sea, and are top predators of large zooplankton and forage fish Fixed passive acoustic surveys have been employed since 2000 to locate these whales, resulting in long acoustic time series that must be analyzed for whale sounds Here we present methods used to analyze acoustic recordings for the sounds of right, fin, and humpback whales, and present data on the seasonal occurrence of these calls in 2006-07 in the eastern Bering Sea at three sites, the long-term oceanographic moorings M2, M4, and M5 Right whale up calls are detected using spectrogram correlation, a method well suited to finding specific frequency contours in noise Because of their rarity, detected up calls can be manually checked to determine the correctness of detection Fin whales can be detected well using long-term average spectra, a normalization step is required to correct for the high variability in background noise Humpback whales are detected using a method that finds any tonal moans in a certain specified frequency band This method can make errors (false detections) on common sounds of bearded seals (*Erignathus barbatus*) and bowhead whales (*Balaena mysticetus*), but these detections can be eliminated through calculation of an error rate The three sites that were monitored in 2006-07 show that seasonal peaks occur at different times for each species at each site Generally, right whale calling peaked in August in September, while fin whale calling peaked in late September and early October Humpback data are still being analyzed and will be presented

# Arctic
## Climate and Oceanography & Ecosystem Perspectives

Thursday 22 January 2009
10 10 AM - Noon
**Session Chair Lowell Fritz**
**Alaska Fisheries Science Center**

TALKS

| Speaker | Title |
|---|---|
| **KEYNOTE**<br>**G Carleton Ray** | **Impact of Diminished Sea Ice on Marine Mammals and Indigenous Hunters of Beringia** |
| James E Overland | What do we learn about the future Arctic from the summer 2008 sea ice minimum? |
| Gleb Panteleev | Reanalysis of the Arctic Ocean case study for the Chukchi and East Siberian Seas |
| Jia Wang | Is the Dipole Anomaly a major driver to record lows in Arctic summer sea ice extent? |
| Natalia A Donoho | Tides, tidal currents, and sea level trends in Alaska CO-OPS activities and data sources |
| Aixue Hu | Role of Bering Strait in the thermohaline circulation's response to freshwater forcing under present day and LGM conditions |
| Carrie L Parris | Advanced Monitoring Initiative Arctic Coastal Data Mining and Assessment Project |
| *** Student Presentation** | |

*Arctic - Keynote*

**Impact of Diminished Sea Ice on Marine Mammals and Indigenous Hunters of Beringia**

**G Carleton Ray**, University of Virginia, cr@virginia edu
Gary L Hufford, NOAA, gary hufford@noaa gov
Igor Krupnik, Smithsonian Institution, krupnik@si edu

Satellite imagery, shipboard observations, and natural-history information form the basis for multiscale analyses of the consequences of diminished sea ice on the sustainability of ice-dependent marine mammals and the indigenous people that depend on them Sea-ice habitat requires examination at multiple scales Ice cover (how much of a total area is covered by sea ice) and extent (where sea ice is ≥15% concentration at its southernmost boundary) at the regional scale represent the primary setting for pan-Arctic climate change Ice dynamics at the sub-regional ( seascape ) scale is relevant to species life histories And local species/ice associations are necessary for examination of patch dynamics in response to weather conditions We propose that (1) interannual variability in sea-ice extent and cover mask, but do not alter, current trends in sea-ice diminishment, (2) changing seascape and patch dynamics at sub-regional and local scales pose threats to species sustainability, and (3) sustainability of native hunting economies is consequently at risk The Pacific walrus (*Odobenus rosmarus divergens*) and the ribbon seal (*Histriophoca fasciata*) offer contrasting examples of sea-ice dependency during critical reproductive and nursing periods Data and information are derived from observations of ribbon seals, walruses, and ice conditions obtained from satellite images, cruises of the icebreaker USCGC Healy in 2006, 2007, and 2008, and from indigenous hunters of Beringia Our analysis indicates that diminished sea ice and alterations in position, extent, and structure of sea-ice seascapes has caused the Bering Sea to become a mixing bowl wherein floes are relatively free-moving within diminishing habitats For walruses, diminished winter-spring ice increases the energetic costs of migration and may affect reproductive behavior, loss of summer ice threatens female-calf nursing habitat For ribbon seals, diminished ice disrupts the phenology of reproduction and molting, with consequences for pup survival Other consequences include ecosystem effects and reduced access to critical resources for indigenous subsistence hunters, with cascading impacts on the sustainability of hunting practices, knowledge systems, and cultures

**What do we learn about the future Arctic from the summer 2008 sea ice minimum?**

**James E Overland**, NOAA, james e overland@noaa gov
Muyin Wang, Universty of Washington, muyin wang@noaa gov

The question for summer 2008 was whether the previous loss of multi-year sea ice and delay in sea ice formation in 2007 would still allow sufficient winter growth of sea ice thickness for the arctic ice cover to last through the summer 2008, resulting in a major recovery from the 2007 minimum The answer is no, summer 2008 was a second sequential summer of extreme minimum arctic sea ice extent Thus, given typical summer atmospheric conditions in the future, it will be difficult for the arctic sea ice/climate system to return to its previous state of the 1980s However, not all of the first-year sea ice from winter 2008 melted out, especially near the North Pole, providing a basis for forming some second-year sea ice during winter 2009 Initial conditions of sea ice in spring were an important factor in 2008 for determining sea ice loss over the course of the summer The role of summer atmospheric forcing was less important in 2008 compared to 2007 when a rare southerly wind pattern persisted for the entire summer Rather than a continuation of rapid sea ice loss over the next decade, e g a tipping point, it may take the occurrence of several additional rare warm years such as 2007 to continue the sea ice decline, suggesting an expected value for a nearly sea ice free Arctic in the 2030s Anthropogenic greenhouse gas forcing appears to be a necessary factor for major loss of sea ice to occur, but the influence of natural variability in the form of recent warm years meant that the observed loss of summer sea ice occurred many decades earlier than expected from greenhouse gases alone

**Reanalysis of the Arctic Ocean case study for the Chukchi and East Siberian Seas**

**Gleb Panteleev**, IARC, gleb@iarc uaf edu
Andrey Proshutinsky, WHOI, aproshutinsky@whoi edu
Dmitri Nechaev, USM, dnechaev@charter net
Takashi Kikuch, JAMSTEC, takashik@jamstec go jp
Jinlun Zhang, UW, zhang@apl washington edu

In order to develop an efficient data assimilation system and to reconstruct the circulation in the Arctic Ocean we developed several data assimilation algorithms and applied them to reconstruct the circulation in the Chukchi and East Siberian Seas Conventional four-dimensional variational technique for the oceanic data assimilation and nudging data assimilation for the sea-ice observations are proposed to build reanalysis of the sea-ice and ocean conditions in the Arctic Ocean for a period of 20 years In a preliminary effort, the approach was used to reconstruct the circulation in the Chukchi Sea during 1990-1991 and the circulation in the East Siberian Sea during the fall of 1994 The reconstructed circulation in the Chukchi Sea is in good agreement with observations The obtained velocity, temperature and salinity fields are used to estimate volume, heat, salt transports and specific features of the Chukchi Sea circulation The estimates of the circulation in the East Siberian Sea are used to quantify the flow through the Long Strait in 1995 and to derive the non-stationary reference sea surface height for the Chukchi and East Siberian seas

**Is the Dipole Anomaly a major driver to record lows in Arctic summer sea ice extent?**

**Jia Wang**, NOAA, jia wang@noaa gov
Jinlun Zhang, University of Washington, zhang@apl washington edu

The previous record lows of Arctic summer sea ice extent are found to be triggered by the Arctic atmospheric Dipole Anomaly (DA) pattern This local, second-leading mode of sea-level pressure anomaly in the Arctic produced a strong meridional wind anomaly that drove more sea ice out of the Arctic Ocean from the western to the eastern Arctic into the northern Atlantic during the summers of 1995, 1999, 2002, 2005, and 2007 In the 2007 summer, the DA also enhanced anomalous oceanic heat flux into the Arctic Ocean via Bering Strait, which accelerated bottom and lateral melting of sea ice and amplified the ice-albedo feedback A coupled ice-ocean model was used to confirm the historical record lows of summer sea ice extent

## Tides, tidal currents, and sea level trends in Alaska CO-OPS activities and data sources

**Natalia A Donoho**, NOAA/NOS, Natalia Donoho@noaa gov
Kathleen Egan, NOAA/NOS, Kathleen Egan@noaa gov
Todd Ehret, NOAA/NOS, Todd Ehret@noaa gov
Laura Rear, NOAA/NOS, Laura Rear@noaa gov
Manoj Samant, NOAA/NOS, Manoj Samant@noaa gov
Chris Zervas, NOAA/NOS, Chris Zervas@noaa gov

Eighty percent of the population in Alaska lives in close proximity to the ocean and heavily relies on maritime commerce, as many livelihoods are involved in the fishing industry In an effort to support the nation's commerce with information for safe and efficient navigation, NOAA/NOS Center for Operational Oceanographic Products and Services (CO-OPS) offers a suite of web-based products, displaying historic and real-time 6-minute data that are collected at stations as part of National Water Level Observation Network (NWLON) As part of the National Current Observation Program (NCOP), current meter data collected for at least 35 days are used to update the tidal current predictions Real-time current meter and water level data are part of the Physical Oceanographic Real-Time System (PORTS®) with data accessible in real-time on the CO-OPS web site http //tidesandcurrents noaa gov

The primary responsibility of CO-OPS is to collect, analyze and predict tides and tidal currents Presently, there are 26 long-term and 4 short-term operating water level stations in Alaska The harsh Alaskan environment, however, makes high-quality continuous data collection difficult due to freezing, ice and damage from strong storms, especially in the locations at higher latitudes In an effort to gather water level data at North Slope, four short term water level stations were recently installed along the Chukchi Sea and Beaufort Sea at Point Barrow, Point Lay, Wainwright Inlet, and Barter Island

In addition to water level data collection, CO-OPS has used acoustic Doppler current profilers (ADCPs) and High-Frequency Surface Current Mappers (HF-SCMs) to perform extensive current surveys in Alaskan ports and estuaries Recent surveys in Alaskan waters include Cook Inlet, Prince William Sound, and the Southeastern Alaska coast The tidal constituents derived from the ADCP data are being used to update tidal current predictions in NOAA's annually published Tidal Current Tables and other products

Extreme uplift and relative sea level changes in southeast Alaska are documented Both rising and falling trends in Mean Sea Level (MSL) were computed at long-term water level stations using a minimum of 30 years of continuous water level observations at each location

**Role of Bering Strait in the thermohaline circulation's response to freshwater forcing under present day and last-glacial-maximum conditions**

**Aixue Hu**, National Center for Atmspheric Research, ahu@ucar edu
Bette L Otto-Bliesner, NCAR, ottobli@ucar edu
Gerald A Meehl, NCAR, meehl@ucar edu
Weiqing Han, University of Colorado, whan@colorado edu
Carrie Morrill, University of Colorado, carrie morrill@noaa gov
Esther C Brady, NCAR, brady@ucar edu

Responses of the thermohaline circulation (THC) to freshwater forcing (hosing) in the subpolar North Atlantic Ocean under present day and the last glacial maximum (LGM) conditions are investigated using the National Center for Atmospheric Research Community Climate System Model versions 2 and 3 Three sets of simulations are analyzed, with each set including a control run and a freshwater hosing run The first two sets are under present day conditions with an open and closed Bering Strait The third one is under LGM conditions, which has a closed Bering Strait Results show that the THC nearly collapses in all three hosing runs when the freshwater forcing is turned on The full recovery of the THC, however, is at least a century earlier in the open Bering Strait run than the closed Bering Strait and LGM runs This is because the excessive freshwater is diverged almost equally towards north and south from the subpolar North Atlantic when the Bering Strait is open A significant portion of the freshwater flowing northward into the Arctic exits into the North Pacific via a reversed Bering Strait throughflow, which accelerates the THC recovery When the Bering Strait is closed, this Arctic to Pacific transport is absent and freshwater can only be removed through the southern end of the North Atlantic Together with the surface freshwater excess due to precipitation, evaporation, river runoff, and melting ice in the closed Bering Strait experiments after the hosing, the removal of the excessive freshwater takes longer, and this slows the recovery of the THC Although the background conditions are quite different between the present day closed Bering Strait run and the LGM run, the THC responds to the freshwater forcing added in the North Atlantic in a very similar manner

## Advanced Monitoring Initiative Arctic Coastal Data Mining and Assessment Project

**Carrie L Parris**, University of Alaska Fairbanks, belben@sfos uaf edu
Amy L Blanchard, University of Alaska Fairbanks, arnyb@ims uaf edu
Doug Dasher, Alaska Department of Environmental Conservation, doug dasher@alaska gov
Hilary K Nichols, University of Alaska Fairbanks, hilaryknichols@gmail com
A Sathy Naidu, University of Alaska Fairbanks, ffsan@uaf edu
John J Kelley, University of Alaska Fairbanks, ffjjk@uaf edu

Assessment of coastal marine habitats in Alaska, using EPA s Environmental Monitoring and Assessment Program (EMAP) design methods, began in 2002 with a survey of Southcentral Alaska The Alaska Monitoring and Assessment Program, a joint effort between Alaska Department of Environemntal Conservation (DEC) and University of Alaska, is leading the effort to complete these surveys However, with Alaska s extensive coastline, it will be years before resource managers will have new EMAP data available to help understand the current status of Alaska s coastal conditions for much of the state The Advanced Monitoring Initiative project is an inter-agency (EPA, DEC, and UAF) collaborative attempt to jump-start long-term monitoring in the Beaufort Sea by examining historical data using EMAP methods As of date, approximately 20 reports have contributed to the >450 unique stations and the ~200 physical variables (i e , grain size, heavy metal, and hydrocarbon concentrations) dating as far back as the late 1950 s and up to early 2000 s Preliminary assessments of the data suggest that there are trends in these variables over time For example, concentrations of barium in the Beaufort Sea increased from the 1980 s to the 1990 s and then decreased in the early 2000 s Additionally, PAH concentrations in Beaufort Sea sediments had a similar trend to barium, increasing from the 1980 s to the 1990 s and decreasing in the early 2000 s Copper concentrations, on the other hand, decreased from the 1960 s until the 1980 s before increasing in the 1990 s The presence of trends in the data is an indication that historical data can be used to jump-start long-term monitoring projects in coastal Alaska The next step of the AMI project will be to resample the data using to spatially-balanced approach Future plans for the historical data include creating a publically available database as well as continued acquisition of historical data including information on biological resources

# Arctic
## Ecosystem Perspectives, Fish and Fish Habitat, Seabirds & Marine Mammals

Thursday 22 January 2009
1 30 – 5 00 PM
**Session Chair Ana Sirovic**
**Alaska Pacific University**

TALKS

| Speaker | Title |
|---|---|
| **KEYNOTE**<br>**Richard Feely** | **Tribute to Arnold Brower, Sr** |
| Brian Peter Vere Hunt | Zooplankton biogeography as a measure of oceanographic change in Canada Basin (Arctic) |
| Sarah Mincks | Epibenthic megafauna in the Northern Bering and Chukchi Seas Environmental influences on community structure |
| Elizabeth Logerwell | Beaufort Sea Survey Geographic and Historical Comparisions |
| Jennifer L Nielsen | Arctic cisco genetics and otolith microchemistry |
| Pranav Garg | Determination of identity of Salmon Colored $H_2S$ producing colony isolates from Fish and Meat and their characterization by Real Time PCR |
| Steffen Oppel | Importance of the Eastern Chukchi Sea and Southeastern Beaufort Sea as Spring Staging Areas for King and Common Eiders |
| Lori T Quakenbush | Fall Movements of Bowhead Whales in the Chukchi Sea |
| Julien Delarue | A year-long acoustic monitoring program of bowhead whales in the Chukchi Sea |
| S Bruce Martin | Ambient Noise in the Chukchi Sea, July 2007 - July 2008 |
| Lisanne A M Aerts | Sounds from an Offshore Oil Production Island and Bowhead Whale Call Characteristics |
| Marjo Hannele Laurinolli | Study of walrus distribution in the Chukchi Sea using passive acoustics |
| Brendan Cummings | The Polar Bear, a Warming Arctic, and the Endangered Species Act the Role of Wildlife Law in Responding to Climate Change |
| *** Student Presentation** | |

## Zooplankton biogeography as a measure of oceanographic change in Canada Basin (Arctic)

**Brian Peter Vere Hunt**, University of British Columbia, bhunt@eos ubc ca
R John Nelson, Institute of Ocean Sciences, John Nelson@dfo-mpo gc ca
Fiona McLaughlin, Institute of Ocean Sciences, Fiona Mclaughlin@dfo-mpo gc ca
Eddy Carmack, Institute of Ocean Sciences, Eddy Carmack@dfo-mpo gc ca

In response to global climate change the Arctic is experiencing unprecedented reductions in sea-ice cover, and in conjunction with oceanographic changes this is expected to significantly impact both pelagic ecosystem structure and function Between 2006 and 2008 mesoscale surveys were conducted in Canada Basin as part of Canada's Three Oceans initiative, spearheaded by Fisheries and Oceans Canada The overarching aim of this program is to establish a scientific basis for long-term monitoring in Canadian Arctic waters Zooplankton are a key component of the pelagic ecosystem, providing the link between primary producers and higher trophic levels, while also significantly influencing biogeochemical cycling A important step towards understanding the ecosystem role of zooplankton is to establish what structures and controls communities In this light we present zooplankton species and community data from a 2007 Canada Basin survey The spatial distribution of species and communities is assessed in the light of basin wide oceanographic structure and sea-ice conditions, with a biogeographic focus on the contributions of uniquely Arctic species relative to Pacific expatriates

## Epibenthic megafauna in the Northern Bering and Chukchi Seas Environmental influences on community structure

**Sarah Mincks**, University of Alaska, Fairbanks, mincks@sfos uaf edu
Bodil Bluhm, University of Alaska, Fairbanks, bluhm@ims uaf edu
Katrin Iken, University of Alaska, Fairbanks, iken@ims uaf edu
Boris Sirenko, Russian Academy of Sciences, marine@zin ru

Epibenthic megafaunal invertebrate communities were sampled quantitatively in the Northern Bering and Chukchi Seas at 29 stations in 2004 and 2007 Abundance and biomass estimates ranged from 370 to 73,000 individuals per 1000 m2 and from 1 6 to 73 kg wet weight per 1000 $m^2$, respectively Biomass was particularly high in Herald Canyon and in the Bering Strait area Overall, biomass was dominated by echinoderms, including ophiuroids (*Ophiura sarsi*), sea stars (*Leptasterias* spp ), and urchins (*Strongylocentrotus droebachiensis*) Species richness ranged from 16 to 53 across stations, with maximum values found in Mollusca, gastropods were particularly speciose Crustaceans, especially crabs (*Chionoecetes opilio* and *Hyas coarctatus*) and shrimps (*Argis lar* and others) dominated in terms of abundance at many stations Multi-dimensional scaling techniques, based on species relative biomass, grouped the stations primarily by substrate type rather than by water masses Areas of high megafaunal biomass did not align well with regions of high infaunal biomass, suggesting different environmental factors affecting each size class Multi-variate analysis suggests latitude, substrate, and grain size are the chief contributors to variations in epifaunal community structure Several northern range extensions were recorded during the 2004 expedition

## Beaufort Sea Survey Geographic and Historical Comparisions

**Elizabeth Logerwell**, NOAA-NMFS, libby logerwell@noaa gov
Kimberly Rand, NOAA-NMFS, kimberly rand@noaa gov

During August 2008, scientists from NOAA-NMFS Alaska Fisheries Science Center, University of Alaska and University of Washington conducted the first survey of marine fishes in offshore waters of the Beaufort Sea shelf since 1976 The study was funded by the Department of the Interior's Minerals Management Service and the primary objective was to establish a baseline against which the effects of oil and gas development and climate change could be measured The F/V *Ocean Explorer* was chartered for the survey Benthic fish and invertebrate species composition, distribution and abundance were assessed with bottom trawls Pelagic fish were surveyed with hydroacoustics and mid-water net tows The distribution of zooplankton was sampled with bongo nets Physical oceanographic data were collected with conductivity-temperature-depth instruments Data on the distribution of seabirds and marine mammals were also collected Fish made up 6% of the bottom trawl catch, and invertebrates made up the remaining 94% A total of 38 species of fish were identified at sea of which 4 represent range extensions from the Bering or Chukchi Sea A total of 174 species of invertebrates were identified The four most abundant fish species, in terms of biomass, were Arctic cod, eelpouts, Bering flounder and walleye pollock The most abundant invertebrates were brittle stars, opilio crab, a mollusk (*Musculus niger*) and a seastar (*Ctenodiscus crispatus*) The pelagic community was dominated by arctic cod and jellyfish The results of this survey will be put into the context of current surveys in the Bering and Chukchi Seas and past surveys of the Beaufort Sea

## Arctic cisco genetics and otolith microchemistry

**Jennifer L Nielsen**, USGS, jlnielsen@usgs gov
Vanessa R Von Biela, USGS, vvbiela@usgs gov
Christian E Zimmerman, USGS, czimmerman@usgs gov

Arctic cisco (*Coregonus autumnalis*) harvested from the Colville River subsistence fishery are thought to be anadromous, overwintering migrants from the Mackenzie River, Canada Our study used genetics to test population-of-origin hypotheses for Colville River Arctic cisco by comparing data derived from fish captured in the subsistence fishery on the Colville River with anadromous spawning populations collected in the Arctic Red and Peel rivers, both tributaries of the Mackenzie River We analyzed genetic variation at eleven polymorphic microsatellite loci and direct sequence information for a 594 nucleotide fragment of the mitochondrial ATPase subunit VI gene Microsatellite allelic frequencies revealed no significant differences in pairwise FST among these populations supporting the hypothesis that the Mackenzie River watershed is the primary source of Arctic cisco recruiting to the Colville River fishery Differences in mitochondrial DNA haplotypes suggest some fish within the Colville River sample collection may be misidentified to species or are hybrids with other Arctic coregonids

Otolith microchemistry was used to investigate migration patterns and analysis of otolith structure was used to reconstruct growth histories and investigate environmental correlates for young-of-the-year (YOY) growth in Arctic cisco collected in the Colville River Otolith growth was a good predictor of fish growth and transects of otolith elements strontium (Sr) and calcium (Ca) showed patterns of marine migrations reflecting the conceptual model for anadromy in this species Sr/Ca values associated with the second winter were often as low as Sr/Ca values associated with early freshwater residence indicating that these fish may over-winter in non-saline habitats Early growth increments in Arctic cisco (1986-2007) exhibited significant variation both within and among age classes YOY growth was positively correlated with the winter Arctic Oscillation Index (Nov-Mar, $r^2 = 0\ 19$), mean summer air temperatures at Inuvik (June-July, $r^2 = 0\ 15$), and mean Mackenzie River discharge at Ft Simpson lagged two years (April-June, $r^2 = 0\ 50$) The lagged discharge relationship may reflect marine food web dynamics and productivity associated with nutrient distributions resulting from increased river discharge

## Determination of identity of salmon colored $H_2S$ producing colony isolates from fish and meat and their characterization by real time PCR

**Pranav Garg**, Amity University, pranav garg87@gmail com
Robert E Levin, University of Massachusetts Amherst, relevin@foodsci umass edu
Ruth D Witkowsky, University of Massachusetts Amherst, witkowsk@foodsci umass edu

*Shewanella putrefaciens* (formerly *Pseudomonas putrefaciens*) is a spoilage organism in refrigerated foods and can be an opportunistic pathogen The objective of this work was to confirm the identity of 40 presumptive isolates from Cod and Haddock fillets The *S putrefaciens* isolates, both black and salmon colored, were picked from Peptone Iron Agar Plates and streaked for isolation onto Tryptic Soy Agar plates The 40 isolates and 9 control strains (including *P putrefaciens* p19x, *S putrefaciens* ATCC 8071, *S oneidensis* DLM- 7, *S oneidensis* MR-1, *S putrefaciens* ft7, *S frigidimarina* ATCC 1089 and beef isolates HB1, HB3, HB6) were subjected to 4 metabolic tests and 7 enzymatic tests Motility was determined by microscopy Results were compared and the number of presumptives was reduced to 20 by eliminating duplicates Vitamin requirement studies performed with washed agar on the controls and final 20 cultures revealed that vitamins were not required for growth, however about 0 5% NaCl was required All 29 cultures demonstrated the ability to grow in the range of 4-32°C The majority of the isolates were found to resemble *S frigidimarina* ATCC 1089 and *P putrefaciens* p19x, but a few were similar to *S oneidensis* DLM- 7 and MR-1 in their growth requirements This was confirmed by Real Time PCR using *S frigidimarina* primers SFc3f and SFc3r and *S putrefaciens* primers SP-1 and SP-2 which amplify the DNA from the isolates and controls These results provide important insight that could lead to new ways of the identification and characterization of this food spoilage bacterium

Student Presentation

## Importance of the Eastern Chukchi Sea and Southeastern Beaufort Sea as Spring Staging Areas for King and Common Eiders

Lynne Dickson, Canadian Wildlife Service, Lynne Dickson@ec gc ca
**Steffen Oppel**, University of Alaska Fairbanks, steffen oppel@gmail com
Garnet Raven, Canadian Wildlife Service, Garnet Raven@ec gc ca
Abby Powell, U S Geological Survey, ffanp@uaf edu
Tim Bowman, US Fish and Wildlife Service, tim_bowman@fws gov

Receding sea ice cover has sparked hopes for extracting mineral resources buried underneath the Beaufort and Chukchi Seas Industrial development of the areas believed to hold mineral resources may affect wildlife species using the same areas Due to the inaccessibility of both the Chukchi and Beaufort Seas the distribution and temporal use patterns of many species are poorly known, rendering any assessment of their vulnerability to proposed development difficult We used satellite telemetry to track spring migration of 67 King Eiders and 18 Common Eiders wintering in the Bering Sea and North Pacific All of the King Eiders (n=56) and 15 of 16 Common Eiders migrating to breeding areas in western North America stopped in the eastern Chukchi Sea staying an average of 21 ± 10 (SD) days and 22 ± 11 days respectively Furthermore, 6 of 11 King Eiders migrating to breeding areas in Siberia also staged there for at least a week All King and Common eiders migrating to breeding areas in western arctic Canada stopped in the southeastern Beaufort Sea Common Eiders remained in the area an average of 19 ± 9 days (n=16), whereas King Eiders remained about a week longer (27 ± 9 days, n=21) Six male King Eiders that did not continue on to a breeding area remained in the area over 2 months (65 ± 5 days) The high international importance of both eastern Chukchi Sea and southeastern Beaufort Sea to eiders should be taken into consideration when planning for offshore oil and gas development in either region

## Fall Movements of Bowhead Whales in the Chukchi Sea

**Lori Quakenbush**, Arctic Marine Mammal Program, Lori Quakenbush@alaska gov
John J Citta, Arctic Marine Mammal Program, John Citta@alaska gov
John Craig George, North Slope Borough, craig george@north-slope org
Robert Small, Alaska Department of Fish and Game, Robert Small@alaska gov
Mads Peter Heide-Jorgensen, Greenland Institute of Natural Resources, mhj@ghsdk dk

Bowhead whales (*Balaena mysticetus*) from the western Arctic stock have been the focus of considerable research because they 1) are critical to the nutritional and cultural health of Alaska Natives, 2) likely play a significant role as zooplankton grazers in the Bering, Chukchi and Beaufort seas, and 3) are vulnerable to possible effects of oil and gas activities during migration and in their summer range General movements and behavior are known from aerial surveys and from the timing of whaling in coastal villages Some specific feeding areas have also been identified from aerial surveys and the analysis of stomach contents, however, these locations are restricted to areas surveyed and near whaling villages Information on the location of important feeding areas throughout bowhead range and how movements relate to currents, bathymetry, or ice cover is unknown Working with other researchers and subsistence whalers we have attached satellite transmitters to bowhead whales Here we describe the fall migration of 18 bowhead whales in the Chukchi Sea in 2006 2008 Using a Bayesian kernel density estimator, we also describe areas that might be important for feeding and calculate residence times The earliest date any whale passed west of Barrow was 31 August Most whales moved through the Chukchi Sea between 71 and 74°N Seven whales spent time along the eastern side of Wrangel Island before going to the coast of northern Chukotka and following the coast southward Three whales returned to Barrow, two whales returned after travelling 300 km west and one returned after travelling to Wrangel Island Only one whale travelled south along the Alaskan coast All whales that crossed the Chukchi Sea before transmitter failure (13 of 18) travelled through Oil and Gas Lease Sale Area 193 Of 11 whales still transmitting in late November 2008, one whale had passed through the Bering Strait while 10 others were still in the Chukchi Sea The kernel density estimator identified Point Barrow, the east side of Wrangel Island, and the northern coast of Chukotka as areas of importance

### A year-long acoustic monitoring program of bowhead whales in the Chukchi Sea

**Julien Delarue**, JASCO Research, julien delarue@jasco com
Marjo Hannele Laurinolli, JASCO Research, marjo@jasco com
S Bruce Martin, JASCO Research, bruce@jasco com
Scott Carr, JASCO Research, scott@jasco com

Western arctic bowhead whales (*Balaena mysticetus*) transit through the Chukchi Sea in spring and fall during their seasonal migration between their winter grounds in the Bering Sea and their summer feeding grounds in the Beaufort Sea Comparatively little is known about their use of the Chukchi Sea in summer and winter Here we report on bowhead acoustic detections on a multi-recorder array deployed between late July 2007 and 2008 for Shell Exploration and Production Company in this area Bowhead calls were recorded intermittently between August 2007 and January 1st 2008 and again from May 27th 2008 until the end of the study Of particular interest is the detection of songs in late fall-early winter, which had so far only been recorded during the northward spring migration These songs were compared to those recorded off West Greenland during the previous mating season and found to be unique to the Chukchi Sea which represents the first evidence of geographic variation in bowhead songs Overall, these detections bring a new light on bowheads' spatiotemporal use of the Chukchi Sea Their implications with respect to the migratory and mating behavior of western arctic bowheads will be discussed

### Ambient Noise in the Chukchi Sea, July 2007 - July 2008

**S Bruce Martin**, JASCO Research Limited, bruce@jasco com
Marjo Hannele Laurinolli, JASCO Research Limited, marjo@jasco com
Julien Delarue, JASCO Research Limited, julien@jasco com

Shell Exploration and Production Company has commissioned a multi-year acoustic study of marine mammal activity and ambient levels in the Chukchi The first full year s data from the study is July 2007-2008 This paper presents the ambient noise data through out the period The analysis will investigate the contributions made to the ambient levels by shipping, mammals, seismic activity and ice We will show how short term weather conditions can dramatically affect the noise levels even at the bottom of the Chukchi We also investigate how bearded seal trills, which are loud male breeding displays, may affect the ambient noise levels

## Sounds from an Offshore Oil Production Island and Bowhead Whale Call Characteristics

**Lisanne A M Aerts**, LGL Alaska Research Associates, Inc , laerts@lgl com
Susanna B Blackwell, Greenerıdge Sciences, Inc , susanna@greenerıdge com
Charles R Greene, Greenerıdge Sciences, Inc , cgreene@greenerıdge com
W John Richardson, LGL Ltd , environmental research associates, wjr@lgl com
Bill J Streever, BP Exploration (Alaska) Inc , Bill Streever@bp com

This presentation will provide an overview of 8 years of research on bowhead whales migrating past the North Slope oil fields Sounds from Northstar, an offshore oil production island in the Beaufort Sea, and from autumn-migrating bowhead whales (*Balaena mysticetus*), were recorded each September from 2001 to 2008 The main purpose is to document underwater sounds generated by Northstar Island and, ultimately, to understand the relation between those sounds and bowhead whale migration characteristics An array of Directional Autonomous Seafloor Acoustic Recorders (DASARs) was deployed 0 4 to 22 km offshore of Northstar Island, with the more offshore DASARs being within the bowhead whale migration corridor Vessel sounds (crew boat, tugs, self-propelled barges) were the main contributors to the underwater sound field and were often detectable underwater as much as ~30 km offshore Without vessels, broadband island sounds reached background values at 2 to 4 km The DASARs also recorded bowhead whale calls during their westward fall migration and these could be localized via the directional capabilities of the DASARs There was strong annual variation in the number of calls detected, mainly related to the distance of migrating whales from shore, which is related in part to ice conditions The majority of the call directions relative to a DASAR located ~15 km NE of Northstar were northeast to east, except in 2005 and 2006, which were characterized by a high presence of ice The hourly counts of detected calls showed distinct peaks in number of calls, consistent with past evidence that many bowheads migrate in pulses The calls could be divided into simple calls (containing 5 different types) and complex calls, also as found before There was no pattern apparent in prominent call types other than that most calls recorded were simple calls

### Study of walrus distribution in the Chukchi Sea using passive acoustics

**Marjo Hannele Laurinolli**, JASCO Research Ltd , marjo laurinolli@jasco com
Julien Delarue, JASCO Research Ltd , julien delarue@jasco com
S Bruce Martin, JASCO Research Ltd , bruce martin@jasco com
Scott Carr, JASCO Research Ltd , scott carr@jasco com

The distribution of Pacific walruses (*Odobenus rosmarus divergens*) varies seasonally with the extent of sea ice and can be studied through aerial and thermographic surveys in clear weather conditions when animals are hauled out or at the surface However, visibility and weather restrictions are not a factor when surveying using more cost-effective passive acoustics Shell Exploration and Production Company commissioned a multi-year acoustic study in the Chukchi Sea beginning in July 2007 Walrus vocalizations were scattered in small numbers throughout the study area in late July 2007 In August and early September, vocalizations were heard 35 to 80 nm offshore and near a large ice floe and vocalizations increased shoreward with time In the southern Chukchi walrus vocalizations were more concentrated at less than 15 nm offshore and increased in numbers in late August to early September In late September through October very few walruses were heard in the northern Chukchi but they were heard as late as November 28 offshore of Point Lay Walruses reappeared in the study area in spring by mid-June to early July No estimations of numbers of animals present could be made from the current set of knowledge

### The Polar Bear, a Warming Arctic, and the Endangered Species Act the Role of Wildlife Law in Responding to Climate Change

**Brendan Cummings**, Center for Biological Diversity, bcummings@biologicaldiversity org
Rebecca Noblin, Center for Biological Diversity, rnoblin@biologicaldiversity org

The polar bear, Pacific walrus and several other ice-dependant Arctic marine mammals face likely extinction due to anthropogenic greenhouse gas emissions and the consequent rapid warming of the Arctic The polar bear was listed as threatened under the Endangered Species Act ( ESA ) in May 2008 due to the ongoing and projected loss of its sea-ice habitat The Pacific walrus, the ribbon seal, ringed seal, bearded seal and spotted seal have all also been petitioned for ESA listing due to the impacts of global warming Using the case study of the polar bear, we examine the possibilities and limitations of applying the ESA to protect marine mammals threatened by global warming, including the listing process, critical habitat designation, and recovery planning We also discuss how the ESA's statutory prohibitions against *jeopardy* to and *take* of listed species should apply to greenhouse gas generating actions of federal agencies While the ESA was enacted in 1973, long before global warming was recognized as a significant threat to biodiversity, the statute remains highly relevant to species preservation in a changing climate, providing mechanisms to address both mitigation (reducing greenhouse gas emissions) and adaptation (wildlife management in a changing climate)

# Gulf of Alaska

POSTERS

| Climate and Oceanography | |
|---|---|
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| Mayumi Arimitsu* | The Influence of Glacial Features on Oceanographic gradients in Kenai Fjords, Alaska A Closer Look at Kittlitz's Murrelet Foraging Habitat |
| Edward D Cokelet | Long-term Oceanographic Measurements in the Alaska Coastal Current from a Ferry |
| Dimitri Nicolsky | Modeling inundation of the Resurrection Bay by tsunami waves |
| Gleb Panteleev | Volume balance and circulation in the Gulf of Alaska in July, 2007 |
| **Ecosystem Perspectives** | |
| Ginny L Eckert | Marine Ecosystem Sustainability in Alaska, A New Interdisciplinary Graduate Study Program |
| Kim Kloecker | Monitoring Nearshore Marine Ecosystems in the Gulf of Alaska |
| Alan J Mearns | A 20-Year Annual Photo Timeseries Reveals Large Interannual Variation of Seaweed Cover in Prince William Sound |
| Mary C Morris | ShoreZone's Regional Bioareas in Alaska |
| Bonita Nelson | Databases that last decades, what do you really need? |
| Carl Schoch | The Evaluation and Analysis of Shorezone Mapping in Alaska |
| **Lower Trophic Levels** | |
| Sonia Batten | Indices from Continuous Plankton Recorder data |
| Robert W Campbell | Plankton distributions in Prince William Sound and the coastal Gulf of Alaska, 2007-2008 |
| Megan Murphy* | Larval transport of Tanner (*Chionoecetes bairdi*) and Dungeness (*Cancer magister*) crab across Kachemak Bay's inner/outer bay boundary |
| Hilary K Nichols | The Influence of Natural Gradients on Benthic Community Structure in Port Valdez, Alaska |
| Robert J Bochenek | PWS Herring Data and Information Portal |
| **Fish and Fish Habitat** | |
| Mark G Carls | Pacific herring in Lynn Canal endangered, threatened, or just struggling? |
| Vince Patrick | The Bi-Stable State of Herring in Prince William and Sitka Sounds |
| Sharon Wildes | Lynn Canal Herring in Southeast Alaska A Member of One Big Happy Metapopulation? |
| David Csepp | Seasonal abundance and energy availability of forage species to marine predators in southeast Alaska |
| John P Hudson | Energetics of overwintering eulachon (*Thaleichthys pacificus*) reveals size dependence on foraging success |
| ***Student Presentation** | |

| Gulf of Alaska – Posters (continued) | |
|---|---|
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| Brian A Knoth | Dietary overlap and competitive interactions among juvenile gadids in coastal Alaska |
| Fletcher Sewall | Changes in body composition and fatty acid profile during quillback rockfish (*Sebastes maliger*) embryogenesis |
| Ashwin Sreenivasan* | Differences between observed growth and a physiological growth index (RNA/DNA ratio) in larval Pacific cod (*Gadus macrocephalus*) at different temperatures |
| Johanne J Vollenweider | Is Reproductive Investment of Adult Pacific Herring (*Clupea pallasi*) Contributing to Their Decline? |
| **Seabirds** | |
| Aly Mcnight | Marine bird abundance or Prince William Sound, trends following the Exxon Valdez Oil Spill, 1989-2007 |
| Brooke A McFarland* | Black oystercatcher breeding territories biotic and abiotic habitat characteristics |
| Kirsten S Bixler | Is the Recovery of the Pigeon Guillemot Population in Prince William Sound, Alaska Limited by Top-down or Bottom-up Factors? |
| Mary Anne Bishop | Winter Distribution of Seabirds in Relation to Pacific Herring (*Clupea pallasi*) in Prince William Sound |
| **Mammals** | |
| Sarah Bechdel | Genetic consequences of population decline in an Endangered species preliminary results on MHC diversity in Cook Inlet beluga whales |
| Gail M Blundell | Molt Surveys May Understimate Importance of Glacial Habitat For Pupping Harbor Seals |
| J Margaret Castellini | Mercury Levels in Steller Sea Lion Pups in Alaska |
| Karin Harris | Observations of the frequency and severity of encounters between humpback whales and cruise ships in northern Southeast, Alaska |
| Jason K Herreman* | Asymmetrical male-mediated gene flow between harbor seal (*Phoca vitulina*) populations in Alaska |
| Anne Hoover-Miller | Are harbor seal pup non-pup ratios a good measure of productivity? |
| John K Jansen | How close is too close? Acting on short-term disturbance to seals amidst uncertainty about long-term impacts and vessel compliance under the Marine Mammal Protection Act (MMPA) |
| Shawna Karpovich | The effect of boat traffic on harbor seals (*Phoca vitulina*) in Alaska combining physiological and behavioral observations |
| Mandy Jean Keogh* | Impact of Health and Maternal Investment on Survival of Endangered Steller Sea Lion Pups |
| Josh M London | A comprehensive approach for estimating harbor seal abundance in Alaska |
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| Gulf of Alaska – Posters (continued) | |
|---|---|
| **First Author** | **Title** |
| Bill Lucey | Passive acoustic monitoring of beluga whales in Yakutat Bay A pilot study |
| Tamara L McGuire | Photo-identification as a tool to study disease, injury, and survivorship of Cook Inlet beluga whales |
| Kimberly Louise Raum-Suryan | Marine Debris Entanglements of Easter Population Steller Sea Lions |
| Michael J Rehberg | Longitudinal change in Steller sea lion diving and physiology |
| Lawrence E Schaufler | Characterization of humpback whale (*Megaptera novaeangliae*) diets using fatty acid markers |
| Nathan Lord Stewart* | Patterns in sea otter resource selection in Kachemak Bay, Alaska |
| Brooke Symmonds | Genetic analysis of historic and prehistoric beluga whale teeth and bones from Cook Inlet |
| Ryan Wolt* | Foraging Behavior of Sea Otters (*Enhydra lutris kenyoni*) in a Predominantly Soft Sediment Habitat in Alaska |
| Jamie N Womble* | Site Fidelity of Harbor Seals to a Glacial Fiord in southeastern Alaska |
| Colleen Young* | Effects of vessel disturbance on harbor seal behavior in Johns Hopkins Inlet, Glacier Bay National Park, Alaska |
| **Humans** | |
| Jennifer Cahalan | Bycatch characterization in the Pacific halibut fishery Lessons from the Field |
| Ginny L Eckert | The Alaska Harmful Algal Bloom (AHAB) regional monitoring partnership |
| Allen Marquette | Using Community Partnerships to Teach High School Marine Science in Prince William Sound |
| Edward D Cokelet | Evolution of the Bering Sea Shelf's Mixed Layer and Photic Zone Ice to Summer |
| Nancy B Kachel | Biophysical Observations along the 70m isobath in the Bering Sea in 2008 |
| Carol Ladd | Volume, Heat, and Freshwater Transports from the North Pacific to the Bering Sea |
| *** Student Presentation** | |

*Poster Gulf of Alaska - Climate and Oceanography*

**The Influence of Glacial Features on Oceanographic Gradients in Kenai Fjords, Alaska A Closer Look at Kittlitz's Murrelet Foraging Habitat**

Mayumi Arimitsu, USGS-Alaska Science Center, marimitsu@usgs gov
John F Piatt, USGS-Alaska Science Center, jpiatt@usgs gov
Nicola Hillgruber, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, n hillgruber@uaf edu
Erica Madison, USGS-Alaska Science Center, emadison@usgs gov

Physical oceanographic processes can dramatically influence community structure in marine and estuarine systems, but these processes are poorly understood in glacially influenced waters As part of a larger study to define critical marine habitat for Kittlitz's Murrelet (*Brachyramphus brevirostris*) foraging habitat requirements, we conducted oceanographic surveys in two glacial fjords in the Kenai Fjords National Park over the course of the 2007 and 2008 breeding seasons While the outer fjords are exposed to oceanic waters of the Gulf of Alaska, the inner fjords are influenced by tidewater glaciers The inner fjords and outer fjords are demarcated by neoglacial terminal moraine shoals that represent the position of the glacier terminus during the Little Ice Age maximum In June, July and August, we took conductivity- temperature- depth (CTD) profiles in both fjords at 8-10 stations stratified between inner and outer fjord Here we will describe differences in oceanographic characteristics relative to glacial features within fjords over the course of each summer Analyses suggest that Kittlitz s Murrelets predominately occur in the inner fjords and prefer the colder, turbid (silt-laden) waters near the head of the fjords, where estuarine conditions are most pronounced

Student Presentation

*Poster Gulf of Alaska - Climate and Oceanography*

**Long-term Oceanographic Measurements in the Alaska Coastal Current from a Ferry**

Edward D Cokelet, NOAA/PMEL, edward d cokelet@noaa gov
Antonio J Jenkins, University of Washington/JISAO, Antonio Jenkins@noaa gov
Calvin W Mordy, NOAA/PMEL, calvin w mordy@noaa gov
W Scott Pegau, Prince William Sound Science Center, wspegau@pwssc gen ak us
Steve Baird, Kachemak Bay Research Reserve, steve baird@alaska gov
Margaret E Sullivan, University of Washington/JISAO, Peggy Sullivan@noaa gov

An oceanographic monitoring system aboard the Alaska Marine Highway System ferry Tustumena has operated for four years in the Alaska Coastal Current (ACC) with funding from EVOS/GEM, NPRB and NOAA Sampling water at 4 m, the underway system measures (1) temperature and salinity - basic physical variables, (2) nitrate - an essential phytoplankton nutrient, (3) chlorophyll fluorescence - an indicator of phytoplankton concentration, (4) colored dissolved organic matter fluorescence - an indicator of terrestrial runoff, and (5) optical beam transmittance - an indicator of suspended particle concentration

Four years of measurements are sufficient to begin to define the mean annual cycle and anomalies about the mean Kennedy Entrance to Shelikof Strait is a useful index site because most of the ACC flows through there For temperature, 2006 was the median year with 2005 being up to 2°C warmer, and 2007 and 2008 up to 1°C colder Because the ACC is driven by freshwater runoff entering the ocean along the Alaskan coast, one might expect warm years with more ice and snow melt to be fresher in the ACC, and cold years with more precipitation locked in ice and snow to be saltier That relationship holds for the first 3 years (2005=warm/fresh, 2006=neutral/neutral, 2007=cold/salty) but breaks down in 2008(=cold/neutral)

The nitrate and chlorophyll fluorescence signals give an indication of biological activity at the base of the food chain Anomalies in both have been measured, but the relationship between them is complex For instance, the nutrient level may be high and chlorophyll low because no bloom occurs due to light limitations brought about by low seasonal sunlight or mixing below the euphotic depth Conversely, the nutrient level can be high with chlorophyll in step as the spring bloom initiates

The success of this program shows that meaningful oceanographic measurements can be made at the sea surface from a volunteer observing ship These local measurements may provide an oceanographic climate index with greater local applicability than those from basin-wide analyses

*Poster Gulf of Alaska - Climate and Oceanography*

**Modeling inundation of the Resurrection Bay by tsunami waves**

Dmitry Nicolsky, University of Alaska Fairbanks, ftdjn@uaf edu
Elena Suleimani, University of Alaska Fairbank, elena@gi alaska edu
Roger Hansen, University of Alaska Fairbanks, roger@giseis alaska edu
Gleb Panteleev, University of Alaska Fairbanks, gleb@iarc uaf edu

We have developed a robust numerical model to simulate propagation and run-up of tsunami waves in the framework of non-linear shallow water theory A temporal position of the shoreline is calculated using the free-surface moving boundary condition To increase spatial resolution, we construct a series of telescoping embedded grids that focus on areas of interest For large scale problems, a parallel version of the algorithm is developed by employing a domain decomposition technique

The developed numerical model is benchmarked in an exhaustive series of tests suggested by NOAA We conducted analytical and laboratory benchmarking for the cases of solitary wave runup on simple and composite beaches, run-up of a solitary wave on a conical island, and the extreme runup in the Monai Valley, Okushiri Island, Japan, during the 1993 Hokkaido-Nansei-Oki tsunami Additionally, we field-tested the developed model to simulate the November 15, 2006 Kuril Islands tsunami, and compared the simulated water height to observations at several DART buoys In all conducted tests we calculated a numerical solution with an accuracy recommended by NOAA standards In this work we summarize results of numerical benchmarking of the code, its strengths and limits with regards to reproduction of fundamental features of coastal inundation, and also illustrate some possible improvements

We applied the developed model to simulate potential inundation of the city of Seward located in Resurrection Bay, Alaska To calculate an aerial extent of potential inundation, we take into account available near-shore bathymetry and inland topography on a grid of 15 meter resolution By choosing several scenarios of potential earthquakes, we calculated the maximal aerial extent of Seward inundation As a test to validate our model, we compared the calculated inundation to observations collected after the 1964 earthquake in Alaska and obtained good agreement between the computed and observed datasets

*Poster Gulf of Alaska - Climate and Oceanography*

**Volume balance and circulation in the Gulf of Alaska in July, 2007**

Gleb Panteleev, UAF, gleb@iarc uaf edu
Eddy Carmack, Institute of Ocean Sciences, carmacke@dfo-mpo gc ca
Liusen Xie, Institute of Ocean Sciences, xiel@pac dfo-mpo gc ca
Dmitri Nechaev, USM, Dmitri nechaev@usm edu

We present the results of the variational reconstruction of the circulation in the Gulf of Alaska (GoA) in the July, 2007 The reconstructed circulation is obtained by assimilating the oceanic, satellite and atmospheric data into the primitive equation ocean model The oceanic data include CTD observations collected along several hydrophysical sections, contemporary CTD/XCTD observations, and ARGO drifters data The climatological temperature/salinity fields have been used as a background data Two models of the absolute SSH were utilized First model is the gridded SSH anomaly (www aviso oceanobs com) referenced with respect to the Mean Ocean Dynamical Topography (MDOT) derived by Rio *et al*, 2005 The second model is the gridded SSH anomaly referenced with respect to MDOT derived from the variational data assimilation solution obtained for the Bering Sea and a part of the GoA basin The derived circulation have a strong westward current along the Aleutian peninsula in the upper 1000m originated in the regions south from Kodyak Island The current gradually accelerates downstream and has a transport of about 35 Sv near the Unimac Pass Interestingly, our results also reveal a strong eastward counter-current below 2000 m in the region south of Kodyak Island Several numerical experiments indicate that SSH referenced with respect to Rio *et al*, 2005, MDOT may include significant errors in the GoA, while the SSH anomaly referenced with respect to MDOT derived by the variational data assimilation approach is in a better agreement with available velocity observations We speculate that there is a strong necessity to derive a new local MDOT for the GoA by the variational data assimilation of a variety of available observations We believe this product should be extremely useful for the developing of local 4Dvar data assimilation system

**Marine Ecosystem Sustainability in Alaska, A New Interdisciplinary Graduate Study Program**

Ginny L Eckert, University of Alaska Fairbanks, g eckert@uaf edu

The University of Alaska Fairbanks introduces a new interdisciplinary graduate training program in marine ecosystem sustainability This program will prepare professionals to solve problems arising at the interface between dynamic environmental and social systems Students will gain a broad background in fishery science, ecology, marine science, marine policy, economics, and anthropology to complement their own specialized expertise acquired through dissertation research and study

* Students will collaborate on research that transcends traditional disciplinary boundaries
* They will learn to address the unique challenges of ecosystem-based management and to understand its implications for society
* The program will challenge students to develop innovative approaches to pressing real-world problems
* Course work includes marine ecosystem science, traditional ecological knowledge, fisheries management, and resilience theory
* Students will have opportunities to mentor Alaska Native and rural Alaskan undergraduates

We are actively recruiting PhD and MS students starting in 2009 Prospective PhD students (US citizens) can apply for 2 years guaranteed fellowship of $30K per year plus tuition, health insurance, and research funding Graduates will be well-prepared to devise ecosystem-based solutions to critical research and stewardship questions in the sustainable use of living marine resources, skills that are critically needed in today s society

*Poster Gulf of Alaska - Ecosystem Perspectives*

**Monitoring Nearshore Marine Ecosystems in the Gulf of Alaska**

Kim Kloecker, USGS, kkloecker@usgs gov
James L Bodkin, USGS, jbodkin@usgs gov
Thomas Dean, Coastal Resources Associates, tomdean@coastalresources us
Heather Coletti, National Park Service, hcoletti@nps gov

From 2001-2005, the US Geological Survey, the Exxon Valdez Oil Spill Trustee Council, the National Park Service, and Coastal Resource Associates, with extensive input and evaluation from the public and academia, designed and tested long-term monitoring programs for marine nearshore ecosystems in the Gulf of Alaska The resulting sampling design was implemented in Kenai Fjords and Katmai National Parks and Prince William Sound in 2006-2008 The monitoring design is focused on sheltered rocky and soft-sediment habitats and species that occupy positions in a trophic web where kelp and seagrass forests provide a large proportion of the primary productivity These forests provide ecosystem structure, nutrients, habitats, nursery grounds, and substrates that serve as the foundation of the nearshore food web This system is characterized by birds and marine mammals, such as sea ducks, shorebirds, and sea otters that are dependent on nearshore habitats and productivity These high level consumers rely largely on benthic invertebrates, including mussels, snails, clams, urchins, and crabs, that serve as conduits for primary productivity across the nearshore food web We developed a monitoring program that incorporates features designed to test alternative hypotheses related to causes of change over time in species composition and abundance Design features include 1) spatial and temporal components, 2) trophic interactions, 3) environmental variables, 4) species productivity and growth, and 5) species size and age structures Here we provide an overview of our monitoring objectives and design along with examples of data related to trophic linkages between benthic invertebrates (clams, mussels, and limpets) and consumer diets (sea otters and black oystercatchers) collected during the first three years of implementation We expect to begin sampling at Lake Clark National Park in 2009, to continue sampling there and at existing sites indefinitely, and to explore the option of expanding the geographic scope of the program if warranted

## A 20-Year Annual Photo Timeseries Reveals Large Interannual Variation of Seaweed Cover in Prince William Sound

Alan J Mearns, National Oceanic and Atmospheric Administration, alan mearns@noaa gov
John Whitney, National Oceanic and Atmospheric Administration, john whitney@noaa gov
Mandy R Lindeberg, National Oceanic and Atmospheric Administration,
mandy lindeberg@noaa gov
Gary Shigenaka, National Oceanic and Atmospheric Administration, gary shigenaka@noaa gov

Landscape-scale photos of meter- to 10-meter sized mid-intertidal scenes were taken annually during June-early July at 24 photo sites at 9 locations in Western Prince William Sound for up to 20 years (1989-2008) and used to examine longterm interannual variations in percent cover of rockweed (*Fucus spp*) and, at several sites, mussels and barnacles In addition, annual photos were taken at six photo sites along a newly formed shoreline created by a 2000 landslide on the north shore of Knight Island Both photo series show rapid development (2 to 3 years) of intertidal zonation following catastrophic events (the oil spill and the landslide) but they also show significant interannual variation in the development and recession of Fucus cover and recession and development of mussel beds Percent cover at two reference sites was high (>66 7%) in the early 1990 s, low (<33 3%) in 1995-96, high in 1999-2001, and low to medium (>33 3 <66 7%) in the early 2000 s and high again in 2007-08 After Fucus cover at oiled and oiled and cleaned sites had recovered from the oil spill (by 1993-94) it also experienced interannual variation similar to that at the reference sites, with low cover in the 1995 to 96 period, medium to high percent cover in 1999-2001, low cover centered on 2002-03 period and medium to high cover in the period 2006 to 2008 Although percent Fucus cover was not exactly synchronous across all sites in the same year, the majority of photos indicates that in Western Prince William Sound Fucus flourished in the early 1990 s, in 1999 and from 2006 to 2008 but was greatly diminished during 1994-95 and again in 2002-03 suggesting that Fucus experiences a five to seven year cycle of abundance With the advent of climate change it may be valuable to maintain annual photo documentation of dominant biota at these and other locations in PWS

*Poster Gulf of Alaska - Ecosystem Perspectives*

## ShoreZone s Regional Bioareas in Alaska

Mary C Morris, Archipelago Marine Research, marym@archipelago ca
Mandy R Lindeberg, AFSC, NOAA Fisheries, mandy lindeberg@noaa gov
Susan M Saupe, Cook Inlet Regional Citizens Advisory Council, saupe@circac org

ShoreZone is a habitat inventory and mapping system that is currently being applied in Alaska and thousands of kilometres of shoreline have been classified since 2001 Biophysical attributes are systematically described and mapped in alongshore shoreline units , defined spatially at scales of hundreds of meters and smaller As different areas of coastlines have been mapped, regional patterns in the distribution of key biological and geomorphic features have been documented These regions are identified in ShoreZone as bioareas Each small-scale unit is classified within a bioarea

Attributes that distinguish between bioareas include the occurrence of intertidal indicator species, the species of nearshore canopy kelps, wave exposure, and dominant coastal morphology These same attributes are the features in ShoreZone that determine the classification of coastal habitats

Qualitative descriptions based on observations and summaries of data from the detailed scale of mapping describe each bioarea For example, the Icy Strait bioarea in Southeast Alaska is characterised by abundant nearshore dragon kelp bioband, by absence of other canopy kelps, and by wide intertidal zones The outer coast of Southeast Alaska in the Sitka bioarea is defined by diversity of coastal geomorphology, exposed and lower wave energies, lush biobands at higher exposures including extensive giant kelp and bull kelp biobands Twelve bioareas are described so far in Alaska, and more will be added as ShoreZone classification is continued

Bioareas provide a regional context for mangers using the detailed inventory of shorelines that is provided in ShoreZone On-line ShoreZone aerial imagery and classification, along with summary data reports, the mapping protocol and links to program contacts are available at www alaskafisheries noaa gov/maps

*Poster Gulf of Alaska - Ecosystem Perspectives*

**Databases that last decades, what do you really need?**

Bonita Nelson, NOAA AFSC, bonita nelson@noaa gov

The Exxon Valdez Oil Spill Trustee Council Hydrocarbon Database (PWSOIL) is the archival database for the sample collection and chemical analysis information collected for hydrocarbon analysis from projects funded by the Trustee council from the beginning of the spill in 1989 to the present The database operates using a strict chain of custody protocol from sample collection in the field and continuing through analysis in the chemistry laboratory The database is the authoritative source of hydrocarbon analyses for 20,000 samples collected under at least 40 projects by over 100 different researchers from many state and federal agencies These analyses can be recovered along with all quality assurance data and determination of the amount of Exxon Valdez oil found These data have used by Trustee agencies in efforts to determine the extent of injury and rate of recovery following the spill In addition, there is archival information for an additional 35,000 samples many of which are still in storage The database has been in the custody of the Auke Bay Laboratories since the beginning of the spill and maintained by a custodian funded by the Trustee Council

This project is an example of a long-term data series that has been maintained and updated continuously over the last 20 years by only three custodians working with the same agency During this period it has existed in various formats and undergone revisions Its integrity has been tested by numerous FOIA requests This experience has shown that metadata alone may not allow new users to fully understand and therefore use the data as fully as desired In order for a long term data series to maintain its maximum usefulness, the metadata must be accompanied with strictly defined narratives describing collection, quality assurance, interpretation and maintenance processes Plans to construct long term data sets must recognize the increased cost and effort are required to make these data sets useful as investigators, users and agency priorities change

*Poster Gulf of Alaska - Ecosystem Perspectives*

**The Evaluation and Analysis of Shorezone Mapping in Alaska**

Carl Schoch, Coastwise Services, cschoch@alaska net
Susan M Saupe, Cook Inlet Regional Citizen's Advisory Council, saupe@circac org

There is a growing need among resource managers to know the locations of different shoreline habitats and associated biota at fine spatial scales and over large areas This need stems from the increasing encroachment of humans along coastal areas and the direct and indirect effects of our activities On-going mapping efforts in Alaska such as Shorezone (see Harney, Harper and Morris this conference), to a large extent, fulfill these needs by providing physical and biological characterizations of the shoreline that can be accessed through online GIS datasets and aerial videography However, systematic field verification of these map products is lacking and there are potentially many sources of error introduced during the mapping process that may compromise confidence in the data if used inappropriately The goal of this project was to identify the major sources of error and develop quantitative methods for evaluating how well Shorezone maps represent shoreline habitats and their associated biota We utilized a series of independent habitat maps collected from ground surveys to compare against the maps made using Shorezone aerial techniques We found that 1) the Shorezone maps lack a standardized high resolution digital shoreline and many small scale features are missing, 2) the repeatability of the Shorezone methodology is poor and may be susceptible to false positive and false negative indications of change at the scale of individual shore segments, 3) there is no minimum mapping unit or rules to guide the mapper on what to map leading to inconsistent mapping of small scale features, and 4) the Shorezone biobanding is broadly correct for horizontal and vertical differentiation of biota at the time of the aerial overflight but the data are significantly sensitive to time scales ranging from height of tide to seasons to years We conclude that Shorezone arguably represents the most cost effective method for mapping large areas of shoreline habitat and biota at relatively fine spatial scales but users must be cognizant of the limitations imposed by the mapping techniques

*Poster Gulf of Alaska - Lower Trophic Levels*

## Indices from Continuous Plankton Recorder data

Sonia Batten, SAHFOS, soba@sahfos ac uk
David Mackas, Fisheries and Oceans Canada, mackasd@dfo-mpo gc ca

A large-scale plankton sampling program in the Gulf of Alaska and southern Bering Sea was initiated in 2000 and has sampled with Continuous Plankton Recorders, seasonally, along two transects since then Plankton respond rapidly to climate variability because of their short life cycles and limited horizontal movement Indices showing planktonic responses to the recent fluctuations in climate variability across the region are presented here Phytoplankton community composition (only larger, hard-shelled taxa are sampled by the CPR) in the southern Bering Sea corresponds to sea ice cover and sea surface temperature variability, zooplankton biomass, seasonal timing and changes in species composition in the Gulf of Alaska correspond to changes in the Pacific Decadal Oscillation and SST Changes in these lower trophic level parameters are likely to influence the upper trophic levels that ultimately depend on them

## Plankton distributions in Prince William Sound and the coastal Gulf of Alaska, 2007-2008

Robert W Campbell, Prince William Sound Science Center, rcampbell@pwssc org
Laurel McFadden, Prince William Sound Science Center, lmcfadden@pwssc org
Thomas C Kline, Prince William Sound Science Center, tkline@pwssc gen ak us

In order to assess plankton biomass in relation to fish distributions, broadscale surveys were conducted in 2007 and 2008 in Prince William Sound (PWS), four bays around the periphery of the sound (Whale, Eaglek, Zaikof and Simpson bays) and the adjacent shelf and slope Patterns in the structure of the plankton community were analyzed by hierarchical clustering and indicator species analysis (ISA) The resulting clusters broke down fairly well into geographic areas, with an oceanic cluster (open waters of PWS and the shelf/slope) that could be subdivided into a western and eastern PWS cluster, and several clusters made up of stations from the bays In general, within-bay stations tended to cluster together, though there were occasionally some overlaps Bays on the eastern side of PWS tended to occur in clusters distinct from the western side

ISA (the product of the relative abundance of a given species in a given group and the frequency) showed that the taxa characteristic of the different groups was generally not unique Rather, the relative importance of several common taxa (including copepods, larvaceans, chaetognaths and larval euphausiids) differed among the different clusters Analysis of the hydrography at the different stations suggests that the differences between the groups are partially attributable to transport patterns (i e transport of oceanic taxa into the Sound) Local production was also potentially important, as evidenced by meroplanktonic taxa, such as barnacle larvae, particularly in the bays

*Poster Gulf of Alaska - Lower Trophic Levels*

**Larval transport of Tanner (*Chionoecetes bairdi*) and Dungeness (*Cancer magister*) crab across Kachemak Bay s inner/outer bay boundary**

Megan Murphy, University of Alaska Fairbanks and Kachemak Bay Research Reserve,
m murphy@sfos uaf edu

Closures of the Tanner (*Chionoecetes bairdi*) and Dungeness (*Cancer magister*) crab fisheries within Kachemak Bay reflect concerns regarding the sustainability of these commercially important brachyuran crab species In order to create effective management strategies of these crabs, it is imperative to understand their entire life history in addition to their larval transport into and out of the bay Physical forcing, specifically tides and wind, has been shown to control distribution and behavior of larval crabs within estuarine environments, however, no study has documented both larval crab abundance and effects of transport within Kachemak Bay Three hypotheses of this study follow 1 General oceanographic conditions in Kachemak Bay produce a net inflow of Tanner and Dungeness crab larvae on the southern shore and a net outflow along the northern shore 2 Extreme tides increase the abundance of crab larvae entering and leaving the inner bay 3 Out-transport of later larval stages (megalopae) is reduced independent of tidal flow

To address these hypotheses, frequent plankton sampling and Conductivity Temperature Depth [CTD] measurements were taken in relation to different tidal conditions throughout the larval recruitment period (March-October) Based on our findings, we begin to determine the oceanographic effects on larval brachyuran crab transport and distribution between inner and outer Kachemak Bay, Alaska

Student Presentation

*Poster Gulf of Alaska - Lower Trophic Levels*

**The Influence of Natural Gradients on Benthic Community Structure in Port Valdez, Alaska**

Hilary K Nichols, University of Alaska Fairbanks, hilaryknichols@gmail com
Amy L Blanchard, University of Alaska Fairbanks, arnyb@ims uaf edu
Carrie L Parris, University of Alaska Fairbanks, belben@sfos uaf edu
Howard M Feder, University of Alaska Fairbanks, feder@ims uaf edu

A long-term study examining the distribution of benthic invertebrates in Port Valdez, Alaska, provides insights into the role of natural gradients in structuring benthic faunal communities Sampling of benthic invertebrates in Port Valdez was initiated in 1971 and modified in 1989 to address effects of treated ballast-water discharges on benthic communities at the marine oil terminal The benthic database from 1989 to 2007 was assessed to determine environmental factors contributing to benthic community structure Strong natural gradients in Port Valdez, a glacial fjord in the northeastern corner of Prince William Sound, include water depth and sediment flux and composition Water depth changes sharply along the margins of the fjord and had the strongest association with changes in faunal communities Sediment flux decreases with distance from the head of the fjord contributing to an east/west separation in the faunal assemblage Faunal communities of the deep basin and those under the direct influence of glacial sediments were less diverse and fauna are less numerous Fauna associated with the deep basin included the arctic mudstar Ctenodiscus crispatus and the aplacophoran mollusk Chaetoderma robusta Fauna under the influence of glacial sediments and high sedimentation rates were dominated by deposit-feeding organisms, such as the reverse-conveyor belt polychaetes of the family Maldanidae and the capitellid worm Heteromastus filiformis which transport buried organic carbon to the sediment surface Fauna not directly influenced by glacial sediments were diverse and included other feeding modes The faunal community structure in the deep basin of Port Valdez is comparable to glacial fjords elsewhere in the northern Hemisphere The influence of water depth and sediment composition on benthic community structure was large, as compared to anthropogenic stressors These results of this investigation help to understand the influence of different sources of variability in glacial fjords and contribute to understanding the effects of stress on benthic fauna in Alaska

*Poster Gulf of Alaska - Fish and Fish Habitat*

## PWS Herring Data and Information Portal

Robert J Bochenek, Axiom Consulting & Design, rob@axiomdms com
Steve D Moffitt, Alaska Department of Fish and Game, steve moffitt@alaska gov

The overall goal of this project is to salvage, standardize and document historic datasets which have a bearing on understanding the Prince William Sound ecosystem as it pertains to the herring lifecycle Many existing PWS herring related research and monitoring data sets were dispersed and data were not easily accessible to researchers and managers Additionally, the spatial and temporal relationships of were not readily apparent because much data were not in a spatially enabled format During 2007 and 2008 this project spatially enabled a series of key herring data sets (annual biomass estimates, spawn observations, Age Sex Length Weight, commercial harvest, acoustic surveys and egg deposition data) under the stewardship of the Alaska Department of Fish and Game (ADF&G) Cordova In addition, this project acquired, spatially enabled and standardized multiple relevant herring data sets outside of the stewardship ADF&G Cordova These datasets include Lingering Oil, ShoreZone Habitat, Oiled Beach Surveys, Herring Disease datasets, Zooplankton Abundance and acoustical surveys of herring and herring predator surveys Many herring related data sets that were not easily accessible to restoration researchers and managers have been made available through the actions of this project The results of these efforts has provided easier access, standardization and visualization of selected herring data sets and other electronic resources

## Pacific herring in Lynn Canal endangered, threatened, or just struggling?

Mark G Carls, NOAA / NMFS / Auke Bay Laboratories, mark carls@noaa gov
Scott W Johnson, NOAA / NMFS / Auke Bay Laboratories, scott johnson@noaa gov

Examination of the Pacific herring (*Clupea pallasii*) population in Lynn Canal (near Juneau, Alaska) suggests that although it declined in the 1970s and has not recovered, the population is not discrete and significant as defined by the Endangered Species Act (ESA), hence it cannot be protected by this law To be classified as a discrete population segment (DPS), a vertebrate population must fulfill two criteria discreteness and significance To be considered distinct, a population, or group of populations, must first be discrete from other populations and then significant to the entire taxon (species or subspecies) to which it belongs The biological review team assembled to examine and discuss the data concluded the smallest defensible DPS that includes Lynn Canal is southeast Alaska (SEAK) Although the team recognized the possibility that there may be subdivisions within SEAK, available biological data are either too incomplete or too similar to definitively separate herring populations within this region Furthermore, recent genetic results continue to suggest Pacific herring in the Gulf of Alaska region form a metapopulation, implying significant gene flow between impaired populations such as Lynn Canal and Prince William Sound and healthy populations such as at Sitka, Alaska

## The Bi-Stable State of Herring in Prince William and Sitka Sounds

Vince Patrick, Prince William Sound Fisheries Research Applications and Planning, vince@umd edu
Evelyn D Brown, Flying Fish Ltd , husumbandb@embarqmail com
Frank J O'Brien, System Science Applications, fjobrien@cox net
Heather Meuret-Woody, Sitka Tribe of Alaska, hwoody@sitkatribe org

As part of our development of a model of the population dynamics of herring in Prince William Sound, we have examined Alaska Fish and Game s Age Structure Analysis (ASA) Models for Prince William and Sitka Sounds The time series on the population of adult herring and recruitment are remarkably similar and display distinct patterns that provide clues to the dynamics of herring in the two regions These patterns include the existence of bi-stable states for the adult populations in which the size of the populations are clustered in time in either a high density state or a low density state In PWS the high density state of the 80s moved to the low density state in the early 90s and has remained there In SS the low density state of the 60s and early 70s moved to the high density state at the end of the 70s and has remained there The high density states in both regions were triggered by extraordinarily successful recruitments in the mid-70s that most likely resulted from unique oceanographic conditions

The pattern also includes a bi-modal distribution in annual recruitment that occurred in both Sounds between 1976 and 1992 wherein high rates of recruitment occur every 4 years After 1992 the bi-modal distribution either disappeared or was greatly dampened The data suggests that the 4 year cycle was not maintained by an external environmental cycle, but rather it was maintained by the internal biological dynamics of the population The same can be said for the period of relatively stable annual recruitment since 1992 We believe that patterns observed in the ASA time series are best explained density-dependent nonlinearities in dynamics at stages in the herring s life cycle These nonlinearities may occur because of predator-prey interaction, disease-host interaction, food limitation, or the spatial structure of the population

*Poster Gulf of Alaska - Fish and Fish Habitat*

**Lynn Canal Herring in Southeast Alaska A Member of One Big Happy Metapopulation?**

Sharon Wildes, AFSC, sharon wildes@noaa gov
Johanna J VollenweiderJohanna J Vollenweider, AFSC, Johanna Vollenweider@noaa gov
Jeff Guyon, AFSC, jeff guyon@noaa gov

Herring is one of the most energy-rich fish in the Alaskan ecosystem, and when populations struggle over time, such as the Lynn Canal population, there is management concern Prior to 1983, Lynn Canal herring supported a productive sac roe fishery, a bait fishery, and a winter food and bait fishery All commercial fisheries were closed in 1983 and remain so today The purpose of this study was to examine the genetic structure of Lynn Canal herring and determine if it was discrete from other collections in southeast Alaska We used microsatellite DNA to examine both spawning and non-spawning aggregates (collected in two consecutive years) in Lynn Canal, and compared them to two Southeast Alaska populations Prince of Wales Island (southernmost waters) and Sitka Sound on Baranof Island (outer-coast) In addition we examined two collections from Prince William Sound (approx 850 km NW) as a means to compare extent of divergence over large tracts of unsuitable spawning habitat Because the geographic location of Lynn Canal is somewhat isolated and schools are known to over-winter in the area, we hypothesized that Lynn Canal herring experience reduced gene flow The results of our study showed allele frequencies from 16 loci were highly similar across all collections, including the distant Prince William Sound This investigation concurs with previous studies that there is a large amount of movement among herring in the Gulf of Alaska We conclude that Lynn Canal herring are part of a meta-population that is possibly Gulf wide or larger

## Seasonal abundance and energy availability of forage species to marine predators in southeast Alaska

David Csepp, NOAA Fisheries, AK Fisheries Science Center, dave csepp@noaa gov
Johanna J Vollenweider, NOAA Fisheries, AK Fisheries Science Center,
Johanna Vollenweider@noaa gov
Mike Sigler, NOAA Fisheries, AK Fisheries Science Center, Mike Sigler@noaa gov

Seasonally predictable prey aggregations are important energy sources for marine predators, however little work has quantified prey variability in relation to predator response We quantified seasonal and interannual variability in energy available to Steller sea lions (*Eumetopias jubatus*) in southeastern Alaska The study was conducted in Stephens Passage, where 5-14% of the total sea lions in southeastern Alaska reside depending on season Our objectives were to 1) measure seasonal and annual variability in abundance of fish species, 2) measure seasonal and annual variability in energy content of abundant species, and 3) relate energy availability of prey species to prey habits of Steller sea lions

1 The dominant species were walleye pollock, Pacific hake, Pacific herring, Pacific halibut, Pacific cod, sablefish, and sandpaper skate Seasonal and interannual differences in species abundance were detected for walleye pollock and the most abundant demersal species

2 Eulachon, Pacific herring, myctophid sp and sablefish were highest in energy and lipid contents, while walleye pollock, Pacific hake, Pacific cod, Pacific halibut and sandpaper skates were the lowest Significant seasonal variations in energy and lipid content were detected in prey species, particularly the epipelagic species Demersal species had consistent body composition throughout the year Of the species that varied seasonally, we saw a generally coherent pattern of increasing energy and lipid stores following the spring plankton bloom with subsequent losses during winter fasting and gonadal recrudescence

3 Sea lion diet studies from adjacent haulouts show a correspondence of diet with variation in abundance of several pelagic species Pollock, the most abundant species year-round, were consumed most frequently in all seasons During peak abundances of herring in winter and spring, consumption increased Though hake were usually more abundant than herring, they were presumably out of range and rarely consumed Sablefish were the only demersal species consumed in proportion to their abundance, peaking in the fall Fifty-three other prey species were detected in sea lion diets, the majority of which were encountered in this study in reduced abundance

In summary, Steller sea lions in Southeast Alaska have a diverse foraging strategy corresponding to the availability of forage species that is likely key to their increasing population

## Energetics of overwintering eulachon (*Thaleichthys pacificus*) reveals size dependence on foraging success

John P Hudson, Auke Bay Laboratories, AFSC, NOAA Fisheries, Ted Stevens Marine Research Institute, john hudson@noaa gov
Johanna J Vollenweider, Auke Bay Laboratories, AFSC, NOAA Fisheries, Ted Stevens Marine Research Institute, Johanna Vollenweider@noaa gov
Ron A Heintz, Auke Bay Laboratories, AFSC, NOAA Fisheries, Ted Stevens Marine Research Institute, ron heintz@noaa gov
Fletcher Sewall, Auke Bay Laboratories, AFSC, NOAA Fisheries, Ted Stevens Marine Research Institute, fletcher sewall@noaa gov
Robert Bradshaw, Auke Bay Laboratories, AFSC, NOAA Fisheries, Ted Stevens Marine Research Institute, robert bradshaw@noaa gov

Despite the important role of forage fish in marine food webs, the factors that influence their populations in Alaska are poorly understood Size-selective winter mortality from starvation likely plays an important role in the recruitment of north temperate forage fishes In winter 2007 we studied the energetics of juvenile eulachon (age-0 and age-1) in Fritz Cove and Berners Bay near Juneau, Alaska Prey abundance was more than 30% greater in Fritz Cove than in Berners Bay Fritz Cove eulachon maintained energy levels throughout winter indicating that prey consumption offset metabolic demands In contrast, the energy content of eulachon in Berners Bay decreased during winter, primarily from consumption of stored lipid Winter energy losses were independent of size in age-0 eulachon which experienced a 27% decrease in energy content (84% of this energy was derived from lipid reserves and the remainder from protein) Winter energy loss in age-1 eulachon was size-dependent In the smallest fish, energy content decreased by 27% (76% from lipid) whereas energy content decreased by only 4% (91% from lipid) in the largest age-1 fish We attribute this size-dependence in winter energy conservation to enhanced foraging success in larger age-1 fish Previously, higher winter survival of larger juvenile fish has been attributed to lower weight-specific metabolic rates and greater allocation of surplus energy to storage These results suggest that size-dependent foraging success may also influence winter energy dynamics, and ultimately the survival and recruitment of juvenile forage fishes in north-temperate marine systems

*Poster Gulf of Alaska - Fish and Fish Habitat*

**Dietary overlap and competitive interactions among juvenile gadids in coastal Alaska**

Brian A Knoth, Alaska Fisheries Science Center, National Marine Fisheries Service, brian knoth@noaa gov
Benjamin J Laurel, Alaska Fisheries Science Center, National Marine Fisheries Service, Ben Laurel@noaa gov

In Alaska, Pacific cod, *Gadus macrocephalus*, occur sympatrically in shallow-water coastal nursery areas with other species such as saffron cod, *Eleginus gracilis* It is hypothesized that there is food competition between these congeners and that the prolonged residency of multiple age classes in these nursery areas may promote inter-cohort cannibalism A thorough understanding of their diets is needed to predict the impacts these processes have on their growth and survival We examined the diet composition of sympatric age 1+ Pacific and saffron cod, across multiple years and habitats (i e , eelgrass, *Laminaria*, and bare sand) within nursery sites, to quantify the degree of dietary overlap and the extent of cannibalism on younger conspecifics Juvenile cod were collected by hook and line and beach seining at two nursery sites around Kodiak Island, AK during the summer in 2007 and 2008 To date, a total of 354 juvenile cod (n=260 saffron cod, 17 1-39 0 cm TL, n=94 Pacific cod, 17 4-36 0 cm TL) have been collected A preliminary analysis of the stomach contents revealed the two gadids fed primarily on benthic invertebrates and had a high degree of dietary overlap Common prey items included annelids (*polychaeta spp* ) and gammarid amphipods and to a lesser extent crangonid shrimps, hermit crabs (*Paguridae spp* ), and fish (Pacific sand lance, *Ammodytes hexapterus*, *Stichaeidae spp* , and *Cottidae spp* ) Pacific cod had a higher rate of piscivory than saffron cod (Pacific cod 16%, saffron cod 3%) although the species composition and size class of fish prey were similar Although there was no evidence of cannibalism for either species in 2007, the density of age-0 cod in the nursery areas, based on demersal beach seine surveys, was relatively lower than in contiguous years It is possible, therefore, that cannibalism is a density dependent function and is an important process when densities are high Inter-annual variability in the cod diets is expected and will be assessed to examine the degree of food competition and the extent of cannibalism in years of varying age 0 cod densities

*Poster Gulf of Alaska - Fish and Fish Habitat*

## Changes in body composition and fatty acid profile during quillback rockfish (*Sebastes maliger*) embryogenesis

Fletcher Sewall, NOAA-NMFS, Auke Bay Laboratories at Lena Point, fletcher sewall@noaa gov
Cara Rodgveller, NOAA-NMFS, Auke Bay Laboratories at Lena Point, cara rodgveller@noaa gov

Survival during the larval phase can be vital in determining the eventual strength of year classes that recruit to fished stocks, larval survival, in turn, is often dependent on larvae having energy stores sufficient to ensure survival to first feeding Differences in the amounts and use of endogenous protein and lipid sources during embryonic development may influence the survival rates of early planktonic rockfish larvae Little is known regarding biochemical and energetic changes during the early development of Quillback rockfish (*Sebastes maliger*), a commercially important species that has internal development of embryos and gives birth to free-swimming larvae We investigated developmental changes in the body compositions and fatty acid (FA) profiles of embryos and pre-parturition larvae of the quillback rockfish for an assessment of their potential use as indicators of larval condition and for comparison with other species While both lipid and protein mass were consumed by quillback rockfish embryos during development, lipid was used more rapidly and contributed a larger portion (60%) of total energy expended, indicating a protein-sparing effect This is consistent with other studies of rockfish, and affirms the importance of measuring lipid levels when assessing larval condition Oil globule volume was strongly correlated with lipid levels, affirming its utility as an indicator of condition FA profiles of embryos differed distinctly from those of hatched larvae, indicating FAs are depleted at different rates during development The conservation of 20 4n-6, the most abundant n-6 polyunsaturated FA, indicates that this essential FA may well reflect the quality of maternal nutrient provisioning Embryos and larvae of quillback rockfish, like other marine fishes, are likely incapable of synthesizing this metabolically important FA, either entirely or at a rate which will meet their needs for growth and survival

*Poster Gulf of Alaska - Fish and Fish Habitat*

**Differences between observed growth and a physiological growth index (RNA/DNA ratio) in larval Pacific cod (*Gadus macrocephalus*) at different temperatures**

Ashwin Sreenivasan, University of Alaska Fairbanks, ftas2@uaf edu
Ron A Heintz, NOAA Fisheries, ron heintz@noaa gov
Lawrence E Schaufler, NOAA Fisheries, lawrence schaufler@noaa gov
Thomas Hurst, NMFS, Thomas hurst@noaa gov
Stanley D Rice, NOAA Fisheries, jeep rice@noaa gov
William Smoker, University of Alaska Fairbanks, bill smoker@uaf edu
Johanna J Vollenweider, NOAA Fisheries, Johanna Vollenweider@noaa gov

The ratio of RNA/DNA (R/D) has applications as a growth index in larval fish, and is very sensitive to recent changes in nutritional condition and protein synthesis A fluorometric protocol (Caldarone *et al* 2001) was used to obtain nucleic acid levels allowing analyses of whole-body individual larvae Short-term growth patterns were compared between two groups of larval Pacific cod (*Gadus macrocephalus*) maintained at different temperatures (5°C and 8°C) from hatch The aim of this study was to understand aspects of the relationship between early growth and temperature in these fish Fish were sampled immediately after hatch, as well as 23 and 36 days post hatch (dph) Not surprisingly, at both 23 and 36 dph, fish at 5°C had significantly lower growth rates and lengths relative to fish at 8°C However, an expected similar trend was not in fact observed for R/D ratios between groups At 36 dph fish at 5°C exhibited significantly higher R/D ratios relative to fish at 8°C Hence, the expected elevated RNA/DNA ratios were not seen with higher growth The results suggest a compensatory mechanism to maintain protein synthesis, with higher RNA concentrations and consequently higher R/D levels, due to possibly reduced RNA efficiency at colder temperatures An extended sampling period will be useful in elucidating long-term physiological effects, if any, on growth of P cod exposed to cold temperatures

Student Presentation

*Poster Gulf of Alaska - Fish and Fish Habitat*

## Is Reproductive Investment of Adult Pacific Herring (*Clupea pallasi*) Contributing to Their Decline?

Johanna J Vollenweider, NOAA Fisheries, AFSC, Johanna Vollenweider@noaa gov
Ron A Heintz, NOAA Fisheries, AK Fisheries Science Center, ron heintz@noaa gov

We examined overwinter energy expenditure of adult Pacific herring (*Clupea pallasi*, age 3+) using three Gulf of Alaska stocks (two declining populations - Prince William Sound (PWS) and Lynn Canal (LC), and a robust population - Sitka Sound (SS)) While causes underlying the declines remain elusive, it is likely their combined effects are reflected in energy dynamics We examined the overwinter energy expenditures of adult herring and how that pertains to their subsequent reproductive investment

Adult herring (mean fork length = 224mm) in PWS incurred the greatest overwinter energy losses, which were nearly twice (-4 1 kJ/d) as rapid as fish in Southeast Alaska (-2 3 and -1 8 kJ/d in LC and SS, respectively) Though PWS adults began winter with greater energy stores than fish in Southeast stocks, their high rates of energy expenditure caused adults from all stocks to be in relatively similar condition at the end of winter Adults in PWS and LC were more successful foragers than in SS, with 67% of PWS adults containing stomach contents, 62% in LC and 27% in SS Identifiable prey consumed by herring were primarily euphausiids, copepods and pteropods

Gonadosomatic Indices (GSI) of adult herring immediately prior to spawning were significantly higher in the robust stock in SS (23 8) than the depressed stocks (17 0 and 15 6 in PWS and LC, respectively) The relative composition of roe did not differ between stocks, however On a relative mass basis, the energy density of roe from spawning females did not differ between stocks (20 8 + 0 1 kJ g dry mass), nor did the lipid (14 0 + 0 2%) or protein (77 9 + 0 2%) content Thus, female spawning herring in SS had larger roe sacs conferring greater total energy content

In summary, adult herring in PWS (and to a lesser degree LC) incurred high overwinter energy expenditures at the expense of their gonad condition In contrast, fish in SS had the lowest rate of energy loss over winter, resulting in the largest roe with the most energy content prior to spawning Causes for the differential energy loss rates are unknown (disease, predation,and ?), but are likely factors in the population declines

**Marine bird abundance or Prince William Sound, trends following the Exxon Valdez Oil Spill, 1989-2007**

Aly Mcnight, USFWS, alykelsey@yahoo com
Kelsey Sullivan, USFWS, alykelsey@yahoo com
David B Irons, USFWS, david_irons@fws gov
Shawn Stephensen, USFWS, shawn_stephensen@fws gov
Shay Howlin, West Inc , shayhowlin@west-inc com

We conducted small boat surveys to estimate marine bird populations in Prince William Sound, Alaska during March (winter) and July (summer) 2007, using methods developed in 1989-91 (Klosiewski and Laing 1994) We examined trends of marine birds in the oiled and unoiled areas of PWS between 1989 and 2007 We considered an increasing population trend evidence that recovery was occurring, and no trend or a decreasing trend evidence that populations were not recovering We also compared trends between the oiled and unoiled regions, we considered a significantly greater slope in oiled area trends evidence that a population was recovering, while a significantly greater slope in unoiled area trends indicated continuing oil spill effects for that taxon Our data indicated that most taxa for which injury was previously demonstrated were not recovering During winter surveys, three taxa (loons, Common Loons, and scoters) had increasing population trends, while fourteen taxa (Bald Eagles, Black-legged Kittiwakes, Buffleheads, Common Murres, cormorants, goldeneyes, grebes, Glaucous-winged Gulls, Harlequin Ducks, mergansers, Mew Gulls, Marbled Murrelets, Northwestern Crows, and Pigeon Guillemots) did not exhibit any trend toward recovery During summer surveys, three taxa (cormorants, Glaucous-winged Gulls, and Northwestern Crows) showed trends consistent with a recovering population, and fifteen taxa (Bald Eagles, Black-legged Kittiwakes, Black Oystercatchers, goldeneyes, Harlequin Ducks, loons, Common Loons, Kittlitz's Murrelets, mergansers, Mew Gulls, Marbled Murrelets, Common Murres, Pigeon Guillemots, scoters, and terns) showed no trend toward recovery

*Poster Gulf of Alaska - Seabirds*

**Black oystercatcher breeding territories biotic and abiotic habitat characteristics**

Brooke A McFarland, University of Alaska Fairbanks, School of Fisheries and Ocean Sciences, ftbam@uaf edu
Brenda Konar, University of Alaska Fairbanks, School of Fisheries and Ocean Sciences, bkonar@guru uaf edu
Michael I Goldstein, USDA Forest Service, Alaska Region, mgoldstein@fs fed us

Black oystercatchers (*Haematopus bachmani*) are large shorebirds that typically nest immediately above the intertidal zone in a composite breeding and foraging territory Over 60% of these birds breed in Alaska, where they are considered a Management Indicator Species in the Chugach National Forest, a species of high concern , and a Species at Risk Predictive models of preferred breeding habitat are critical to allow for more targeted survey efforts and to mitigate disturbance to these birds In south-central Alaska all known breeding sites (n=148) in western Prince William Sound and Kenai Fjords National Park were paired by substrate and exposure with random sites (n=148) and analyzed for remotely-sensed data parameters In both locations models included chlorophyll a concentrations, sea-surface temperature, aspect, slope, distance to freshwater, isolation and modified effective fetch In Kenai Fjords National Park distance to blue mussel bands, eelgrass and kelp bed locations were also available and included in candidate models A subset of breeding (n = 33) and paired random sites (n = 31) were chosen to sample for intertidal community composition and local-scale habitat characteristics (aspect, slope, distances to a freshwater source and to woody vegetation, intertidal width and rugosity (surface complexity)) A priori models were evaluated and ranked by Akaike s An Information Criterion (AICc) corrected for small sample size, and the area under the curve (AUC) from receiver operating characteristic (ROC) curves was calculated to identify the performance of each model Top-performing models were evaluated for additional sites in Kenai Fjords National Park (n=14) as well as for sites outside of the study region, in south-east Alaska (n=20) Analysis of similarity (ANOSIM) tests were performed on the intertidal community composition at field sites, however no significant differences were found between breeding sites and random available sites All top-performing models contained a measure of the isolation of the site from the mainland, indicating that pressure from predation is a factor in selection of breeding territories

Student Presentation

## Is the Recovery of the Pigeon Guillemot Population in Prince William Sound, Alaska Limited by Top-down or Bottom-up Factors?

Kirsten S Bixler, Oregon State University, kirsten bixler@oregonstate edu
Daniel D Roby, USGS-Oregon Cooperative Fish and Wildlife Research Unit, Oregon State University, daniel roby@oregonstate edu
David B Irons, U S Fish and Wildlife Service, david_irons@fws gov

The Pigeon Guillemot (*Cepphus columba*) population in Prince William Sound, Alaska has declined by more than 85% from ca 15,500 individuals in the 1970 s to ca 2,100 today The Exxon Valdez oil spill (EVOS) in 1989 directly killed 2-3,000 guillemots, and sublethal effects from EVOS may have limited recovery for up to 15 years post-spill But population recovery is now apparently limited by either indirect, long-term EVOS effects or factors unrelated to the spill In 2008, we investigated potential factors currently limiting recovery at the Naked Island Archipelago, which formerly supported one-third of the Sound-wide population of guillemots, and compared nesting success at the Naked Island Archipelago, which now has mink (*Mustela vison*), with that at Fool Island, a small, mink-free island 25-km away The nesting density of guillemots on the Naked Island Archipelago is extremely low compared to nesting densities on Fool Island and other mink-free islands in central Prince William Sound Nest predation rate during chick-rearing was higher at the Naked Island Archipelago than at Fool Island The proportion of high-quality forage fishes in chick diets at the Naked Island Archipelago has not changed appreciably since the 1990's, although is less than at Fool Island We conclude that the low numbers of guillemots nesting on the Naked Island Archipelago may be primarily limited by mink Restoration of guillemots in Prince William Sound to pre-spill levels may require mink control or eradication on the Naked Island Archipelago

## Winter Distribution of Seabirds in Relation to Pacific Herring (*Clupea pallasi*) in Prince William Sound

Mary Anne Bishop, Prince William Sound Science Center, mbishop@pwssc org
Kathy A Kuletz, U S Fish Wildlife Service, kathy_kuletz@fws gov
Neil Dawson, Prince William Sound Science Center, ndawson@pwssc org
Richard E Thorne, Prince William Sound Science Center, rthorne@pwssc org

Little is known about winter foraging dynamics of seabirds in Alaska We conducted seabird surveys in Prince William Sound in conjunction with hydroacoustic fish surveys in historic juvenile and adult Pacific herring (*Clupea pallasi*) wintering areas during the 2007/2008 winter Distribution patterns by the most numerous seabird species appeared to reflect preferences for different herring age and size classes Marbled Murrelets (*Brachyramphus marmoratus*) were strongly associated with juvenile herring (age 0 - 2) Common Murres (*Uria aalge*) were most often encountered in deeper waters with aggregations of adult herring (age-3 or older) Glaucous-winged Gulls (*Larus glaucescens*) were opportunistic and fed in areas with large fish concentrations, regardless of herring age or size class Black-legged Kittiwakes (*Rissa tridactyla*) were found with all age classes of herring, but did not show a significant association, possibly because of the influence of depth to the fish schools Both Common Murre and Marbled Murrelet showed marked seasonal distribution patterns in response to shifts in herring availability By March, murres moved from deeper waters outside of the bays to inside bays, as pre-spawning adult herring entered bays In early winter, murrelet densities were high in bays with juvenile herring schools, but dropped by March as juvenile herring decreased in these same bays Seabird densities were best explained by a model containing location (bay) and fish density at a specific depth

**Genetic consequences of population decline in an Endangered species preliminary results on MHC diversity in Cook Inlet beluga whales**

Sarah Bechdel, Harbor Branch Oceanographic Institute - Florida Atlantic University, sbechdel@hboi fau edu
Brad Smith, National Oceanic and Atmospheric Administration, brad smith@noaa gov
Shannon Atkinson, Alaska Sea Life Center - University of Alaska Fairbanks, shannon_atkinson@alaskasealife org
Kaja Brix, National Oceanic and Atmospheric Administration, kaja brix@noaa gov
Greg M O'Corry-Crowe, Harbor Branch Oceanographic Institute - Florida Atlantic University, gocorryc@hboi fau edu

The apparent failure of the small, endangered population of beluga whales (*Delphinapterus leucas*) in Cook Inlet to recover from a dramatic population decline in the 1990s, despite the cessation of the known cause of the decline, raises the question of whether there may be intrinsic factors associated with this failure to thrive We recently initiated a study to investigate changes in the genetic components of individual fitness and population viability of the Cook Inlet whales over time One important question is whether the recent decline resulted in the loss of biologically relevant genetic variability Our initial research has focused on characterizing genetic diversity within the major histocompatibility complex (MHC), a suite of genes involved in the immune response where diversity at the population level has been linked to population viability in a number of species We report on our preliminary findings here The peptide binding regions of the $DQ^2$ and DRB genes from a number of beluga whales from Cook Inlet and two other populations were successfully amplified and sequenced Amplicons were cloned into a plasmid vector and screened for allelic diversity using Invitrogen s TOPO®-TA cloning kit Ligation, transformation and colony screening were performed multiple times and both strands were sequenced using M13 primers Allelic characterization is ongoing but initial results are yielding multiple alleles Future work will involve mass screening of samples from Cook Inlet and two other populations a small, stable, sub-arctic population and large, arctic population Historic and pre-historic samples will also been screened using ancient DNA methods, and individual MHC profiles will be compared to independent estimates of reproductive success and survivorship

*Poster Gulf of Alaska - Mammals*

**Molt Surveys May Understimate Importance of Glacial Habitat for Pupping Harbor Seals**

Gail M Blundell, Alaska Department of Fish and Game, gail blundell@alaska gov
Christine Schmale, Alaska Department of Fish and Game, christine schmale@alaska gov
Josh M London, NOAA Alaska Fisheries Science Center, josh london@noaa gov
Peter L Boveng, NOAA Alaska Fisheries Science Center, peter boveng@noaa gov

Some tidewater glaciers provide important habitat for pupping harbor seals (*Phoca vitulina*), seasonally supporting disproportionate numbers of mothers and pups relative to total seals in the area, suggesting that females travel from elsewhere to pup on icebergs Harbor seals mate shortly after pups are weaned, thus mating likely occurs where pups are raised With the seasonal influx of disproportionate numbers of parturient harbor seals, birthing sites in glacial fjords may effectively serve as source locations for recruitment of individuals into populations over a larger area Little is known about where seals that use glacial habitat during pupping and mating season spend the remainder of the year Ours was the first study to capture harbor seals in a glacial fjord during pupping season We conducted captures in June/July 2008 in Endicott Arm, southeast Alaska We equipped 15 adults and subadults (13 females, 2 males), and 15 pups with SPOT tags and monitored their movements through molt season (July-Aug ) All seals tagged in glacial habitat dispersed within days to a few weeks and spent the majority of their time in terrestrial habitat Many remained in terrestrial habitat while some moved between glacial and terrestrial sites From tagging through August, an average of 21% of locations for nonpups and 15% of locations for pups occurred in glacial habitat Pups, which do not molt until the following year, traveled over large areas without localizing movements at a particular site The average maximum, direct swimming-distance that pups moved from their capture site was 114km, with a maximum distance of 167km for one pup Nonpups localized movements during molt The average distance traveled between the glacial capture site and their molt site for nonpups was 149km One subadult female, in estrus when she was captured, moved 331km between her probable mating site and her molt site Surveys to estimate harbor seal abundance are conducted during molt season (mid-August) Our preliminary data indicate that most glacial seals present during pupping season disperse to terrestrial habitat before molt surveys are conducted, thus current abundance data may underestimate the importance of glacial habitat to pupping and breeding harbor seals

*Poster Gulf of Alaska - Mammals*

## Mercury Levels in Steller Sea Lion Pups in Alaska

J Margaret Castellini, University of Alaska Fairbanks, maggiec@ims uaf edu
Lorrie D Rea, Alaska Department of Fish and Game, lorrie rea@alaska gov
Kimberlee B Beckmen, Alaska Department of Fish and Game, kimberlee beckmen@alaska gov
Todd M O'Hara, University of Alaska Fairbanks, fftmo@uaf edu

Exposure to mercury of Steller sea lions (SSL) was assessed by measuring total mercury (THg) in hair and THg and methyl mercury (MeHg) in liver Livers were obtained from necropsies of SSL pups found dead on rookeries

THg in hair varied significantly by region and age Young pups had the highest and most variable levels with lowest mean values occurring in hair from pups in the southeastern (SEA) population (mean ± S D , 4 0 ± 1 6 µg/g) THg in hair from month old pups from Amak and Sugarloaf Islands averaged 7 7 ± 2 7 µg/g and 8 2 ± 3 8 µg/g, respectively Hair from 3 month old pups from Prince William Sound (PWS) had the highest and most variable THg (9 1 ± 6 3 µg/g) 25-40% of young pups from the western populations had THg higher than 10 µg/g, a level which the EPA suggests may indicate exposure sufficient to produce toxic effects

Older pups, young of the year (YoY) and yearlings had significantly lower THg in hair but regional differences were still apparent in YoY In this case, hair from pups from SEA and PWS had the lowest THg (1 6 ± 0 6 µg/g and 1 1 ± 0 3 µg/g, respectively) while values from pups captured around Kodiak and in the Aleutians were slightly higher (2 7 ± 0 9 µg/g and 2 3 ± 1 0 µg/g, respectively) This represents lactationally derived hair

There was no apparent difference in THg between the livers of month old Steller sea lion pups from SEA (0 80 ± 0 49 µg/g) and PWS (0 84 ± 0 29 µg/g) THg and MeHg were within ranges reported for other marine mammal pups Consistent with previous marine mammal studies, the proportion of THg that was in the MeHg form was relatively high (53 ± 6 %) A single fetal sample had a very high proportion of MeHg (75%), although both THg (0 41 µg/g) and MeHg (0 31 µg/g) were relatively low

Hair is likely an efficient post-parturient excretory mechanism for newborn pups exposed to Hg in utero This matrix offers important insights for exposure of the fetus, a well recognized life stage of concern for Hg toxicosis

*Poster Gulf of Alaska - Mammals*

**Observations of the frequency and severity of encounters between humpback whales and cruise ships in northern Southeast, Alaska**

Karin Harris, University of Washington, karinh2@u washington edu
Scott M Gende, National Park Service, Scott_Gende@nps gov

Interactions between large ships and large whales are a concern to resource managers because ships produce underwater sound which can mask communication and disrupt foraging and other vital activities Ships can also strike and kill whales, which for some populations can serve as a significant source of mortality Southeast Alaska is a popular destination for cruise ship tourism and an important foraging area during the summer months for humpback whales (*Megaptera novaeangliae*) To determine the frequency, severity, and relative spatial pattern of interactions between cruise ships and humpback whales, we designed and implemented a study using cruise ships as observational platforms We conducted 197 hours of observations during 20 cruises between June and September, 2008 in Glacier Bay National Park and adjacent waterways including Icy Strait, Glacier Bay, Chatham Strait, North Passage, Inian Pass and Cross Sound Although more than 600 encounters (separation distance <5km) between ships and whales were recorded across the study area, 100% of the severe encounters (<100m from bulbous bow) occurred near the entrance of Glacier Bay In 2009 we will expand the number of cruises to help identify what factors, such as ship speed and spatial variability, may contribute to the frequency and severity of encounters with ships Ultimately we hope to evaluate the efficacy of management measures designed to decrease severe interactions between cruise ships and humpback whales in the vicinity of Glacier Bay

**Asymmetrical male-mediated gene flow between harbor seal (*Phoca vitulina*) populations in Alaska**

Jason K Herreman, University of Wyoming, jkherreman@hotmail com
Gail M Blundell, Alaska Department of Fish and Game, gail blundell@alaska gov
David B McDonald, University of Wyoming, dbmcd@uwyo edu
Merav Ben-David, University of Wyoming, bendavid@uwyo edu

Harbor seals (*Phoca vitulina richardsi*) in Alaska are currently treated as three distinct management stocks Previous genetic analyses using mitochondrial DNA (mtDNA) suggested that these stocks are differentiated genetically We studied populations in Glacier Bay (GB, Southeast Alaska Stock), where harbor seals are declining, and Prince William Sound (PWS, Gulf of Alaska Stock), where the population has recently stabilized Using 6 hypervariable microsatellite primers, we determined that these populations are a single panmictic unit with estimated migration rates of 22 (PWS to GB) and 63 (GB to PWS) animals per generation The asymmetrical gene flow between GB and PWS is likely driven in part by a recent increase in competitors and predators of seals in GB In contrast with males, emigration of females from PWS to GB (8 3 seals/generation) is higher than emigration of females from GB to PWS (3 3 seals/generation), likely because females use glacial ice as pupping habitat Despite the high gene flow, the number of migrants per year (0 02% of the Gulf of Alaska population) is likely too low to influence the demographics of harbor seals in PWS, and the two populations may best be managed as separate stocks

Student Presentation

*Poster Gulf of Alaska - Mammals*

**Are harbor seal pup non-pup ratios a good measure of productivity?**

Anne Hoover-Miller, Alaska Sealife Center, anneh@alaskasealife org

Proportions of harbor seal pups relative to non-pups that are counted during the pupping season have been proposed for use as relative measures of productivity Those indices, however, assume that the likelihood of haulout is the same between groups being contrasted Harbor seals in Aialik Bay, a tidewater glacial habitat on the Kenai Peninsula, have been monitored since 1979 by field observations and remotely controlled video cameras From 1980-2002 mean numbers of pups, adjusted for environmental conditions, declined 88% from 148 to 18 pups while seals counted during molt declined 82% from 801 seals to 141seals From 2002-2007 numbers of pups remained stable at low levels while molting seals showed rapid growth of 21%/yr The ratio of female-pup pairs (FP) to seals without pups (Pv) was determined for each census conducted from 4-15 June for the years 1979-1981 and 2002-2007 Near the onset of the decline (1979-1981), mean FP Pv ranged from 0 23 in 1979 to 0 38 in 1981, from 2002-2007, when numbers of pups were low but stable, mean FP Pv ranged from 0 26-0 15 with highest proportions in 2004-2005 (0 26) and lowest in 2006-2007 (0 15-0 17) The proportion of pups, relative to seals without pups, is influenced by both reproductive rates and the haulout behavior of seals without pups Pups are dependent on haulouts for nursing and resting and show less variability in haulout with respect to environmental conditions Seals without pups are less dependent on haulouts and are more sensitive to environmental variability Although FP Pv ratios should be high when productivity is high, high ratios also may be obtained under adverse conditions when seals without pups may spend less time at haulouts Conversely, low FP Pv ratios could reflect poor reproductive success but also could represent increased presence of subadults and other seals without pups at haulouts In the absence of concurrent knowledge of the haulout behavior of non-reproductive seals, those confounding influences severely weaken the applicability of using pup non-pup relationships as an index of population productivity

**How close is too close? Acting on short-term disturbance to seals amidst uncertainty about long-term impacts and vessel compliance under the Marine Mammal Protection Act (MMPA)**

John K Jansen, NMML, AFSC, NMFS, NOAA, john jansen@noaa gov
Peter L Boveng, NMML, AFSC, NMFS, NOAA, peter boveng@noaa gov
Shawn P Dahle, NMML, AFSC, NMFS, NOAA, shawn dahle@noaa gov
Jay M Ver Hoef, NMML, AFSC, NMFS, NOAA, Jay VerHoef@noaa gov
Gavin M Brady, NMML, AFSC, NMFS, NOAA, gavin brady@noaa gov
John L Bengtson, NMML, AFSC, NMFS, NOAA, john bengtson@noaa gov
Kaja Brix, Office of Protected Resources, Alaska Regional Office, NOAA, kaja brix@noaa gov
Alena Jensen, Office of Protected Resources, Alaska Regional Office, NOAA,
Alena Jensen@noaa gov

Studies are rare on the biological significance of vessel disturbance to marine mammals Behaviors altered on short time scales are readily discernible, declines in population fitness are not Using observers aboard cruise ships and aerial surveys, we documented routine disturbance of harbor seals in an Alaskan glacial fjord Seals hauled out on ice increasingly fled into the water when ships approached within 500 m, a limit adopted by cruise ships and rarely followed Spatial distribution of seals was also altered by ships Physiological models indicate that seal pups are close to an energetic threshold whereby greater time submerged would impact survival Pup productivity was half that documented at less disturbed fjords, and, compared to a nearby fjord with no vessel traffic, peak abundance was a third Though the MMPA prohibits resource users from taking (defined to include disturbance) individuals or populations of marine mammals, in practice it appears the burden still rests on resource managers to determine if such takes are biologically meaningful While the observed takes by cruise ships do not point unequivocally to long-term, population effects, combined with 1) recent, dramatic increases in cruise ship visits, 2) uncertain compliance by ships with voluntary codes of conduct, and 3) an established guideline for minimum distance of vessels (91 m) that would routinely disturb 90% of approached seals, our findings demonstrate a need to enact precautionary conservation measures under the MMPA We explore measures to reduce the potential for vessels to cause long-term effects to the health of harbor seal populations in Alaska

**The effect of boat traffic on harbor seals (*Phoca vitulina*) in Alaska combining physiological and behavioral observations**

Shawna Karpovich, State of Alaska, shawna karpovich@alaska gov
Gail M Blundell, State of Alaska, gail blundell@alaska gov

Most studies of anthropomorphic disturbance of phocids measure behavior, and define disturbance as entry into the water from a haul-out platform However, behavior alone may not be a reliable indicator of the timing, magnitude or associated physiological cost of disturbances The objective of this study is to measure a physiological response to vessel disturbance for harbor seals, estimate the associated increase in energetic costs and describe the behaviors associated with the first discernable physiological response In Endicott Arm, Alaska, we fitted harbor seals with external data-loggers that recorded dive depth and heart rate (n=4) A remote camera recorded boat traffic from May-19 to June-26, 2008 Boat traffic was classified as low (0-4 boats/day) or high (5-7 boats/day) Preliminary data indicate that average heart rate increased during the high boat traffic days for all animals The difference observed in heart rate calculates to an additional energetic cost of 148 to 217 kcal/12 hr period Also, instrumented harbor seals were approached by boats to record the timing of behaviors such as head lifting, repositioning and entering the water (n=4) During known disturbances change in heart rate was examined and ranged from no discernable difference, to a 30 beat/minute increase once the animal became aware of the approaching vessel When no difference was detected, we suspect that heart rate was already elevated during the post-dive oxygen debt recovery period When a difference was detected, harbor seals experienced a physiological response as soon as head lifting was observed, 1-4 minutes before entering the water Peak boat tourism occurs during the summer and coincides with pupping, nursing and molting Therefore, harbor seals are leanest during the summer, utilizing their fat reserves during these costly life history periods In popular tour boat destinations, such as Endicott Arm, disturbances may occur repeatedly and the cumulative additional costs of boat-seal interactions could decrease individual animal fitness and ultimately survival Our preliminary results indicate that vessel traffic can present harbor seals with an additional energetic burden and that the definition of disturbance should be redefined, increasing the distance boats use to avoid disturbing harbor seals

**Impact of Health and Maternal Investment on Survival of Endangered Steller Sea Lion Pups**

Mandy Jean Keogh, University of Alaska Fairbanks, mandyk@alaskasealife org
John M Maniscalco, Alaska Sealife Center, johnm@alaskasealife org
Shannon Atkinson, University of Alaska, atkinson@sfos uaf edu

Several species of marine mammals and birds in the Northeast Pacific have been in decline since the mid-1970 s including the endangered Steller sea lion (SSL, *Eumetopias jubatus*) A leading theory is the nutritional stress associated with a reduction in prey abundance or quality The impact of limited resources would be greatest during periods of development and rapid growth The overall goal of this project is to determine if changes in maternal investment, body condition, and circulating hormone levels results in measurable changes in the health and survival of SSL pups, as measured through the immune system

At Chiswell Island, Alaska, a SSL rookery was monitored by remote video cameras enabling the determination of the age of pups, maternal investment, and survival rates A total of 61 pups (24 female, 37 male) were sampled during 2005, 2007, and 2008 ranging in age from 5 to 38 days old Each pup was measured, weighed, and branded Blood samples were collected for complete blood cell counts, lymphocyte proliferation, serum chemistries and circulating hormone levels

Female pups were significantly smaller than males in mass ($F= 26\ 7 \pm 4\ 1$ kg, $M=32\ 2 \pm 4\ 6$ kg, $F=16\ 276$, $p<0\ 001$) and length ($F=101\ 6 \pm 4\ 7$ cm, $M=108\ 0 \pm 4\ 9$, $F=17\ 331$, $p<0\ 001$) Age also significantly affected mass ($F=49\ 802$, $p<0\ 001$) and length ($F=17\ 331$, $p<0\ 001$) with older pups being larger While there was a significant difference between male and female pups in body condition these differences were not found in circulating hormones or lymphocyte proliferation Circulating TT4 ($F=6\ 007$, $p<0\ 017$), FT4 ($F=6\ 405$, $p<0\ 014$), and T cell proliferation ($F=4\ 984$, $p<0\ 038$) decreased while leptin ($F=5\ 679$, $p<0\ 020$) increased with age Further analysis will explore the use of two indices (body condition and maternal investment) in an effort to increase the fit of the models

Student Presentation

*Poster Gulf of Alaska - Mammals*

**A comprehensive approach for estimating harbor seal abundance in Alaska**

Josh M London, NOAA Alaska Fisheries Science Center, josh london@noaa gov
Peter L Boveng, NOAA Alaska Fisheries Science Center, peter boveng@noaa gov
Jay M Ver Hoef, NOAA Alaska Fisheries Science Center, Jay VerHoef@noaa gov
John K Jansen, NOAA Alaska Fisheries Science Center, john jansen@noaa gov
Kymberly M Yano, NOAA Alaska Fisheries Science Center, kym yano@noaa gov
Luciana Santos, NOAA Alaska Fisheries Science Center, luciana santos@noaa gov

Estimating the statewide abundance of harbor seals (*Phoca vitulina*) in Alaska has always been challenging Harbor seals range from southeastern Alaska through the Aleutian Island chain into Bristol Bay Past efforts have involved dividing the state into five regions and conducting aerial surveys from small aircraft in one of those regions annually An estimate is only possible once every five years, and trends were determined from surveys conducted by the Alaska Department of Fish and Game (ADFG) at a small subset of sites We present a comprehensive, new approach that overhauls the design and techniques for aerial surveys of harbor seals in coastal regions and tidewater glacier habitats The new approach adopted by the NOAA National Marine Mammal Laboratory (NMML) and ADFG allows surveys to be conducted annually across the entire range This is accomplished by dividing the coastline into distinct survey units and focusing survey effort such that units with more seals are surveyed more frequently This was first implemented for the statewide surveys in August 2008 Seven planes were distributed throughout most of the range and new technologies were used to improve navigation and data collection efficiency during the surveys We estimate approximately 70 percent or more of the seals hauled out during our survey were photographed from the air This approach also incorporates a new model of haul-out behavior (see Ver Hoef *et al* presentation) based on the deployment of over one hundred satellite tags The model accounts for effects of time of day, day of year and tidal state Seals are more likely to haul-out near mid-day within 15 minutes of the low tide during the August molt period Not only is this critical for estimating the number of seals in the water at the time of a survey, it also provides additional flexibility in the timing and implementation of the survey In collaboration with ADFG, we hope this new approach will result in annual estimates of harbor seal abundance and trends in Alaska

**Passive acoustic monitoring of beluga whales in Yakutat Bay A pilot study**

Bill Lucey, City and Borough of Yakutat, yakutat_salmon_board@yahoo com
Manuel Castellote, L Oceanografic of Valencia, Spain
Kate Stafford, Applied Physics Lab, University of Washington
Greg O Corry-Crowe, Harbor Branch Oceanographic Institution, Florida

Beluga whales (*Delphinapterus leucas*) are difficult animals to study Passive acoustic monitoring has become an effective method to study other odontocetes To date there have been few efforts to test these techniques on beluga whales, despite their proclivity as acoustically active cetaceans Acoustic loggers (T-POD) developed for Harbor porpoise (*Phocoena phocoena*) and Bottlenose dolphin (*Tursiops truncatus*) echolocation detection were tested with captive belugas at L Oceanografic of Valencia during 2006 and with free-ranging belugas in Svalbard (Norway) in 2007 Results suggested that acoustic loggers have the potential to detect and therefore allow monitoring beluga whales in their habitat During spring 2008, four T-PODs were deployed concurrently with acoustic recordings and visual observations in Yakutat bay as a pilot study to evaluate the efficacy of this acoustic monitoring method The T-Pods, deployed at five locations over a ten-day period, detected 167,579 clicks from beluga echolocation activity Beluga whales were present every day during the 10-day sampling period in the study area, showing preference for the inner bay at high tides and outer bay at low tides (Pearson's correlation <0 01) Daylight cycle did not show any apparent effect in whale presence or habitat use Beluga click rate varied with time of the day and area, suggesting different behavioral states such as feeding for fast click trains or resting for slow click trains Visual and sound recorded data confirmed these interpretations, therefore passive acoustic monitoring using acoustic loggers proves to be an effective method to monitor beluga whales

**Photo-identification as a tool to study disease, injury, and survivorship of Cook Inlet beluga whales**

Tamara L McGuire, LGL Alaska Research Associates, tmcguire@lgl com
Chris C Kaplan, LGL Alaska Research Associates, ckaplan@lgl com
Megan Blees, LGL Alaska Research Associates, mblees@lgl com

Photo-identification provides information about individual Cook Inlet beluga whales and the population as a whole, including residency/movement patterns, habitat use, reproduction, and abundance Over four field seasons (2005-2008) we developed a photo-catalog containing digital images of individual Cook Inlet beluga whales that were repeatedly identified during the course of the study using natural markings that persist over time Many photographs of whales contain marks indicative of infection and injury By documenting the occurrence and frequency of these marks and attempting to identify mark sources, we can learn more about disease and injury affecting the endangered Cook Inlet beluga whale population We also use long-lasting marks caused by satellite tags applied by NMFS 1999-2002 to track individual whales and to study survivorship (and reproduction of females) during the intervening 3-9 years We present a summary of the types of marks indicating disease and injury that we encounter, and sighting histories of previously-tagged whales We discuss the importance of continued collaboration among research projects in the area to increase the documentation and understanding of disease, injury, and survivorship of Cook Inlet beluga whales

## Marine Debris Entanglements of Easter Population Steller Sea Lions

Kimberly Louise Raum-Suryan, Oregon State University, kim raum-suryan@oregonstate edu
Lauri Jemison, Alaska Department of Fish and Game, lauri jemison@alaska gov

Entanglement in marine debris is a contributing factor in Steller sea lion (SSL, *Eumetopias jubatus*) injury and mortality, although to an unknown extent Our aim was to provide baseline data of marine debris entanglements (i e , sources, rate, sex or age class biases, population level effects in Alaska) affecting SSLs in Southeast Alaska (SEA), northern British Columbia (NBC), and Oregon (OR) Surveys (SEA/NBC n = 12, OR n = 95) of SSL haul-outs and rookeries (SEA/NBC n = 85, OR n = 2), were conducted during June and July 2000-2007 in SEA/NBC and from November-April 2005-2007 in OR We recorded 572 entangled SSLs (388 unique individuals) in SEA/NBC and 129 entangled SSLs (44 unique individuals) in OR Entanglement rate was 0 26% (SD = 0 0064, n = 69 sites) in SEA/NBC and 0 54% (SD = 0 0016, n = 2 sites) in OR Entanglements affected both sexes and all age classes In SEA/NBC, 48 5% (n = 190) of SSLs had some sort of debris around their necks and 50% (n = 194) had interacted with sport or commercial fisheries and had swallowed fishing gear Packing bands were the most common neck entangling material (55%), followed by rubber bands (30%), rope (7%), net (7%), and monofilament line (2%) Ingested fishing gear included salmon fishery flashers (lures, 80%), longline gear (12%), hook and line (4%), spinners/spoons (2%), and bait hooks (2%) In OR, neck entanglements accounted for all entangled SSLs (n = 44), rubber bands being most common (74%), followed by packing bands (17%), net (4%), and Frisbee (4%) SSLs were observed in OR with salmon flashers and spinners/spoons during June and July These results highlight the importance of continued documentation of SSL entanglements to fully assess the impact of marine debris on the vital rates and population trends of SSLs in the North Pacific Incentives should be made to the fishing industry to implement simple solutions to decrease entanglement rates, particularly with regard to plastic packing bands and large rubber bands Simple procedures such as cutting entangling loops of synthetic material that could potentially end up as marine debris can prevent entanglements

*Poster Gulf of Alaska - Mammals*

**Longitudinal change in Steller sea lion diving and physiology**

Michael J Rehberg, Alaska Department of Fish and Game, michael rehberg@alaska gov
Lorrie D Rea, Alaska Department of Fish and Game, lorrie rea@alaska gov

The ADF&G Foraging Ontogeny Project was developed to examine the combined roles that physiological development, nutritional source and the demand for independent foraging play in the ontogeny of behavior in sea lions during their first winter To accomplish this, we captured sea lions at 5 months of age and recaptured the same individuals at 10 months Field work is now complete and laboratory and behavioral analyses are underway We captured 30 and 39 young-of-year sea lions during November 2005 and 2007, respectively, at 3 haulouts within Prince William Sound, taking morphological measurements, physiological samples and affixing archival time-depth recorders (TDR) to their heads We re-captured 8 and 12 of these sea lions during April 2006 and 2008, respectively, repeated the measurements and sample collection and recovered the TDRs Mean increase in mass between November and April, by individual, was 32 ± 15 kg (mean, SD, range 4 56 kg), mean increase in length 16 ± 7 cm (range 1 28 cm) and mean increase in girth 20 ± 10 cm (range 2 38 cm) Between November and April, 90th percentile dive depth decreased for 12 individuals (9 ± 8 m decrease, mean, SD) but increased for 6 individuals (12 ± 9 m increase) The 90th percentile dive duration decreased for 8 individuals (0 2 ± 0 2 min decrease), increased for 7 individuals (0 4 ± 0 4 min increase) and did not change for 3 individuals There is no clear linkage between changes in diving depth and duration and changes in 3 common growth metrics increase in weight, increase in standard length and increase in girth More sensitive measures of behavior, including foraging trip distribution, bout organization and dive structure will be included in analyses with age related changes in percent body lipid content and assessment of weaning status of each pup, based on stable isotope ratios of carbon and nitrogen, to assess the driving factors behind changes in fine scale diving behavior in young sea lions

**Characterization of humpback whale (*Megaptera novaeangliae*) diets using fatty acid markers**

Lawrence E Schaufler, TSMRI / Auke Bay Labs / AFSC / NOAA Fisheries,
lawrence schaufler@noaa gov
Gwenn Miller, TSMRI / Auke Bay Labs / AFSC / NOAA Fisheries, Gwenn Miller@NOAA gov
John R Moran, TSMRI / Auke Bay Labs / AFSC / NOAA Fisheries, john moran@noaa gov
Janice M Straley, University of Alaska Southeast, jan straley@uas alaska edu

Understanding the diets of humpback whales in Southeast Alaska is crucial to the management of herring and other prey species in the region, given the immense daily caloric requirements of these predators Humpback whale diets in Southeast Alaska are typically dominated by euphausiids and small schooling fish such as herring and capelin, though little information has been collected regarding the relative proportions of each While stomach content analyses are infeasible, blubber fatty acid signatures may be useful in assessing proportions in the diet We obtained fatty acid profiles from eight humpback whale blubber samples, collected from free ranging whales using a crossbow or veterinary capture rifle and a small biopsy tip attached to a floating bolt or dart We had direct diet observation of the whales biopsied (four primarily herring-eaters and four primarily euphausiid-eaters), and knew they had been foraging on these diets for at least a month We then identified individual fatty acid trophic markers that could potentially be used to differentiate between diet types Relative abundances of fatty acid markers such as C18 4n3 and C20 5n3, which are typically high in euphausiids, and C20 1n11, which is typically high in herring, were most useful in discriminating the diet classes Using Discriminant Function Analysis (DFA) and Analysis of Similarity (ANOSIM), we were able to easily separate the two groups of whales with different known diets, as well as characterize the diet types from blubber samples of whales for which we had no feeding observations (unknowns) These data suggest that we can identify the dominant lipid source consumed by these animals based on blubber biopsies Furthermore, identification of fatty acid markers that can be used to differentiate whale diet types may be useful to determine whether humpback whales have strong seasonal prey preferences

*Poster Gulf of Alaska - Mammals*

**Patterns in sea otter resource selection in Kachemak Bay, Alaska**

Nathan Lord Stewart, University of Alaska Fairbanks, n stewart@sfos uaf edu

Sea otters (*Enhydra lutris*) are known to forage extensively in both rocky and soft-bottom habitats throughout their range in Alaska Their ability to significantly reduce prey abundance, limit prey size, and consequently alter community structure has been well documented Much of this research, however, has focused on sea otter interactions with rocky habitats and associated epifaunal invertebrate prey Relatively little is known about how sea otter interact with heterogeneous habitat types within their natural range and how this relates to patterns in their local foraging ecology and distribution

In South Central Alaska, sea otters occupying the shallow, broad shelf habitats of Kachemak Bay have access to both rocky and soft-bottom habitat types The proximity of different grain sizes in the bay provides a unique opportunity to relate known sea otter foraging activity, gathered via telemetry, to a particular substrate type and associated prey community The recent VHF tagging of 44 sea otter in Kachemak Bay (FWS 2007) has indicated a broad use of habitats and highly variable patterns in seasonal resource use Our study, carried out during the summer of 2008 in collaboration with FWS, sampled across contours in sea otter utilization distribution in order to investigate mechanisms driving local resource selection

Sea otter foraging sites (n=36) were identified using GIS and binned based on magnitude of use Habitat type was quantified by grain size and live prey and the sea otter cracked-shell record were sampled using SCUBA Length to mass and mass to energy density were calculated using species-specific conversion factors Multivariate analysis was used to interpret the contribution of biomass (mg dry mass/m2) and energy per unit area (J/mg dry mass/$m^2$) of available prey species to patterns in the preferential selection of certain grain sizes Results from this research suggest that otter prefer gravel and cobble habitats, grain sizes most commonly associated with patchy but calorically rich crab species in the bay

Findings from this study provide a baseline description of the relative productivity and potential contribution of particular habitats to sea otter diet in Kachemak Bay, information critical to the monitoring and management of sea otter

Student Presentation

**Genetic analysis of historic and prehistoric beluga whale teeth and bones from Cook Inlet**

Brooke Symmonds, Harbor Branch Oceanographic Institute - Florida Atlantic University, BSymmond@hboi fau edu
Janet Klein, Anchorage Museum, jrklein@homernet net, Barbara Mahoney, National Oceanic and Atmospheric Administration, barbara mahoney@noaa gov
Greg M O Corry-Crowe, Harbor Branch Oceanographic Institute - Florida Atlantic University, gocorryc@hboi fau edu

The recent decline of the Cook Inlet population of beluga whales, its current small population size (N=375), and its apparent lack of recovery since increased protection in 2001, highlight the need for a better understanding of the abundance, distribution and genetic diversity of this population in the past Molecular genetic analyses can theoretically address all three Estimates of contemporary genetic diversity have been used in other species to estimate historical population size and document past distribution, while analyses of samples collected over the period of a population s decline can chart the loss of important genetic diversity that could compromise individual fitness and influence population viability Ideally, such analyses would include tissue samples collected over very large time scales We are using ancient DNA technology combined with radiocarbon dating to investigate historic and pre-historic abundance, distribution and genetic diversity of beluga whales in Cook Inlet These methods are also being used to investigate population structure of this species at different times in the past We report here on preliminary genetic analyses of osteological material, identified as beluga whale based on gross morphology, recovered from historic and pre-historic sites in lower Cook Inlet In a specially designed clean laboratory, we modified silica-based ancient DNA extraction methods, allowing us to regularly amplify and sequence up to 500bp of mtDNA control region from 0 08 0 1g of drilled teeth and bone A total of 22 specimens, including teeth dated to 1575 A D were analyzed This highly efficient method, in combination with similarity, distance- and character-based phylogeny reconstruction analyses enabled us to determine species and in some cases mtDNA lineage Comparison of genetic diversity among different time periods is currently underway Future research will focus on amplifying, cloning and sequencing several nuclear DNA markers including genes from the Major Histocompatibility Complex, microsatellite loci, and regions of the X and Y chromosome More material will also be accessed from museum collections

## Foragıng Behavıor of Sea Otters (*Enhydra lutrıs kenyoni*) ın a Predomınantly Soft Sedıment Habıtat ın Alaska

Ryan Wolt, Texas A&M Unıversıty, ryanwolt@yahoo com, Francıs P Gelwıck, Texas A&M Unıversity, fgelwıck@taμu edu
Randall W Davıs, Texas A&M Unıversity

Sea otter foragıng behavıor and prey preference were studıed from May-August 2001-2004 ın Sımpson Bay (ca 60 6°N Lat , 145 9°W Long ) located ın Prınce Wılliam Sound, Alaska The study area (21 $km^2$) had an average water depth of 30 m (max depth 125 m), and the benthos consısted prımarıly of soft sedıments (ı e , glacıal clay, sılt, and gravel) and some areas of hard rocky reefs There were no large-bodıed kelps (e g , *Nereocystıs*) that formed canopıes Feedıng otters were recognızed by theır characterıstıc dıve behavıor and the presence of prey ıtems Dıve locatıon, water depth (used to estımate dıve depth), dıve duratıon, and prey ıtem (to the lowest possıble taxonomıc level) were recorded for each otter Adult otters were categorızed by sex male, female (wıth a pup) or unknown A total of 1,819 foragıng dıves from 209 feedıng bouts were recorded Dıves ranged ın depth from < 5 m to 82 m, but the largest percentage (40%) were shallower than 15 m 88% of foragıng dıves were successful resultıng ın the capture of one or more prey ıtems In 46% of these dıves the prey was ıdentıfied 75% clams of varıous specıes ıncludıng *Saxıdomus gıgantea*, *Protothaca stamınea*, 9% blue mussels (*Mytılus trossulus*), 6% crabs of varıous specıes, and 2% scallops (*Chlamys rubıda*) The remaınıng 8% of prey ıncluded varıous echınoderms, other mollusks and cephalopods Maxımum dıve depths were roughly correlated wıth the bathymetry of Sımpson Bay except for dıves less than 15 m ın depth whıch were dısproportıonately represented Average maxımum dıve depths and duratıons were 30 m and 2 mın for males, 29 m and 1 7 mın for females, and 25 m 1 9 mın for otters of unknown sex Maxımum dıve depth was sıgnıficantly dıfferent between males and otters of unknown sex, but not sıgnıficantly dıfferent between males and females and females and otters of unknown sex Dıve duratıons were all sıgnıficantly dıfferent male > unknown > female These results provıde addıtıonal ınformatıon on the dıvıng performance and ecologıcal role of sea otters ın an area of Alaska wıth a soft sedıment benthos and a stable populatıon

Student Presentatıon

**Site Fidelity of Harbor Seals to a Glacial Fiord in southeastern Alaska**

Jamie N Womble, Oregon State University & National Park Service,
jamie womble@oregonstate edu
Scott M Gende, National Park Service, Scott_Gende@nps gov
David C Douglas, USGS Alaska Science Center, ddouglas@usgs gov
Peter L Boveng, National Marine Mammal Laboratory, peter boveng@noaa gov

Glacier Bay National Park (GBNP) has historically supported one of the largest breeding aggregations of harbor seals in Alaska During the breeding season, two-thirds of the seal population in GBNP relies upon glacial ice calved from a tidewater glacier in John Hopkins Inlet (JHI) However, from 1992-2008, survey counts of seals, both pups (-5 0 %/year) and non-pups (-7 7%/year), declined precipitously in JHI To address management and conservation concerns, a study was initiated in 2007 to quantify site fidelity of harbor seals to GBNP and individual variability in over-winter movement patterns Satellite-linked transmitters were attached to juvenile and adult female harbor seals captured in JHI in September 2007 (n=15) and 2008 (n=22) Juvenile seals (n =15) captured in 2007 ranged extensively throughout the inner and outer coastal waters of northern Southeast Alaska (SEAK) and also Prince William Sound, using both glacial ice and terrestrial sites for hauling out The mean cumulative distance traveled by harbor seals from September 2007 to June 2008 was 1,770 km ± 672 (range 621 3,296 km) Satellite-linked transmitters on eight of the fifteen (53%) seals captured in September 2007 transmitted until the next breeding season in June 2008 Seven of those eight (88%) seals returned to the GBNP area and six of the eight (75%) seals returned to JHI where they were captured the previous year, suggesting strong site fidelity to GBNP and specifically to JHI One seal did not return to GBNP and was located in June 2008 in Disenchantment Bay, another glacial ice site approximately 450 km from JHI Although seals captured in JHI may range extensively throughout northern SEAK and the eastern Gulf of Alaska during the non-breeding season, data from this study suggest that there is substantial site fidelity of harbor seals to GBNP, particularly JHI, and emphasize the importance of glacial ice habitat for harbor seals

Student Presentation

*Poster Gulf of Alaska - Mammals*

**Effects of vessel disturbance on harbor seal behavior in Johns Hopkins Inlet, Glacier Bay National Park, Alaska**

Colleen Young, Moss Landing Marine Labs, cyoung@mlml calstate edu
James T Harvey, Moss Landing Marine Labs, harvey@mlml calstate edu
Scott M Gende, National Park Service, Scott_Gende@nps gov

Harbor seal abundance in Johns Hopkins Inlet (JHI), Glacier Bay National Park, Alaska, decreased significantly between 1992 and 2002, and this trend is continuing The cause of this decrease remains unknown, however, vessel disturbance may be a possible causal factor As part of a multi-organization effort to try to elucidate the reason for the harbor seal decrease, I assessed the behavioral impacts of vessels on harbor seals in JHI during June, July, August, and September during 2007 and 2008 Focal follows of individual seals and moms with pups were conducted while seals were hauled out on icebergs in JHI Focal follows occurred under four levels of disturbance vessels not allowed in inlet (NA), vessels allowed in inlet but not present (NP), vessels in inlet but <1000m from seals (II), and in inlet and within 1000m (WI) The percentage of time that each seal was engaged in each behavior was calculated and compared for the different levels of vessel disturbance Of all behaviors recorded, only vigilant (V) and inactive (I) varied significantly among the different levels of vessel presence, with a trend of increasing vigilance and decreasing inactivity as the level of vessel presence increased In addition to observations of behavioral changes, vessel disturbance was quantified by observing flushing (vacating a haulout site and entering the water) of seals under the same four vessel presence regimes The proportion of focal follows ending in the focal seal flushing differed significantly among the four levels of vessel presence, indicating an effect of vessel presence on the probability of flushing harbor seals in JHI Flushing not only represents a behavioral change, but also inflicts a potential energetic cost on the seal, as additional energy is required to swim to and haul out on a new iceberg Repeated disturbance events may result in decreased fitness of seals, and/or may prompt seals to relocate to areas with less vessel traffic An investigation of the bioenergetic costs associated with flushing, along with a more detailed evaluation of the behavioral effects of vessel disturbance on seals in JHI is in progress

Student Presentation

**Bycatch characterization in the Pacific halibut fishery Lessons from the Field**

Jennifer Cahalan, Pacific States Marine Fisheries Commission, jennifer_cahalan@psmfc org
Gregg Williams, International Pacific Halibut Commission, gregg@iphc org
Brian Mason, NMFS Alaska Fisheries Science Center, Brian mason@noaa gov
Bruce Leaman, International Pacific Halibut Commission, bruce@iphc org
William Karp, NMFS Alaska Fisheries Science Center, bill karp@noaa gov

The focus of our research is to improve our understanding of the ecosystem impacts of halibut fishing through improved monitoring of halibut longline fishery bycatch and to provide data on mortality of bycatch species for input to stock assessments The majority of vessels operating in this fishery are not required to carry observers, hence estimates of bycatch are not based on direct observation of the fishery We have implemented a study comparing and evaluating the effectiveness of electronic monitoring (EM) and the currently utilized National Marine Fisheries Service (NMFS), North Pacific Groundfish Observer Program (NPGOP) monitoring methods to operate effectively in a commercial longline (hook-and-line) setting

On each vessel included in the study group, we placed a full EM system and a NMFS-certified observer to obtain observations of fish species for each hook on the retrieved gear The hook-specific counts of each species provide a pseudo-census of the fish on the incoming gear

As with any field based research, we faced many challenges during the implementation phase We have had to make adjustments and changes to our study plan in response to fishing schedules, vessel availability, and vessel accommodations Uncertainty in vessel fishing schedules resulted in increased costs of EM and observer coverage Additionally, initial EM installations were unreliable as a result of changes in the operating system in 2008, however, installation improvements have resulted in minimal data loss for the later portion of the season

In 2008, we were able to successfully solicit four vessels to participate in this study In spite of the implementation difficulties, we have collected data for 13 trips and over 150 monitored longline sets Of the four vessels, one was under 60ft and therefore not typically subject to observer coverage Additionally, three of the vessels fished in the Gulf of Alaska while one fished in the Bering Sea Although this deviates somewhat from our original study plan to collect data balanced between areas and vessel size (observer coverage requirements), we expect to collect additional in spring 2009, increasing sample size and potential comparisons between vessel sizes

**The Alaska Harmful Algal Bloom (AHAB) regional monitoring partnership**

Ginny L Eckert, UAF, g eckert@uaf edu, Kate Sullivan, UAS, ksullivan@uas alaska edu
Vera L Trainer, NOAA, vera trainer@noaa gov, Steve L Morton, NOAA, Steve Morton@noaa gov
Steve L Morton, NOAA, Steve Morton@noaa gov

The Alaska Harmful Algal Bloom (AHAB) regional monitoring partnership has brought together shellfish farmers, shellfish fishermen, tribal groups, state and federal government agencies, and the University of Alaska as a capacity-building effort to create a phytoplankton monitoring network in Alaska Costs of harmful algal blooms to the commercial fishery, recreational harvesters and aquaculture surpass $10 million annually It has long been recognized that harmful algal blooms are a problem in Alaska, however the difficulty of working along America s largest, most remote and rugged coastline has hampered progress The first AHAB training workshops were held in Ketchikan in April 2008 and Homer in October 2008 Participants included 21 shellfish farmers, 2 representatives from Alaska Native Villages, 10 federal, state and University scientists, educators and students, and 9 people from other community organizations and NGOs Training provided included collecting and handling water samples used to enumerate toxic cells, conducting plankton tows, measuring environmental parameters and using a microscope to identify common phytoplankton, as well as data recording Participants willing to return to their communities and conduct monitoring on a regular basis are provided with equipment and technical support The workshops were led by phytoplankton experts from NOAA s National Ocean Service and Biotoxins Programs and shellfish biologists and other faculty from the University of Alaska AHAB s objective is to provide data on the timing and distribution of harmful algae along with measurements of environmental conditions and to analyze indicators and potential mechanisms for toxic algae bloom formation to develop the capacity to predict HAB events Broader impacts of this project, beyond benefits to the shellfish industry, include education and outreach to subsistence and sport harvesters of shellfish, for whom no regular monitoring of shellfish exists Aquatic farmers benefit from increased knowledge regarding phytoplankton, particularly as it relates to farm site selection sites with good sources of food phytoplankton and few blooms of potentially toxic phytoplankton are better sites for placing a farm PIs Ginny Eckert, UAF SFOS, Kate Sullivan, UAS Ketchikan, Vera Trainer, NOAA NWFSC, Steve Morton, NOAA CCEHBR

*Poster Gulf of Alaska - Humans*

## Using Community Partnerships to Teach High School Marine Science in Prince William Sound

Allen Marquette, Prince William Sound Science Center, amarquette@pwssc org

Educational outreach opportunities are often limited in remote communities in Alaska This poster will highlight two separate cruises taken by Cordova High School marine biology students in Prince William Sound Five PWSSC oceanographers and four education staff, fifteen volunteers from the community and the U S Coast Guard Cutter Sycamore, its commander, science officers and crew, gave twenty-eight high school marine biology students and their teacher an opportunity to explore oceanography in PWS

All participants spent an entire day on the Sound doing physical and biological oceanography experiments Sediment dredging and plankton tows were carried out on deck with a microscope station setup in the mess hall of the Cutter Sycamore allowing students to identify the organisms they found Students also deployed a CTD and analyzed the computer data on the return trip to port, students also identified seabirds with an avian biologist from the PWS Science Center soon after the cruise, students wrote science papers for their class and an article for the local newspaper describing their experiences while on the cruise

This poster will demonstrate how various organizations, government agencies, oceanographers, high school students and teachers can partner to provide a high quality educational oceanography experience for students within small remote Alaskan communities

# Bering Sea and Aleutian Islands

POSTERS

| Climate and Oceanography | |
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| Todd TenBrink | Age, growth, and maturation of sculpins in the eastern Bering Sea and Aleutian Islands |
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| Gay Sheffield | Bowhead Whale Feeding in the Northern Bering Sea Near Saint Lawrence Island, Alaska |
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*Poster Bering Sea - Climate and Oceanography*

**Evolution of the Bering Sea Shelf's Mixed Layer and Photic Zone Ice to Summer**

Edward D Cokelet, NOAA/PMEL, edward d cokelet@noaa gov
Calvin W Mordy, NOAA/PMEL, calvin w mordy@noaa gov
Phyllis J Stabeno, NOAA/PMEL, phyllis stabeno@noaa gov
Nancy B Kachel, University of Washington/JISAO, Nancy Kachel@noaa gov
Peter Proctor, University of Washington/JISAO, peter proctor@noaa gov
Dylan Righi, University of Washington/JISAO, Dylan Righi@noaa gov

Access to the continental shelf of the eastern Bering Sea is limited in early spring due to sea ice Beginning in 2007, the National Science Foundation s BEST (Bering Ecosystem Study) program has sponsored research cruises to study this productive ecosystem in a manner not possible previously aboard the USCG icebreaker Healy in ice-covered waters In 2008 follow-up cruises on Healy and Melville give a sequence of oceanographic sections over three periods from the time of maximum ice extent through late summer Salinity sections show that salinity controls density, and ice-melt leads to a fresh surface layer that overlays saltier water below Temperature sections show cooling due to sea ice with later summer surface warming capping off the cold water below to form the Cold Pool (summer temperature < 2°Celsius) Chlorophyll sections show where and when phytoplankton blooms occur, sometimes below the surface mixed layer where adequate light and nutrients exist Nitrate sections show ample near-surface nutrients in the upper layer before the spring bloom and nutrient depletion after Ammonium sections show a build-up just below the surface mixed layer as summer progresses This probably occurs due to some combination of excretion, remineralization of particulate organic matter and ammonification of dissolved organic matter Overlays of the mixed layer and euphotic depths show their interplay For example, surface mixed-layer blooms occur when the mixed layer shoals to the euphotic depth, providing adequate light for phytoplankton Observations show strong north-to-south differences in the water column properties owing to prolonged ice cover in the north and abbreviated or no ice cover in the south These differences dwindle as summer progresses, but the effect of the spring ice cover is not erased by autumn

**Biophysical Observations along the 70m isobath in the Bering Sea in 2008**

Nancy B Kachel, EcoFOCI/NOAA and University of Washington, Nancy Kachel@noaa gov
Edward D Cokelet, NOAA/PMEL, edward d cokelet@noaa gov
Calvin W Mordy, NOAA/PMEL, calvin w mordy@noaa gov
Jeffrey M Napp, NOAA/NMFS, jeff napp@noaa gov
Phyllis J Stabeno, NOAA/PMEL, phyllis stabeno@noaa gov

In 2008, hydrographic observations were made on the 70m isobath of the Bering Sea on two BEST cruises (spring and summer) and an EcoFOCI cruise (late summer) in combination with data from four the biophysical moorings (M2, M4, M5, M8) revealed that conditions in spring and summer of 2008 were extreme The sea ice arrived late in the northern Bering Sea due to warm conditions in the Arctic Ocean, but then rapidly advanced over the southern shelf On the central and northern shelf ice extent and persistence were at or below average, due to the late arrival of sea ice there But on the southern shelf, the ice did not retreat until May, making the ice extent and persistence the largest since 1976 The southern shelf (south of 60°N) was characterized by sharp, temperature-dominated, two-layer structure, while the northern shelf was characterized by more gradual pycnocline, with approximately equal contributions from temperature and salinity An extensive cold pool lasted through September, accompanied by cold surface temperatures (<9 5°C) At M2 (southern shelf) the spring bloom began in April in association with ice, with an additional bloom in late May during mixing event, whereas at M4 and M5 (central shelf) the bloom began with the retreat of the ice Some depletion of nutrients was evident both on the southern shelf (near M2) and on central shelf between M5 and M4 during the spring cruise Low concentrations of ammonium were observed over the entire 70-m isobath in the spring By late summer, that pattern changed to one with high concentrations on the southern shelf and continued low concentrations on the northern shelf We observed that the northern shelf had a subsurface bloom in the pycnocline during summer, while the southern shelf had none By mid September, there was little evidence of a fall phytoplankton bloom likely caused by the lack of significant early storms Temporal differences in integrated nitrate suggest that the region between M4 and M5 may be heavily influenced by cross-shelf advection

*Poster Bering Sea - Climate and Oceanography*

**Volume, Heat, and Freshwater Transports from the North Pacific to the Bering Sea**

Carol Ladd, NOAA, carol ladd@noaa gov
Phyllis J Stabeno, NOAA, phyllis stabeno@noaa gov

The southeastern Bering Sea circulation is dominated by the eastward Aleutian North Slope Current (ANSC) north of the Aleutians and the northwestward Bering Slope Current (BSC) flowing along the eastern Bering Sea shelf break Cross-shelf exchange from the BSC supplies freshwater to the eastern Bering Sea shelf and ultimately to Bering Strait and the Arctic Because the Aleutian passes (primarily Amukta Pass) supply the ANSC and the BSC, it is important to quantify the transport of mass, heat, and freshwater through the passes and to examine variability in these transports Four moorings, spanning the width of Amukta Pass, have been deployed since 2001 Data from these moorings allow quantitative assessment of the transports through this important pass In addition, transports through some of the other passes can also be evaluated, although with more limited datasets and higher uncertainty Variability in transports through the passes is related to the direction of the zonal winds, with westward winds resulting in higher northward transport Freshwater transport through Amukta Pass alone is large enough to account for the cross-shelf supply of freshwater needed to supply the estimated transport through Bering Strait into the Arctic Recent data show a decrease in mass transport and a freshening of bottom water in Amukta Pass in 2008 Ongoing measurements in the Aleutian Passes are critical to understanding the influence of these waters on the Bering Sea and the Arctic

*Poster Bering Sea - Climate and Oceanography*

**CDOM Optical Properties in the Southeastern Bering Sea During Summer 2008**

Eurico J D'Sa, Louisiana State University, ejdsa@lsu edu
Puneeta Naik, Louisiana State University, pnaik2@lsu edu
Joaquim I Goes , Bigelow Laboratory for Ocean Sciences, jgoes@bigelow org
Helgado R Gomes, Bigelow Laboratory for Ocean Sciences, jgoes@bigelow org

Chromophoric colored dissolved organic matter or CDOM forms an important constituent of the dissolved organic carbon (DOC) pool in natural waters and is that fraction that absorbs light Light absorption by CDOM is characterized by an exponential increase in absorption with decreasing wavelength over the visible and ultraviolet region of the spectrum with important implications to carbon cycling through the process of photooxidation or its effects on primary production due to decreased amount of light available to phytoplankton In this study we examine CDOM optical properties along cross-shelf transects in the eastern Bering Sea using data collected during a cruise in July 2008 on the icebreaker USCGC Healy Sources of CDOM in natural waters such as the eastern Bering Sea include terrestrial inputs due to discharge from rivers or in situ production due to microbial action on organic matter Other potential factors influencing CDOM distribution in the southeastern Bering Sea during the summer include water column stratification, spring sea ice retreat, the spring phytoplankton bloom and the sinking or export of organic matter to the bottom Preliminary analysis of data acquired along four cross-shelf transects suggest both east-west and north-south variability in CDOM distribution Increases in CDOM absorption with depth at many stations were associated with subsurface increase in chlorophyll fluorescence suggesting potential CDOM sources due to microbial action on algal biomass Further analysis in conjunction with physical measurements such as salinity and temperature will be presented

*Poster Bering Sea - Climate and Oceanography*

**Volume balance and mean ocean dynamical topography in the Bering Sea**

Gleb Panteleev, IARC, gleb@iarc uaf edu
Phyllis J Stabeno, PMEL, phyllis stabeno@noaa gov
Dmitri Nechaev, USM, Dmitri nechaev@usm edu
Vladimir Luchin, FEBRAS, vluchin@poi dvo ru
Motoyoshi Ikeda, University of Hokkaido, mikeda@ees hokudai ac jp

We present the results of the multiyear efforts on the development of 4Dvar data assimilation system in the Bering Sea The presented result include the estimate of the Bering Sea volume balance as a variational inverse of the hydrographic (temperature, salinity and velocity) and atmospheric climatologies The optimized transports through the Kamchatka Strait, Near Strait, Amchitka and Amukta passes are -28, 13, 6, and 3 5 Sv respectively These transports are significantly higher than the conventional climatological estimates but agree well with the recent transports calculations based on direct velocity measurements Posterior error analysis and satellite sea surface height observations indicate high interannual and seasonal variability of the transports through the Aleutian passes It was found, that the changes in the Kamchatka strait transport are controlled by variability of the Near strait inflow and by Alaska Stream transport Another important result of this study is the estimate of the mean climatological sea surface height (SSH) distribution that can be used as a reference SSH for the satellite altimetry data in the Bering Sea region Several numerical experiments reveal that the combination of the obtained reference SSH with satellite altimetry anomaly observations results in a realistic reconstruction of the Amukta pass circulation

*Poster Bering Sea - Climate and Oceanography*

**Modeling seasonal variations of sea ice and ocean circulation in the Bering Sea**

Jia Wang, NOAA, jia wang@noaa gov
Haohuo Hu, University of Michigan, haoguo hu@noaa gov

A 9-km Coupled Ice-Ocean Model (CIOM, Wang et al , 2002, 2005a) was implemented in the entire Bering Sea to investigate seasonal cycles of sea ice and ocean circulation under atmospheric forcing Sea ice cover with a maximum of 0 6x10 km in February to late March was reasonably reproduced by the Bering-CIOM and validated by SSM/I (Special Sensor Microwave/Imager) measurements The model also captures some important spatial variability and downscaling processes such as polynyas and ridging, which the SSM/I measurements cannot reproduce due to their coarse (25 km) resolution There are two distinct surface ocean circulation patterns in winter and summer on the Bering shelves due to the dominant winds, which are northeasterly in winter and southwesterly in summer Summer low-temperature, high-salinity water mass (<3 C) on the Bering shelf is formed locally during winter due to strong vertical convection caused by salt injection when ice forms, wind, and wind-wave mixing on the shelf The northward volume transport across the 62 5N-Line, with an annual mean of 0 8 0 33 Sv that is consistent with the measurements in the Bering Strait, has barotropic structure, which transports heat flux (with an annual mean of 7 74 TW, 1 TW=10 Watts) northward The Anadyr Current advects warmer, saltier water northward during summer, nevertheless, it reverses its direction to southward during winter due to predominant northeasterly and northerly wind forcing, therefore, the Anadyr Current advects cold, salty water southward The volume transport on the broad Mid-shelf is northward year round, advecting heat (3 3 2 4 TW) and freshwater [-8 10 10 psu (practical salinity unit) m s ] northward One important finding is that the Anadyr Current and the Mid-shelf current are out of phase in volume and heat transports The Alaskan Coastal Current also transports heat and freshwater northward on an annual basis The Bering-CIOM also captures the winter dense water formation along the Siberian coast, which is promoted by the downwelling-favorable northeasterly wind, and the summer upwelling due to the basin-scale upwelling-favorable southwesterly wind, which brings up the cold, salty, and nutrient-rich water from the subsurface to the surface within a narrow strip along the west coast This upwelling found in the model was also confirmed by satellite measurements in this study

*Poster Bering Sea - Climate and Oceanography*

**Seasonal and spatial variations in southeastern Bering Sea shelf sediment oxygen consumption and sulfate reduction rates**

Heather R Whitney, University of Washington, hwhitney@u washington edu
Allan H Devol, University of Washington, devol@u washington edu

As part of the Bering Sea Ecosystem Study (BEST), sediment cores were taken from the southeastern Bering Sea on three cruises in late winter 2007, 2008, and summer 2008 Cores were incubated and analyzed for dissolved oxygen using membrane inlet mass spectrometry (MIMS) and isotope ratio mass spectrometry (IRMS) Shelf oxygen consumption rates in the study area increased from an April average of 0 9 mmol/m2/day to 3 4 mmol/m2/day in July 2008 This dramatic shelf-wide increase in oxygen consumption rates may be a reflection of high organic matter input from an early spring bloom Summer 2008 oxygen consumption rates also exhibited a sharp latitudinal gradient in oxygen consumption rates with higher rates in the north near St Lawrence Island Sulfate reduction rates (SRR) were also measured using sulfur-35 radiotracer techniques at selected stations Results reveal insights into the aerobic/anaerobic organic matter respiratory partitioning and a potential relationship to seasonality, organic matter input, and benthic animal abundance and activity

Student Presentation

**Pribilof Islands Community-Based Ocean Monitoring**

Phillip A Zavadil, Aleut Community of St Paul Island-Tribal Government, pazavadil@tgspi com
Max Malvansky, Traditional Council of St George, pazavadil@tribaleco com
Bruce W Robson, Community & Ecology Resources, mandybruce@co-eco com
Antonio J Jenkins, Pacific Marine Environmental Laboratory, Antonio Jenkins@noaa gov
Peggy Sullivan, Pacific Marine Environmental Laboratory, Peggy Sullivan@noaa gov

The Pribilof Islands Aleut communities of St Paul and St George in collaboration with the Pacific Marine Environmental Laboratory implemented a community-based ocean monitoring program using scientific methodology coupled with local and traditional knowledge to assess long-term changes in the Bering Sea In collaboration scientific researchers and local researchers we deployed moored temperature and salinity sensors in the harbors St George and St Paul using Seabird's 37SM Microcat instruments The data collected from the moorings maintained by each community provided regional scientists with valuable time-series measurements to track climate-induced changes in the coastal zone of the Bering Sea Preliminary results of these data are being worked on and will be presented in this poster Additionally, the data collected from each moored sensor is compared with that of the M2 mooring maintained by the PMEL on the Bering Sea shelf The poster will also describe future data collection and use of data for management purposes

*Poster Bering Sea - Ecosystem Perspectives*

## Bering Sea Integrated Ecosystem Research Program Patch Dynamics Study 2008

Kelly Benoit-Bird, Oregon State University, kbenoit@coas oregonstate edu
G Vernon Byrd, US Fish & Wildlife Service, vernon_byrd@fws gov
Lee W Cooper, University of Maryland Center for Environmental Science, cooper@cbl umces edu
Jacqueline M Grebmeier, University of Maryland Center for Environmental Science, jgrebmei@cbl umces edu
Scott Heppell, Oregon State University, Scott Heppell@oregonstate edu
David B Irons, US Fish & Wildlife Service, david_irons@fws gov
Sasha Kitaysky, University of Alaska, Fairbanks, ffask@uaf edu
Kathy A Kuletz, US Fish & Wildlife Service, kathy_kuletz@fws gov
Chadwick V Jay, US Geological Survey, chad_jay@usgs gov
Daniel D Roby, Oregon State University, daniel roby@oregonstate edu
Andrew W Trites, University of British Columbia, a trites@fisheries ubc ca

The goal of our study is to undertake a coordinated fine-scale study of birds and mammals, and their forage base to determine the consequences of spatial patterns (patches) on predator-prey dynamics We are thereby attempting to establish mechanisms that control the abundance and distributions of top predators in the Bering Sea, and provide models with data to predict how and why these species respond to changes in the physical and biological environment

Concurrent fine-scale field studies were undertaken during 2008 in two geographic areas of the Eastern Bering Sea (St Lawrence Island from March May, and at the Pribilof Islands during July to September) The Pribilof Islands region included a comparison between seabirds and fur seals at St Paul and St George islands as part of the large-scale BSIERP research component Seabirds (thick-billed murres and black-legged kittiwakes) and marine mammals (northern fur seals and Pacific walrus) were tracked at sea to determine where, when, and how they capture prey Forage species were sampled from vessels using nets, bottom grabs, and hydro-acoustics to describe the patches (quality and quantity) and their relationship with physical oceanography Relative densities of prey patches and foraging success of birds and mammals were related to regional and interannual differences in population processes Results from 2008 provide insights into (i) how changes in patch dynamics influence diets (species composition and energy content), and (ii) how diets affect the nutritional status of individuals, which in turn determines population dynamics (reproductive success and population trends)

## Bringing Research Into Schools Through Classroom Magazines and the TREC Program

Patricia L Janes, Scholastic Inc, pjanes@scholastic com
Lee W Cooper, University of Maryland, cooper@cbl umces edu

In May 2006, I joined a team of scientists including Lee Cooper and Jackie Grebmeier aboard the U S Coast Guard icebreaker Healy The expedition s research focused on the ecological changes taking place in the northern Bering Sea as seasonal sea ice decreases and the climate warms I embarked on the expedition as an informal educator with the Teachers and Researchers Exploring and Collaborating (TREC) program administered by the Arctic Research Consortium of the U S (ARCUS), with funding from the National Science Foundation

As the executive editor of Scholastic s Science World and SuperScience, two of the nation s leading classroom science magazines for students in grades 3 through 10, I had the rare opportunity to engage in current research and then translate my experiences to young readers across the country Articles describing various aspects of the research appeared in Science World and SuperScience, as well as other Scholastic publications, namely Junior Scholastic, Scholastic News, Scholastic Math, and Scope In total, roughly 8 million students from all walks of life learned about the science that took place aboard the Healy Additionally, I developed a web site describing my experiences that lives on Scholastic s Web site www scholastic com/globalwarming

This poster presentation details my TREC experiences and highlights various articles that developed as a result of my participation in the program The poster illustrates how the articles adhered to the National Science Education Standards (NSES), thereby helping students to make meaningful connections between research that is taking place halfway around the world and the lessons they are learning in school The poster also underscores the importance of fostering an ongoing relationship between scientists and students at the pre-collegiate level, and shows how classroom magazines can help to bridge these two communities

*Poster Bering Sea - Ecosystem Perspectives*

## At-Sea Distribution and Abundance of Three Central Place Foragers Around the Pribilof Islands

Nathan M Jones, US Fish and Wildlife Service, nmj pacific@yahoo com
Kathy A Kuletz, US Fish and Wildlife Service, kathy_kuletz@fws gov
Elizabeth Labunski, US Fish and Wildlife Service, elizabeth_Labunski@fws gov

As part of the BSIERP Patch Dynamics Study we examined distribution, abundance, and diet of seabirds and marine mammals at sea, in conjunction with colony based studies at the Pribilof Islands Our focal species were black-legged kittiwakes (Rissa tridactyla), thick-billed murres (*Uria lomvia*), and northern fur seals (*Callorhinus ursinus*) Between 12 July and 13 August, 2008 we conducted strip transect surveys of marine birds and mammals concurrent with oceanographic measurements and prey sampling The study area was within a 200 km radius of St Paul Island (SPI), and included St George Island (SGI) Transects were distributed across three shelf domains mid-shelf (depths of d100m), outer shelf (100-200m depth), and slope (e200m depth) With a combination of randomly selected transects and directed survey effort from tagged birds, we surveyed 2111 km Murres were the most frequently encountered seabird on the water and were most numerous south of SPI, over the outer domain and slope (including the Pribilof Canyon area) In this deep water habitat we observed significantly more murres in the early morning and late evening than during mid-day hours Concurrent net trawl data suggests murres were foraging nocturnally for deep water fishes that migrate to the upper water column at night (e g , Myctophids) Kittiwakes were most numerous over the deepest water and least numerous over the shallowest, and had highest densities south of SGI and to the southwest beyond the slope domain Northern fur seals were the most abundant marine mammal encountered, and they showed no clear pattern of distribution During surveys we collected 47 Thick-billed Murres and 39 Black-legged Kittiwakes that will be used to link prey patch dynamics relative to seabird diet on-site (from stomach contents) and at temporal scales of days and weeks (using stable isotope analyses of tissues and feathers) In 2009 we will conduct two simultaneous surveys around the Pribilof Islands and Bogoslof Island This will allow us to contrast predator foraging patterns and prey patch dynamics for animals breeding on islands in different marine habitats

Student Presentation

## Aleutian Survey Reveals 16 New Species of Benthic Marine Algae

Mandy R Lindeberg, Auke Bay Laboratories, mandy lindeberg@noaa gov
Sandra C Lindstrom, University of British Columbia, sandracl@interchange ubc ca

Benthic marine algae have been poorly surveyed in the Aleutian Islands due to the remote and harsh nature of this island Archipelago which spans over 1,800 km from the Alaska Peninsula to Attu Island Surveys conducted during 2006 and 2007 by the Alaska Department of Environmental Conservation (ADEC) as part of the EPA s Environmental Monitoring and Assessment Program (EMAP) and collaboration with NOAA Fisheries have resulted in a major collection of benthic marine algae Collections were made from 97 sites throughout 24 different islands of the Aleutian archipelago resulting in a catalogue of over 900 specimens Preliminary results show 151 species have been identified including 16 new species, 9 of which appear endemic to the Aleutian Islands, and 52 new distribution records Many of the new species were discovered west of the biogeographic boundary Samalga Pass, a common finding among a variety of Aleutian marine species A highlight of the collection is the discovery of a kelp representing a new genus and species we have formally named Aureophycus aleuticus (Kawai *et al* , 2008)

## Translating Science into Learning

Margaret Mary Prevenas, Hawaii department of Education, Maui, prevenas@hawaiiantel net

Native students living on isolated islands in the middle of the ocean, experience firsthand, environmental repercussions to increased greenhouse gasses The indigenous way of knowing is different than traditional science, and needs to be explored Educating our students about global climate change requires curriculum that uses specific intelligences taught in a way that connects the student with the environmental problem Native learners have strengths in naturalistic, spatial and musical intelligences Visual and performing arts are a way to have students authentically learn complicated environmental lessons The use of metaphors provide assessments that document their understanding of content

Maggie Prevenas, PolarTREC and NOAA Teacher-at-Sea onboard USCGC Healy for Bering Sea Ecosystem Study during April-May 2007, translates science into classroom learning for her Hawaiian and Pacific Islander populations of students in upcountry Maui Using arts integration workshops offered through the Maui Arts and Cultural Center, she has designed unique science curriculum to teach a diverse populations of Hawaiian students

*Poster Bering Sea - Ecosystem Perspectives*

**Three Decades of Change in a Far North Eelgrass Food Web**

Amy C Tippery, University of Alaska Fairbanks, fsact3@uaf edu

In 1974-76, a baseline transect was established to sample the abundance, biodiversity and isotopic values of organisms across a morphological range of eelgrass in Izembek Lagoon, Alaska (McConnaughey & McRoy 1979) The same transect, visited in July 2008, established a current snapshot of the eelgrass (Zostera marina) ecosystem s trophic architecture Now standard in food web analysis, $^{13}C$ isotope investigations were rare for the 1970 s, and $^{15}N$ analysis was not yet viable This preliminary report compares present and historical data to assess food web shifts over the last three decades

Facing the Bering Sea (N55°18 by W162°54 ), Izembek Lagoon shelters one of the world s largest eelgrass beds This habitat offers high quality refuge compared to other types of nearshore ecosystems (Jonhson *et al*, 2003) It is essential to the survival of resident and migratory bird species, including threatened Steller s Eiders (Taylor and Sowl 2007), and as nursery ground for important fisheries In the last three decades, climate oscillations in the Gulf of Alaska have critically changed the marine ecosystem Tracking consumption shifts of primary production in Izembek s food web can forecast similar change in the Bering General warming trends in the Bering Sea, coupled with a decrease in overcast days at nearby Cold Bay, potential production of eelgrass increased in the last several decades Therefore, we predict the food web at Izembek Lagoon has shifted to higher reliance on eelgrass-based carbon This would present itself as an overall enrichment in 13C compared to the original data Our objectives were to sample eelgrass ecosystem biota and calculate significant differences occurring over the last several decades

Samples were collected in July 2008 within Izembek Lagoon s eelgrass beds and analyzed for $^{13}C$ and $^{15}N$ ratios in the Alaska Stable Isotope Facility at the University of Alaska, Fairbanks

Although organisms of Izembek Lagoon apparently have more eelgrass in their diets now vs in 1974-76, no significant overall food web shift has occurred A few lower trophic level organisms have made the opposite shift from eelgrass to POM, and several upper trophic level organisms show significant transitions from primarily POM to mostly eelgrass

Student Presentation

*Poster Bering Sea - Ecosystem Perspectives*

**Understanding Ecosystem Processes in the Bering Sea**

Clarence Pautzke, NPRB, cpautzke@nprb org
Bill Wiseman, NSF, wwiseman@nsf gov
Francis Wiese, NPRB, francis wiese@nprb org, Carrie Eischens, NPRB, carrie eischens@nprb org
Tom Van Pelt, NPRB, tvanpelt@nprb org

The North Pacific Research Board (NPRB) and National Science Foundation (NSF) are studying the response of the eastern Bering Sea shelf ecosystem to climate change and sea ice loss The program includes three field seasons (2008-2010) and two years of analysis and is based on NSF s 2005 Bering Ecosystem Study and NPRB s Bering Sea Integrated Ecosystem Research Program Funds for the $52 million partnership include $16 million from NPRB, $21 million from NSF, and matching funds from NOAA, U S Fish and Wildlife Service, and U S Geological Survey Over 90 federal, state, and university scientists are involved, many from Alaska, Washington, Oregon, and British Columbia NSF researchers are studying atmosphere, ocean physics and lower trophic levels, including physical and biological sampling around sea ice and on the ocean floor, primary production near sea ice, nutrients and stratification, and energy transfer through zooplankton NPRB funded research emphasizes forage fish, commercial fish species such as pollock, Pacific cod, and arrowtooth flounder, northern fur seals, walrus and whales, and thick-billed murres and black-legged kittiwakes Foraging patterns of marine mammals and seabirds will be studied within large prey aggregations near the Pribilof, Bogoslof, and St Lawrence Islands Local and traditional knowledge research involves the coastal communities of Akutan, St Paul, Togiak, Emmonak, Savoonga and Nelson Island Federal matching funds from NOAA, USGS, and USFWS will support trawl surveys, seabird telemetry, and studies of fur seal pups and persistence of foraging hotspots An innovative ecosystem modeling activity will tie the program components together

*Poster Bering Sea - Lower Trophic Levels*

**Mesozooplankton-Microbial Food Web Interactions in Spring 2008 in the Bering Sea Mesozooplankton Grazing and Calanus Reproduction Rates**

Robert G Campbell, University of Rhode Island, campbell@gso uri edu
Carin J Ashjian, Wood Hole Oceanographic Institution, cashjian@whoi edu
Evelyn B Sherr, Oregon State University, sherre@coas oregonstate edu
Barry F Sherr, Oregon State University, sherrb@coas oregonstate edu
Philip Alatalo, Woods Hole Oceanographic Institution, palatalo@whoi edu
Celia Ross, Oregon State University, celiaross@hotmail com
Donna G Van Keuren, University of Rhode Island, jvkdvk@yahoo com

Our primary focus is to understand the impact of changing sea ice conditions on planktonic food web structure by describing mesozooplankton and microzooplankton trophic linkages and the fate of phytoplankton blooms in the Bering Sea during spring sea ice conditions During the 2008 spring cruise on USCGC Healy, as part of the BEST-BISIERP program, we conducted fourteen grazing experiments using dominant mesozooplankton (copepods and euphausiids) over a range of oceanographic and ice conditions to determine carbon-specific grazing rates on water column phytoplankton, ice algae, and microzooplankton Ingestion rates increased with increasing food concentration, with an apparent threshold concentration observed for euphausiids but not for copepods Phytoplankton, ice algae and microzooplankton were all important food sources for mesozooplankton, however significant differences in prey preferences (phytoplankton vs ice algae vs microzooplankton) were observed between the different mesozooplankton types We also conducted twenty-two egg production (EPR) experiments with reproductively active copepods species For Calanus marshallae, spawning frequency, but not clutch size, was most important in determining EPR Egg production rate was strongly dependent on food availability (using chlorophyll as a proxy) and increased during the period of the cruise Egg hatching success was high at most locations (92±8%, n=17)

*Poster Bering Sea - Lower Trophic Levels*

**Zooplankton species composition on the southeastern Bering Sea shelf during summer the potential role of water column stability in structuring the zooplankton community and influencing the survival of pollock**

Kenneth O Coyle, University of Alaska, coyle@ims uaf edu
Alexei I Pinchuk, University of Alaska, fntaip1@uaf edu

The southeastern Bering Sea sustains one of the largest fisheries in the nation, as well as wildlife resources supporting valuable tourist and subsistence economies The fish and wildlife populations in turn are sustained by a complex food web linking primary producers to apex predators through the zooplankton community Recent shifts in climate toward warmer conditions may threaten these resources by altering trophic relationships in the ecosystem on the southeastern Bering Sea shelf We examined the zooplankton community on the middle shelf of the southeastern Bering Sea in summer of 1999 and 2004 for any significant differences in species composition, abundance or biomass by region and year Between August 1999 and August 2004, the summer zooplankton community of the middle shelf shifted from large to small species Significant declines were observed in the biomass of large scyphozoans (*Chrysaora melanaster*), large copepods (*Calanus marshallae*), arrow worms (*Sagitta elegans*) and euphausiids (*Thysanoessa raschii, T inermis*) between 1999 and 2004 In contrast, significantly higher densities of the small copepods (*Pseudocalanus spp , Oithon similis*) and small hydromedusae were observed in 2004 relative to 1999 The shift in the zooplankton community was accompanied by a three fold increase in water column stability in 2004 relative to 1999, primarily due to warmer water above the thermocline, with a mean temperature of 7 3°C in 1999 and 12 6°C in 2004 Stomach analysis of zero-class pollock from the middle shelf indicated a dietary shift from large to small copepods in 1999 relative to 2004 Recovery of large zooplankton populations during colder conditions in recent years and diet analyses showing fish containing large zooplankton indicate a transition back to a large zooplankton community and a shift is diets of large fish from zero-age pollock to large zooplankton This research suggests that if climate on the Bering Sea shelf continues to warm, the zooplankton community may shift from large to small taxa, thus altering energy transfer to commercial fish species, and potentially impacting the fisheries and the economies they support

*Poster Bering Sea - Lower Trophic Levels*

## Gastroclods Pleistocene Remnants from Pribilof Canyon

Michelle Ridgway, a Oceanus Alaska Environmental Svcs , m ridgway@hotmail com
Nora R Foster, NRF Taxonomic Services, swamprat@mosquitonet com

Located about 60 km south of St George Island, Pribilof Canyon descends abruptly from the Bering Sea shelf break (about 120 m deep) to over 1,800 m, and is among the largest undersea canyons in the world During explorations in the summer of 2007, a field of rounded, sedimentary masses was found lying atop a dark silty seafloor at 400 meters Ridgway collected two of the mysterious fist-sized clods by research submarine At surface, specimens were photographed and frozen in polyethylene bags for later examination for living organisms, remains of past creatures and other clues to their paleontological history To illuminate potentially fragile contents, the clods were examined using mammogram-imaging technology Resulting imagery revealed one large, intact gastropod shell in each clod The gastropods were identified as Neptunea heros (Gray, 1850) and Buccinum scalariforme (Moller 1842) both are abundant and widely distributed in the Bering, Chukchi and Beaufort seas

Both ice age algae from the clod s surfaces and the two gastropod s typical distribution suggest that the gastroclods originated in areas shallower than the 400 m depth where collected A consideration of the sea ice algae species suggest that the samples the last glacial (or ca 15 to 25 + kyrBP) If so, perhaps they originated in shallow upper layers (100-200 m) and rolled down or were moved Until we have fine scale bathymetry of the canyon, we cannot know the proximity of specimens to a slope steep enough to roll It is also possible that they may have originated in shallows and were redistributed by seasonal sea ice, or possibly were dislodged and swept into depths via fishing nets Several hundred clod-like features were observed on transect, with the highest density of clods adjacent to deep gauges in the seafloor presumed to be human disturbance by trawling Perhaps these objects were dislodged near where collected Regardless of their location of origin, each clod has a gastropod shell nucleus, which likely leached calcium carbonate into the sediment around it, forming an incipient concretion These masses may have remained intact while other sediments washed away in canyon currents

## Modeling processes controlling the on-shelf transport of oceanic mesozooplankton populations in the Gulf of Alaska and SE Bering Sea

Georgina A Gibson, University of Alaska Fairbanks, george@ims uaf edu
Kenneth O Coyle, University of Alaska Fairbanks, coyle@ims uaf edu

Oceanic interzonal copepods are large-bodied high-energy crustaceans that can provide an important food source for a variety of planktivorous fish However, they require deep water to successfully reproduce and therefore tend to occur in oceanic and shelf-break habitats geographically removed from many commercially important coastal fish stocks Annual differences in year class strength of forage and commercial fish stocks such as herring, pollock, capelin and salmon may therefore depend on climatic and oceanographic conditions promoting cross-shelf transport of oceanic copepods to coastal regions where they are fed on by larval and juvenile stages of the above fish species However, specific conditions promoting or suppressing on and cross-shelf transport in the Gulf of Alaska and Bering Sea are poorly understood Our project aims to determine the climate-driven mechanistic processes driving the timing and magnitude of transport of oceanic zooplankton onto the continental shelves of the SE Bering Sea and the Gulf of Alaska using a modified float track model and a Nutrient-Phytoplankton-Zooplankton (NPZ) ecosystem model fully coupled to a three-dimensional oceanographic model (ROMS) Here we present initial results from the float track model and discuss insights into the relationship between physical oceanographic processes and cross-shelf transport of oceanic zooplankton in the SE Bering Sea and the Gulf of Alaska

## Collaborative Research· Downscaling global climate projections to the ecosystems of the Bering Sea with nested biophysical models The NPZ Model

Georgina A Gibson, University of Alaska Fairbanks, george@ims uaf edu

Initial results from the Nutrient-Phytoplankton-Zooplankton (NPZ) model developed through the Bering Ecosystem Study (BEST) are presented This modeling effort is a fundamental element of an integrated program to develop a forecast system for predicting the effects of future climate change on the ecosystem of the Bering Sea Specifically, the integrated modeling effort aims to test the hypothesis that Climate-induced changes in physical forcing of the Bering Sea will modify the availability and partitioning of food for all trophic levels of the shelf ecosystem through bottom-up processes The NPZ model simulates the lower trophic levels that form the basis of the marine food chain and is coupled to a higher trophic level model (FEAST) and the physical ocean model (ROMS) The integrated suite of models will be used to produce a series of multi year forecasts for the Bering Sea ecosystem given alternative Intergovernmental Panel on Climate Change (IPCC) climate forcing scenarios

*Poster Bering Sea - Lower Trophic Levels*

**Nutrient and Bloom Dynamics over the Southeast Bering Shelf**

Calvin W Mordy, Genwest Systems,Inc , calvin w mordy@noaa gov

Over the wide shelf of the eastern Bering Sea, primary production supports a predominately pelagic food web in the southern portion of the shelf and a predominantly benthic food web in the northern portion of the shelf The timing of the spring bloom may be critical in determining which compartment (e g benthic vs pelagic) of the ecosystem it supports The presence of sea ice, and freshening from ice-melt, altered the physical and chemical characteristics of the water column throughout the summer, and significantly forced the location and timing of phytoplankton production During spring expeditions, ice covered waters of the inner and middle shelf were in sharp contrast the inner shelf appeared to be in post-bloom conditions (low nitrate, high ammonium), while much of the middle shelf looked to be in pre-bloom conditions (well mixed, high nitrate) In summer, the northern shelf was almost entirely stripped of inorganic nitrogen (nitrate and ammonium) Flow over the middle shelf was sufficiently sluggish in summer to allow for estimates of new production based on the seasonal change in nutrients Altogether, these results demonstrate significant along-shelf and cross-shelf dependencies between primary production and the presence of sea-ice

*Poster Bering Sea - Lower Trophic Levels*

**Assessing the Variability in the Material Properties of Bering Sea Euphausiids to Improve Acoustic Scattering Models**

Joy N Smith, Stony Brook University, joy smith@stonybrook edu
Joseph D Warren, Stony Brook University, joe warren@stonybrook edu
Patrick H Ressler, NOAA Fisheries, Patrick Ressler@noaa gov

Walleye pollock (*Theragra chalcogramma*) are a commercially important fishery in the Bering Sea, and echosounders are regularly used to assess the population in order to manage the fishery Aggregations of euphausiids (or krill), a primary food source for pollock, are also detected by echosounders Acoustic techniques for measuring such nekton and zooplankton stocks provide the ability to estimate the abundance and distribution of a population as it changes through time and space, as well as to delineate between acoustic scattering from different species However, in order to accurately convert acoustic measures of biota into ecologically meaningful parameters (e g number of animals, biomass), one needs to know how these animals scatter acoustic energy Physics-based mathematical models can be used to predict the amount of acoustic energy that a particular organism will scatter These models are dependent on parameters that are specific to the animal group being studied and include their size, orientation, and material properties Material properties include g, the ratio of an individual animal's density to the density of the surrounding seawater, and h, the ratio of sound as it travels through the animal compared to the speed of sound as it travels though water Zooplankton were collected using a Methot trawl on the Bering Sea shelf during June and July 2008, and g and h were measured for live individual euphausiids from three species (*Thysanoessa raschii*, *Thysanoessa inermis*, and *Thysanoessa spinifera*) Environmental conditions were recorded and in some cases manipulated in order to determine the effect that temperature and salinity may have on the g and h of the animals The range in g and h measurements for each euphausiid species will be presented, as well as how these parameters changed with environmental or physiological factors Better knowledge of the material properties of these zooplankton will lead to more accurate acoustic scattering models, which in turn will allow bioacousticians to better estimate the abundance of these animals in the ocean

Student Presentation

*Poster Bering Sea - Lower Trophic Levels*

**Reproductive potential of Bristol Bay red king crab and eastern Bering Sea snow crab**

Katherine M Swiney, NOAA Fisheries, Alaska Fisheries Science Center,
katherine swiney@noaa gov
Joel B Webb, University of Alaska Fairbanks, School of Fisheries and Ocean Sciences,
joel webb@alaska gov
Ginny L Eckert, University of Alaska Fairbanks, g eckert@uaf edu
Gordon H Kruse, Univsersity of Alaska Fairbanks, gordon kruse@uaf edu

Incorporation of reproductive potential in the development of biological reference points is a pressing fishery management need for Bering Sea crab stocks Currently, assessments of reproductive potential are based upon spawning stock biomass, which does not incorporate variability in production or variability due to density-dependent or density-independent factors To improve estimates of production variability for Bristol Bay red king crabs (*Paralithodes camtschaticus*), we estimated egg loss during brooding and examined interannual variability in fecundity by comparing the relationship between carapace length and fecundity among samples collected during fall 2007 and summer 2007 and 2008 Likewise, interannual variability in fecundity for eastern Bering Sea snow crabs (*Chionoecetes opilio*) was examined by comparing the relationship between carapace width and fecundity among samples collected during summer 2007 and 2008 Multiparous red king crabs were significantly less fecund in the fall than summer in 2007, with estimates of egg loss ranging from 1 9 to 14 8% Significant interannual differences in fecundity were not observed for multiparous female red king crabs or multiparous snow crabs between 2007 and 2008 These preliminary findings suggest that egg loss occurs during brooding among multiparous red king crabs and that fecundity may not be highly variable between years for multiparous red king crabs and snow crabs Thus, sources of variability in reproductive potential should be explicitly defined in the development of biological reference points associated with reproductive potential

*Poster Bering Sea - Lower Trophic Levels*

**Improving Acoustic Scattering Models for Various Bering Sea Zooplankton**

Joseph D Warren, Stony Brook University, joe warren@stonybrook edu
Joy N Smith, Stony Brook University, joy smith@stonybrook edu
Patrick H Ressler, NOAA Fisheries, Patrick Ressler@noaa gov

Echosounders are used to survey stocks of commercially important fish species in the Bering Sea, such as walleye pollock (*Theragra chalcogramma*) In addition to detecting echoes from pollock, these systems also receive echoes from other scatterers in the water column, including aggregations of zooplankton While euphausiids are typically the most abundant zooplankton group in terms of biomass, other types of zooplankton may contribute significantly to the measured acoustic backscatter Zooplankton were collected using a Methot trawl on the Bering Sea shelf during June and July 2008 Live animals were maintained onboard the ship and several important acoustic scattering model input parameters were measured on individuals, including body size, shape, body composition, density, and sound speed We report these measurements for several different types of zooplankton, including copepods, gastropods, amphipods, squid, chaetognaths, fish larvae, jellyfish, and siphonophores We discuss how these data can improve acoustic scattering models that are used to either estimate organism abundance or distinguish between scattering from different types of animals

## Spatial patterns in physical habitat and animal biomass from the At-Sea component of the BSIERP Patch Dynamics Study

Kelly Benoit-Bird, Oregon State University, kbenoit@coas oregonstate edu
Scott Heppell, Oregon State University, Scott Heppell@oregonstate edu
Kathy A Kuletz, US Fish and Wildlife Service, kathy_kuletz@fws gov
Nathan M Jones, Moss Landing Marine Lab, nmj pacific@yahoo com
Luke Whitman, Oregon State University, luke_whitman@msn com
Neal McIntosh, Oregon State University, nmcintosh@coas oregonstate edu

During July and August of 2008, the At-Sea research team of the BSIERP Patch Dynamics Study collected data from 110, 10-km long transects distributed across three topographic zones around the Pribilof Islands The physical habitat at each transect was sampled with 2 CTD casts The biomass of fish and zooplankton along each transect was sampled with tows of two types of nets and multi-frequency acoustics while marine birds and mammals were quantified using visual observations We found significant spatial variability in both the habitat and the biomass of animals across our three zones Some animals were strongly associated with topographic zones consistent with our a priori sampling divisions, however other animals showed very limited associations in their variability with the physical habitat In this poster, the bird and forage fish teams present the first integration of results from the 2008 field study The maps presented of the observed spatial patterns will serve as a basis for discussion for further synthesis among investigators in the BSIERP program

## Spatial Distribution, Energetic Status, and Food Habits of Eastern Bering Sea Age-0 Walleye Pollock

Edward V Farley, Ted Stevens Marine Research Institute,
Alaska Fisheries Science Center, ed farley@noaa gov

Age-0 walleye pollock were collected from the eastern Bering Sea (EBS) during years when ocean temperatures were anomalously warm (2004-2005) and cool (2006-2007) Variability in the spatial distribution, food habits, energetic condition, and recruitment to the age-1 life stage was investigated in relation to thermal regime Age-0 pollock were large and widely distributed during warm years but small and largely confined to the middle domain of the EBS during cool years Energy density was positively correlated with body weight and greater during years when conditions were anomalously cool The proportion of smaller age-0 pollock in the diet of larger individuals was high when conditions were warm (21 9% of diet by weight), and euphausiids were the most important prey (36 5% of diet by weight) when conditions were cool EBS age-0 pollock were abundant and broadly distributed from Bristol Bay to offshore and northern locations during warm years, during cool years, age-0 pollock were less abundant and their distribution was constricted to the southeastern Bering Sea An inverse relationship between brood year abundance and survival of age-0 to age-1 was found Our results indicate that when spring (summer) sea temperatures on the EBS shelf are very warm and the water column is highly stratified during summer, age-0 pollock allocate more energy to growth than to lipid storage, leading to low energy density prior to winter, and thus higher over-winter mortality

*Poster Bering Sea - Fish and Fish Habitat*

## Winter Food Habits of Chinook Salmon in the Eastern Bering Sea

Nancy D Davis, University of Washington, ncdd@u washington edu
Katherine W Myers, University of Washington, kwmyers@u washington edu
Wyatt J Fournier, University of Washington, wyattak@u washington edu

Winter is a critical period for ocean survival of salmon Sampling by the U S North Pacific Groundfish Observer Program (NOAA Fisheries) provided data on winter food habits of Chinook salmon in the eastern Bering Sea Stomach samples, scale samples, and associated catch and biological data collected by U S observers from January to March and July to August 2007 were analyzed Results showed the proportion of empty stomachs was higher in winter (45%) than in summer (8%), indicating winter starvation of Chinook salmon We discovered that some Chinook salmon feed in winter on walleye pollock offal (cut fins, bone, skin, etc ), presumably discarded by at-sea groundfish processors The most common natural food of Chinook salmon in winter was squid Diversity of squid species in Chinook salmon diets was higher in winter than in summer, when more fish (particularly, juvenile walleye pollock) were consumed Additional seasonal-, spatial-, age-, size- and maturity-related patterns of prey utilization by Chinook salmon in the eastern Bering Sea will be discussed and compared to results of the Bering Aleutian Salmon International Survey research

*Poster Bering Sea - Fish and Fish Habitat*

## Assessment of Bristol Bay Red King Crab Resource for Future Management Action Implementing a Cooperative Approach

Steven E Hughes, Natural Resources Consultants, Inc , shughes@nrccorp coom
Scott E Goodman, Natural Resources Consultants, Inc , sgoodman@nrccorp com

The Bering Sea Fisheries Research Foundation (BSFRF) cooperating with NMFS and ADF&G conducted a 2nd full survey of Bristol Bay red king crab (BBRKC) in late May - June 2008 under NPRB project 825, as continuing work of NPRB project 625 The 2008 survey used the same specialized trawl gear with a NETMIND package aboard the same chartered vessel The area swept for each trawl tow was accurately measured by the trawl mensuration sensors and the use of the NMFS newly designed bottom contact sensor developed for the 2007 survey again provided the ability to measure on-bottom time of the trawl Survey methodology relied on results from a 2005 pilot study for design, conduct and analysis of full-scale assessments for 2007 and 2008 of the BBRKC stock The 2008 survey sampling was conducted in 30 days at sea with an experienced scientific crew of four The survey was conducted over approximately the same 24,000 sq nm region as in 2007, consisting of 255 random site tows with GPS measured area swept Fourteen additional stations were added along the eastern edge of the survey area in 2008 to expand survey coverage over the eastern-most distribution of the BBRKC As in the prior year s survey, the 2008 survey methodology and gear proved highly effective The specialized trawl is believed to have a crab catchability coefficient near 1 0 resulting in a more accurate measure of adult and small sized juvenile crab densities The high number of stations sampled and the application of geostatistics generated higher precision BBRKC biomass estimates than estimates from the standard NMFS survey in the same area and time BSFRF research for 2008 provided for a 2nd year of consistent comparative survey results Abundance and biomass estimates and station catch rates have been compared with the standard NMFS survey for the same region Results have been shared with NPRB, ADFG and NMFS in preparation for a formal peer review workshop in the spring of 2009 and for future research application

*Poster Bering Sea - Fish and Fish Habitat*

**A cooperative pollock acoustic biomass survey for management of fisheries interactions with Steller sea lions in the Aleutian Islands**

Elizabeth Logerwell, NOAA/NMFS, libby logerwell@noaa gov
Lowell Fritz, NOAA-NMML, lowell fritz@noaa gov
Steve Barbeaux, NOAA-NMFS, Steve Barbeaux@noaa gov

The goal of our project is to investigate whether cooperative biomass surveys are an effective way to manage fisheries at local scales important to predators such as Steller sea lions Our long-term vision is that one or more commercial fishing vessels conducts hydro-acoustic surveys in specific areas of Steller sea lion critical habitat prior to commercial fishing beginning in these areas Biomass estimates from these surveys would then be used to set a quota for the area surveyed that does not jeopardize the foraging success of Steller sea lions in the area To design an effective cooperative survey, we need to know whether the data collected by commercial vessels is of sufficiently high quality and resolution, and sufficiently low variability to assess biomass at local scales We also need to know where the fishery would be expected to operate and where Steller sea lions prey upon pollock Finally, information on the physical oceanographic processes that drive pollock distributions is important for building conceptual models of the interactions between environment, fishing, prey and predators To address these information needs, we conducted replicate winter acoustic surveys of pollock in the central Aleutians from a NOAA research vessel and a commercial vessel equipped with a scientific quality ES60 echosounder To assess the relative importance of haul-outs near pollock spawning areas and near fished areas, we collected data on sea lion distribution and diet Physical and biological oceanographic data were collected to compare water column properties and zooplankton distribution in areas of high and low pollock biomass In this presentation we will address the questions of data quality, resolution and variability from pollock surveys on commercial vessels We will also present a preliminary analysis of the distribution of sea lions and the prey composition of their diet, as well as how both relate to pollock biomass distribution and oceanographic properties

*Poster Bering Sea - Fish and Fish Habitat*

## Estimating Pacific cod movement design of a mark-recapture experiment on a large geographic scale

Peter Munro, National Marine Fisheries Service, peter munro@noaa gov

In autumn 2009 a large scale mark-recapture experiment will commence in the eastern Bering Sea to estimate movement rates of Pacific cod as they aggregate for spawning (funded by the North Pacific Research Board under NPRB Project 815 and the Alaska Fisheries Science Center) Several years of preliminary study have culminated in a stratified design for an experiment to provide data for a movement model based on that described in Anganuzzi et al (1994) Results from much of the preliminary work have been reported by Shi (NPRB Project 620) and those findings will be summarized Shi s conclusions about site fidelity and about the apparent high estimated rates of annual survival, exploitation, and instantaneous natural and fishing mortalities will be discussed Justification of the mark-recapture experimental design will be provided Also, a cruise to validate the efficacy of longlining as a method for capturing and tagging Pacific cod was completed in October 2008 and results will be given as they pertain to the design of the experiment

The experiment consists of a dedicated late autumn cruise aboard a factory longliner to tag and release cod, recovery of tags by commercial fisheries from January through April, and a late winter or early spring cruise aboard a factory longliner to estimate fishery independent tag recovery rates Dedicated cruises will allow tag mixing, calibration of commercial recovery rates, and provide data for estimating stratum specific exploitation rates Further details of the design will be provided, including strata definition, sample size, and locations of sampling stations Particular attention will be paid to the role of the timing of marking and recapturing to assure validity of the assumption of constant and straight-line movement of cod among strata

*Poster Bering Sea - Fish and Fish Habitat*

**First steps for fish movement studies**
**tag attachment considerations for Atka mackerel and Pacific cod**

Julie K Nielsen, UAF, j nielsen@uaf edu
Nicola Hillgruber, UAF, n hillgruber@uaf edu

Understanding the movement of marine animals at different spatial and temporal scales is important for managing fisheries and environmental resources, e g , movement information is used for various management tools ranging from stock identification and assessment to design of marine protected areas Tags used in movement studies range from simple harvest tags to electronic tags (e g , archival, acoustic, or satellite tags) Recent technological advances in electronic tags are spurring an expansion in the scope, scale, and number of movement studies Because movement studies assume implicitly that attaching tags to an animal will not affect its behavior, choosing the optimal method for tag attachment is critical for achieving unbiased movement results However, information on optimal tagging methods is not always available The generic and often-cited *2% rule* (CATAG Concerted Action project, European Commission) guideline for choosing tag size does not account for morphological and behavioral differences between fish species, ontogenetic stages, and sexes Therefore, laboratory studies to determine the maximum size of tag and optimal attachment methods are often a necessary first step for proper study design We will present preliminary results from an on-going laboratory study to assess tag retention, mortality, growth, and behavioral changes in tagged kelp greenling (*Hexagrammos decagrammus*) as a locally available surrogate species for the closely-related Atka mackerel (*Pleurogrammus monopterygius*) Information from this study will be used to design future acoustic telemetry studies for Atka mackerel in the Aleutian Islands In addition, we will present a comparison of important considerations for tagging Atka mackerel vs Pacific cod to highlight the effects of morphological and behavioral differences between species in developing tag attachment methods for movement studies

*Poster Bering Sea - Fish and Fish Habitat*

## Marine Habitat Mapping Technology for Alaska Workshop Report and Published Monograph

Jennifer R Reynolds, University of Alaska Fairbanks, jreynolds@guru uaf edu

A workshop entitled Marine Habitat Mapping Technology for Alaska, sponsored by the North Pacific Research Board and organized by Alaska Sea Grant, was convened in Anchorage on April 2-4, 2007 This workshop examined existing technologies that would be effective for mapping subtidal benthic habitats in the Gulf of Alaska, Bering Sea/Aleutian Islands, and Arctic The purpose was to increase understanding of benthic habitat mapping and to help guide selection of technologies for future habitat mapping programs The focus was on technologies rather than specific habitat mapping projects, although Alaskan examples were used as illustrations The workshop covered five general topics (1) Motivation for the workshop, i e , what is marine habitat mapping and why do managers need it? (2) Remote sensing technologies for seafloor mapping, primarily acoustic technologies for multibeam sonar, side-scan sonar, and sub-bottom profiling, and these technologies may be deployed from ships, small boats, or undersea vehicles Airborne bathymetric LIDAR was also discussed (3) Technologies for visual surveys, specifically manned submersibles, remotely operated vehicles (ROVs), autonomous underwater vehicles (AUVs), and towed video sleds (4) Translating data into habitat classification through analysis of video data, construction of databases, and classifying areas of the seafloor with specific habitat characteristics (5) Case histories of major habitat mapping programs from Heceta Bank (Oregon) and the Exclusive Economic Zones of Ireland and Australia, which described several approaches to effective habitat mapping of large regions

Alaska Sea Grant published a peer-reviewed monograph containing papers developed from presentations by the invited speakers in October, 2008 The publication contains 16 chapters plus the full workshop report and an index It is available in CD format (no charge) from Alaska Sea Grant at http //seagrant uaf edu/bookstore/pubs/AK-SG-08-03 The chapters and index are also available online through the web sites of Alaska Sea Grant (bookstore) and the North Pacific Research Board (Project 615)

J R Reynolds and H G Greene, editors 2008 Marine Habitat Mapping Technology for Alaska Alaska Sea Grant College Program, University of Alaska Fairbanks (Fairbanks, Alaska), 282 pp ISBN 978-1-56612-131-6 DOI 10 4027/mhmta 2008 00

*Poster Bering Sea - Fish and Fish Habitat*

**Rockfish abundance and diurnal habitat associations on isolated rocky habitat (Zhemchug ridges) in the eastern Bering Sea**

Chris Rooper, Alaska Fisheries Science Center, chris rooper@noaa gov
Gerald R Hoff, Alaska Fisheries Science Center, jerry hoff@noaa gov

The substrates of the eastern Bering Sea shelf are dominated by mixed sand, mud and clay sediments, with very few locations with hard substrates similar to those found in the Aleutian Islands and the Gulf of Alaska Consequently, many rockfish species are absent or in low abundance in the eastern Bering Sea However, a persistent aggregation of rockfishes was detected around Zhemchug Canyon in 2006 and 2007 in association with two isolated ridges We explored these two unique ridge features near the southern arm of Zhemchug Canyon that rise from an otherwise flat ocean floor during July 2008 One objective of this project was to examine day/night differences in habitat utilization and abundance by rockfish on Zhemchug ridges Acoustic data for relative biomass estimates as well as bottom topography and general substrate types were collected using an EK60 single beam (38 kHz) hydroacoustic system EK60 transects conducted during daylight and nighttime hours along the same tracklines showed rockfish in greater abundance in the water column during daylight hours than at night A stereo-video drop camera system was used to collect data on fish and invertebrate abundance, species compositions, size frequency, and habitat associations at 15 transects Video from camera drops showed adult rockfish (mostly northern rockfish and Pacific ocean perch) to be predominantly benthic during night, when fish were observed lying directly on the bottom and, consequently, not visible using hydroacoustic methods During daylight hours adult fish were demersal to pelagic forming large active schools above the bottom with smaller fishes (juvenile Pacific ocean perch) present on bottom throughout the daytime Both hydroacoustic and video data showed the rocky ridges to be highly productive as rockfish habitat and the ridges possessed an abundance of HAPC organisms such as coral and sponges, unlike the surrounding eastern Bering Sea slope habitat

*Poster Bering Sea - Fish and Fish Habitat*

**Seasonal bioenergetics of walleye pollock (*Theragra chalcogramma*) and Pacific cod (*Gadus macrocephalus*) in the southeastern Bering Sea**

Elizabeth Calvert Siddon, University of Alaska Fairbanks, Elizabeth Siddon@noaa gov
Ron A Heintz, NOAA/NMFS/Alaska Fisheries Science Center
Ted Stevens Marine Research Institute, ron heintz@noaa gov
Nicola Hillgruber, University of Alaska Fairbanks, n hillgruber@uaf edu

Energy density of early life stages of fishes can be an indicator of growth and survival potential Seasonal variability in fish condition may indicate differential allocation of resources (i e , to growth or storage) and may help predict survival through the fishes first winter In the present study, seasonal bioenergetics data will be collected over three years, 2008-2010, to determine the seasonal pattern of energy density of age-0 walleye pollock (Theragra chalcogramma) and Pacific cod (Gadus macrocephalus) and to examine the relationship between energy content of age-0 juveniles and the abundance of age-1 fish the following summer While survival and recruitment of walleye pollock and P cod are affected by interannual environmental changes, including the extent of the cold pool, processes affecting survival, particularly during the larval stage, during which larvae are subject to local advection and current patterns, are not well understood Condition factors, including energetic content of larvae, as well as prey composition, prey quality, and temporal and spatial distribution patterns of prey, may help to explain the variability in survival and recruitment success To better understand these processes, larval walleye pollock and Pacific cod will be sampled during the following annual surveys from spring through fall NPCREP (early spring), BEST/BSIERP and MACE (early summer), FOCI (September), and BASIS (late fall) To date, walleye pollock energetics samples from BASIS 2007 (age-1) and BEST/BSIERP 2008 (age-0), as well as select zooplankton samples, which will be used as indicators of prey quality, have been analyzed The energy content of walleye pollock sampled during BASIS 2007 was well above previous years, indicating adequate energy content for overwinter survival Because overwintering survival may be an important component of recruitment success, these results will be essential in improving our understanding of recruitment variability of these important groundfish stocks in the eastern Bering Sea

**Sperm reserves of primiparous snow crab (*Chionoecetes opilio*) in the eastern Bering Sea**

Laura M Slater, Alaska Department of Fish and Game, laura slater@alaska gov
Kirsten A MacTavish, International Pacific Halibut Commission, Kirsten@iphc washington edu
Douglas Pengilly, Alaska Department of Fish and Game, doug pengilly@alaska gov

The snow crab (*Chionoecetes opilio*) stock in the eastern Bering Sea supports an important commercial fishery in which males of a minimum size are harvested The stock s mature biomass abruptly declined prior to the 2000 fishery and annual harvests fell from a range of 66-329-million pounds during 1990 1999 to a range of 24-57-million pounds during 2000-2008 Female snow crabs possess sperm storage organs and, if sufficiently inseminated, can store sperm for successive clutch fertilization, a feature that could conceivably buffer the stock from recruitment overfishing by the males-only fishery However, a study of the reproductive potential of snow crab following the stock decline showed that primiparous females had relatively low sperm reserves To better understand the factors affecting the reproductive potential of snow crab in the eastern Bering Sea, sperm reserves were assessed in 2005 and 2007 Mean spermathecal load of primiparous snow crab was biologically similar between 2005 (0 02482 g, n=56) and 2007 (0 02542 g, n=92) Primiparous snow crab from the northern area of distribution in the eastern Bering Sea showed slightly lower mean spermathecal load values (2005 0 0248 g, n=56, 2007 0 0225 g, n=56) in comparison to those from the southern area of distribution (2007 0 03039, n=31) Sperm reserves of primiparous snow crab from the eastern Bering Sea appear low relative to levels reported for snow crab from the Northwest Atlantic

**The Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative A Collaborative Approach to Addressing Marine and Freshwater Salmon Research in Western Alaska**

Joseph J Spaeder, Bering Sea Fishermen s Association, jjspaeder@earthlink net

Through cooperative management (or co-management), governmental managers and local or regional groups of resource users have jointly devised collaborative approaches to resource management and research In this presentation, we examine the evolution and performance of what has emerged as one the largest examples of cooperative management of research across the full salmon life history of Pacific salmon the Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative (AYK SSI) In 2001, in response to salmon declines, a diverse set of stakeholders established this innovative partnership including two federal agencies, one state agency, one non-governmental organization, and three regional native organizations representing three different Alaska native cultures (Inupiat, Yup ik and Athabascan) Based on five years of experience in the implementation of this collaborative research initiative, we examine a series of challenges including 1) creating an integrated approach to marine and freshwater research addressing declined salmon stocks, 2) using a consensus process to establishing a shared vision of research priorities and make research funding decisions among diverse stakeholders, 3) integrating capacity building for local involvement in salmon research into all aspects of the research program We will discuss how such collaborative processes work, how they address the interconnectedness of marine, estuarine and freshwater domains and how they influence governmental research and management institutions Understanding how these barriers and challenges have been addressed reveals both strengths and fragility of this cooperative research initiative and suggests potential modifications for future regime design

**Age, growth, and maturation of sculpins in the eastern Bering Sea and Aleutian Islands**

Todd TenBrink, Alaska Fisheries Science Center, todd tenbrink@noaa gov
Kerim Aydin, Alaska Fisheries Science Center, Kerim Aydin@noaa gov

Age, growth, maturity, and food habits of five sculpins (plain sculpin, *Myoxocephalus jaok*, great sculpin, *M polyacanthocephalus*, warty sculpin *M verrucosus*, yellow Irish lord *Hemilepidotus jordani*, and bigmouth sculpin *Hemitripterus bolini*) are currently being investigated in the eastern Bering Sea and Aleutian Islands Filling life history data gaps will aid in assessing sculpin stocks and to better understand their ecological role in these regions Here, we present results on the age, growth and maturity aspects of this project Ageing was conducted using the break and burn method for all species, with the exception of the yellow Irish lord, which was aged using thin sectioning Maximum ages are as follows 28 yellow Irish lord, 20 bigmouth sculpin, 18 warty sculpin, 17 great sculpin, and 16 plain sculpin In each species, growth as expressed by the von Bertalanffy model was statistically significant between sexes This study is the first to report on the ageing of the warty and bigmouth sculpins and our results indicate that the estimated maximum ages for the yellow Irish lord, great sculpin, and plain sculpin is the highest reported Maturation was investigated based on histological methods and analyses are being conducted for three of the five species Length and age at 50% maturity for the yellow Irish lord for the eastern Bering Sea and Aleutian Islands was estimated to be 26 1 cm (3 4 years) and 28 9 cm (5 0 years), respectively Maturity estimates are also being reported here for the great and bigmouth sculpins in the eastern Bering Sea

**Variability in egg quality for eastern Bering Sea snow crab, *Chionoecetes opilio***

Joel B Webb, University of Alaska Fairbanks, joel webb@alaska gov
Pauline Zheng, Juneau-Douglas High School , pauline zheng@hotmail com

Understanding variability in population reproductive potential is important for management of exploited crab stocks For the snow crab, *Chionoecetes opilio*, a commercially important species in the eastern Bering Sea, reproductive potential can be measured by the number of viable eggs carried by females Population egg production is known to vary with female abundance and characteristics of individual females such as size and reproductive status However, in addition to the number of eggs carried by mature females, reproductive potential may also vary if females produce eggs of differing quality To assess possible trade-offs between egg number and egg quality, indicators of egg quality were evaluated among three groups of eastern Bering Sea snow crab of differing age relative to the terminal molt to maturity Females collected near St Matthew Island in August 2007 were classified by condition of the exoskeleton as newshell primiparous, oldshell multiparous, or very oldshell multiparous Primiparous females carrying their first clutch of ontogeny had similar egg energetic content, mean egg diameter, mean egg weight, and number of eggs per unit size as oldshell or very oldshell multiparous females Several very oldshell females had relatively lower fecundity and had non-developing ovaries indicating possible senescence These results support the conclusion that reductions in reproductive potential for female snow crab are likely to be observed as lower individual fecundity rather than a decrease in egg quality

*Poster Bering Sea - Fish and Fish Habitat*

**Fine-scale analysis of arrowtooth flounder catch rates in the eastern Bering Sea reveals spatial trends in abundance and diet**

Stephani Zador, NOAA, stephani zador@noaa gov
Kerim Aydin, NOAA-Alaska Fisheries Science Center, Kerim Aydin@noaa gov

Multiple lines of evidence suggest that changes in the marine climate in the Bering Sea are leading to numerical and distributional shifts in fish populations Arrowtooth flounder (*Atherestheses stomias*) have quadrupled since the early 1980s in the eastern Bering Sea, in contrast to other important groundfish species Recently, recommended catches for Bering Sea walleye pollock (*Therega chalcogramma*) have been reduced, in part due to concerns about the growing threat of arrowtooth flounder predation of juvenile pollock as has been witnessed in the Gulf of Alaska Thus, the goal of our study was to improve our understanding of the impact of arrowtooth flounder to commercial fisheries in the changing climate of the Bering Sea, with a specific focus on potential distributional shifts in overlap between the two species To meet this goal, we identified physical and biological habitat characteristics that are correlated with arrowtooth flounder biomass trends sampled at individual trawl stations We found that small-scale regions within the eastern Bering Sea shelf have contributed unequally to the overall rapid increase in abundance of arrowtooth flounder Hierarchical k-medoids clustering of arrowtooth catch-per-unit-effort revealed four distinct spatial groups showing stable, increasing, and variable trends Catch rates in high-density areas near the shelf break have remained stable since the early 1990s while catch rates have increased to the northwest and east Annual changes in range expansion and contraction are negatively correlated with the extent of the cold water pool on the Bering Sea shelf Age-1 and -2 pollock comprise the majority of arrowtooth diets in all areas, but higher rates of non-empty stomachs in the northwest region indicate that predatory impacts on pollock may be higher there This analysis will provide information about the potential for arrowtooth flounder to further increase their distribution and abundance in the Bering Sea and help to predict future responses to climate and fisheries management actions

*Poster Bering Sea - Seabirds*

**Breeding ecology of Kittlitz's murrelet at Agattu Island, Alaska, in 2008 Progress report**

Leah A Kenney, Alaska Maritime National Wildlife Refuge, leahkenney@gmail com
John F Piatt, U S Geological Survey, john_piatt@usgs gov
Jeff Williams, Alaska Maritime National Wildlife Refuge, Jeff_Williams@fws gov
G Vernon Byrd, Alaska Maritime National Wildlife Refuge, vernon_byrd@fws gov

We report the results from the first year of a four year study to investigate chick growth rates, adult provisioning and reproductive success of Kittlitz s murrelets (Brachyramphus breverostris) at Agattu Island, Alaska The Kittlitz s murrelet is a poorly known seabird with population declines of >80% reported over the last 10 to 20 years During the 2008 field season, we located and monitored 17 murrelet nests using a disturbed/control study design to investigate researcher bias on nest survival Nest initiation was highly synchronous with all first-nests laid within 11-days of each other In areas where three or four nests were located on a single massif, semi-colonial nesting was not observed, distances among neighboring nest sites at three massifs averaged 287 m, 310 m and 453 m apart, respectively Growth rates between control and disturbed treatment groups did not differ for mass (P = 0 14) or wing length (P = 0 83), the pooled mean for mass for the two groups was 2 4 g/day and the pooled mean for wing length was 2 3 mm/day For first-nest attempts, nest survival was low (0 32 ± 0 13) due to avian predators (31%, four of 13 eggs) or inviable eggs (15%, 2 of 13 eggs) Survival during the nestling period was also low (0 19 ± 0 14), but most chick mortalities (70%) were due to exposure to inclement weather or starvation Of the 17 nests monitored in 2008, only one fledged a chick (0 06 ± 0 06) after day 40 and at 40% of adult mass Using time-lapse cameras at nest sites, we found that fish provisioned to young are of low lipid content, however, feeding frequency ranged widely between nests Our findings indicate that Kittlitz s murrelets have low reproductive success in the west Aleutians, as well as the lowest chick growth rates for any alcid Our estimates of reproductive success at Agattu are likely too low to sustain a viable population and may provide insight into causes of population declines elsewhere in its range

## At-Sea GPS tracking of chick-rearing black-legged kittiwakes and thick-billed murres at the Pribilof Islands, Alaska

Rosana Paredes Oregon State University, u92rp@mun ca
David B Irons US Fish and Wildlife Service, david_irons@fws gov
Daniel D Roby Oregon State University, daniel roby@oregonstate edu
G Vernon Byrd Alaska Maritime NWR, vernon_byrd@fws gov
Rachael Orben St George Island Institute, raorben@yahoo com
Kathy A Kuletz, US Fish and Wildlife Service, kathy_kuletz@fws gov

This project is part of the North Pacific Research Board s Bering Sea Integrated Ecosystem Research Program (BSIERP) and the Patch Dynamics Study The goal of this study is to test the hypothesis that climate warming and sea ice retreat from the southern portions of the Bering Sea will have differential impacts on seabirds nesting on St Paul Island (STP) and St George Island (STG) because STP is closer to the historical southern limit of Bering Sea pack ice and STG is closer to the productive Bering Sea continental shelf break We sought to test this hypothesis by comparing the foraging behavior and at-sea habitat use of a surface-feeding piscivore, the Black-legged Kittiwake (*Rissa tridactyla*), and a diving piscivore, the Thick-billed Murre (*Uria lomvia*) We used state-of-the-art GPS data logger technology to track breeding seabirds during at-sea foraging trips in 2008, a year of relatively low food availability Both kittiwakes and murres displayed three different types of foraging trips, (1) short-distance, nearshore around the islands, (2) intermediate-distance, on the shelf, and (3) long-distance, over deep water beyond the shelf break Chick-rearing kittiwakes traveled as far as 190 km and 295 km from STP and STG, respectively There was no overlap in foraging tracks between birds nesting on the two islands for either kittiwakes or murres Kittiwakes did not use persistent hotspots for foraging, but kittiwakes from STP generally foraged nearshore (61%, N = 18 tracks), while kittiwakes from STG primarily took long foraging trips beyond the shelf break to the southwest (72%, N = 18 tracks), suggesting that prey resources were relatively predictable in these areas Short-distance foraging trips usually occurred during the day and long-distance trips during the night for both species We obtained a small number of murre tracks from both islands in 2008, so inferences are limited Nevertheless, observations of on-colony attendance indicated that murres from STP made longer foraging trips to provision chicks than murres from STG Altogether, these results suggest different seabird foraging strategies nesting at the two Pribilof Islands Whether these inter-island differences mirrored differences in food availability and oceanography that can be linked to climate change will require further integrative analysis with other BSIERP components following the 2009 and 2010 nesting seasons

*Poster Bering Sea - Seabirds*

**Plasma Yolk Precursor Validation in Captive Spectacled Eiders and Application for Estimation of Breeding Propensity In Free Ranging Birds**

David E Safine, Alaska Sealife Center, david_safine@alaskasealife org
Tuula E Hollmen, University of Alaska Fairbanks and Alaska SeaLife Center,
tuula_hollmen@alaskasealife org
Ann E Riddle, Alaska Sealife Center, ann_riddle@alaskasealife org
Daniel Esler, Simon Fraser University, desler@sfu ca
Tony D Williams, Simon Fraser University, tdwillia@sfu ca

Estimates of breeding propensity are important for understanding potential sources of constraints on productivity of declining sea duck populations To estimate breeding propensity on nesting areas, the breeding status of birds needs to be determined Breeding status of females of some waterfowl species has been determined non-lethally using the plasma yolk precursors vitellogenin (VTG) and very low density lipoprotein (VLDL) To evaluate yolk precursor concentrations in relation to egg laying by spectacled eiders (*Somateria fischeri*), we collected blood samples from captive females (n = 5) prior to egg-laying in 2007 and 2008 We bled each female at approximately weekly intervals until VTG exceeded 1 4 µg/ml, a threshold previously used to classify breeding status in greater scaup (*Aythya marila*) Females began rapid follicle growth 15 5 (SE 2 3) and 10 7 (SE 1 2) days prior to laying of the first egg in 2007 and 2008, respectively Initial pre-laying concentrations of VTG and VLDL were 0 13 µg/ml (SE 0 08) and 2 92 mmol/l (SE 0 41), respectively Concentrations of VTG and VLDL for the last serial bleed in each year were 1 95 µg/ml (SE 0 24) and 11 06 mmol/l (SE 1 04), respectively VTG and VLDL levels were highly correlated (r = 0 86, P < 0 001) Free-ranging spectacled eiders may initiate nests 7 days after arrival on breeding areas, given our finding that rapid follicle growth is detectable 11-16 days before egg laying, we conclude that plasma yolk precursors can be used to estimate breeding propensity in spectacled eiders Using precursors alone, we may fail to detect egg production in females that nest later but still arrive early on breeding grounds, therefore we recommend the addition of a radio telemetry component to help address this potential source of bias Yolk precursors may also be used to estimate breeding propensity in other sea birds species that have relatively brief pre-laying intervals and nesting seasons, but longer periods of follicular development

*Poster Bering Sea - Seabirds*

**Validating quantitative fatty acid signature analysis (QFASA) to estimate diets of threatened spectacled and Steller s eiders**

Shiway Wang, Alaska Sealife Center, shiway_wang@alaskasealife org
Tuula E Hollmen, Alaska SeaLife Center, University of Alaska Fairbanks,
tuula_hollmen@alaskasealife org
Sara Iverson, Dalhousie University, sara iverson@dal ca

The spectacled eider (*Somateria fischeri*) and the Alaska-breeding population of Steller's eider (*Polysticta stelleri*) were listed as threatened under the provisions of the U S Endangered Species Act in the 1990s Potential threats to the recovery of these populations include changes in the marine environment and available food resources Relatively little is known of foraging ecology, nutritional requirements, and food limitation in eiders Development of diet assessment techniques is a recovery task for both species, due to the importance of further understanding of nutrient requirements and habitat associations of threatened populations Quantitative fatty acid (FA) signature analysis (QFASA) provides a minimally invasive method for studying foraging ecology in marine birds Using a comprehensive database of prey FA signatures and accounting for predator FA metabolism, it is possible to estimate the proportions of different prey in the diet using QFASA Our goal was to validate QFASA in captive adult male spectacled (N=8) and Steller's eiders (N=8) Prior to the study, birds were kept on a consistent diet of approximately 88% Mazuri sea duck formula and 12% rotating treats of krill, clams, silversides and mussels for 69 days On day 0, biopsy 1 was taken and birds were switched to a diet of approximately 40% Mazuri and 60% krill After 21 days, biopsy 2 was taken and birds were switched to a diet of approximately 40% Mazuri and 60% silverside On day 50, biopsy 3 was taken From the long-term feeding period, we assessed the quantitative characteristics of FA deposition and developed calibration coefficients (CCs) for individual FAs to account for eider lipid metabolism Our results revealed that QFASA accurately estimates diet and diet switches in captive eiders QFASA also confirmed that complete FA turnover of the new introduced diets is not complete by 21 or 29 days, and that diets can be estimated over an extended period Thus, our understanding of diet can be back-tracked to more than a month in a feeding eider We conclude that applying QFASA techniques to eiders in the wild has the potential to provide valuable information about foraging ecology and habitat associations of threatened populations

*Poster Bering Sea - Mammals*

**Diving behavior of northern fur seals from St Paul Island**

Brian C Battaile, UBC fisheries, battaile@fisheries ubc ca
Andrew W Trites, UBC fisheries, trites@zoology ubc ca
Chad Nordstrom, UBC fisheries, nordstrom@fisheries ubc ca

This study of northern fur seal diving behavior is part of the Bering Sea Integrated Ecosystem Research Project under the Path Dynamics study We are testing the hypothesis that climate change will profoundly affect the foraging behavior of northern fur seals a spatially limited (land dependent reproduction) species We tagged twenty eight lactating seals with a combination of GPS, CTD and accelerometer tags from July to September 2008 at Reef rookery on St Paul Island Alaska Foraging trips averaged 7 5 days during which the animals travelled an average of 231 kilometers from the island Animals which were tracked on multiple foraging tips indicated a tendency to revisit previously explored waters Our CTD instruments provide data on the temperate, salinity and source of the water that fur seals prefer to forage in, which when combined with predictive oceanographic models and fisheries trawl survey data, will inform us on potential future fur seal habitat based on changes in the Bering Sea from climate change The accelerometer data provides fine scale spatial and temporal diving behavior allowing us to determine the three dimensional foraging trips and also to inform us on bioenergetic requirements of the northern fur seal, as single flipper beats are identifiable in the accelerometer data

*Poster Bering Sea - Mammals*

**Genetic Diversity in Killer Whales of the Russian Far East**

Alexander M Burdin, UAF, ASLC, Kamchatka Branch of Pacific Institute of Geography, RAS, Petropavlovsk-Kamchatsky, Russia, fewr@mac com
Rick LeDuc , NOAA Fisheries, Southwest Fisheries Science Center, rick leduc@noaa gov
Kim Robertson, NOAA Fisheries, Southwest Fisheries Science Center, Kim Robertson@noaa gov
Dave Weller, NOAA Fisheries, Southwest Fisheries Science Center, Dave Weller@noaa gov

Four research cruises and shore-based small boat work, mostly between 2002 and 2006, resulted in a total of 110 biopsy samples collected from killer whales in the Russian Far East Seas Biopsy sampling occurred in the Anadyr Gulf (Chukotka), Eastern Kamchatka (from Olutorsky Cape to southern Avacha Gulf), Commander Islands, Kuril Islands, and east coast of Sakhalin Island In spite of the modest number of samples, we found significant genetic diversity in killer whales of the Russian Far East In total, seven haplotypes were found four transient ecotype and three resident ecotype Unfortunately, no samples were collected from offshore killer whales Unexpectedly, killer whales from the Russian coast had higher genetic diversity then has been reported for the species at the same latitude off the west coast of North America The most common haplotype (97%) in the present study was identical to SR (Southern Resident) found in the NE Pacific (Barrett-Lennard, 2000) and was found in all areas sampled except Sakhalin Island Another haplotype known from North America, AT1, was found in Kamchatka and Sakhalin Genetic analysis showed a few rare haplotypes shared with North America, and even some new killer whales haplotypes Transient haplotype NT1 was found in the Aleutian Islands and was new for North America (Zerbini et al , 2006) In addition, haplotype 16 (previously found in two KWs from the Gulf of Mexico) was found in the Sakhalin Island sample Haplotypes 37 (transient ecotype) and 33 (resident ecotype), indentified in this study, have never been recorded in any other area Haplotype 50 is also new and probably the most curious It is only one base different from a haplotype recorded from Antarctica This haplotype is most similar to those found in resident ecotype whales, though it is somewhat intermediate in similarity between resident and transient haplotypes The genetic diversity in killer whales of the Russia Far East is likely to be higher than reported here because samples from the greater part of the Sea of Okhotsk and northern Bering Sea have yet to be collected and analyzed

*Poster Bering Sea - Mammals*

## Steller Sea Lion Survey in Russia, 2008

Vladimir N Burkanov, National Marine Mammal Laboratory, AFSC, NMFS, NOAA & Kamchatka Branch of the Pacific Institute of Geography, RAS, Petropavlovsk-Kamchatsky, Russia, vladimir burkanov@noaa gov
Russel D Andrews, Alaska SeaLife Center & School of Fisheries and Ocean Sciences, University of Alaska Fairbanks , RussA@alaskasealife org
Don G Calkins, North Pacific Wildlife Consulting, LLC, don_calkins@northpacificwildlife com
Andrey V Tretiyakov, North Pacific Wildlife Consulting, LLC, atretyakovnn@mail ru
Vladimir V Vertyankin, Sevvostrybvod, vertjankin@mail iks ru
Jason N Waite, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks jnwaite@gmail com

We conducted a survey of Steller sea lions in western Bering Sea, in Commander Islands and the Kamchatka Peninsula on the R/V *Georg Steller* during June 28 to July 14, 2008 All 35 known Steller sea lion sites were visited one or two times during the survey At most sites sea lions were counted from land on locations above the animals The approximate age and sex of hauled out animals was recorded as well A total of 1,353 non-pups and 366 pups were counted Compared to survey 2004, the total number on trend sites slightly declined from 1,707 to 1,679, or 1 6% Number of pups during this time slightly increased (from 322 to 326) but number on non-pup decreased from 1,385 to 1,353 individuals The abundance of Steller sea lions in the region stays relatively stable at low level In contrast with surveyed areas the abundance of Steller sea lions in the Kuril Islands continued grow In 2007 the total number compare with 2005 counts increased from 8,597 to 10,182 individuals (15 6%) Surveys conducted in Sakhalin and northern part the Sea of Okhotsk in 2006 showed lower number but changes in these areas weren t related to real decline but redistribution (Sakhalin) and undercount (Yamsky Islands) Estimated total current abundance of Steller sea lion in Russian waters is about 25 thousand individuals including newly born pups

**Using dynamic descriptions of prey distributions to evaluate Steller sea lion crtical habitat**

Rowenna D Flinn, University of British Columbia, r flinn@fisheries ubc ca
Edward Gregr, University of British Columbia, gregr@zoology ubc ca
Ruth Joy, University of British Columbia, r joy@fisheries ubc ca
Andrew W Trites, University of British Columbia, a trites@fisheries ubc ca

The biomass distributions of three prey species (walleye pollock *Theragra chalcogramma*, Pacific cod *Gadus macrocephalus* and Atka mackerel *Pleurogrammus monopterygius*) consumed by Steller sea lions (*Eumetopias jubatus*) were estimated for June and July of 2000-2004 in the Bering Sea, Aleutian Islands and Gulf of Alaska Quantitative predicted prey distributions were derived by incorporating the relationship between survey catches of prey and the bathymetry, modelled oceanographic data, and remotely sensed data of areas sampled The currently defined critical habitat of Steller sea lions was evaluated based on the amount of prey contained within the boundary and compared to an alternate description of sea lion habitat in the Bering Sea, the Aleutian Islands and Gulf of Alaska (derived from simple relationships between sea lion foraging behaviour and habitat suitability) Predicted biomasses of prey (pollock, cod and Atka mackerel) within sea lion habitat varied by month and between cold and warm years suggesting that information about water temperature and monthly variation in fish distributions should be used to delineate a more dynamic and ecosystem based definition of critical habitat for Steller sea lions

## Cetacean distribution in the Bering Sea in the spring and summer 2008

Nancy Friday, Alaska Fisheries Science Center, nancy Friday@noaa gov
Alexandre N Zerbini, Alaska Fisheries Science Center, alex zerbini@noaa gov
Janice Waite, Alaska Fisheries Science Center, Janice Waite@noaa gov
Amy Kennedy, Alaska Fisheries Science Center, Amy Kennedy@noaa gov
Brenda Rone, Alaska Fisheries Science Center, brenda rone@noaa gov
Phillip Clapham, Alaska Fisheries Science Center, phillip clapham@noaa gov
Sue E Moore, Alaska Fisheries Science Center, sue moore@noaa gov

Cetaceans correspond to an important high-trophic level ecosystem component in the Bering Sea (BS) In the spring and summer 2008, multiple surveys were conducted to describe abundance and distribution of cetaceans in this region As one component of the North Pacific Research Board (NPRB) Bering Sea Integrated Ecosystem Research Program (BSIERP), three marine mammal observers conducted visual surveys along transect lines sampled during the AFSC/NOAA walleye pollock stock assessment cruise, from 1 June to 30 July 2008 Whale sightings included fin (78), humpback (46), minke (7), sei (1), gray (1), sperm (4), killer (35), and Baird s beaked (2) as well as harbor (55) and Dall s (171) porpoise In correlative research funded by the US Minerals Management Service and NPRB, aerial (22 July to 31 August) and shipboard (2 August to 12 September) surveys were conducted in the southeastern Bering Sea to locate and track North Pacific right whales Baleen whale sightings during aerial (A) and shipboard (S) surveys included fin (A=40, S=28), humpback (A=129, S=50), right (A=10, S=22) minke (S=3), sei (A=2), and killer whales (A=4, S=14) Small cetaceans observed were Dall s (A=7, S=25) and harbor porpoises (A=15, S=12) and Pacific white sided dolphins (A=4, S=1) Some of these sightings are duplicates because the plane and the ship often surveyed the same area simultaneously Distribution patterns largely match those previously observed for these species For instance, fin whales were found in the middle and outer continental shelf and humpback whales were concentrated to the north of Unimak Pass and Unalaska Island, in coastal waters near the Alaska Peninsula and in the northeast portion of Bristol Bay An opportunistic acoustic survey was undertaken during the first BEST cruise, 13-26 March 2008 Bowhead whale calls were recorded at 8 of 15 locations where functional sonobuoys were deployed Two bowheads were seen, both near the area where a flock of over 10,000 spectacled eiders were discovered south of St Lawrence Island

*Poster Bering Sea - Mammals*

**Spatial Patterns of Walruses and their Benthic Prey Near St Lawrence Island**

Chadwick V Jay, USGS Alaska Science Center, chad_jay@usgs gov
Jacqueline M Grebmeier, University of Maryland Center for Environmental Science
jgrebmei@cbl umces edu
Anthony S Fischbach, USGS Alaska Science Center, afischbach@usgs gov
Andrew W Trites, Marine Mammal Research Unit,
University of British Columbia, a trites@fisheries ubc ca
Lee W Cooper, Chesapeake Biological Laboratory, University of Maryland Center for
Environmental Science, cooper@cbl umces edu

Climate change may alter lower level physical and biological processes of the Bering Sea ecosystem, resulting in changes in the distribution and abundance of prey through bottom-up mechanisms Top level predators are likely to be affected by these changes, but in unknown ways Walruses are benthic foragers and may shift their spatial patterns of foraging in response to changes in prey distribution We are using satellite radio-tags to map walrus foraging locations with concurrent sampling of benthic infauna to determine how changing distributions of dominant walrus prey may alter spatial patterns of walrus foraging We radio-tagged walruses and collected benthic samples south of St Lawrence Island in early spring of 2006 and 2008, and will do so again in 2009 The locations from radio-tagged walruses in 2006 (n = 40) indicate areas of high foraging use immediately south and southwest of the island The low walrus sample size in 2008 (n = 10) may necessitate pooling of these data with data collected in 2009 Benthic biomass data are not yet available from 2008 samples, but community analysis of benthic samples from cruises in our study area spanning more than 30 years suggest that infaunal community composition is becoming increasingly different from its past state, specifically a change in bivalve dominance and overall decline in station biomass The observed change in community structure is likely caused by an increase in the percent composition of the silt and clay fraction in bottom sediments, perhaps from reduced current velocities in the St Lawrence Island region, and changing infaunal biomass due to a reduced food supply to the underlying benthic community

*Poster Bering Sea - Mammals*

**Using GPS tracking of northern fur seals to evaluate satellite tracking data and a continuous-time movement model**

Carey E Kuhn, National Marine Mammal Lab, Carey kuhn@noaa gov
Devin Johnson, National Marine Mammal Lab, devin johnson@noaa gov
Tom Gelatt, National Marine Mammal Lab, Tom Gelatt@noaa gov

Understanding at-sea movements of marine species is critical for conservation ARGOS satellite tracking technology has provided a great deal of information about the movement patterns, space use, and critical habitat of many marine species However, satellite tracking often provides only intermittent locations that can be largely inaccurate as a result of location error With the development of Fastloc GPS technology it is now possible to obtain more frequent, higher quality locations of animals while at-sea Here we compare differences between GPS tracks and ARGOS tracks acquired simultaneously on 18 northern fur seals (*Callorhinus ursinus*) during summer foraging in 2007 and 2008 We examine gap times and distances between locations as well as final trip outputs including total distance traveled, maximum distance travelled, and transit rate Average gap times for the satellite tracks ranged from 1 5 to 2 2 hours and were 1 5 times longer than GPS tracks However, the maximum gap time for all trips was only 13 3 hours for the GPS tracks compared to nearly 24 hours for the satellite tracks These differences were also reflected in the distances between locations for both tracks types In addition, the high quality GPS data was used to test the accuracy of a continuous-time movement model created to cope with the unknown error associated with satellite locations This comparison is necessary in order to be able to match historic data sets (based on satellite tracking) with future data sets acquired with GPS technology Finally, this analysis provides other researchers the ability to qualitatively determine if the added cost of GPS instruments will provide significantly greater information to help understand the at-sea behavior of marine species or if movement models can appropriately deal with unknown satellite location error

*Poster Bering Sea - Mammals*

**Fur seal predation by killer whales at the Pribilof Islands**

Craig O Matkin, NGOS, cmatkin@acsalaska net
John Durban, Center for Whale Research, john durban@noaa gov
David Ellifrit, Center for Whale Research, dellifrit@hotmail com

Numbers of fur seals returning to the Pribilof Islands are declining, and there is not a clear cause of the decline Historical accounts have documented a history of predation on fur seals by killer whales, dating as far back as the early 1900 s Our study provided current data on the occurrence and predatory behavior of killer whales around the Pribilof Islands, filling key data gaps towards an assessment of the impact of predation Boat-based surveys between July 7 and August 13 2008 documented killer whales on 14 occasions with 22 observations of predation or harassment, all targeting northern fur seals A total of 32 killer whales were identified, with over half of these observed repeatedly Visual observations and satellite telemetry were used to describe the movement of whales into near-shore areas, where predation was observed in evening and morning, with movements offshore to rest/socialize during the day Although we photographed some whales also identified in Aleutian Island region, most individuals photographed have only been identified around the Pribilof Islands in previous years Skin biopsy samples were collected, and these will be used to study population identity and discreteness, as well as dietary preferences There were few encounters in late July, when the whales apparently left the region, possibly due to declining nutritional value of the fur seals This movement was documented by satellite tags deployed in both 2007 and 2008, with one male tagged in the Pribilofs that subsequently moved more than 1800km southwards into the subarctic-subtropical transition region of the central North Pacific Further work will document if the same whales return in the September-October period when killer whales have been observed to feed on out-migrating pups

*Poster Bering Sea - Mammals*

**The Role of Unmanned Aerial Systems in Monitoring Ice-associated Seals**

Erin E Moreland, Alaska Fisheries Science Center, Erin Moreland@noaa gov\
Michael F Cameron, Alaska Fisheries Science Center, michael cameron@noaa gov
Peter L Boveng, Alaska Fisheries Science Center, peter boveng@noaa gov
Lisa Hiruki-Raring, Alaska Fisheries Science Center, Lisa Hiruki-Raring@noaa gov

The remote pack ice of the arctic and sub-arctic regions is a challenging area to access and monitor, yet an extremely important environment to study Arctic pack ice holds the key to ecosystem responses to climate change and is important habitat for many species including ice-associated seals Unmanned aerial systems (UAS) are a new tool which may solve the challenges associated with expansive offshore surveys Although there have been sporadic aerial surveys to estimate ice-seal densities along the coastline of the Bering, Beaufort and Chukchi Seas, and a few surveys using helicopters based from icebreakers, the costs of surveying more frequently and the risks of surveying farther off shore have precluded reliable assessment of the status and trends for these populations We intend to determine whether recent advances in UAS technology have enabled large-scale, systematic ship-based surveys for ice-seals in the Bering, Beaufort and Chukchi Seas Three successful test flights were conducted from the NOAA ship Oscar Dyson in October 2008 Our first phase of UAS flights over the pack ice are planned for a spring 2009 NOAA cruise to the Bering Sea Primary objectives include testing the ability of synchronized digital and thermal imagers to record the presence and identify the species of seals on the ice and determining the ability of the aircraft to operate in the extreme weather conditions of the north Future surveys might employ multiple unmanned aircraft to obtain sufficient coverage of the quickly changing pack ice environment in a short time span for reliable assessment of ice-seal abundance and distribution

## Investigating Stock Differences in Nutritional Metabolites of young Steller Sea Lion pups in Southeast Alaska, Western Alaska and Russia

Lorrie D Rea, Alaska Department of Fish and Game, lorrie rea@alaska gov
Brian Fadely, NMFS / NOAA , brian fadely@noaa gov
Vladimir N Burkanov, NMFS, NOAA, vladimir burkanov@noaa gov

The decline of the western stock of Steller sea lions (*Eumetopias jubatus*) since the 1970 s prompted seasonal monitoring of health indices to assess nutritional stress using blood metabolites known to change predictably when animals are food deprived Here comparisons of blood metabolites were used to determine if young Steller sea lion pups (SSLs) (< 2 mo) had blood chemistry profiles indicative of fasting or starvation Blood samples were collected from pups at rookeries in the west (Aleutian Islands, Gulf of Alaska, Prince William Sound) (W), southeast Alaska (SE) (n=629), and Russia (R) (n=512) Plasma blood urea nitrogen (BUN) and ketone bodies (b-HBA) were measured spectrophotometrically and used to assess whether pups fasted longer than the normal (1 - 2 days) foraging bouts of lactating adult females BUN plasma concentrations in SE were higher than W and R (SE 5 55 mM ± 1 82, n=249, (range 2 37-11 31 mM), W 5 1 mM ± 1 99, n=383, (range 1 51 - 13 44 mM), R 5 12 ± 1 87 mM, n=491, (range 1 70 - 12 70 mM), p = 0 006) These values are similar to those of same aged SSLs fasted for 2 5 days (4 8mM ± 0 5) during a controlled fasting study (Rea et al , 2000) The majority of sites from all regions had less than 35% of all samples with b-HBA concentrations ([b-HBA]) above 0 3mM, the threshold concentration indicative of fasting in SSLs Pups with [b-HBA] above fasting threshold had accompanying low [BUN] indicative of adaptive, short-term fasting rather than Phase III fasting or starvation The proportion of pups that exhibited b-HBA fasting threshold concentrations was higher in SE than in W or the R (p=0 00) Plasma [b-HBA] in SE were higher than W but similar to the R (SE 0 239 mM ± 0 172, n=251 (range 0 040 - 1 088 mM), W 0 206 mM ± 0 131, n=382 (range 0 00 - 0 853 mM), R 0 219 ± 0 172 mM, n=498 (range 0 00 - 1 270 mM), p = 0 041) Higher plasma BUN and b-HBA concentrations in Southeast Alaska may suggest differences in fasting behavior among pups from Southeast Alaska, compared to western Alaska or Russia

## Encounters of marine mammals in the waters of southwestern Bering Sea

Oksana V Savenko, Ukrainian Youth Environmental League, okeanna@meta ua
Tatiana S Shulezhko, Kamchatka Branch of the Pacific Institute of Geography, Russian Academy of Sciences, t shulezhko@gmail com
Karina K Tarasyan, Winogradsky Institute of Microbiology, Russian Academy of Sciences, tarasyan_k@mail ru
Vladimir N Burkanov, Kamchatka Branch of the Pacific Institute of Geography, Russian Academy of Sciences & National Marine Mammal Laboratory, AFSC, NMFS, NOAA, vladimir burkanov@noaa gov

Research on the marine mammals that inhabit Russian part of the North Pacific is of particular interest In spite of the fact that large numbers of Odontocete and Mysticete whales, as well as Pinnipeds, can be found throughout the year in this water area, their numbers, migration patterns, and population structure remain largely unknown Considering the very low number of survey cruises carried out in the Bering Sea, the Sea of Okhotsk, and in the northwestern part of the Pacific Ocean in past years, any data on marine mammal encounters in these areas are of great importance This research presents the data on the marine mammal species encountered during 6 cruise surveys carried out in summer period of 2006, 2007 and 2008 in the southwestern part of Bering Sea including coastal waters of the Commander Islands and Eastern Kamchatka During the study 8 species of the Cetaceans, 176 sightings of 674 individuals were recorded including Dall's porpoise (88 encounters, 401 individuals), harbor porpoise (2, 3), killer whale (20, 175), sperm whale (6, 6), Minke whale (28, 34), humpback whale (19, 32), gray whale (5, 9), fin whale (2, 5) The following 5 species of Pinnipeds were found (in total 64 encounters of 167 individuals) northern fur seal, Steller sea lion, spotted seal, harbor seal and walrus Sea otters were also found in total 36 encounters of 140 individuals were recorded The obtained data showed that during the research period the number of humpback whales encounters significantly increased during last year In 2006 these whales were recorded 4 times (in total 9 individuals), in 2007 only one whale was encountered, in 2008 14 encounters (in total 22 individuals) It's interesting to notice that in 2008 comparatively big gatherings of whales (up to 5 whales) were recorded in the waters of the Commander Islands Also in 2008 grey whales were for the first time encountered in Karaginsky Gulf It is also interesting to notice regular encounters in the Avacha Bay near Petropavlovsk-Kamchatsky of one adult walrus, far away of its common range

**Bowhead Whale Feeding in the Northern Bering Sea near Saint Lawrence Island, Alaska**

Gay Sheffield, State of Alaska, Gay Sheffield@alaska gov

We studied feeding of bowhead whales taken by Alaska Natives at Saint Lawrence Island in the northern Bering Sea during the spring (April-May) and fall (November) migrations from 1972-2008 Our objectives were to 1) identify the proportion of harvested whales that had been feeding based on historical harvest records and 2) describe the prey identified from the stomach and/or intestinal contents of eight whales harvested during 2005-2008 Harvest records (1972-2008) were reviewed for information on feeding status during the spring Six whales (30%) harvested during the spring had evidence of feeding Three whales (100%) harvested during the fall had been feeding shortly before death The sample sizes for feeding status between seasons is small and we recommend caution when interpreting these results However, there are indications there may be a seasonal difference in the proportion of whales feeding as has been determined in bowhead whale diet studies in the Beaufort Sea Of note, there was no difference (P= 0 73) in the proportion of bowhead whales feeding in the Bering Sea (30%, n=20) and the Beaufort Sea (34%, n=91, Lowry et al 2004) during the spring migration Five whales harvested during spring (2007-2008) provided the first spring prey data from the northern Bering Sea since 1982 Copepods occurred most frequently and were identified in 87% of the whales sampled The three whales harvested during late November 2005 provided the first prey data from bowhead whales during their fall migration into the northern Bering Sea Euphausiids dominated the diet samples of whales sampled during late November Euphausiids were not present in any whales sampled during the spring The sample sizes for diet samples are small and we recommend caution when interpreting these results The data we document is consistent with bowhead whale feeding behavior observed by Alaska Native whalers from Saint Lawrence Island Bowhead whales feed near Saint Lawrence Island during spring and fall migrations

## Estimating the Number of Pacific Walruses on Sea Ice During a Range-wide Survey in 2006

Suzann G Speckman, US Fish and Wildlife Service, suzann_speckman@fws gov
Vladimir I Chernook, GIPRORYBFLOT, chernook@grf spb ru
Doug M Burn, US Fish and Wildlife Service, douglas_burn@fws gov
Mark S Udevitz, USGS, mudevitz@usgs gov
Anatoliy Anatoliy, ChukotTINRO (Pacific Research Institute of Fisheries and Oceanography, Chukotka branch), kochnev@anadyr ru
Alexander Vasilev, GIPRORYBFLOT, chernook@grf spb ru
R Bradley Benter, US Fish and Wildlife Service, brad_benter@fws gov
Alexander Lisovsky, GIPRORYBFLOT, chernook@grf spb ru

In spring of 2006, a range-wide survey of the Pacific walrus (Odobenus rosmarus divergens) was conducted collaboratively by the U S Fish and Wildlife Service, the U S Geological Survey and the Russian institutes Giprorybflot and ChukotTinro The goal was to estimate the size of the Pacific walrus population The survey was conducted in April when the entire population uses pack ice haulouts across the continental shelf of the Bering Sea U S and Russian teams coordinated aerial survey efforts on their respective sides of the international border The Bering Sea was partitioned into survey blocks, and a systematic sample of transects within each block was surveyed with airborne thermal scanners using standard strip-transect methodology Transects covering a total of 91,032 km2 of sea ice were surveyed, representing 9-45% of the area in each of the 26 survey blocks Thermal intensities (thermal signatures) were recorded for each detected walrus group, and a sample of the detected groups was aerially photographed with digital cameras Counts of walruses in photographed groups were used to model the relation between the thermal signature and the number of walruses in a group, and to estimate the probability of thermally detecting a walrus group of a given size These models were then used to estimate the number of walruses in groups that were not photographed but were detected by the thermal scanner, and to estimate the number of walruses in groups that were not detected by the scanner Estimating the number of walruses hauled out on sea ice was a critical step in developing the overall population estimate Thermal imagery is only capable of detecting walruses that are hauled out on ice, and the on-ice estimate will need to be adjusted to account for walruses in the water and unavailable for detection by thermal scanners

**Analysis of acoustic and oceanographic data from the Bering Sea June 2006-May 2007**

Kathleen Stafford, University of Washington, Stafford@apl washington edu
David K Mellinger, Oregon State University, david mellinger@oregonstate edu
Phyllis J Stabeno, National Oceanic and Atmospheric Administration,
phyllis stabeno@noaa gov
Sharon L Nieukirk, Oregon State University, sharon nieukirk@noaa gov
Sara L Heimlich, Oregon State University, sara heimlich@noaa gov
Sue E Moore, National Oceanic and Atmospheric Administration,
sue moore@noaa gov

There is relatively little information on the year-round distribution of large whales in the Bering Sea Although summertime visual surveys have provided information on the occurrence of North Pacific right, humpback and fin whales, passive acoustic recordings have been used to study the presence of these whales during other times of the year when visual surveys are not effective We deployed autonomous hydrophone packages from June 2006-June 2007on three Bering Sea oceanographic moorings (BS-2, BS-4 and BS-5) located in a line along the 70 m isobath These instruments were in different oceanographic domains BS-2 in the southeastern Bering Sea, BS-5 in the central-eastern Bering Sea, and BS-4 in the transition between the two domains In order to better understand the physical processes affecting the distribution and habitats of large whales, we compared the occurrence of the species-specific calls of these whales with in-situ and satellite-derived oceanographic data including ice cover, sea surface temperature and chlorophyll a concentration The southeasternmost instrument (BS-2) recorded calls from all three species seasonally While fin and humpback whale calls were relatively common on the middle instrument (BS-4), very few of the targeted species calls were recorded on the northwesternmost instrument (BS-5) Seasonal ice cover was greatest over this latter mooring but in 2006-07 came down as far as BS-2 Unsurprisingly, none of the three whale species were recorded when the instruments were under ice, although other species such as bowhead whales, bearded seals and walruses were recorded in heavy ice conditions In all cases temperature, chlorophyll and salinity varied with location and time of year Temperatures were highest at BS-2 and lowest at BS-5 and chlorophyll peaks were very different at the three sites Comparisons of oceanographic time series with whale call detections will be presented to examine whether, with a time series that is only one year long, any clear seasonal patterns can be seen that might allow for prediction of large whale occurrence in different oceanographic domains of the Bering Sea

**Oceanography and fur seal foraging behavior and diet on the eastern Bering Sea shelf domain**

Jeremy Todd Sterling, NOAA, jeremy sterling@noaa gov

This study combined distribution and abundance data for walleye pollock (*Theragra chalcogramma*) and Pribilof fur seal (*Callorhinus ursinus*) foraging ecology to describe their relationship during contrasting years of shelf oceanography and walleye pollock stock structure and abundance Locations at sea and dive behavior of fur seals departing St Paul Island, AK, were compared to fish distributions and eastern Bering Sea shelf oceanography Previous studies on fur seal diet, pup weights, and trip durations were revisited and compared to walleye pollock abundance estimates Fur seal behavioral indices (locations at sea and dive depths), diet, and pup weights could be explained by the spatial distribution, abundance and stock structure of eastern Bering Sea walleye pollock in most years Fur seals spent more time in the outer domain in some cold years while occupying similar thermal regimes to those preferred by walleye pollock Diving was deeper in the outer domain (estimated average daily dive depth = 47 2 meters SE ± 2 3) but similar between the coastal and middle domains (estimated average daily dive depth = 25 7 meters SE ± 4 2 and 28 2 meters SE ± 2 0, respectively) Fur seal dive depths reflected the dominant year class of walleye pollock and its age related behavior in the water column Fur seal dives were deeper in 1995 (estimated average daily dive depth = 54 7 meters SE ± 3 9) with a maturing large year class of walleye pollock and shallower in 2000 when a large age-0 cohort emerged (estimated average daily dive depth = 21 0 meters SE ± 3 4) Also, the proportion of dives at or above the thermocline increased to as much as 78 2%, in 1992, as the estimated numbers of age-1 walleye pollock increased In years with above average numbers of age 1-5 walleye pollock, fur seals had a higher frequency of occurrence of walleye pollock in their diet, adult females had shorter trips to sea, and pups were heavier

## Recent Counts of Freshwater Seals in Alaska s Lake Iliamna

David E Withrow, National Oceanic and Atmospheric Administration,
Alaska Fisheries Science Center, Dave Withrow@noaa gov
Kymberly M Yano, National Oceanic and Atmospheric Administration,
Alaska Fisheries Science Center, kym yano@noaa gov

Lake Iliamna, a freshwater lake located 362 km (225 mi) southwest of Anchorage, is home to a small breeding colony of harbor seals (*Phoca vitulina*) Iliamna is the largest lake in Alaska, measuring 124 km (77 mi) long and 35 km (22 mi) wide These seals are known to live in the lake year round Although the lake is connected to Bristol Bay via the Kvichak River 120 km (75 mi) in length, there are no known accounts of immigration or emigration The only other instance of a freshwater population of harbor seals is the subspecies (*P v mellonae*) that inhabits Lacs des Loups Marins on the Ungava Peninsula of northern Quebec, Canada Worldwide, there are only four other freshwater seals (all believed to be ringed seals, *Pusa* spp ), including those located in Lake Baikal, (*P sibirica*), Caspian Sea (*P caspica*), Lake Saimaa (*P hispida saimensis*), and Lake Ladoga (*P h ladogensis*) In a continuing effort to monitor harbor seal abundance, distribution, and trend throughout Alaska (see poster by London et al ), scientists from NOAA s National Marine Mammal Laboratory (NMML) flew six surveys of Lake Iliamna in July and August 2008 These flights occurred at different times of day and varying weather conditions to understand not only how covariates such as date, time of day, weather, etc influence seal haulouts, but improve our population estimates and better predict the variability in our estimates Unadjusted (raw) counts indicated that there were at least 235 seals (visible) at the lake during the survey period This compares with counts of 137 in 1991 (Mathisen and Kline, 1992), 321 in 1998 (Small, 2001), 225 in 1999 (Small, 2001), and 84 in 2005 (NMML, unpublished data) Iliamna seals deserve special attention Aside from their atypical habitat, it is unknown whether these seals are genetically-isolated from other harbor seals in Bristol Bay and should be considered a separate stock, or perhaps even a separate subspecies Other concerns include a small annual hunt by Alaska Native subsistence hunters and environmentally, the controversial Pebble Mine Project (North America's largest deposits of gold and copper), which is located only 24 km (15 mi) north, may begin operations shortly

*Poster Bering Sea - Mammals*

**Occurrence of the endangered North Pacific right whale (*Eubalaena japonica*) in the Bering Sea in 2008**

Alexandre N Zerbini, Alaska Fisheries Science Center
alex zerbini@noaa gov
Phillip Clapham, Alaska Fisheries Science Center, phillip clapham@noaa gov
Catherine Berchok, Alaska Fisheries Science Center, Catherine Berchok@noaa gov
Amy Kennedy, Alaska Fisheries Science Center, Amy Kennedy@noaa gov
Brenda Rone, Alaska Fisheries Science Center, brenda rone@noaa gov

The North Pacific right whale (*Eubalaena japonica*) was once abundant and widely distributed throughout the North Pacific Ocean The eastern population is arguably the most endangered stock of whales in the world Although there are currently no estimates of abundance, the extreme rarity of sightings in recent decades suggests that the population numbers in the tens, the result of extensive historical whaling in the 19th century, followed by large illegal catches by the USSR in the 1960s Little is known about the distribution, movements, migrations or habitat use of this population, but the scant existing data suggest that it now occupies a reduced range compared to historical times, when right whales were clearly widely distributed across the Gulf of Alaska (GOA) and the Bering Sea (BS) In the summer 2008, a multidisciplinary study funded by the Minerals Management Service and the North Pacific Research Board was conducted to investigate distribution, movements and ecology of right whales in the BS both in general as well as with respect of the planned oil and gas development activities in the North Aleutian Basin area During aerial and vessel surveys a total of 10 (13 individuals) and 22 (34 individuals) sightings were recorded, respectively Ten to twelve individuals were individually identified and matched whales previously photographed in the BS in 1997, 2000, and 2004 An individual monitored with satellite telemetry for 58 days stayed within a relatively small area (~100 x 200km) within the recently established right whale critical habitat in the BS The 303 sonobuoys deployed during the vessel survey recorded two types of calls upsweeps and gun shots within an area similar to the one occupied by the individual monitored with telemetry Acoustic moorings were deployed to investigate seasonal distribution of whales within the NAB lease area Further studies planned for upcoming years should provide a better understanding of the ecology and status of this endangered population

## Connecting Science Research and Science Education

Craig R Kasemodel, Anchorage School District, kasemodel_craig@asdk12 org

The PolarTREC program, funded by the U S National Science Foundation and managed by the Arctic Research Consortium of the U S , is an educational research experience for K-12 teachers, in which they participate in polar research by working closely with scientists as a pathway to improving science education (www polartrec com) A key component of this program is ongoing interactive online communication by the teachers, wherever they are, with students and teachers around the nation

In 2007, Mr Kasemodel traveled aboard the USCGC Healy in the Bering Sea during the month of March conducting public educational outreach and assisting polar researchers for the Bering Sea Ecosystem (BEST) and the Bering Sea Integrated Ecosystem Research Program (BSIERP) science expedition The research is documenting how climate change is affecting the Northern Pacific ecosystem Mr Kasemodel broadcasted live on the Internet for a Live from IPY during the cruise and maintained daily Internet journals, forums, and websites for public outreach In addition, Mr Kasemodel produced several digital products, curriculum materials, collaborated and conducted educational outreach, and promoted polar science and research upon his return

This poster uses the Healy science expedition to demonstrate how PolarTREC creates interdisciplinary educational and public outreach efforts across age groups, bridging cultures to increase awareness of climate change, polar science, communicating the effects on rural Alaska in urban Alaska, and sharing the experience with scientists, educators, communities, and hundreds of students of all ages across the globe via the internet

## Scientific and Local Traditional Knowledge of Climate-Change and Fishing Effects on Salmon in the Bering Sea and Bering Straits Region

Katherine W Myers, University of Washington, kwmyers@u washington edu,
Julie Raymond-Yakoubian, Kawerak, Inc , JRaymond-Yakoubian@kawerak org

Salmon are an important subsistence resource for the indigenous people of the Bering Strait region Families have been fishing in this area for generations, and for many people the harvest of salmon is a critical part of their cultural and economic survival The High Seas Salmon Research Program at the University of Washington (UW) and the regional Native non-profit, Kawerak, Inc , are collaborating on a project to assemble scientific and local knowledge about salmon in the Bering Sea and Bering Strait region These data are being used to explore the question Is the ocean environment a more important cause of variation in the abundance of salmon populations than marine fishing? In 2008, salmon experts from villages in the Norton Sound region, identified by local village councils, were interviewed Semi-structured interviews, mapping, recording indigenous salmon taxonomy, and other methods were used Results are contributing to a better understanding of both scientific and local knowledge of factors that affect abundance of salmon in this region The final product will be a shared database that can be used as a baseline for addressing future salmon research, restoration, and management issues

*Poster Bering Sea - Humans*

## PolarTREC Successful Methods and Tools for Attaining Broad Educational Impacts with Interdisciplinary Polar Science

Kristin M F Timm, Arctic Research Consortium of the United States, kristin@arcus org
Janet Warburton, Arctic Researche Consortium of the United States, warburton@arcus org
Wendy K Warnick, Arctic Research Consortium of the United States, warnick@arcus org

PolarTREC Teachers and Researchers Exploring and Collaborating, a program of the Arctic Research Consortium of the U S (ARCUS), is a National Science Foundation (NSF)-funded International Polar Year (IPY) project in which K-12 teachers participate in polar research, working closely with scientists as a pathway to improving science education The PolarTREC conceptual model applies and advances best-practices of Teacher Research Experiences through intensive scientific content training, use of cutting-edge technology for field communications and outreach, the application of inquiry-based learning in all activities, a focus on sustained, long-term, collaborations between educators, scientists, and students, and promotion of broad public interest and engagement in polar science and the IPY Educator and student feedback from preliminary results of the program evaluation has shown that PolarTREC s comprehensive program activities have many positive impacts on educators and their ability to teach science concepts and improve their teaching methods Additionally, K-12 students polled in interest surveys showed significant changes in key areas including amount of time spent in school exploring research activities, importance of understanding science for future work, importance of understanding the polar regions as a person in today s world, as well as increased self-reported knowledge and interest in numerous science content areas Building on previous programs and successes, PolarTREC has developed a successful internet based program for teachers and researchers to interact, leveraging their diverse experiences and expertise for the creation of interdisciplinary educational tools including online journals and forums, real-time Internet seminars, lesson plans, classroom activities, audio, video, and other highly relevant and adaptable educational resources that address a broad range of scientific topics These highly accessible methods and resources are available to educators and students of varying ages and abilities across the globe, and have connected thousands of students and citizens to the excitement of polar science PolarTREC provides a tested approach and a clear route for varying levels of researcher participation in the education community, therefore facilitating the types of positive benefits and understanding that ensure increased educator, student, and community understanding of science and the polar regions during times of interrelated global change

# Arctic

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*Poster Arctic - Climate and Oceanography*

**Impact of inter-annual variability in ocean conditions on bowhead feeding near Barrow, Alaska**

Carin J Ashjian, Woods Hole Oceanographic Institution, cashjian@whoi edu
Robert G Campbell, University of Rhode Ilsand, campbell@gso uri edu
John Craig George, North Slope Borough, craig george@north-slope org
Sue E Moore, NOAA, sue moore@noaa gov
Stephen R Okkonen, University of Alaska Fairbanks, okkonen@alaska net
Barry F Sherr, Oregon State University, sherrb@coas oregonstate edu
Evelyn B Sherr, Oregon State University, sherre@coas oregonstate edu

The coastal region near Barrow, Alaska is a critical feeding area for bowhead whales, particularly during the fall migration (e g , Lowry et al , 2004) Barrow lies at the junction of three oceanographic regions, the Chukchi and Beaufort shelves, Barrow Canyon and the deep Beaufort Sea, and is the location past which much of the Pacific Water entering the Arctic through Bering Strait flows Hence, the ocean here is particularly sensitive to ongoing climate warming and inter-annual variability Oceanography and bowhead whale distributions on the shelf near Barrow were sampled during August and September of 2005-2008 as part of an ongoing study to identify and describe conditions that produce a favorable feeding environment for the whales, and to document short term and inter-annual environmental variability Multiple water masses were observed each year, with close coupling between water mass and biological characteristics Both 2005 and 2007 were characterized by little or no sea ice and warm surface and Pacific-origin water (~11°C in 2007), while melting sea ice in 2006 and 2008, and a reduced amount of Pacific Water, contributed to colder surface waters (<4°C) Shorter-term variability in conditions on the shelf, including plankton abundance and composition, was intimately tied to the direction and strength of the wind We advance a conceptual hypothesis regarding the availability of prey for the bowhead whale near Barrow Krill and copepods are upwelled onto the Beaufort Shelf from Barrow Canyon or the Beaufort Sea when winds are from the E or SE A favorable feeding environment is produced when these krill and copepods are retained and concentrated on the shelf near Barrow by the prevailing westward Beaufort shelf currents that converge with the strong Alaska Coastal Current, which flows to the northeast along the eastern side of Barrow Canyon Despite high inter-annual variability over the four years, the region persisted as a favorable feeding environment for bowhead whales in all years

*Poster Arctic - Climate and Oceanography*

**Modeling circulation in the landfast ice zone**

Jeremy Kasper, UAF, kasper@sfos uaf edu
Thomas J Weingartner, UAF, weingart@ims uaf edu

Immobile, landfast ice covers the region inshore of the 20 m isobath over arctic shelves and prevents the direct transfer of wind stress to the inner shelf in winter Thus the outer shelf circulation is directly wind-forced whereas inner shelf dynamics are controlled by remotely-established pressure gradients and frictional coupling of the flow field to the bottom and the under-ice boundaries The Regional Ocean Modeling System (ROMS) was used to investigate the effects of winds offshore of the landfast ice edge along a straight coast with friction applied at the bottom and at the surface to mimic frictional coupling between the landfast ice and the ocean The ice-water friction coefficient was varied spatially to examine three cases constant, linearly increasing offshore, and random The numerical model was forced with different offshore wind profiles to investigate the response of the inner and outer shelves to offshore winds The circulation response to winds differs markedly between the inner and outer shelf with the transition between the inner and outer shelf marked by a sharp velocity front suggesting limited exchange across the landfast ice edge throughout winter implying dissolved and suspended materials may be trapped on the inner shelf throughout winter The underice flow field is sensitive to the magnitude of the ice-water friction but less sensitive to the spatial structure of the frictional coupling In addition, alongshore variations in landfast ice appear to drive flows under the ice

## SEARCH Study of Environmental Arctic Change--A System-scale, Cross-disciplinary, Long-term Arctic Research Program

Helen V Wiggins, Arctic Research Consortium of the United States, helen@arcus org
Peter Schlosser, Columbia University, schlosser@ldeo columbia edu
Alysa J K Loring, Arctic Research Consortium of the United States, alysa@arcus org
Wendy K Warnick, Arctic Research Consortium of the United States, warnick@arcus org

The Study of Environmental Arctic Change (SEARCH) is a multi-agency effort to observe, understand, and guide responses to changes in the arctic system Interrelated environmental changes in the Arctic are affecting ecosystems and living resources and are impacting local and global communities and economic activities Under the SEARCH program, guided by the Science Steering Committee (SSC), the Interagency Program Management Committee (IPMC), and the Observing, Understanding, and Responding to Change panels, scientists with a variety of expertise--atmosphere, ocean and sea ice, hydrology and cryosphere, terrestrial ecosystems, human dimensions, and paleoclimatology--work together to achieve goals of the program Over 150 projects and activities contribute to SEARCH implementation The Observing Change component is underway through National Science Foundation s (NSF) Arctic Observing Network (AON), NOAA-sponsored atmospheric and sea ice observations, and other relevant national and international efforts, including the EU-sponsored Developing Arctic Modelling and Observing Capabilities for Long-term Environmental Studies (DAMOCLES) Program The Understanding Change component of SEARCH consists of modeling and analysis efforts, with strong linkages to relevant programs such as the NSF Arctic System Synthesis (ARCSS) Program The Responding to Change element is driven by stakeholder research and applications addressing social and economic concerns As a national program under the International Study of Arctic Change (ISAC), SEARCH is also working to expand international connections in an effort to better understand the global arctic system SEARCH is sponsored by eight (8) U S agencies, including the National Science Foundation (NSF), the National Oceanic and Atmospheric Administration (NOAA), the National Aeronautics and Space Administration (NASA), the Department of Defense (DOD), the Department of Energy (DOE), the Department of the Interior (DOI), the Smithsonian Institution, and the U S Department of Agriculture (USDA) The U S Arctic Research Commission participates as an IPMC observer For further information, please visit the website http //www arcus org/search or contact Helen V Wiggins helen@arcus org, SEARCH Project Office, Arctic Research Consortium of the U S (ARCUS), or Peter Schlosser, schlosser@ldeo columbia edu, SEARCH SSC Chair

## Arctic Synthesis Collaboratory A Virtual Organization for Transformative Research and Education on a Changing Arctic

Wendy K Warnick, Arctic Research Consortium of the United States, warnick@arcus org
Helen V Wiggins, Arctic Research Consortium of the United States, helen@arcus org
Larry Hinzman, University of Alaska Fairbanks, lhinzman@iarc uaf edu
Marika Holland, National Center for Atmospheric Research (NCAR), mholland@ucar edu
Maribeth S Murray, University of Alaska Fairbanks, ffmsm@uaf edu
Charles Vorosmarty, City College of New York, cvorosmarty@ccny cuny edu
Alysa J K Loring, Arctic Research Consortium of the United States, alysa@arcus org

The Arctic Synthesis Collaboratory concept, developed through a series of NSF-funded workshops and town hall meetings, is envisioned as a cyber-enabled, technical, organizational, and social-synthesis framework to foster

- Interactions among interdisciplinary experts and stakeholders
- Integrated data analysis and modeling activities
- Training and development of the arctic science community, and
- Delivery of outreach, education, and policy-relevant resources

Rapid arctic change and incomplete understanding of the arctic system present the scientific community with three key challenges First, a wealth of observations now exists as disconnected data holdings, which must be coordinated and synthesized to detect and assess arctic change Second, despite great strides in developing arctic system simulations, we still have limited capabilities for predicting its behavior Third, policy-makers, stakeholders, and the public increasingly demand forecasts and guidance in mitigation and adaptation strategies
The Arctic Synthesis Collaboratory is organized around four integrated functions that will be established virtually as a distributed set of activities, but also with the advantage of existing facilities that could sponsor some of the identified activities

- Community Network "Meeting Grounds will link distributed individuals, organizations, and activities to enable collaboration and new research initiatives Activities could include an expert directory, social networking services, and virtual and face-to-face meetings
- Data Integration, Synthesis, and Modeling Activities will utilize appropriate tools to improve the amalgamation of data and models Activities could include a web-enabled model library, user forums, a data search and discovery system, and an online library
- Scientist Professional Development Resources to help experts at all career levels keep pace with developments in data integration and modeling, interdisciplinary science, and cyber-enabled collaboration Activities could include web seminars, short courses, and a mentor program
- An Arctic Virtual Outreach Center (AVOC) will provide critical education, outreach, and policy elements of the Collaboratory Activities could include public eSeminars, a virtual pressroom, K 12 classroom resources, and an eNewsletter

A Collaboratory Implementation Workshop is planned for spring 2009 For more information, see the website of the community workshop, "New Perspectives through Data Discovery and Modeling," at http //www arcus org/ARCSS/2007_data/index html

*Poster Arctic - Climate and Oceanography*

## Study of Environmental Arctic Change (SEARCH) Sea Ice Outlook

James E Overland, National Oceanic and Atmospheric Administration (NOAA), james e overland@noaa gov
Hajo Eicken, University of Alaska Fairbanks, hajo eicken@gi alaska edu
Helen V Wiggins, Arctic Research Consortium of the United States, helen@arcus org

The Study of Environmental Arctic Change (SEARCH) Sea Ice Outlook provides an integrated summary of the state of summer arctic sea ice The Outlook is an effort by the international scientific community to improve understanding of the arctic sea ice system, given 2007 s unexpected drastic sea ice decline The Outlook does not issue predictions but summarizes all available information from ongoing observing and modeling efforts to provide the scientific community, stakeholders, and public the best available information on the evolution of the arctic sea ice cover The 2008 Outlook produced monthly reports from May to September 2008 A monthly request to the international arctic science community solicited information on the current and expected state of arctic sea ice The Outlook Core Integration Group and Advisory Group synthesized and reviewed this input, summarized the evolution and expected state of arctic sea ice for September 2008, and posted resulting reports on the SEARCH Sea Ice Outlook website (www arcus org/search/seaiceoutlook/index php) The 2008 Summary Report, released in October 2008, discusses preliminary analyses of the causes of the 2008 minimum, accuracy of the Outlook values, and implications for future efforts Highlights include

- The 2008 minimum nearly matched the 2007 minimum
- September 2008 ice extent was driven by pre-existing conditions in late spring, as well as variable wind patterns over the summer
- There was good agreement between outlook projections and observations, the median projected September ice extent from the July Outlook report was 4 9 million km2, the observed value was 4 7 million $km^2$
- Preliminary interpretations suggest that future summer sea ice may remain near current conditions until another warm year causes rapid sea ice loss

Follow-up activities include a community analysis of factors and driving forces for the 2008 sea ice minimum, assessment of our current predictive ability and how it can be improved, and an initial plan for a 2009 Sea Ice Outlook The final 2008 retrospective report is expected by March 2009 Sea Ice Outlook activities are supported by NSF and NOAA and implemented through close cooperation with relevant national and international efforts For more information, see www arcus org/search/seaiceoutlook/index php

*Poster Arctic - Ecosystem Perspectives*

## Seabed Habitat Mapping - Eastern Canadian Arctic

Brian D Bornhold, Coastal and Ocean Resources Inc , brian@coastalandoceans com
Mary C Morris, Archipelago Marine Research Ltd , marym@archipelago ca
John R Harper, Coastal and Ocean Resources Inc , john@coastalandoceans com
Sarah Cook, Archipelago Marine Research LTD, sarahc@archipelago ca

Shallow marine habitat surveys were undertaken in an inlet off northern Foxe Basin in the eastern Canadian Arctic using protocols developed initially in Bristol Bay, Alaska with funding from the North Pacific Research Board The approach relies on a combination of high-resolution sidescan sonar and georeferenced towed seabed video The sidescan sonar imagery was interpreted for seabed morphology and substrates, providing 100 % seabed coverage The seabed video imagery was carried out on a nominal 100-m grid and used as groundtruth for substrate definition, and to determine the nature of the biological communities Surveys included areas from the upper intertidal zone to approximately 45 m water depth Very nearshore substrates consisted of bouldery/cobbly materials with minor sand Beyond a few meters water depth substrates were dominated by sandy gravels trending to gravelly sands and muddy gravelly sands Scattered gravel was found throughout the survey area Ice-related features were abundant in water depths less than 9 m and consisted of (1) ice wallows, shallow circular depressions several meters in diameter, rimmed with coarse materials, and, (2) linear ridges and troughs, parallel to sub-parallel to the shoreline and extending many tens of meters in length The biota observed in the video imagery was classified by dominant epibenthic algal assemblages Of particular note was the extensive distribution of kelp, seafloor vegetation coverage of 25 to 75 % was not uncommon in water depths as great as 30 to 35 m On-site sampling of epibiota confirmed that several species of benthic kelp were present, including Laminaria longicruris, Saccharina latissima and Agarum sp Associated invertebrates included brittle stars, tudeworms, sea urchins, anemones and sea stars Crinoids were common at deeper locations Four distinct habitat associations were apparent, named for the dominant flora and substrate (1) Rockweed/Gravel-sandy Gravel (< 3 m water depth), (2) Bladed Kelp/Boulder Cobble (~3-15 m), (3) Bladed Kelp-Filamentous Red Algae/muddy sandy Gravel (15-25 m), and, (4) Foliose Red Algae/muddy sandy Gravel (>25 m) The depth stratification of these communities was very evident

*Poster Arctic - Ecosystem Perspectives*

**High protein assimilation of the phytoplankton in the Chukchi Sea**

Sang Lee, Korea Polar Research Institute, sanglee@kopri re kr
Hak-Jun Kim, Korea Polar Research Institute, hjkim@kopri re kr
Terry E Whitledge, Univ of Alaska Fairbanks, terry@ims uaf edu

High incorporation of carbon into proteins and low incorporation into lipids were a characteristic pattern of the photosynthetic allocations through the euphotic water columns in the Chukchi Sea in 2004 According to earlier studies, this indicates that phytoplankton had no nitrogen limitation and a physiologically healthy condition, at least during the cruise period in 2004 This is an interesting result, especially for the phytoplankton in the Alaskan Coastal Water mass dominated region in the Chukchi Sea which has been thought to be nitrogen limited The relatively high ammonium concentration is believed to have supported the nitrogen demand of the phytoplankton in the region where small cells (< 5 μm) were composed of about 50% of the community since they prefer assimilated nitrogen such as ammonium In fact, a small cell-size community of phytoplankton incorporated much more carbon into proteins in nitrate-depleted water suggesting that small phytoplankton had less nitrogen stress than large phytoplankton If the high protein assimilation of the phytoplankton in 2004 is a general pattern of the photosynthetic allocations in the Chukchi Sea, they could provide nitrogen-sufficient food for the highest benthic faunal biomass sustaining large populations of benthic-feeding marine mammals and seabirds at higher trophic levels in the food chain in the Arctic Ocean

*Poster Arctic - Ecosystem Perspectives*

## Canada s Three Oceans - Arctic and Arcto-Boreal Pelagic Ecosystem Research

R John Nelson, Fisheries and Oceans Canada, jnelson@uvic ca
Eddy Carmack, Fisheries and Oceans Canada, Eddy Carmack@dfo-mpo gc ca
Fiona McLaughlin, Fisheries and Oceans Canada, Fiona Mclaughlin@dfo-mpo gc ca
Svein Vagle, Fisheries and Ocean Canada, Svein Vagle@dfo-mpo gc ca
Bill Williams, Fisheries and Oceans Canada, Bill Williams@dfo-mpo gc ca
Brian Hunt, Fisheries and Oceans Canada, bhunt@eos ubc ca
Corinne Pomerleau, Fisheries and Oceans Canada, corinne pomerleau@dfo-mpo gc ca
Steve Ferguson, Fisheries and Oceans Canada, Steve Ferguson@dfo-mpo gc ca
Kelly Young, Fisheries and Oceans Canada, underwater101@hotmail com
Diana Varela, University of Victoria, dvarela@uvic ca
Ian Wrohan, University of Victoria, wrohani@uvic ca
Akash Sastri, Unviersity of Victoria, asastri@uvic ca

Exploration of pelagic ecosystem biogeography and dynamics is an important component of the Canada s Three Oceans initiative spearheaded by Fisheries and Oceans Canada as a contribution to International Polar Research Pelagic ecosystem research projects underway in the Bering, Chukchi, and Beaufort seas as well as in Canada Basin are supported by this program Biogeographical work currently underway investigates zooplankton distribution, abundance and population genetics, frequently zooplankton surveys are coupled to acoustic surveys aimed at developing methods for acoustical survey of zooplankton Two focal topics for the biogeographical work are to track penetration of Pacific Fauna into the Arctic and to understand the influence of zooplankton distribution and abundance on Bowhead Whale ecology Ecosystem dynamics work aims to assess primary and secondary production and by extension calculate trophic transfer efficiency Both the biogeographical and ecosystem work is coupled to careful study of ocean currents and characteristics so that the influence of ocean habitat on biotic process can be taken into consideration

*Poster Arctic - Lower Trophic Levels*

**Upwelling and aggregation of zooplankton on the western Beaufort shelf as inferred from moored acoustic Doppler current profiler measurements**

Stephen R Okkonen, University of Alaska Fairbanks, okkonen@alaska net
Carin J Ashjian, Woods Hole Oceanographic Institution, cashjian@whoi edu
Robert G Campbell, University of Rhode Island, campbell@gso uri edu
Dixon Jones, University of Alaska Fairbanks, fndjj@uaf edu

Water column measurements of relative acoustic backscatter, current velocities, temperature and salinity acquired at mooring locations on the western Beaufort shelf are used to identify upwelling and aggregation of acoustically-detected zooplankton during late summer 2008 Within a few days after the onset of easterly, upwelling-favorable winds, acoustic backscatter signatures indicative of diel vertical migration of zooplankton were recorded at two mid-shelf mooring locations near Barrow Measurements of near-bottom temperature and salinity show that the inferred presence of zooplankton coincided with the arrival of upwelled Chukchi Sea pycnocline water at the mid-shelf moorings Comparison of current velocities at the mid-shelf mooring sites implies current convergence and zooplankton aggregation in the vicinity of the southern flank of Barrow Canyon

*Poster Arctic - Fish and Fish Habitat*

**Arctic Nearshore Fishes Establishing a Baseline in a Dynamic Environment**

Scott W Johnson, NOAA Fisheries, scott johnson@noaa gov
John F Thedinga, NOAA Fisheries, john thedinga@noaa gov
Darcie Neff, NOAA Fisheries, darcie neff@noaa gov
John Craig George, North Slope Borough, craig george@north-slope org

Nearshore fishes were sampled at six locations in the Chukchi Sea in August 2007 and 2008 At each location, fish were sampled once with a beach seine in shallow water (<5 m deep) and with a small bottom trawl for five minutes at two depths (5 and 8 m) approximately 0 3 km and 1 4 km offshore A total of 6,202 fish representing 12 species were captured in 12 beach seine hauls, and 3,037 fish representing 18 species were captured in 24 trawl tows Species composition differed by year and gear type In 2007 and 2008, capelin accounted for 96% (n = 5,669 fish) and 3% (n = 91 fish) of the total catch, whereas Arctic cod accounted for <1% (n = 12 fish) and 52% (n = 1,726 fish) of the total catch For both years combined, beach seine catch was dominated by capelin (92%), and trawl catch was dominated by Arctic cod (57%) Other species captured in smaller numbers were Pacific sand lance, sculpins, pricklebacks, and flatfish High annual variability in fish catches is likely the result of different environmental conditions between 2007 and 2008 The shoreline near Barrow was ice free by late July 2007, but ice persisted until about mid-August 2008 Mean sea surface temperature was 9 0° C in 2007 and only 1 8° C in 2008 Changing environmental conditions in the Arctic will likely affect the distribution and abundance of nearshore fishes, a northward expansion of species is expected as ocean temperatures warm and sea ice retreats Longer periods of open water may also provide a more suitable nearshore environment for some fish species Thus, establishing baseline sites in the dynamic Arctic environment may be difficult or at least require several years of sampling to detect long term changes

*Poster Arctic - Mammals*

**Seasonal movements, habitat selection, foraging and haul-out behavior of adult bearded seals in the Chukchi Sea**

Michael F Cameron, NOAA Fisheries, Alaska Fisheries Science Center, michael cameron@noaa gov
Peter L Boveng, NOAA Fisheries, Alaska Fisheries Science Center, peter boveng@noaa gov
Jay M Ver Hoef, NOAA Fisheries, Alaska Fisheries Science Center, Jay VerHoef@noaa gov
Heather L Ziel, NOAA Fisheries, Alaska Fisheries Science Center, heather ziel@noaa gov

Bearded seals (*Erignathus barbatus*) are an important subsistence resource for northern and western coastal Alaska Native communities, a key component of arctic marine ecosystems, and the subject of a recent petition for listing under the Endangered Species Act (ESA) Yet relatively little is known of bearded seal abundance, seasonal distribution, migrations, or foraging behaviors, especially in offshore areas not frequented by subsistence hunters Ice-associated seals such as the bearded seal may be negatively impacted by oil and gas development as well as by climate warming and loss of sea ice Our ability to predict impacts, however, is limited by our inadequate knowledge of seal population structure, foraging ecology, and habitat use This lack of information is due in part to the challenges of studying free-ranging bearded seals, which are extremely wary and difficult to capture for live sampling and attachment of data-logging instruments By working cooperatively with Alaska Native subsistence hunters we will develop methods for capturing live adult bearded seals in the Chukchi and Bering Seas and fitting them with satellite-linked, data recorders (SDRs) The SDRs will provide data on a seals locations, and on the timing and depths of dives These data will be analyzed to 1) provide haul-out correction factors for existing abundance and distribution surveys, 2) assess the seasonal movements, distribution, and diving/foraging behavior, and 3) identify and determine the priority of importance for specific marine habitats associated with key bearded seal life history events such whelping, breeding, foraging, and molting Results from this study will be used to support assessments of impacts from oil and gas activities in the Chukchi, Beaufort, and Bering Seas, and to support an ESA status review

## Marine Mammal Occurrence in the Northeastern Chukchi Sea, Alaska Summer 2008

Laura Morse, National Marine Mammal Laboratory, National Marine Fisheries Service, laura morse@noaa gov
Janet Clarke, Science Applications International Corporation, janet clarke@saic com
Dave Rugh, National Marine Mammal Laboratory, National Marine Fisheries Service, dave rugh@noaa gov

Broad-scale aerial surveys in the northeastern Chukchi Sea for marine mammals were conducted in summer 2008 This study (termed COMIDA for Chukchi Offshore Monitoring in Drilling Areas) represents the first effort to document the occurrence of marine mammals from mid-June through late August in this large geographic area Previous survey efforts have occurred during the spring bowhead migration in April and May (although efforts were focused on areas north and east of Barrow) and during the early autumn migration from mid-September through October The study area extends from the northwestern Alaskan coast westward to the International Dateline at 169°W, between 68° and 72°N The survey area overlays Lease Sale 193 of the Chukchi Sea Planning Area, and surveys are being conducted to collect information on marine mammals undergoing seasonal migrations through and to lease areas and nearby waters Sightings of cetaceans, including bowhead (*Balaena mysticetus*), gray (*Eschrichtius robustus*), fin (*Balaenoptera physalus*) and beluga (*Delphinapterus leucas*) whales, walrus (*Odobenus rosmarus*) and polar bears (*Ursus maritimus*) are summarized Observations of summer sea ice breakup are also included and discussed with historical context Results presented here are preliminary This is the first year of a multiyear study sponsored by the Minerals Management Service, Alaska OCS Region

*Poster Arctic - Mammals*

## Will Sea Ice Reduction Facilitate the Transfer of Diseases from Terrestrial to Marine Mammals in the Arctic?

Erich H Follmann, University of Alaska Fairbanks, ffehf@uaf edu

The reduction of sea ice in the Arctic which appears to be accelerating faster than many models have predicted, and is projected to continue well into the present century, will have significant effects on both marine and terrestrial mammals The reduction and perhaps eventual loss of this important substrate on which these animals depend for a significant part of the year probably will increase contact between species This in turn will facilitate the transfer of diseases such as rabies, morbillivirus (e g , canine distemper) and canine adenovirus between and among species Similar transfer of parasitic infestations could result from these associations Pagophilic seals, namely ringed and bearded seals, and polar bears are most dependent on sea ice and constitute a significant predator-prey association in northern waters However, the arctic fox at times also utilizes the ice in winter to forage Transfer of the aforementioned diseases from fox to seals and bears could initiate an epizootic in seals especially, similar to that which occurred in years past in northern Europe with morbillivirus infections in harbor seals Other terrestrial factors such as the greater northward incursion of red foxes into coastal areas will likely change the dynamics of disease transmission within and between species of fox These environmental changes will undoubtedly affect the subsistence harvest of marine mammals by Native communities in the North and also could increase their exposure to zoonotic diseases such as rabies

*Poster Arctic - Mammals*

## Bowhead Whale Feeding Ecology Study (BOWFEST) Aerial Surveys A Comparison of Bowhead Whale Distribution and Survey Effort in 2007and 2008 in the Vicinity of Barrow, Alaska

Kimberly T Goetz, NOAA-AFSC, kim goetz@noaa gov
Dave Rugh, NOAA-AFSC, dave rugh@noaa gov
Julie A Mocklin, NOAA-AFSC, julie mocklin@noaa gov

The Bowhead Whale Feeding Ecology Study (BOWFEST) examines the relationship between bowhead whales and their environment in an area northeast of Point Barrow This multiyear study involves a coalition of scientific parties gathering data from oceanographic samples, boat-based observations, tagging operations, acoustic monitoring, and aerial surveys An aerial trackline sampling scheme was designed to best combine preset distributions of acoustic moorings, oceanographic transects, bathymetric gradients, and distance from the base of operations (Barrow) The aerial survey component of BOWFEST is designed to document patterns and variability in the timing and locations of bowhead whales as well as provide an estimate of temporal and spatial habitat use Using a NOAA Twin Otter, scientists from NMML conducted aerial surveys from late-August to mid-September 2007 and 2008 over continental shelf waters from 157° W to 152° W and from the Alaska coastline to 72° N The number of animals sighted during the 2007 and 2008 aerial surveys differed markedly In 2007, there were 16 sightings of bowheads (approximately 49 whales) seen on only 2 of the 6 survey days (31 total flight hours) By contrast, in 2008, bowheads were seen nearly every day (8 survey days, 43 total flight hours) for a total of 56 bowheads (approximately 163 whales) While bowheads were sighted predominately along the 20 m depth contour during both years, in 2007, the bowhead sightings were tightly congregated approximately 35 kilometers NE of Point Barrow, whereas, in 2008, bowheads were sighted on a continuum throughout the study area In addition to documenting bowhead distribution during the aerial surveys, photographs were taken to provide information on residence times, feeding ecology, and sizes of individual whales In 2007, 158 pictures were taken with a 55 mm lens for photogrammetry, and 161 pictures were taken with a 180 mm lens for photo identification In 2008, 256 pictures were taken for photogrammetry with a 50 mm lens, and 307 were taken with a 70-200 mm lens for photoidentification The majority of bowheads seen in both years appeared to be feeding This bowhead research project was terminated in mid-September each year out of respect for local whaling operations

## The Implications of Climate Change for Arctic Marine Mammals Key Findings from a Supplement to Ecological Applications

Henry P Huntington, Huntington Consulting, hph@alaska net
Sue E Moore, NOAA NMML, sue moore@noaa gov
Timothy Ragen, Marine Mammal Commission, tragen@mmc gov

Arctic temperatures are rising and sea ice is decreasing Global warming is amplified in the Arctic, which is the region of the Northern Hemisphere most sensitive to climatic change Recent late summer sea ice retreats have been dramatic and are expected to be persistent By the middle of this century or sooner, the Arctic Ocean may be without sea ice in summer Polar bear, walrus and ice seals typically spend much of their lives on, around, or near sea ice Less sea ice means less habitat When sea ice forms later and melts earlier, polar bears have fewer feeding opportunities Seals have difficulty finding suitable places to have their pups and to molt With less ice and warmer water, the Arctic marine food web will also change Ice-edge productivity will decline and whales may have to travel farther offshore to find concentrations of their prey Walrus often rest on sea ice when they are not feeding With the retreat of the ice pack beyond the continental shelf where they typically feed, they will have to swim farther to find food, and their feeding areas may be overgrazed Warmer water will bring new species to the Arctic, including novel disease vectors A disease outbreak could affect large numbers of animals, particularly if they are already stressed by changes in food or habitat Polar bears, whales, walrus, and seals are symbols of a pristine Arctic wilderness For indigenous peoples in the Arctic, marine mammals are a vital connection to heritage and environment Loss of the Arctic and its charismatic fauna, by our own hand, would greatly diminish the world s beauty, diversity, and wonder Some conservation measures will help, at least in the short term We can protect areas where sea ice is likely to remain We can minimize impacts from other sources, such as offshore development of oil and gas, commercial fishing, shipping, and military activities In the long term, however, we must either address the causes of climate change, or accept that at least some Arctic marine mammals will become first threatened, then endangered, and finally extinct

**Calibration of bowhead whale measurements from photographs using over-land and over-water calibration targets**

William R Koski, LGL Limited, bkoski@lgl com
Dave Rugh, National Marine Mammal Laboratory, Alaska Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Dave Rugh@noaa gov
Julie A Mocklin, Alaska Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, julie mocklin@noaa gov
Kimberly T Goetz, Alaska Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, kim goetz@noaa gov
Kelly Trask, LGL Limited, k-trask@lgl com
John Craig George, North Slope Borough, craig george@north-slope org

Aerial photographs of bowhead whales have been used to document many life-history parameters through reidentification of individual animals and to calculate whale length, a proxy for age The many variables that complicate measurements made from aerial photography demand fairly precise corrections for altitude, lens characteristics, aircraft motion, and differences between camera, altimeter, and data entry systems Most previous studies have used over-land calibration targets to scale measurements from photographs to actual whale measurements because it has been logistically difficult to set up known-length calibration targets on water and to compare altimeter performance over land relative to over the sea surface In 2008, as part of a bowhead whale feeding study sponsored by Minerals Management Service, calibration targets were set up on an abandoned runway near Barrow, AK Another set of targets was towed behind a boat offshore of Barrow on a relatively calm day (Beaufort wind force 2) in an area where bowheads were commonly found Targets were photographed using a Canon EOS-1DS Mark III digital camera with a 50 mm lens mounted in a motion-compensating system that triggered the camera to take a photograph when the camera was over a target and vertical to the land/water surface Each target was over-flown at altitudes ranging from 200 to 400 m, which spanned the range of altitudes used to photograph whales Seven measurements ranging from 3 00 to 18 00 m were taken from 20 photographs of over-land targets, and four measurements ranging from 5 16 to 15 49 m were taken from 16 photographs of over-water targets Measurements from targets were regressed against the true measurement, and the resulting regression equations were compared There was no significant difference between the slopes of the regression equations obtained from the over-land and over-water calibrations, indicating that previous studies using over-land calibrations have not been biased because of differences in radar altimeter measurements made over land versus over water

**Renal interstitial fibrosis, pulmonary fibromuscular hyperplasia and other findings from a histological assessment of the bowhead whale (*Balaena mysticetus*)**

Cheryl Rosa, North Slope Borough Department of Wildlife Management,
Cheryl Rosa@north-slope org
Todd M O'Hara, University of Alaska Fairbanks, fftmo@uaf edu
Matthew J Gray, University of Tennessee, mgray11@utk edu
John E Blake, University of Alaska Fairbanks, j blake@uaf edu

We performed gross examinations and collected tissues for histological assessment during the Inuit subsistence harvest of bowhead whales (*Balaena mysticetus*) in Northern Alaska Tissue samples were collected for histological analyses from bowhead whales (n=64) hunted during the spring and fall in Barrow and Kaktovik, Alaska (1998-2002) Our objectives were to describe the range of normal histological findings in the species and to define the prevalence of disease in the Bering-Beaufort-Chukchi Sea stock of bowhead whale We identified and discriminated abnormalities that could be attributed to heavy metal/mineral toxicity, specific disease entities, age, reproductive status or capture Overall, few pathological changes were observed during gross necropsy or histological assessment Qualitative observations were made more quantitative through the use of histological staining, digital imaging/measurement and rating profiles, which allowed the assignment of histological observations to a clearly-defined scoring system Abnormalities were few, consisting mainly of hepatic and renal fibrosis and pulmonary fibromuscular hyperplasia Additionally, pigment was observed in the liver (25/58 whales examined) and extra-medullary hematopoeisis was noted in the spleen (17/45 whales examined) The putative effects of seasonal feeding and fasting on the pancreas and liver were assessed through the evaluation of pancreatic zymogen stores and the degree of hepatic lipidosis observed Minimal parasitism was noted

## Marking, Tagging and Reporting Program Subsistence harvest assessment for northern sea otters, Pacific walruses and polar bears in Alaska

John N Trent, Office of Marine Mammals Management, USFWS, john_trent@fws gov
R Bradley Benter, Ofice of marine Mammals Management, USFWS, Brad-Benter@fws gov
Jonathan Snyder, Office of Marine Mammals Management, USFWS, Jonathan_Snyder@fws gov

The U S Fish and Wildlife Service uses the Marking, Tagging and Reporting Program (MTRP) to monitor and assess subsistence harvest authorized under the Marine Mammals Protection Act (1972) as amended in 1981 The dual purpose of the MTRP is to monitor the subsistence and handicraft harvest of polar bears, sea otters and walruses to 1) obtain essential biological information needed to manage these species or stocks and to 2) help prevent the illegal take, trade, and transport of specified raw marine mammal parts MTRP data thus contribute directly to both population management decision making and enforcement of the Marine Mammals Protection Act Hunters are required to have a numbered plastic tag attached to the hide and skull of both polar bears and sea otters within 30 days of harvest or beach finding Walrus tusks must be similarly wire tagged To provide this service, we maintain a permanent network of 150 contract and Service taggers in 100 maritime Alaska communities Data are collected first on paper certificates and then entered into a Microsoft ACCESS data base We present examples of harvest data collected between 1989-2008 for all three species and for selected hunting communities The MTRP is an extensive real-time harvest reporting system that attempts to census longitudinal harvest in even very small coastal Alaska communities by employing local residents as taggers It provides for the collection of certain essential biological data and clearly identifies the subsistence hunter as responsible for providing it The efficacy of the MTRP compared to other harvest assessment methodologies such as household surveys relying on respondent recall, is unknown at this time

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# Marine Science in Alaska: 2009 Symposium
# Addendum: Book of Abstracts

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  - **Afternoon:** Symposium Welcome. Climate, Oceanography, Ecosystem Perspectives, Lower Trophic Levels, Fish and Fish Habitat
  - **Evening:** Poster Reception

- Tuesday 20 January
- **Gulf of Alaska**
  - **Morning:** Fish and Fish Habitat, Seabirds, Mammals & Humans
  - **Afternoon:** Prince William Sound Herring Workshop
  - **Evening:** Poster Reception

- Wednesday 21 January
- **Bering Sea and Aleutian Islands**
  - **Keynote Address** – Michael Sigler

*Understanding Ecosystem Processes in the Bering Sea: BEST-BSIERP 2008 Headlines*

  - **Morning:** Climate and Oceanography, Ecosystem Perspectives & Lower Trophic Levels
  - **Afternoon:** Fish and Fish Habitat & Seabirds
  - **Evening:** Poster Reception

- Thursday 22 January
- **Bering Sea and Aleutian Islands**
  - **Morning 1:** Mammals
- **Arctic**
  - **Dedication** – J Craig George

*Tribute to Arnold Brower Sr.*

  - **Keynote Address** – Richard Feely

*Ocean Acidification: The Other $CO_2$ Problem for the Arctic*

  - **Morning**: Climate and Oceanography
  - **Afternoon:** Ecosystem Perspectives, Fish and Fish Habitat, Seabirds & Mammals

# Gulf of Alaska
# Climate and Oceanography, Ecosystem Perspectives, Lower Trophic Levels & Fish and Fish Habitat

Monday 19 January 2009
2:15 – 5:00 PM
**Session Chair: Molly McCammon**
**Alaska Ocean Observing System**

TALKS

| **Speaker** | **Title** |
|---|---|
| Markus A Janout * | Temperature controlling processes and the recent cooling in the northern Gulf of Alaska |
| Wieslaw Maslowski | Effects of mesoscale eddies on the flow of the Alaskan Stream |
| S Ian Hartwell | Sediment Quality Triad Assessment in the Kachemak Bay: Characterization of Soft Bottom Benthic Habitats and Contaminant Bioeffects Assessment |
| James L Bodkin | Using Trophic Cascades to Develop Ecosystem-Based Recovery Criteria for Threatened Sea Otters in Alaska |
| Richard E Thorne | Biological Forcing by Combinations of Dominant Prey and Predators on Juvenile Pink Salmon Survival in the Prince William Sound Ecosystem |
| Nora R Foster | Evaluating a Potential Relict Arctic Invertebrate and Algal Community on the West Side of Cook Inlet |
| Amy L Blanchard | Long-term Investigation of Benthic Communities in Port Valdez, Alaska 1971-2007 |
| Elizabeth C Atwood * | Influence of mesoscale eddies on ichthyoplankton assemblages in the Gulf of Alaska |
| Terrance J Quinn | Failure of Population Recovery in Relation to Disease for Pacific Herring in Prince William Sound |
| **Sarah Hinckley** | **Modeling spawning-nursery connectivity of walleye pollock between the Gulf of Alaska and the Bering Sea: Toward an understanding of stock structure and recruitment** |
| * Student Presentation | |

**Change from Abstract Book**

# Gulf of Alaska
# Fish and Fish Habitat, Seabirds, Marine Mammals & Humans

Tuesday 20 January 2009
8:00 AM – Noon
**Session Chair: Robert Spies**
**Alaska SeaLife Center**

TALKS

| Speaker | Title |
|---|---|
| **Russell R Hopcroft** | **Oceanographic conditions along the northern Gulf of Alaska's Seward Line, 1997-2008** |
| Joseph J Bizzarro | Diet and trophic ecology of skates in the Gulf of Alaska (*Raja* and *Bathyraja* spp.) |
| Lorenz Hauser | Genetic population structure in Pacific cod, *Gadus macrocephalus*: evidence for limited dispersal and isolated fjord populations |
| Clifford H Ryer | Ampharetid worm turf: an essential character of juvenile flatfish habitat in Kodiak nurseries. |
| Marlin Keith Cox | Phase angle as a new independent condition index for fish |
| Julia K Parrish | On death and dying: coast breeding, cumulative, and wreck signals in Alaskan beached bird surveys |
| Veronica Marie Padula | Health Assessment of Marbled Murrelets in Port Snettisham, Southeast Alaska |
| John F Piatt | Competitive Coexistence and Scale-Dependent Ecological Segregation of *Brachyramphus* Murrelets in a Glacial-Marine Ecosystem |
| Jason K Herreman * | Evidence of bottom-up control of diet driven by top-down processes in a declining harbor seal (*Phoca vitulina richardsi*) population |
| Lorrie D Rea | Percent total body lipid content increases in Steller sea lion (*Eumetopias jubatus*) pups during the first year of life in a similar pattern to other otariid species |
| Markus Horning | Chronicle of a death re-told: quantifying predation on juvenile Steller sea lions in the Gulf of Alaska |
| Craig O Matkin | Ongoing population-level impacts on killer whales 18 years after the *Exxon Valdez* oil spill |
| Courtney Carothers | Privatizing the Right to Fish: Challenges to Livelihood and Community in Kodiak, Alaska |
| William E. Simeone | Subsistence Harvests and Local Knowledge of Rockfish *Sebastes* in four Alaskan Communities |
| *** Student Presentation** | |

**Change from Abstract Book**

*Gulf of Alaska - Lower Trophic Levels*

## Oceanographic conditions along the northern Gulf of Alaska's Seward Line, 1997-2008

**Russell R. Hopcroft**, University of Alaska, hopcroft@ims.uaf.edu
Kenneth O. Coyle, University of Alaska Fairbanks, coyle@ims.uaf.edu
Thomas J. Weingartner, University of Alaska Fairbanks, weingart@ims.uaf.edu
Terry E. Whitledge, University of Alaska Fairbanks, terry@ims.uaf.edu

The Seward Line in the Northern Gulf of Alaska has been the focus of multidisciplinary sampling for the past 11 years. Here we report on the observations of physical oceanography, nutrients, phytoplankton, and zooplankton over that period. In particular, we discuss the biological conditions during 2007 and 2008 when spring temperatures have been lower than observed over the past decade. During both years, the spring bloom was delayed, as was the development of the zooplankton community dependant upon it. Under these conditions some key zooplankton species have done better than average, while others have not. Specifically, biomass during May of the key copepod species *Neocalanus plumchrus/flemingeri* was lower than average in 2007. Implications to higher trophic levels will be discussed. Notably, 2008 returns of pink salmon released in 2007 showed **high** survival compared to other years.

**Change from Abstract Book**

# Bering Sea and Aleutian Islands
# Lower Trophic Levels, Fish and Fish Habitat & Seabirds

Wednesday 21 January 2009
1:30 – 5:00 PM
**Session Chair: Leslie Cornick**
**Alaska Pacific University**

TALKS

| **Speaker** | **Title** |
|---|---|
| Sarah Hinckley | New information about connectivity: relationships between larval release and potential settlement areas for snow crab in the Bering Sea |
| W. Stewart Grant | Contrasting genetic population structures and responses to ice-age variability in North Pacific pollock and Pacific cod |
| Carwyn F. Hammond * | Estimating unobserved mortality rates of Bering Sea crabs due to encounters with trawls on the seafloor |
| Andrew C Seitz | Behavior of satellite tagged Pacific halibut in the Bering Sea/Aleutian Islands region and its biological implications |
| Patrick H Ressler | Trends in walleye pollock and euphausiid abundance on the Bering Sea shelf since 2004 |
| Craig S Rose | Modifications of trawl sweeps to reduce epifauna damage by Bering Sea flatfish fisheries |
| **James Ianelli** | **Opportunistic temperature-at-depth recorders on Bering Sea pollock trawls to evaluate linkages between location-specific temperatures and pollock, salmon, and other species** |
| Anne B. Hollowed | Biogeography of forage fishes in the Bering Sea |
| Dongwha Sohn * | Distribution and Connectivity between Spawning and Settling Locations of Greenland halibut (*Reinhardtius hippoglossoides*) in the Bering Sea |
| Martin Renner | The roles of fisheries, climate and seascape on the distribution of Northern Fulmars (*Fulmarus glacialis*) in the Bering Sea |
| Robert Suryan | Safeguarding Short-Tailed Albatrosses by Reestablishing a Third Breeding Colony: Condition, Post-Fledging Survival, and Migration of Artificially- vs. Naturally-Reared Chicks |
| Ine Dorresteijn * | Stable isotopes in diets of planktivorous auklets indicate low trophic level responses to climate variability |
| **Ian Jones** | **Covariation between North Pacific climate and auklet demographic parameters at three western Aleutian islands during 1990-2008** |
| *** Student Presentation** | |

**Change from Abstract Book**

*Bering Sea - Fish and Fish Habitat*

## Opportunistic temperature-at-depth recorders on Bering Sea pollock trawls to evaluate linkages between location-specific temperatures and pollock, salmon, and other species

**James Ianelli**, NMFS Alaska Fisheries Science Center, james.ianelli@noaa.gov
John Gauvin, Cooperative Research, Marine Conservation Alliance, gauvin@seanet.com
Diana Stram, North Pacific Fisheries Management Council, diana.stram@noaa.gov
Phyllis Stabeno, NOAA Pacific Marine Ecosystem Laboratory, phyllis.stabeno@noaa.gov

Minimizing salmon taken incidentally in North Pacific groundfish fisheries is a fishery management priority. Consistent bycatch avoidance in the Bering Sea pollock fishery has become increasingly difficult in recent years, with the changing environment generally accepted as a factor affecting the variability in observed bycatch levels. One hypothesis is that salmon co-locate more with pollock in some years based upon temperature. Consequently, methods to better monitor current oceanographic conditions in conjunction with incidental catch rates are needed. To this end, temperature-at depth recorders were deployed from commercial fishing boats during three consecutive pollock seasons: summer/fall 2007, winter 2008, and summer/fall 2008. Cooperating vessels were selected to maximize spatial and seasonal coverage of the Bering Sea pollock fishery. Temperature-at-depth sensors were attached to trawls and matched with location and corresponding catch data. Different resolutions of spatial and temporal strata were developed to compare bycatch patterns with the temperature data. For the three seasons, operations from a total of 1,805 vessel-days were recorded. Some temperature recording devices failed during part or all of the seasonal deployments so the number of boats effectively involved ranged from 8 to 17 for the three seasons. These data were also used to evaluate the evolution of the "cold pool" subsequent to the NMFS summer survey bottom temperatures. Preliminary results on fine-scale bottom temperatures show a weak relationship with bycatch rates of Chinook salmon, the most pressing incidental catch species for the pollock fishery. An evaluation of temperature relationships with bycatch of other species (e.g. chum salmon, sharks, and squid) is presented for contrast. Extent and persistence of the cold pool relative to the summer NMFS bottom trawl survey temperatures is compared for the two relatively cold years. The results provide insight on how to improve on the practical aspects of deploying scientific recording devices on commercial fishing gear. The long-term ability to accurately characterize environmental conditions relative to direct catch observations will play a critical role towards improving our understanding of the ecosystem. This information can provide the fishing industry and managers information on how to optimize their operations and minimize bycatch.

# Arctic
## Climate and Oceanography & Ecosystem Perspectives

Thursday 22 January 2009
10:00 AM - Noon
**Session Chair: Lowell Fritz**
**Alaska Fisheries Science Center**

TALKS

| Speaker | Title |
|---|---|
| **DEDICATION**<br>**John Craig George** | **Tribute to Arnold Brower Sr.** |
| **KEYNOTE**<br>**Richard Feely** | **Ocean Acidification: The Other $CO_2$ Problem for the Arctic** |
| **G. Carleton Ray** | **Impact of Diminished Sea Ice on Marine Mammals and Indigenous Hunters of Beringia** |
| James E. Overland | What do we learn about the future Arctic from the summer 2008 sea ice minimum? |
| Gleb Panteleev | Reanalysis of the Arctic Ocean: case study for the Chukchi and East Siberian Seas |
| Jia Wang | Is the Dipole Anomaly a major driver to record lows in Arctic summer sea ice extent? |
| Natalia A. Donoho | Tides, tidal currents, and sea level trends in Alaska: CO-OPS activities and data sources. |
| Aixue Hu | Role of Bering Strait in the thermohaline circulation's response to freshwater forcing under present day and LGM conditions |
| *** Student Presentation** | |

**Change from Abstract Book**

# Arctic
# Keynote Address

Thursday 22 January 2009
1:30 PM

## Ocean Acidification: The Other $CO_2$ Problem for the Arctic

**Richard A. Feely**
Pacific Marine Environmental Laboratory
National Oceanic and Atmospheric Administration
7600 Sand Point Way NE Seattle, WA 98115-6349
(206) 526-6214 Phone / (206) 526-6744 FAX
e-mail: Richard.A.Feely@noaa.gov
http://www.pmel.noaa.gov/co2/co2-home.html

Carbon dioxide ($CO_2$) is one of the most important "green-house" gases in the atmosphere affecting the radiative heat balance of the earth. As a direct result of the industrial and agricultural activities of humans over the past two centuries, atmospheric $CO_2$ concentrations have increased by about 100 ppm. The atmospheric concentration of $CO_2$ is now higher than experienced on Earth for at least the last 800,000 years, and is expected to continue to rise, leading to significant temperature increases in the atmosphere and oceans by the end of this century. The global oceans are the largest natural long-term reservoir for this excess heat and $CO_2$, absorbing approximately 85% of the heat and 30% of the anthropogenic carbon released into the atmosphere since the beginning of the industrial era. Recent studies have demonstrated that both the temperature increases and the increased concentrations of $CO_2$ in the oceans are causing significant changes in marine ecosystems. Many marine organisms are already affected by these anthropogenic stresses, including impacts due to ocean acidification. Dr. Feely will discuss the present and future implications of increased $CO_2$ levels on the health of our ocean ecosystems and related ocean-based economies.

### Biographical Sketch

Dr. Richard A. Feely is a Supervisory Oceanographer at the NOAA Pacific Marine Environmental Laboratory in Seattle. He also holds an affiliate full professor faculty position at the University of Washington School of Oceanography. His major research areas are carbon cycling in the oceans and ocean acidification processes. He received a B.A. in chemistry from the University of St. Thomas, in St Paul, Minnesota in 1969. He then went onto Texas A&M University where he received both an M.S. degree in 1971 and a Ph.D. degree in 1974. Both of his post-graduate degrees were in chemical oceanography. He is the co-chair of the U.S. CLIVAR/$CO_2$ Repeat Hydrography Program. He is also a member of the U.S. Science Steering Committees for the U.S. Carbon Cycle Science Program, the U.S. Ocean Carbon and Climate Change Program, and the U.S. Carbon and Biochemistry Program. He is a member of the American Geophysical Union, the American Association for the Advancement of Science and the Oceanography Society. Dr. Feely has authored more than 160 refereed research publications. He was awarded the Department of Commerce Gold Award in 2006 for his pioneering research on ocean acidification. In 2007, Dr. Feely was elected to be a Fellow of the American Geophysical Union.

# Arctic
# Ecosystem Perspectives, Fish and Fish Habitat, Seabirds & Marine Mammals

Thursday 22 January 2009
1:30 – 5:00 PM
**Session Chair: Ana Sirovic**
**Alaska Pacific University**

TALKS

| Speaker | Title |
|---|---|
| **Carrie L Parris** | **Advanced Monitoring Initiative: Arctic Coastal Data Mining and Assessment Project** |
| Brian Peter Vere Hunt | Zooplankton biogeography as a measure of oceanographic change in Canada Basin (Arctic) |
| Sarah Mincks | Epibenthic megafauna in the Northern Bering and Chukchi Seas: Environmental influences on community structure |
| Elizabeth Logerwell | Beaufort Sea Survey: Geographic and Historical Comparisons |
| Jennifer L Nielsen | Arctic cisco genetics and otolith microchemistry |
| Steffen Oppel | Importance of the Eastern Chukchi Sea and Southeastern Beaufort Sea as Spring Staging Areas for King and Common Eiders |
| Lori T. Quakenbush | Fall Movements of Bowhead Whales in the Chukchi Sea |
| Julien Delarue | A year-long acoustic monitoring program of bowhead whales in the Chukchi Sea |
| S. Bruce Martin | Ambient Noise in the Chukchi Sea, July 2007 - July 2008 |
| Lisanne A.M. Aerts | Sounds from an Offshore Oil Production Island and Bowhead Whale Call Characteristics |
| Marjo Hannele Laurinolli | Study of walrus distribution in the Chukchi Sea using passive acoustics |
| Brendan Cummings | The Polar Bear, a Warming Arctic, and the Endangered Species Act: the Role of Wildlife Law in Responding to Climate Change |
| *** Student Presentation** | |

**Change from Abstract Book**

# Arctic

POSTERS

| Climate and Oceanography | |
|---|---|
| **First Author** | **Title** |
| Carin J. Ashjian | Impact of inter-annual variability in ocean conditions on bowhead feeding near Barrow, Alaska |
| Jeremy Kasper* | Modeling circulation in the landfast ice zone |
| Helen V. Wiggins | SEARCH: Study of Environmental Arctic Change--A System-scale, Cross-disciplinary, Long-term Arctic Research Program |
| Wendy K. Warnick | Arctic Synthesis Collaboratory: A Virtual Organization for Transformative Research and Education on a Changing Arctic |
| James E. Overland | Study of Environmental Arctic Change (SEARCH) Sea Ice Outlook |
| **Ecosystem Perspectives** | |
| Brian D. Bornhold | Seabed Habitat Mapping - Eastern Canadian Arctic |
| Sang Lee | High protein assimilation of the phytoplankton in the Chukchi Sea |
| R. John Nelson | Canada's Three Oceans - Arctic and Arcto-Boreal Pelagic Ecosystem Research. |
| **Lower Trophic Level** | |
| Stephen R Okkonen | Upwelling and aggregation of zooplankton on the western Beaufort shelf as inferred from moored acoustic Doppler current profiler measurements |
| **Fish and Fish Habitat** | |
| Scott W. Johnson | Arctic Nearshore Fishes: Establishing a Baseline in a Dynamic Environment |
| **Mammals** | |
| Michael Foley Cameron | Seasonal movements, habitat selection, foraging and haul-out behavior of adult bearded seals in the Chukchi Sea. |
| **Janet Clarke** | **Marine Mammal Occurrence in the Northeastern Chukchi Sea, Alaska: Comparison of Data from Autumn 1989-91 and Autumn 2008** |
| Laura Morse | Marine Mammal Occurrence in the Northeastern Chukchi Sea, Alaska Summer 2008 |
| Erich H. Follmann | Will Sea Ice Reduction Facilitate the Transfer of Diseases from Terrestrial to Marine Mammals in the Arctic? |
| Kimberly T. Goetz | Bowhead Whale Feeding Ecology Study (BOWFEST) Aerial Surveys: A Comparison of Bowhead Whale Distribution and Survey Effort in 2007 and 2008 in the Vicinity of Barrow, Alaska |
| Henry P. Huntington | The Implications of Climate Change for Arctic Marine Mammals: Key Findings from a Supplement to Ecological Applications |
| ***Student Presentation** | |

**Change from Abstract Book**

*Poster: Arctic - Mammals*

# Marine Mammal Occurrence in the Northeastern Chukchi Sea, Alaska: Comparison of Data from Autumn 1989-91 and Autumn 2008

Janet Clarke, SAIC, janet.clarke@saic.com
Laura Morse, National Marine Mammal Laboratory, National Marine Fisheries Service, laura.morse@noaa.gov
Dave Rugh, National Marine Mammal Laboratory, National Marine Fisheries Service, dave.rugh@noaa.gov

Broad-scale aerial surveys for marine mammals in the northeastern Chukchi Sea were conducted in autumn 2008 after a hiatus of 17 years. The study area extends from the northwestern Alaskan coast westward to the International Dateline at 169°W, between 68° and 72°N (surveys in 1989-1991 were conducted north to 73°N). The area overlays Lease Sale 193 of the Chukchi Sea Planning Area, and surveys are being conducted to collect information on marine mammals undergoing seasonal migrations through these lease areas and associated waters. Broadscale surveys were previously conducted in this area from 1989-91. Changes in late autumn prevailing sea ice between 1991 and 2008 have been monumental, and there are concerns over the effect of later-developing sea ice on marine mammal populations. Sightings of cetaceans, including bowhead (*Balaena mysticetus*), gray (*Eschrichtius robustus*), and beluga (*Delphinapterus leucas*) whales and walrus (*Odobenus rosmarus*) in autumn 2008 are compared to sightings of the same species in autumn 1989-1991. Results presented here are preliminary. This is the first year of a multiyear study sponsored by the Minerals Management Service, Alaska OCS Region.

# Communicating Ocean Science Workshop

**January 19, 2009**
**8 a.m. to 1:30 p.m.**
Hotel Captain Cook Foredeck (Ballroom)
2009 Alaska Marine Science Symposium

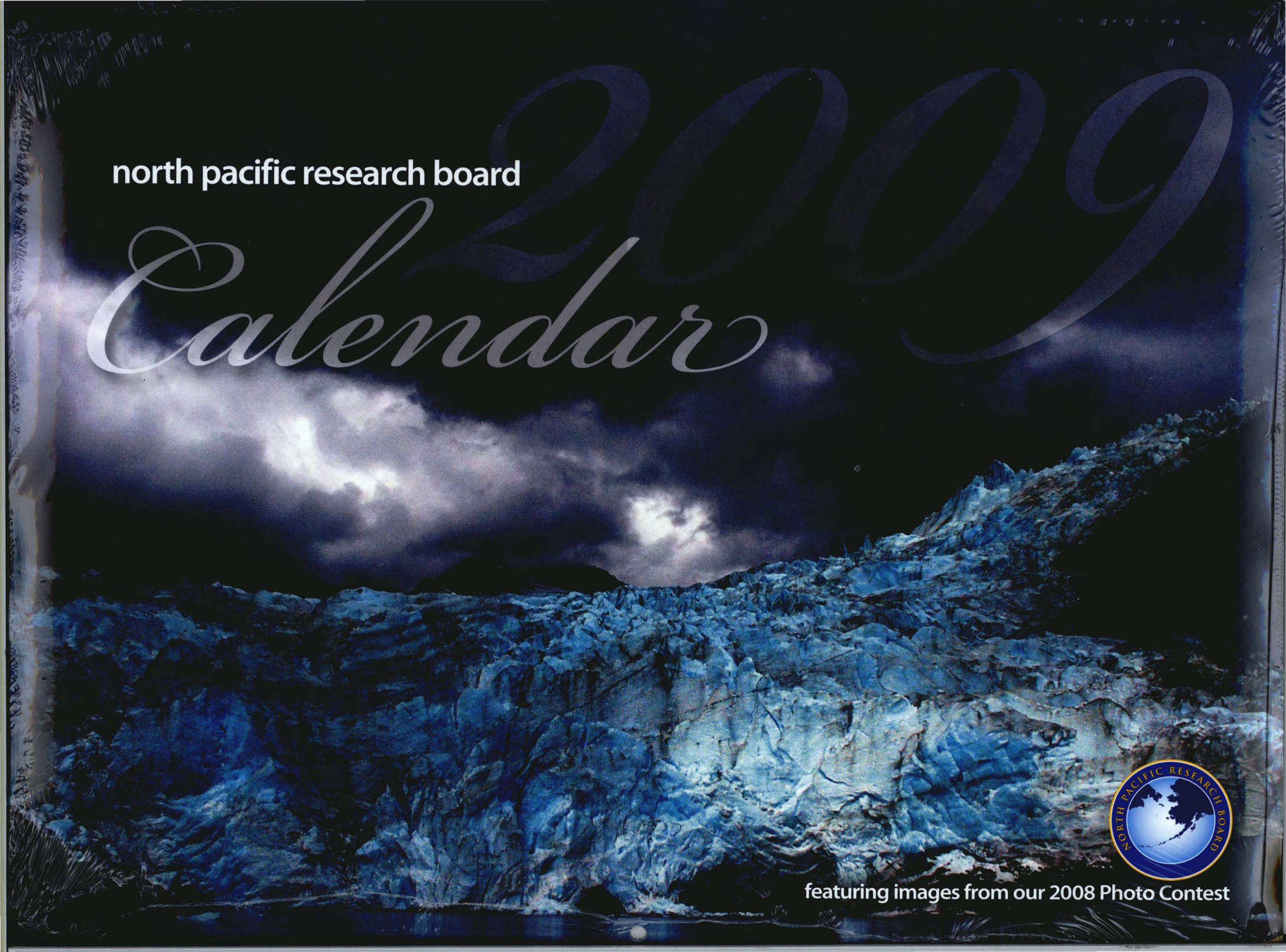
**Hosted by**
**COSEE Alaska, North Pacific Research Board and Alaska Ocean Observing System**
**Nora L.Deans, Moderator**

## GOALS

- Share programs and events that communicate information about research in Alaska's oceans to national, regional and local audiences.
- Join SEANET (Scientists and Educators of Alaska Network) - a network of those focusing on communicating ocean science in Alaska.

## AGENDA

| | |
|---|---|
| **8:00 am - 8:15 am** | **Welcome, Introductions** - Nora L. Deans, COSEE Alaska |
| **8:15 am - 8:30 am** | **Alaska Sea's and Rivers** - Marla Brownlee, Alaska Sea Grant and Marilyn Sigman, Center for Coastal Alaskan Studies |
| **8:30 am - 9:30 am** | **Communicating Ocean Science at Sea - Scientists and Teachers Sharing Research Experiences in Remote Locations** - Janet Warburten, Kristen Timm, PolarTREC ARCUS; Lee Cooper, University of Maryland |
| **9:30 am - 9: 45 am** | **Discussion** |
| **9:45 am - 10:15 am** | **Sharing Science by Visualizing Data** - Rob Bochenek, Information Architect, Axiom Consulting and Design |
| **10:15 am - 10:45 am** | **"Don't Zoom, Don't Pan" Tips for taking videos in the field** - Deborah Mercy, Alaska Sea Grant |
| **10:45 am - 11:00 am** | **Discussion** |
| **11:00 am - 11:45 am** | **COSEE Alaska: People Oceans and Climate Change** - Nora L. Deans, COSEE Alaska |
| **12:00 pm - 1:15 pm** | **SEANET -- LUNCH provided** |


north pacific research board
Calendar
2009
NORTH PACIFIC RESEARCH BOARD
featuring images from our 2008 Photo Contest












# The North Pacific Research Board

funds research to build a clearer understanding of the North Pacific, Bering Sea and Arctic Ocean ecosystems that enables effective management and sustainable use of marine resources.

Our 2009 Calendar features stunning images of sea life and seascapes from the 2008 NPRB Photo Contest.

Pollock fleet near the Russia-Alaska border, Bering Sea.
— Mark Rauzon

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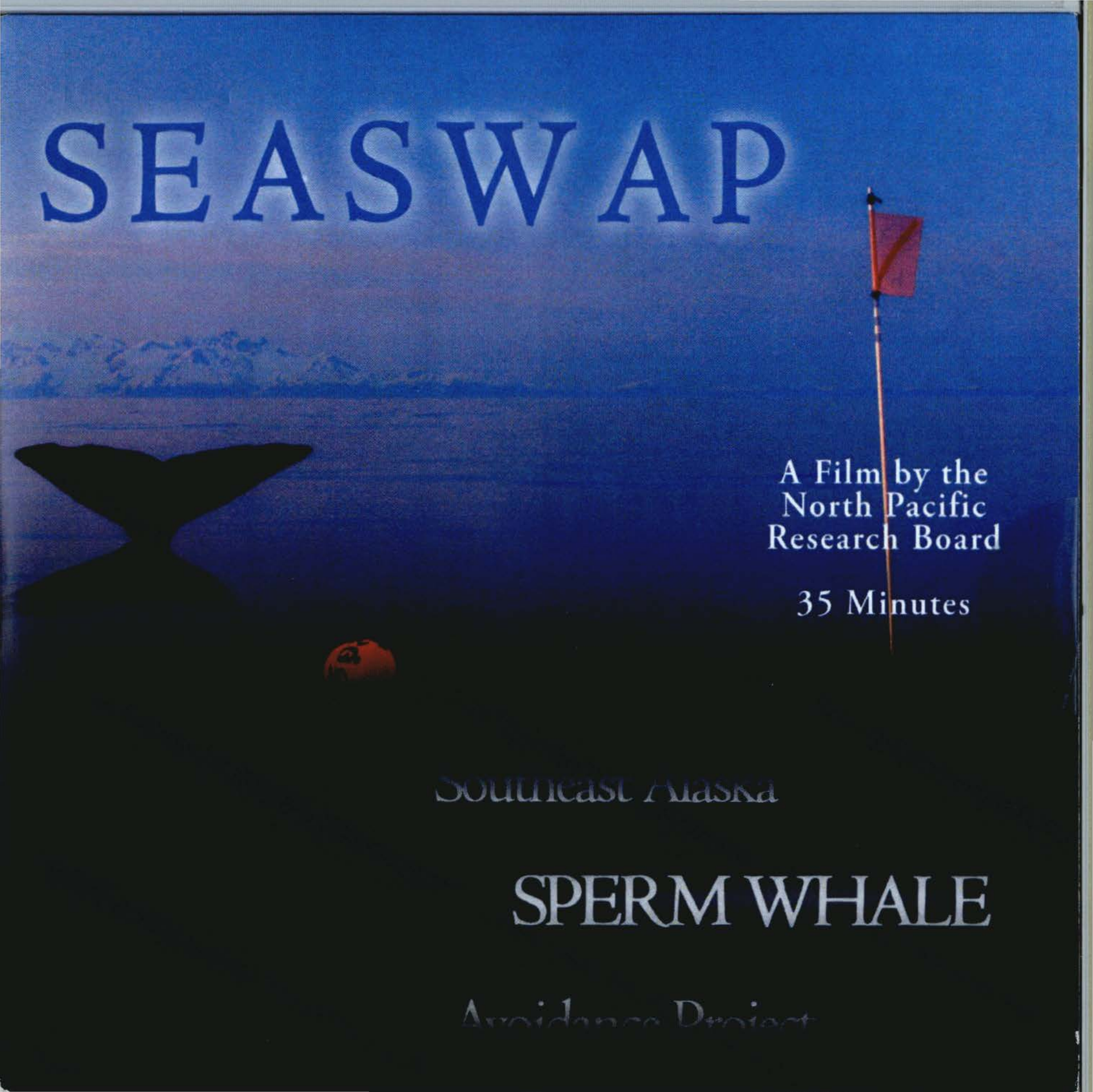
Published under NOAA Grant No. NA07NMF4720082.

# SEASWAP



A Film by the
North Pacific
Research Board

35 Minutes

Southeast Alaska

## SPERM WHALE

Avoidance Project

# SEASWAP

Alaska commercial fisherman Kendall Folkert works hard for his catch. Long hours on the boat can lead to disappointment and financial trouble when crafty sperm whales steal black cod off his longline gear. A team of researchers joins Kendall in the North Pacific to outwit the clever animals.

Whale researchers Aaron Thode (Scripps Institution of Oceanography) and Jan Straley (University of Alaska Southeast) join forces in a unique collaboration with fishermen and fisheries managers to understand the signals prompting sperm whales to the fishing vessel Cobra. Watch as these individuals give you a look inside their work, marvel at the ingenuity of this endangered species off the coast of Alaska, and experience how fishing and science come together to stymie these creatures from getting an easy meal.

www.nprb.org

**EXECUTIVE PRODUCER | PRODUCER** Michael Illenberg
**PRODUCER | DIRECTOR | CINEMATOGRAPHER | EDITOR** Kelly D. O'Brien
**MUSICAL SCORE** Joe Nathan Cosio

35 minutes

This video was created by the North Pacific Research Board in collaboration with the Alaska SeaLife Center.




A Production of the
North Pacific Research Board

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Anchorage, Alaska 99501
907 644 6700
www.nprb.org

# 2009 Alaska Sea Grant CATALOG

Free

Field Guide to Sharks, Skates, and Ratfish of Alaska

page 3

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# About the Publisher

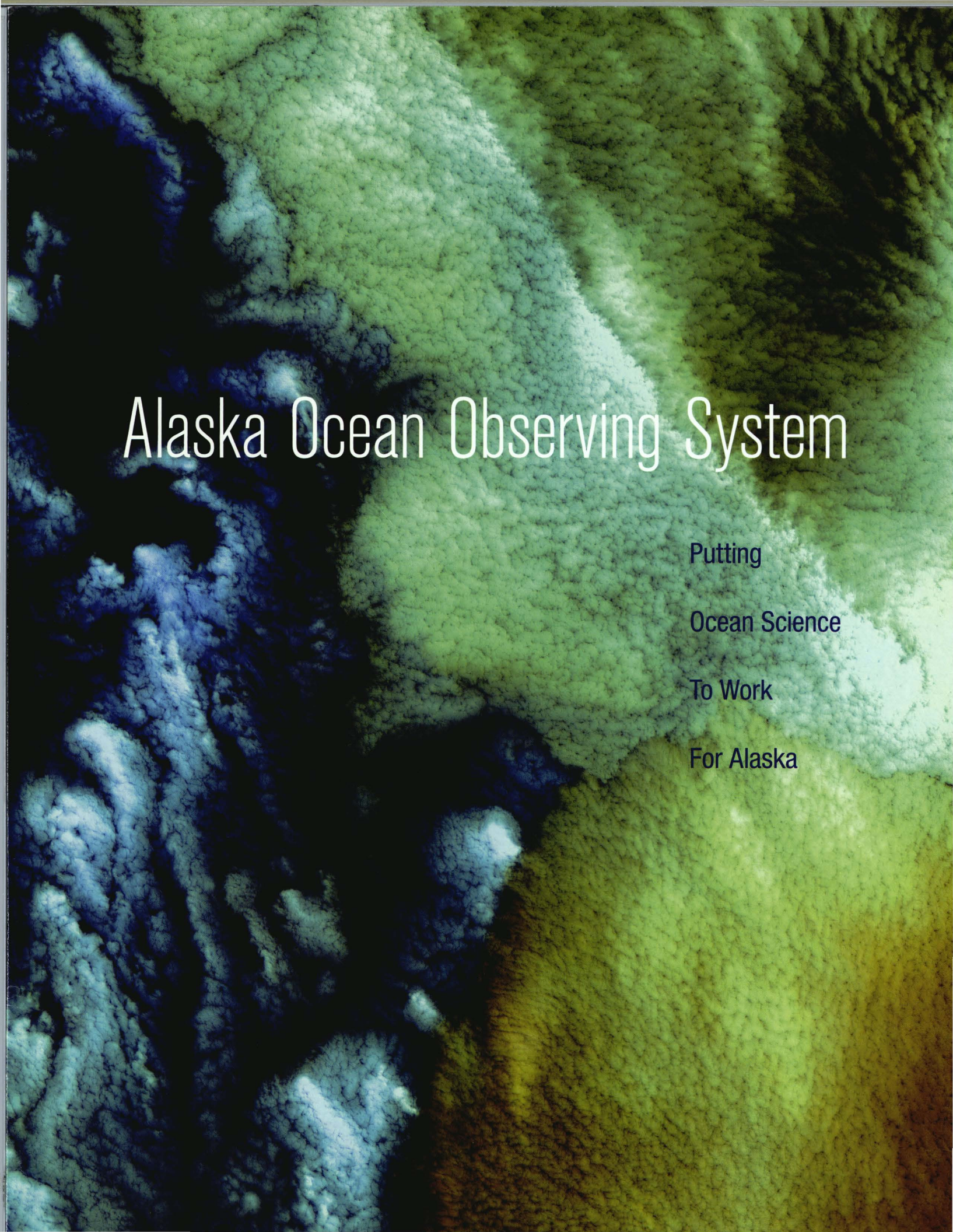
Alaska Sea Grant has published hundreds of books and other products to help Alaskans, and all Americans, understand and more wisely use our precious ocean waters. Alaska Sea Grant helps bolster the long-term value of Alaska's marine resources by funding scientific research. Reports on new discoveries reach the public via publications and videos in this catalog, and through a statewide network of Marine Advisory agents. Proceeds from the sale of the publications and videos help fund marine education. Alaska Sea Grant is part of the National Oceanic and Atmospheric Administration's National Sea Grant College Program, a partnership of 30 state programs and 300 colleges and universities serving millions of people. **Visit us at alaskaseagrant.org.**

Sea Grant
Alaska


**Alaska Sea Grant College Program**
University of Alaska Fairbanks
P.O. Box 755040
Fairbanks, AK 99775-5040
phone (907) 474-6707 • fax (907) 474-6285
toll free (888) 789-0090 (U.S. and Canada)
fypubs@uaf.edu • www.alaskaseagrant.org



*Catalog design and layout by Dave Partee.*
*Cover photo of spotted ratfish (Hydrolagus colliei) courtesy Thomas Kline.*



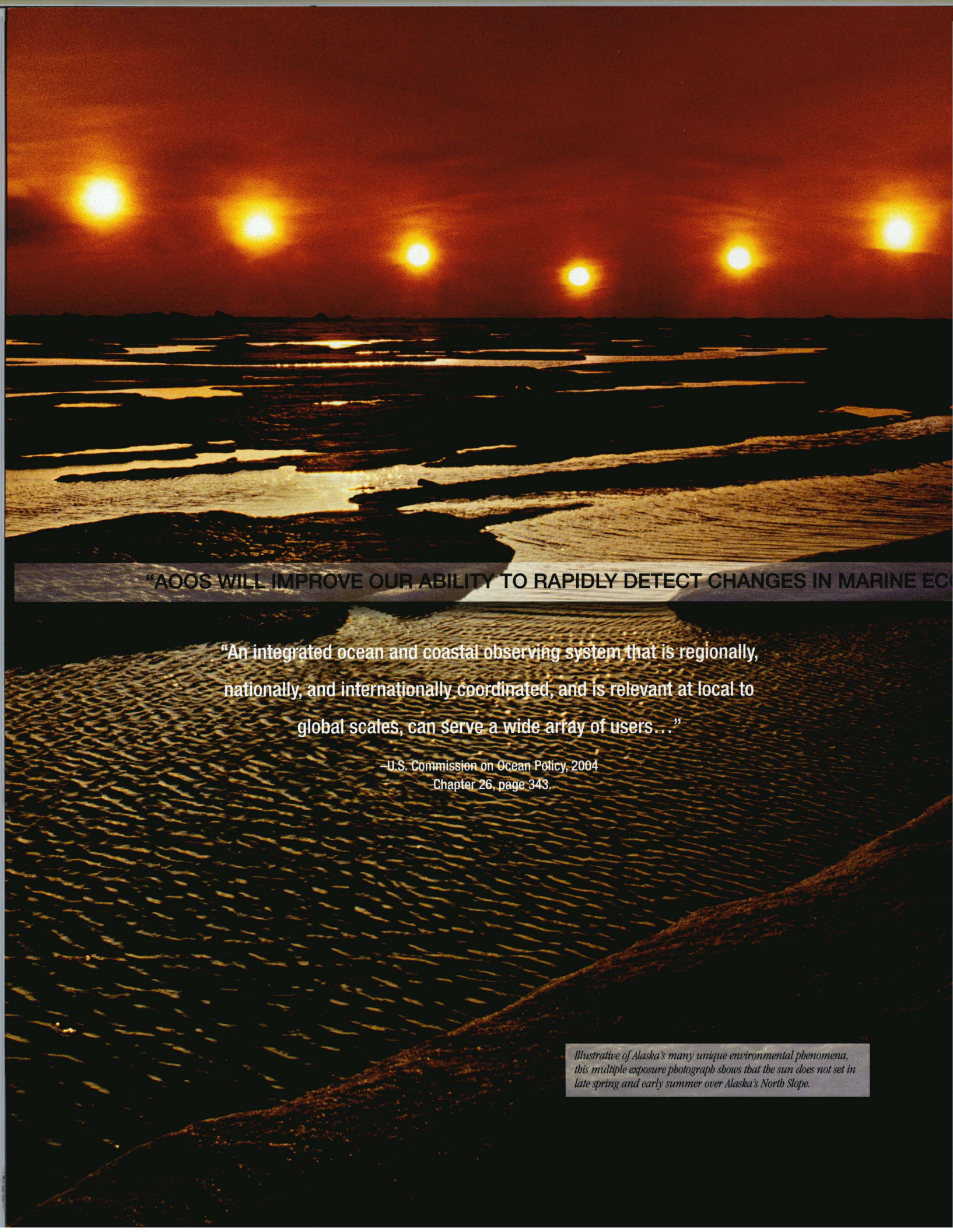
# Alaska Ocean Observing System

Putting

Ocean Science

To Work

For Alaska



"AOOS WILL IMPROVE OUR ABILITY TO RAPIDLY DETECT CHANGES IN MARINE EC

"An integrated ocean and coastal observing system that is regionally, nationally, and internationally coordinated, and is relevant at local to global scales, can serve a wide array of users…"

–U.S. Commission on Ocean Policy, 2004
Chapter 26, page 343.

*Illustrative of Alaska's many unique environmental phenomena, this multiple exposure photograph shows that the sun does not set in late spring and early summer over Alaska's North Slope.*

# What Is the Alaska Ocea

### Imagine the Benefits of Forecasting Conditions on Alaska's Seas as Routinely as Meteorologists Forecast the Weather.

- Maritime shippers would be able to take advantage of favorable currents while avoiding heavy seas, ice-choked straits, and strong headwinds.
- Fishermen could pinpoint the likely location of nutrient and temperature "hotspots" to find fish more efficiently.
- Subsistence users would have better forecasts of sea ice conditions.

Such benefits are the goal of the Alaska Ocean Observing System (AOOS)—a federal, state, and private partnership that will collect coastal and ocean observation data and make it available in useful ways to a broad audience of Alaska stakeholders.

*A network of tsunami-sensing buoys, known as DART, deployed by NOAA in the North Pacific Ocean, is a component of AOOS.*

*AOOS will help scientists understand, integrate, and track changes in sea ice, and convey their information to marine industries.*

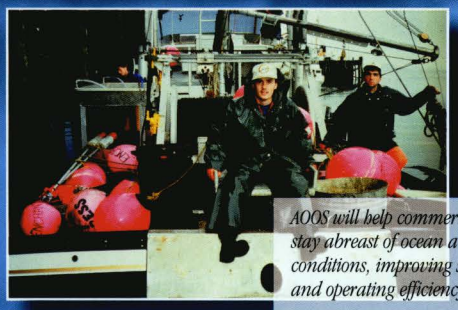
## SYSTEMS AND LIVING RESOURCES AND PREDICT FUTURE CHANGES AND THEIR CONSEQUENCES

- Shellfish farmers would be able to take steps to protect their crops when ocean conditions become ripe for spawning crop-damaging diseases.
- Resource managers would see changes occurring in the ocean in "real time," and be able to respond with better management.
- Coastal communities could be better warned and prepared for conditions that cause coastal erosion.
- Detailed maps of currents would allow for faster, more efficient cleanup of oil spills.
- Search and rescue teams could save lives by having more detailed information about winds and currents.

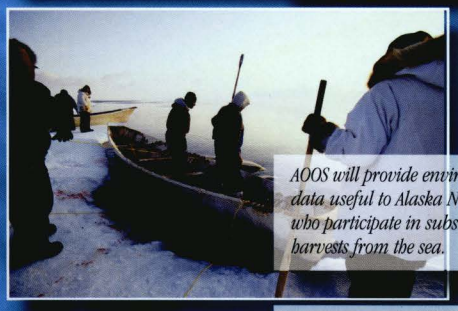
### What Is the Alaska Ocean Observing System?

AOOS is a network of air-, land-, and sea-based instruments that collect a host of valuable oceanographic, atmospheric, and biological data, which are then turned into information and tools for Alaskans to use.

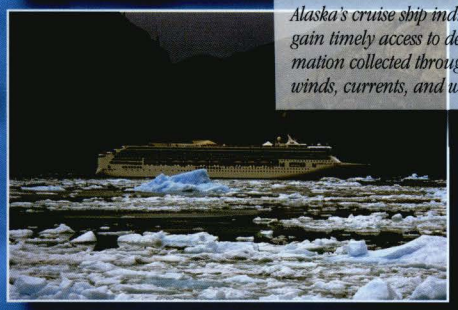
Moorings and buoys already in place, as well as other sensors envisioned for the future, will collect information about winds, currents and wave height, salinity, sea ice, precipitation, and other parameters. Satellites and land-based radar will monitor sea temperature, seasonal and fast-ice extent and thickness, cloud cover, and springtime



*AOOS will help commercial fishermen stay abreast of ocean and weather conditions, improving safety at sea and operating efficiency.*



*AOOS will provide environmental data useful to Alaska Native groups who participate in subsistence harvests from the sea.*



*Alaska's cruise ship industry will gain timely access to detailed information collected through AOOS about winds, currents, and waves.*

# n Observing System?

plankton blooms. Researchers on ships will feed their data into the AOOS information system. Direct observations by Alaskans themselves, as well as the local and traditional knowledge kept by Alaska Natives, will play vital roles.

AOOS will deliver real- and near real-time information—call them ocean "nowcasts" and forecasts—about our ever-changing marine environment. Over time, the information can reveal long-term trends about Alaska's ocean ecosystem and marine life.

The vast amounts of data collected by AOOS partners will be offered as tailored products—ocean forecasts, maps, and images—to meet the needs of mariners, fishermen, subsistence users, scientists, resource managers, coastal planners, educators, emergency response officials, and many others who use and depend on the sea.

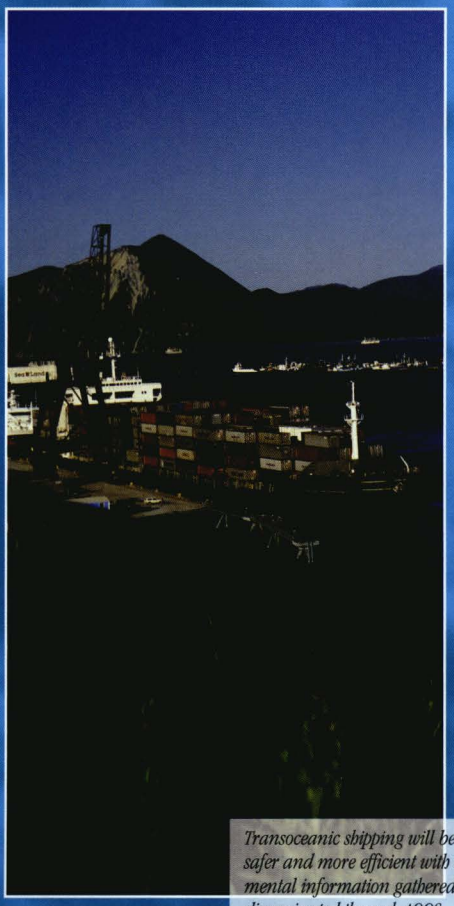
## Why Do We Need AOOS?

Alaska has 44,000 miles of tidal shoreline, more than twice that of the rest of the United States combined. Vast, often dangerous seas flank the state on three sides. More than 80 percent of Alaskans reside along the coast and make their living directly or indirectly from what the sea provides. Indeed, our seas are our lifeblood. Approximately 40 percent of the U.S. seafood catch is harvested from Alaska's waters. The sea yields other resources as well. About 15 percent of the nation's oil supply comes from within Alaska's coastal zone. Cruise ships ply our seas, bringing more than one million wide-eyed visitors to the state each year.

The sea also brings natural disasters. Tsunamis, undersea earthquakes, storm surges, shoreline erosion, and sea ice all pose threats to Alaska coastal communities. Scientists agree that the global climate is warming, and that the Arctic and subarctic, including Alaska's seas, are experiencing major changes as a result. Many of these impacts, such as coastal erosion already being experienced by some Alaska communities, are the direct result of Alaska's changing marine environment.

While much information is collected about our oceans today, there is no coordinated effort to package the information in practical, useful ways that can help Alaska stakeholders cope with the multitude of changes they now face and will face in the future. AOOS will serve as a centralized program to gather, sort, store, and share ocean observations to help us better understand, prepare for, and respond to our changing seas, including the potential to save lives and benefit the Alaska economy.

**S FOR THE PUBLIC GOOD."** – MOLLY MCCAMMON, DIRECTOR, ALASKA OCEAN OBSERVING SYSTEM



*Transoceanic shipping will become safer and more efficient with environmental information gathered and disseminated through AOOS.*

## Our Vision

To provide easy access to information about the physical, chemical, and biological states of Alaska's oceans and coastal ecosystems.

## Our Mission

To develop and maintain a network of ocean and coastal observations for Alaska stakeholders, used to generate informational products and tools for informed decision-making to ensure sustained use of the marine environment.

## Science Working for You, and Alaska's Oceans.

*AOOS will facilitate dissemination of information collected by the National Polar-orbiting Operational Environmental Satellite System (NPOESS), which collects data on oceanic, terrestrial, atmospheric, and near-space environments.*

## How Will It Work?

AOOS will organize around three regions: the Arctic, Bering Sea/Aleutians, and Gulf of Alaska. Observing platforms will be established in each region to collect and send data to the University of Alaska Fairbanks. Because Alaska is so remote and conditions are extreme, setting up and maintaining observing stations will be a challenge. But once they are established, AOOS will join a growing worldwide network of ocean observing systems.

The U.S. Commission on Ocean Policy strongly supports the creation and funding of a national network of regional ocean observing systems. In Alaska, AOOS will be driven by the needs of a diverse group of stakeholders which includes shippers, Alaska Native communities, oil and gas developers, fishermen and women, resource managers and regulators, and others.

## Who Will Make AOOS a Reality?

A broad-based partnership of state, federal, university, and private organizations has been formed to meet the needs of Alaska's marine stakeholders. Partners include the University of Alaska, National Oceanic and Atmospheric Administration, North Pacific Research Board, Alaska SeaLife Center, Arctic Research Commission, Barrow Arctic Science Commission, Alaska Sea Grant, Prince William Sound Science Center, and industry groups such as fisheries and shipping associations. Federal funding is expected to finance a national ocean observing system composed of regional systems, including one in Alaska. Internationally, the Global Ocean Observing System is working to link U.S. efforts with those of other countries as part of the Global Earth Observing System of Systems.

*Oceanographers aboard a NOAA research ship prepare to deploy data-gathering instrumentation attached to a subsurface mooring buoy.*

For more information:

www.aoos.org

Alaska Ocean Observing System
1007 West Third Avenue, Suite 100
Anchorage, Alaska 99501
Phone: 907-644-6703

For additional ideas see:

www.oceancommission.gov/

*The cover illustration is a satellite image of clouds over the western Aleutian Islands. Color variations are likely due to differences in air temperature and the size of water droplets in the clouds. Image was acquired by the Landsat 7 satellite, and provided by the USGS EROS Data Center Satellite Systems Branch.*

*Midnight sun: ©2005 Arend/Soucek/Alaska Stock.*
*Tsunami buoy: National Data Buoy Center.*
*Two fishermen: Photo by Kurt Byers/Alaska Sea Grant.*
*Pan ice & oil rig: ©2005 Chris Arend /Alaska Stock.*
*Native group: ©2005 Oakley Cochran/AlaskaStock.*
*Cruise ship: ©2005 Mark Kelley/Alaska Stock.*
*Container ship: ©2005 Chris Arend/Alaska Stock.*
*Mooring buoy: Photo by Terry Whitledge, UAF/IMS.*
*Text by Doug Schneider, and editing and photo research by Kurt Byers, Alaska Sea Grant College Program.*
*Design by Phil Raymond, Genesis Design and Media.*

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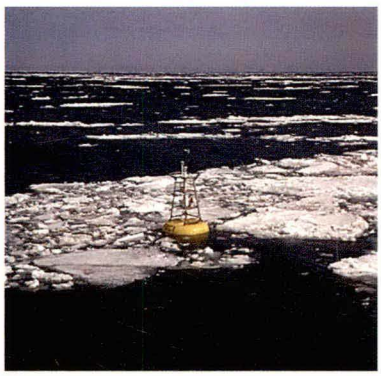
AOOS Quarterly
www.aoos.org
January 2008

## Record Shattering Summer for Arctic Sea Ice

On September 16, 2007, Arctic sea ice reached the lowest level in the 28-year satellite record—an annual minimum extent of 4.13 million square kilometers, according to the National Snow and Ice Data Center (NSIDC). This shatters the previous record from September 21, 2005, of 5.32 million square kilometers, and was over 1.6 million square kilometers below the long-term average calculated over the years 1979 to 2000. An area north of the Chukchi and East Siberian seas, roughly the size of California (about 450,000 square kilometers), was completely ice-free for the first time. For more about the disappearing sea ice, visit the NSIDC Arctic Sea Ice News Web page. ■

http://nsidc.org/news/press/2007_seaiceminimum/20070810_index.htm

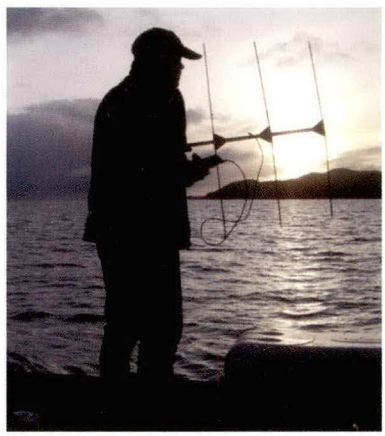


## Arctic Sea Ice and Ocean Information System Priorities for 2008-2010

During its fall meeting, the AOOS Board approved a conceptual design for the program's 2008-2010 coastal and ocean observing priorities. Visit www.aoos.org to view both the overview and more comprehensive design. These priorities became the foundation of the funding request sent to NOAA in early December. AOOS Regional Coastal and Ocean Information System is the highest priority. This project focuses on acquiring, displaying, and archiving the most important marine data in Alaska; broadening website access and developing new visualization and decision-making tools; expanding access to processed remote sensing data of ocean parameters; and launching the development of an operational analysis center in Alaska. Another top priority involves continued testing of a prototype "end-to-end" system in Prince William Sound, which moves from user needs to observations to data management to modeling. Plans for a 2009 field experiment are still underway. The Board also determined that enhancing observing capacity in Alaska's Arctic nearshore region was of paramount importance. Plans call for creating a nearshore sea ice atlas, monitoring sea ice movement in three communities in real time, and greatly expanding the monitoring of sea ice thickness as the most direct way to improve sea ice forecasts. ■

## Conceptual Designs Drive AOOS Priorities

To lay the foundation for determining AOOS priorities, staff focused intently for six months on creating and reviewing draft comprehensive conceptual designs, looking at the issues and products identified through the multitude of stakeholder and user outreach activities held over the past four years. They identified existing observations and models that could produce products, as well as gaps in observations and modeling. In August, these were reviewed by a Scientific-Technical Advisory Team representing a broad spectrum of expertise and geographic regions. During the workshop, the team prioritized products to be developed for the next 3-5 years on the basis of critical need and feasibility. In concert with these, the Institute of Social and Economic Research (ISER), located at the University of Alaska, first reviewed other programs that used some form of socio-economic criteria for developing priorities and provided guidance for doing so as part of the AOOS process.



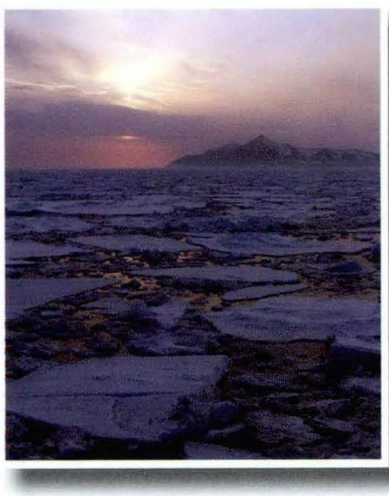
ISER and AOOS staff organized a Socio-Economic Team, which met on September 17 to develop a suite of socio-economic criteria that would serve as a second filter for reviewing the priorities. Criteria included costs, benefits, and risks. The AOOS Board met on October 2 and set AOOS conceptual design priorities for the next three years based on the recommendations and information from both the Scientific-Technical Team and the Socio-Economic Team. A paper describing this process will be submitted to a peer-reviewed journal. ■

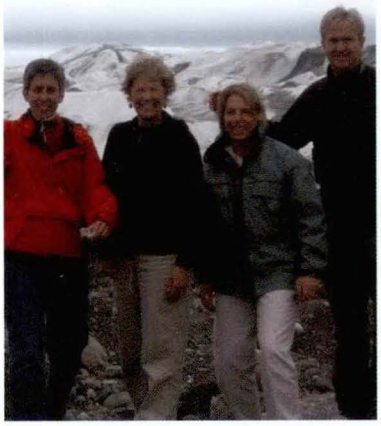
**Alaska Ocean Observing System**
1007 West Third Avenue
Suite 100
Anchorage, Alaska 99501
(907) 644-6703

For the latest AOOS Outreach, visit
**www.aoos.org**

## Arctic Environmental Data Exchange Roundtable

AOOS and the University of Alaska's International Polar Year program, under the leadership of Dr. Hajo Eicken, hosted a roundtable discussion on October 11, in conjunction with the International Oil and Ice Conference in Anchorage, to explore ways to share environmental data among scientific researchers, state and federal managers, and the oil and gas industry. New observing initiatives, such as the AOOS and Arctic Observing Network, as well as the International Polar Year, are resulting in significant observation efforts that should be of interest to industry from the perspective of environmental monitoring, improving design criteria for specific locations and oil-spill mitigation and response efforts. At the same time, industry is collecting environmental data that in the short- or long-term are of significant value in helping to understand and adapt to the changing Arctic marine environment. This was the first, informal meeting to explore options and to initiate an exchange among different groups collecting environmental data. The roundtable agenda, summary and a draft white paper can be accessed on the AOOS website, at www.aoos.org. The response was very positive, and the group agreed to focus on sea ice data as an initial effort. ■





*Timi Vann, Molly McCammon, Zdenka Willis and Jack Harlan at Spencer Glacier outside Cordova, Alaska.*

## AOOS Hosts New IOOS Program Office Director

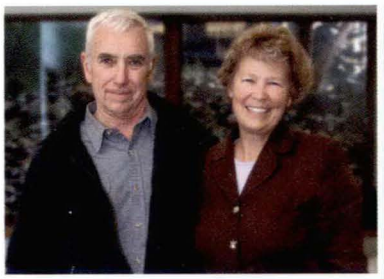
In June, AOOS hosted three members of the newly established NOAA Integrated Ocean Observing System (IOOS) Program Office: director Zdenka Willis, strategic planning director Timi Vann, and HF radar team lead Jack Harlan. The group visited the AOOS Data Management Team and HF Radar group at the University of Alaska Fairbanks, and toured observing activities in Kachemak Bay (including the NOAA Kasitsna Bay Lab, the Kachemak Bay National Estuarine Research Reserve, and the USFWS Maritime Refuge). The site visit ended in Prince William Sound with a ferry tour and briefings in Cordova. ■

## State of Alaska Signs AOOS MOA

The commissioners of three state resource agencies have signed onto the AOOS Memorandum of Agreement, officially marking state support for the mission and goals of AOOS. The three are Commissioner Denby Lloyd, Alaska Department of Fish and Game; Commissioner Larry Hartig, Alaska Department of Environmental Conservation; and Deputy Commissioner Richard Lefebvre, Alaska Department of Natural Resources. ■

## Craig Dorman Steps Down as Chair of AOOS Board

With his retirement as the University of Alaska Vice-President for Research, Retired Vice Admiral Craig Dorman announced that he would officially be leaving the AOOS Board. University of Alaska Fairbanks School of Fisheries and Ocean Sciences Dean Denis Wiesenburg noted that Dr. Dorman was largely responsible for the inception of AOOS, and his vision and leadership would be greatly missed. Vice-chair Tylan Schrock with the Alaska SeaLife Center will serve as Acting Chair. ■



*Craig Dorman and Molly McCammon*

## McCammon NFRA Chair

AOOS director Molly McCammon was unanimously re-elected as chair of the National Federation of Regional Associations (NFRA) for Coastal and Ocean Observing at the organization's annual meeting in St. Petersburg, Florida in November. McCammon has served as chair of NFRA, which represents the interests of the 11 regional ocean observing associations, since its inception in 2005. McCammon also serves as a member of the Ocean Research and Resources Advisory Panel (ORRAP), a formally recognized group that gives advice to federal ocean agencies, and she was recently selected as chair of a new ocean observing sub-panel of that group. ■

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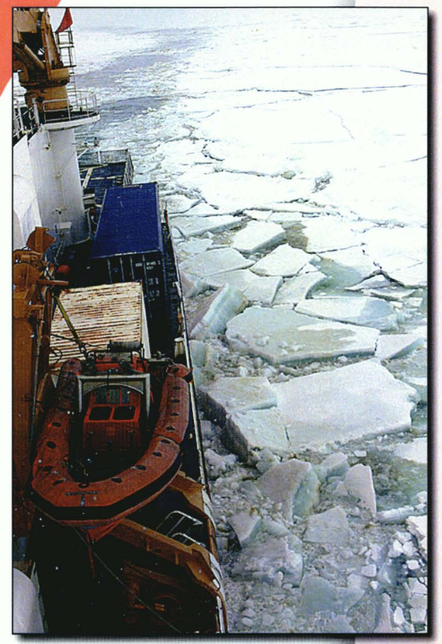
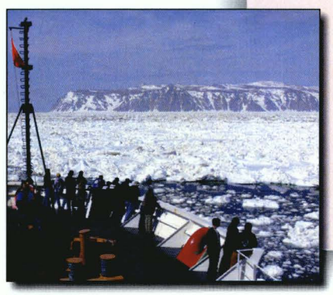


Seagoing vessels often report changing ice conditions to the NWS Ice Forecaster.
Photo: Elizabeth Labunski, USFWS

Seals and other marine mammals, as well as seabirds, depend on the presence of sea ice for rest and protection.
Photo: Kathy Kuletz



Seabird observers and scientists aboard the US Coast Guard cutter *Healy* amid thick sea ice.
Photo: Elizabeth Labunski, USFWS

# WHICH PRODUCTS BEST SUIT MY USES?

## Operational/Applied Users

**Including field camp workers, shippers, US Coast Guard search and rescue teams, and US Navy personnel, as well as whalers and commercial and subsistence fishermen**

These users seek real-time sea ice condition analyses, most often as charts or pictures. They are often on the water, either approaching or already in sea ice, and make navigation decisions based on the most updated information they receive.

### Most Useful Operational Products

- **National Weather Service**
  - » Sea Ice Advisories
  - » Sea Ice Analysis Charts
  - » SST Charts and Sea Ice Forecast charts (important to vessel operators looking for fish and crab, and wanting to avoid freezing spray)
- **National Ice Center**
  - » Northern Hemisphere Ice Charts
  - » Alaska regional ice charts
  - » Products are available in EASE-Grid (gridded binary) and GIS-compatible (selected products only) formats; browse images are GIF files.

## Researchers and Forecasters

**Including climate modelers, sea ice scientists, and climatologists**

Researchers are in a position to take best advantage of many of the products from the National Snow and Ice Data Center, which provides many sea ice data sets in gridded formats, and some in formats that can be easily used with Geographic Information System (GIS) software. Images shown on individual NSIDC web pages are large-scale and not likely to be of immediate use to those at sea. However, more "applied science" users may find these data useful now that National Ice Center chart climatologies are available in GIS as well as gridded formats.

### Most Useful Research Products

- **National Ice Center**
  - » Sea Ice Charts
  - » Climatologies
- **National Snow and Ice Data Center**
  - » Sea Ice Concentrations from passive microwave data
  - » Sea Ice Indices
  - » Arctic Sea Ice Charts and Climatologies

## Feedback and Suggestions

Additional products, such as seasonal sea ice outlooks at the NIC, are under development to better serve user needs. If you have a need for a product that does not currently exist, we'd like to know about it. Please feel free to contact us:

- **National Snow and Ice Data Center:** nsidc@nsidc.org
- **National Weather Service Anchorage Ice Desk:** nws.ar.ice@noaa.gov
- **National Ice Center Liaison:** liaison@natice.noaa.gov

1007 West Third Avenue, Suite 100
Anchorage, AK 99501
tel 907 644 6703 • fax 907 644 6780
www.aoos.org

AOOS Alaska Ocean Observing System

**Sea Ice and Ocean Observing** As part of its mission to develop an integrated ocean observing system for Alaska and the Arctic, the Alaska Ocean Observing System (AOOS) considers sea ice observations to be a key component of an Alaska observing system for the Arctic (Beaufort and Chukchi Seas), the Bering Sea, and Cook Inlet in order to meet stakeholder and resource management needs. In addition, the US Arctic Research Commission (USARC) needs enhanced coastal sea ice observations for Alaska as part of the US contribution to the Arctic Marine Shipping Assessment.

In 2006, AOOS and the USARC established a Sea Ice Working Group (SIWG) to develop strategies for furthering our knowledge of coastal sea ice in Alaska. The SIWG will assess the status of past and current sea ice data for Alaska (Arctic and Cook Inlet), identify gaps in the current observations and research, and provide recommendations to AOOS and to the USARC.

This brochure highlights several **existing, mainly operational** sea ice products for Alaska and will be used to help identify future product needs.

Polar bear photo courtesy National Ice Center

# SEA ICE

## Tools for Measuring and Observing Sea Ice Along Alaska's Coasts

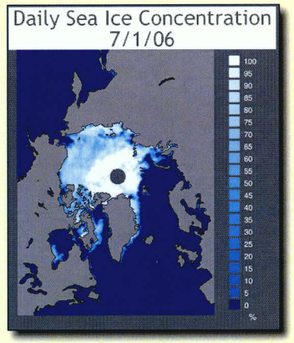
AOOS Alaska Ocean Observing System

www.aoos.org

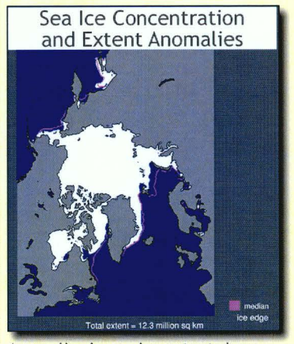
# NATIONAL SNOW AND ICE DATA CENTER

**nsidc.org**

Established to support polar and cryospheric research, NSIDC archives and distributes snow and ice data as well as information about snow cover, avalanches, glaciers, ice sheets, freshwater ice, sea ice, ground ice, permafrost, atmospheric ice, paleoglaciology, and ice cores.




A daily browse image of sea ice concentration derived from passive microwave data. (Updated several times yearly)




Anomalies in sea ice extent show the difference between where the ice edge is on average, and where it is in a particular month. (Updated monthly)

## Sea Ice Concentrations from Passive Microwave Data

NSIDC provides passive microwave data that show sea ice concentrations (percentage of ocean area covered by sea ice), including daily and monthly averages for polar regions. Images and data set documentation are available at **nsidc.org/data/nsidc-0051.html.**

## Sea Ice Index

Images in the Sea Ice Index data set depict average ice conditions, which are estimated using passive microwave data for the most recent month are available, as well as "snapshots" that compare recent conditions with monthly means. Images, animations and documentation are available at **nsidc.org/data/seaice_index/.**

## Arctic Sea Ice Charts and Climatologies

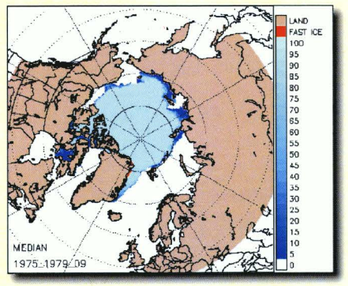
Sea ice concentration climatologies (aggregations of historic climate trends) are derived from the National Ice Center's ice charts. Monthly climatologies include median, maximum, and minimum concentrations, as well as frequency of occurrence of ice for 33-year, 10-year, and 5-year periods. This data set is an important alternative to passive microwave-derived ice concentration, which underestimates summertime ice presence. Data files and documentation are available at **nsidc.org/data/g02172.html.**

## Most Frequent Users

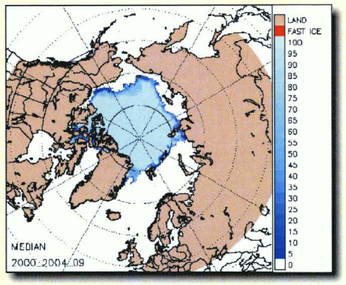
Sea ice and climate scientists are the major users of these products. NSIDC distributes other research sea ice data, including many from relatively high-resolution sensors (e.g., NASA Earth Observing System satellites). However, the Data Center expects more non-research users since climatologies are now available in GIS and gridded formats. Summaries of all of NSIDC's sea ice products are available at **nsidc.org/data/seaice/.**

## Benefits and Limitations

Products from passive microwave data and data sets based on operational charts have complementary strengths and weaknesses. Passive microwave products have coarse resolutions of 25 km or greater, but are consistent over the entire time series and can therefore be used to derive trends in ice concentration. Arctic Sea Ice Charts and Climatologies are based on operational data that are not consistent over the entire series.




Median sea ice concentration climatology for September for 1975-1979.




Median sea ice concentration climatology for September for 2000-2004.

# NOAA NATIONAL WEATHER SERVICE

**http://pafc.arh.noaa.gov/ice.php**

The Anchorage Weather Forecast Office (WFO) assists the NWS mission to protect life and property and enhance the nation's economy with 24-hour sea ice support. This includes advisories, analysis and short-term forecasts available in text and .gif image formats. Future dissemination includes GIS data (beginning March 2007) and inclusion in the National Digital Forecast Database.

Graphics and descriptions for each of these products are available at **http://pafc.arh.noaa.gov/ice.php.**

## Sea Ice Advisories

Sea Ice Advisories (text only) describe ice conditions in Alaska waters out to five days, and are issued every Monday, Wednesday, and Friday with updates as needed. Advisories also include monthly seasonal outlooks and climatological ice year comparisons. WFO Anchorage issues Marine Weather Statements to warn coastal and at-sea users of dangerous conditions including flash freezes and Ivus/ice shoves (sea ice run-ups on beaches).

## Sea Ice Analysis Charts

These charts are 1km-resolution graphics for Cook Inlet and the Bering/Beaufort/Chukchi Seas with emphasis on the ice edge and shorefast conditions; they are issued in conjunction with Sea Ice Advisories.

## Sea Ice Forecast Charts

Five-Day Sea Ice Forecasts display "snapshots" of ice conditions expected five days from the issuance date. Interim ice conditions are described in Sea Ice Advisories.

## Sea Surface Temperature (SST) Charts

SST charts are produced every Tuesday and Thursday for the north Pacific and Arctic Oceans from Russia's Kamchatka Peninsula to British Columbia.

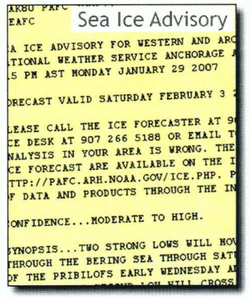
## Most Frequent Users

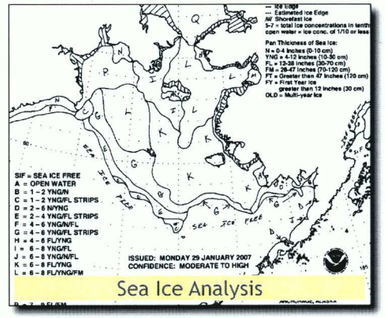
WFO Anchorage provides 24-hour support specifically for Alaska users: emergency managers concerned about ice formation/concentration and coastal erosion impacts, government agencies, subsistence hunters and fishermen, commercial fishing fleets, boat operators, energy and shipping industries, and navigation safety partners.

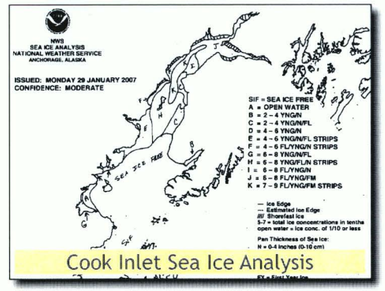
## Benefits and Limitations

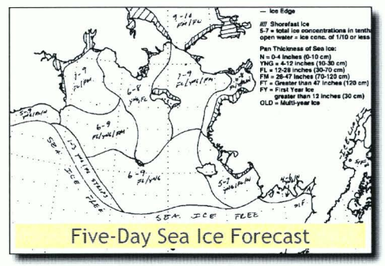
Graphical products are rich in detail but designed for low-bandwidth dissemination so users can obtain these products in remote locations via satellite internet and HF Radiofax services. Beginning in March, the Sea Ice Analysis will be available in GIS format with the intention of expanding digital services to all graphical sea ice products. Five-Day Sea Ice Forecasts display end results of ice conditions and movement at day 5, but does not display fluctuations that may occur.

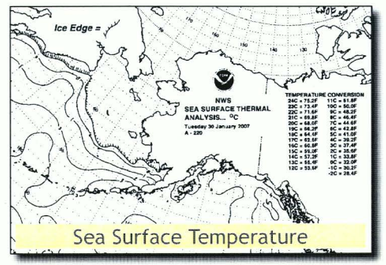
**See the back panel for a summary of which products best suit different users.**



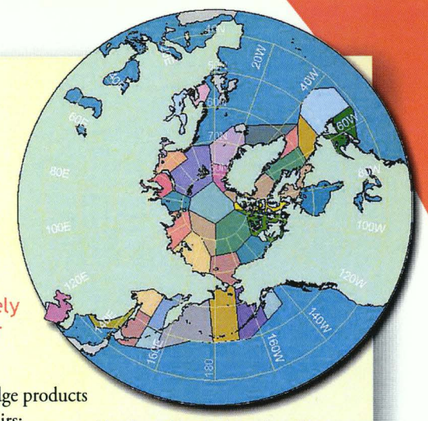




# NATIONAL ICE CENTER (NIC)

**www.natice.noaa.gov/**

NIC is operated by the US Navy, NOAA and the US Coast Guard. Since 1972, NIC has produced sea ice charts using in situ, remotely sensed, and model data for regions containing sea ice.



Northern Hemisphere Ice Charts: Interactive map of sea ice regions

Digital products include sea ice-edge products consisting of latitude-longitude pairs; sea ice analysis charts in .gif format; and ArcInfo coverages.

## Northern Hemisphere Ice Charts

NIC produces ice analysis charts for regions in the Arctic, the North Atlantic, the Baltic Sea, the Yellow Sea, the Sea of Okhotsk, and the Sea of Japan that contain sea ice. Charts are available at **www.natice.noaa.gov/products/arctic/index.htm.**

## Alaska Ice Charts

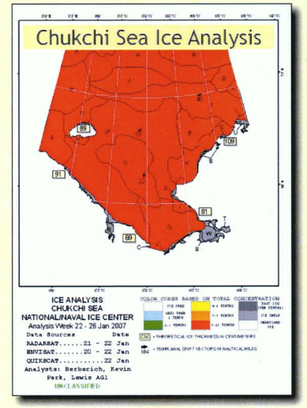
NIC produces Alaska regional analysis charts of current ice conditions for regions in the Beaufort Sea, the Chukchi Sea and the Bering Sea that contain sea ice. Charts are available at **www.natice.noaa.gov/products/alaska/index.htm.**

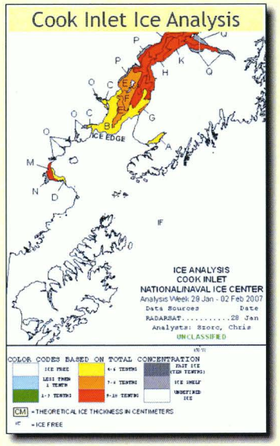
## Arctic Hemispheric Ice Coverage

Northern Hemisphere ice charts are combined and provided as hemispheric analyses in ArcInfo and SIGRID formats. These are available at **www.natice.noaa.gov/pub/arcgis/arctic/arctic_hemi/** (current year) and **www.natice.noaa.gov/pub/Archive/arctic/** (past years).

## Daily Ice Edge and Marginal Ice Zone (MIZ)

NIC analysts adjust daily ice edge contours using additional higher resolution imagery. The MIZ product is similarly generated, but includes the ice edge (ice/no ice boundary) as well as pack ice contour analyses. These are available at **www.natice.noaa.gov/products/edge/index.htm** and **www.natice.noaa.gov/pub/MIZ/.**




## Most Frequent Users

Users of NIC products include both operational users and researchers.

## Benefits and Limitations

NIC charts are used for trip planning and navigation safety. In general, they show more ice than do passive microwave-derived ice concentrations, especially in the summer when passive microwave algorithms can underestimate ice concentration.

# Prince William Sound ...

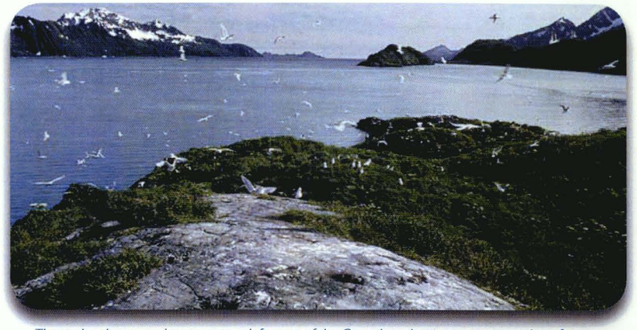
- contains approximately 3,500 miles of coastline, including hundreds of islands;
- has two major entrances: Montague Strait (west) and Hinchinbrook Entrance (east);
- is used extensively by transoceanic shippers, oil tankers, state ferries, fishing boats, cruise ships, sailboats, and kayaks;
- is relatively protected from severe weather in the adjacent Gulf of Alaska; and
- takes in large, seasonal additions of fresh water from rivers and melting glaciers that result in rich marine habitat for plankton, fish, marine mammals, and people.

Since the mean tidal range in Prince William Sound is about three meters, all mariners need to consider the currents created by the ebb and flood of the tides. When winds and waves are also factors, the velocity of the currents can magnify waves to dangerous heights. Currents are also important in the set and drift of vessels in the tanker traffic corridor leading to the Port of Valdez, as well as the trajectory of drifting debris, icebergs and oil spills.

We have been working with state, federal and private groups to strategically establish and maintain moored weather buoys and ocean sensors, as well as land-based surface current radar and SnoTel stations all over the Sound. These measure phenomena such as the speed and direction of wind and ocean currents, water temperature, salinity, and precipitation. We use these data to create complex numerical simulations, or models, of the atmosphere and ocean. We are now refining the models to the point where they can more accurately mimic the phenomena indicated by the observed data—and then forecast what will happen if a variable changes.

This information will be used in products needed by fishers, boaters, recreationists, resource managers and others to make better decisions about how to use the ocean environment.

Our partners in Prince William Sound include Chugach Regional Corporation, the National Data Buoy Center, the National Resources Conservation Service, the Prince William Sound Aquaculture Corporation, the Prince William Sound Regional Citizens' Advisory Council, the University of Alaska Fairbanks, the US Coast Guard, the US Forest Service, and the Village of Tatitlek.



*The rocky shores and temperate rainforests of the Sound are home to many species of seabirds. Photo: Exxon Valdez Oil Spill Trustee Council*

*Glaciers provide huge seasonal inputs of fresh water to the Sound and influence coastal currents. Photo: Exxon Valdez Oil Spill Trustee Council*

*The intricate coastline of the Sound contains many small bays and islets, presenting a challenge to mappers and modelers. Photo: Exxon Valdez Oil Spill Trustee Council*

PRINCE WILLIAM SOUND OIL SPILL RECOVERY INSTITUTE
*www.pws-osri.org/*

PRINCE WILLIAM SOUND SCIENCE CENTER
*www.pwssc.org*

IOOS INTEGRATED OCEAN OBSERVING SYSTEM™
*www.ocean.us/*

AOOS
Alaska Ocean Observing System

1007 West Third Avenue, Suite 100
Anchorage, AK 99501
tel 907 644 6703 • fax 907 644 6780
www.aoos.org

# Alaska Ocean Observing

## A Pilot Project in Prince William Sound

**Improving our ability to observe and forecast changes in Alaska's oceans**

The Alaska Ocean Observing System is building a network of observation platforms and forecast models that will provide information products and tools to improve our understanding of Alaska's ocean ecosystem and allow us to make better decisions about our use of the marine environment.

AOOS
Alaska Ocean Observing System
www.aoos.org

# End-to-End Demonstrations of Ocean Observing: Observe ► Forecast ► Use

## **Observe:** Land- and sea-based platforms record data

### Buoys and Moorings

Telemetered weather buoys operated by NOAA's National Data Buoy Center provide real-time data for modeling ocean circulation. In winter, non-tidal circulation in the Sound results primarily from strong winds and small inputs of fresh water. Summertime non-tidal circulation in the region is driven by buoyancy (freshwater) related effects: winds are weak and freshwater inputs are large from melting glaciers and other runoff from streams.

Oceanographic moorings are located along the continental shelf and at entrances to key embayments to measure seasonal and interannual variation in exchange rates of coastal waters.

### High-Frequency Radar

Two High-Frequency (HF) radar stations have been established at Knowles and Shelter Bays to map surface currents. The remote locations of these stations require the installation and maintenance of independent power sources such as wind turbines, solar panels, and propane generators (Forest Service regulations forbid the use of diesel fuel as a power source). The stations are most useful when both are working; however, maintaining a consistent power source and protecting the instruments from severe weather is an ongoing challenge.

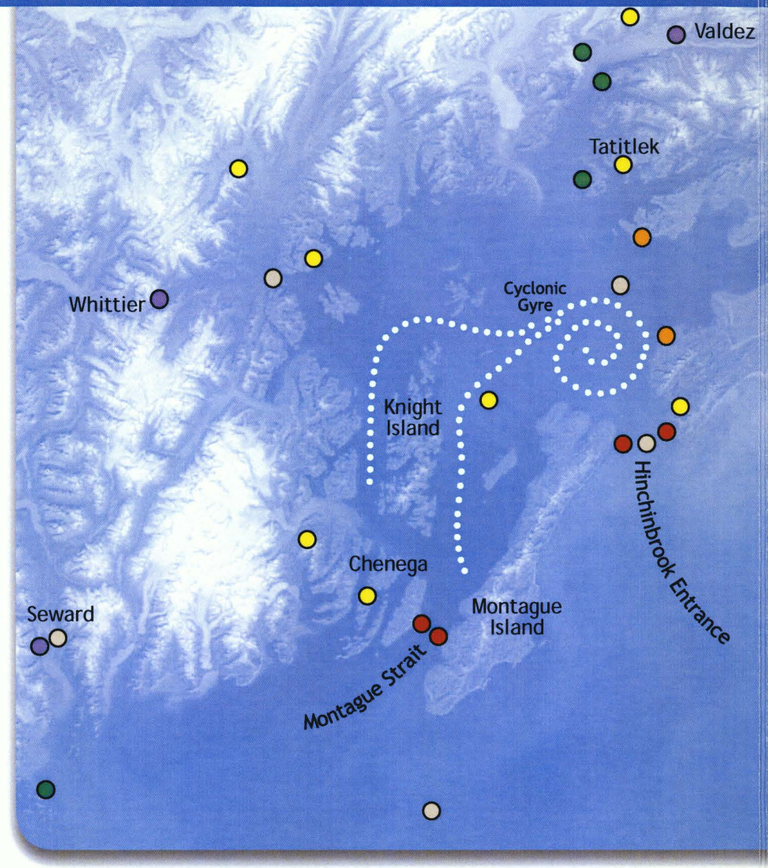
### SnoTel Weather Stations

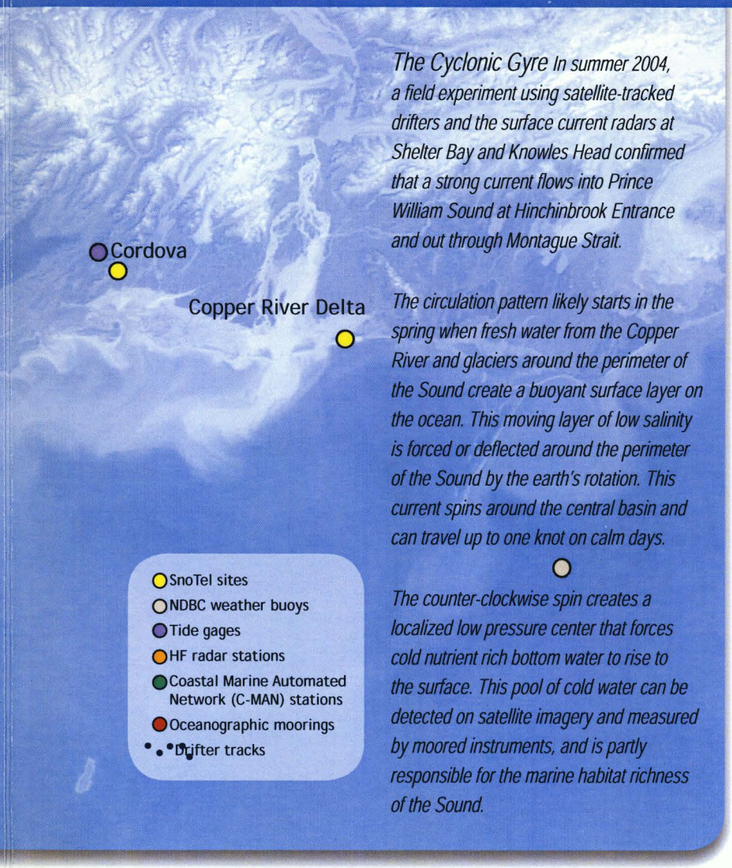
SnoTel weather stations and monthly snow surveys measure accumulated water stored as snow during the winter. The spring melt and runoff is an important driver of coastal ocean circulation and the spring plankton bloom. The stations are designed to operate unattended for one year, using meteor burst technology to communicate precipitation and weather data in near real time.

### Drifting Data Collectors

The trajectories of argosphere, or "argos," drifters (deployed at the surface) and drogues (deployed ten meters underwater) are strongly influenced by wind speed and circulation. Should dispersants be used following an oil spill in the central Sound, results suggest that the trajectory and fate of subsurface oil would likely differ considerably from the trajectory and fate of untreated surface oil. Argos drifters and drogues helped reveal the presence of a summertime cyclonic gyre in the central basin of the Sound.

*Cover photos: Prince William Sound, Exxon Valdez Oil Spill Trustee Council; NOAA buoy, Carl Schoch.*




*The Cyclonic Gyre In summer 2004, a field experiment using satellite-tracked drifters and the surface current radars at Shelter Bay and Knowles Head confirmed that a strong current flows into Prince William Sound at Hinchinbrook Entrance and out through Montague Strait.*

*The circulation pattern likely starts in the spring when fresh water from the Copper River and glaciers around the perimeter of the Sound create a buoyant surface layer on the ocean. This moving layer of low salinity is forced or deflected around the perimeter of the Sound by the earth's rotation. This current spins around the central basin and can travel up to one knot on calm days.*

*The counter-clockwise spin creates a localized low pressure center that forces cold nutrient rich bottom water to rise to the surface. This pool of cold water can be detected on satellite imagery and measured by moored instruments, and is partly responsible for the marine habitat richness of the Sound.*

## **Use:** Information products are online

### The AOOS website provides:

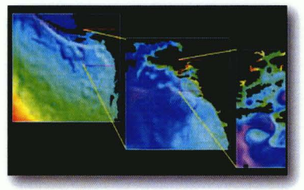
- **Data and information products** from remote observation platforms, such as weather buoys, that provide wind and current speed and direction, wave height, sea temperature and salinity, and more.
- **Weather buoy enhancements,** such as current velocity sensors, for specialized local needs.
- **Processed satellite data** that present Alaska-wide information on sea-surface temperature, ocean color (chlorophyll) and wind.
- **Surface current maps** from high frequency radar for the central basin.
- **Biological data** on fish, birds and marine mammals, the environmental effects of human activities, and any other information that can be used with the physical data to predict future changes to the ocean ecosystem.

## Direct benefits to user groups

AOOS contributes to safety at sea by helping **commercial fishermen** and **transoceanic shippers** stay informed about ocean and weather conditions. AOOS also provides customized data products for the **oil spill response community** and US Coast Guard **search and rescue** teams.

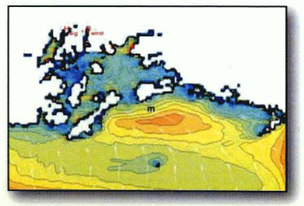
We link **educators** from formal and informal settings by creating exemplary educational resources for use in and outside of Alaska. We work with **local communities,** including Alaska Native groups, that make their living from the sea by providing relevant environmental data for daily decision-making.

## **Forecast:** Computer models forecast the dynamics of the Sound



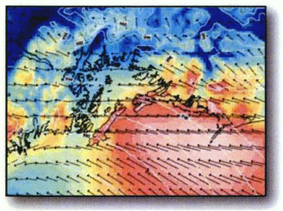
### Circulation: ROMS

A data assimilation Regional Ocean Modeling System (ROMS) for the Gulf of Alaska is being developed by the University of California-Los Angeles (UCLA) and the NASA Jet Propulsion Laboratory (JPL) to simulate offshore, shelf and embayment circulation. These currents vary with seasonal cycles of winds and freshwater runoff and represent an important pathway for organisms and climate perturbations to propagate around the Gulf of Alaska and potentially into the Bering Sea and Arctic Ocean. A coupled circulation-ecosystem model capable of producing real-time and forecasted nutrient concentrations and plankton abundances is now under development at the University of Maine.



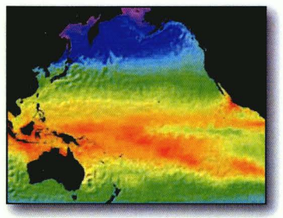
### Waves: SWAN

The grid-based Simulating Waves in the Nearshore (SWAN) model is being developed by Texas A&M University. Satellite and in situ wave observations are used to validate the model and artificial intelligence techniques are being explored to improve model results.



### Weather: RAMS, WRF

The Regional Atmospheric Modeling System (RAMS) and the Weather and Research Forecasting (WRF) model are numerical simulations of atmospheric circulation operated by the Alaska Experimental Forecast Facility (AEFF) at the University of Alaska Anchorage (UAA). They provide accurate meteorological information for use in ocean circulation models and National Weather Service forecasts.



### El Niño Southern Oscillation: ENSO

A Pacific basin-scale numerical model was developed at JPL and will provide boundary conditions for higher resolution coastal models. These coastal models will therefore be linked by the JPL basin-scale model to track the propagation of El Niño Southern Oscillation (ENSO) signals along the coast of North America to the Gulf of Alaska.

# OUR CHANGING COASTS & OCEANS

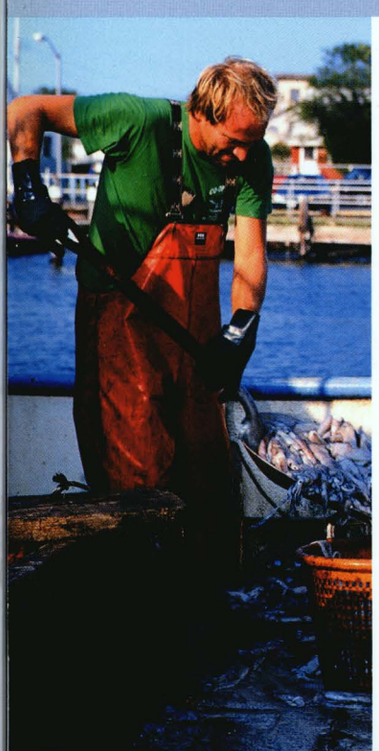
## FORECASTING OUR FUTURE


The National Office for
Integrated and Sustained Ocean Observations

## Secrets of the seas

Oceans and estuaries support the largest store of biodiversity on the planet. Yet, even though we rely on and enjoy the oceans, we know surprisingly little about what goes on inside them. Not because the oceans are impenetrable ... but because our ability to quickly detect and foresee change has been limited. Armed with new knowledge and technology, the stage is set for a revolution in how we study, manage and mitigate changes in oceans and coasts and their resources.

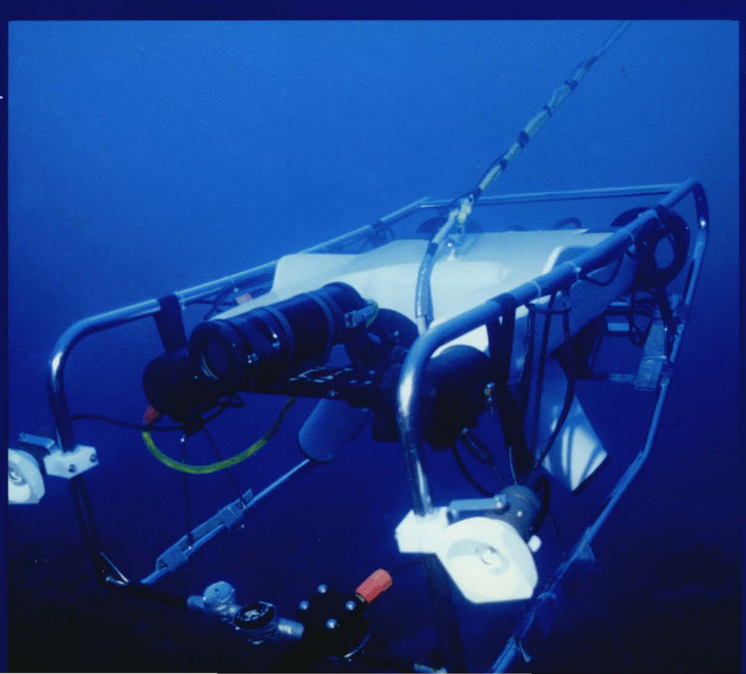
© Uwe Kils



## Depth of impact

Even though we live on land, the oceans affect our lives in many ways. For example, coastal tourism adds $57 billion to the U.S. economy each year! The oceans are an important source of transportation, food, recreation, medicine and minerals. More than half of the people in the United States live in coastal counties. Those living inland connect to the oceans through rivers that make their way to the sea and through air currents flowing over continents and oceans.

© Kip Evans



## Turning the tide

The oceans are the most important factor driving weather and climate. With more accurate storm track predictions, we can reduce the length of coastlines put under hurricane warnings, saving $600,000 to $1 million per mile in evacuation costs. Major climate events, such as El Niño, result from ocean temperature changes. Even a 3°C change can lead to billions of dollars in economic losses. Better predictions will significantly reduce these losses.

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For more information, contact:

Ocean.US
2300 Clarendon Blvd., Ste. 1350
Arlington, VA 22201
www.ocean.us
E-mail: support@ocean.us


Ocean.US

The National Office for
Integrated and Sustained Ocean Observations

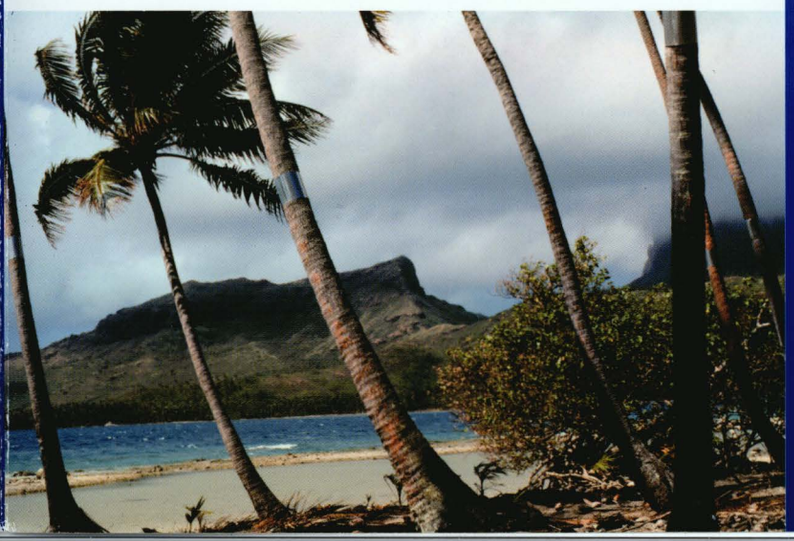
# A sustained and integrated ocean observing system for the U.S.

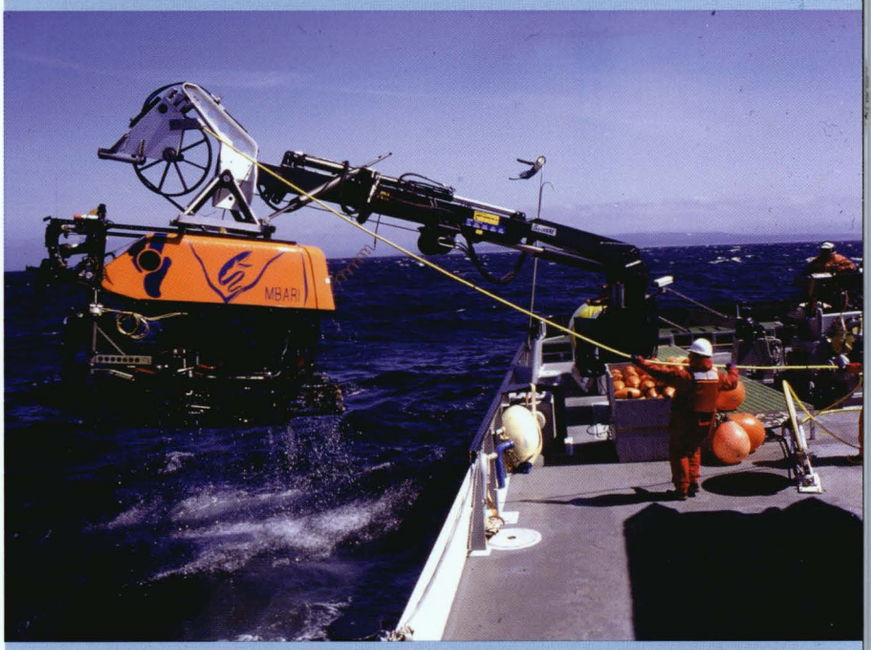
The Integrated Ocean Observing System (IOOS) will be a sustained network of "eyes" on buoys, ships, satellites, underwater vehicles and other platforms that routinely supply the data and information needed for rapid detection and timely predictions of changes in our nation's coastal waters and on the high seas.

As the ocean observing network evolves, we will add to it more systems that improve our ability to observe the oceans or that create new uses for ocean information.

The ocean observing system will take in all of the data collected and make it easily available to the public so it can be used to save lives, benefit the economy and protect the environment and ocean life.

Parts of this system already are in place around the U.S., but they operate independently. Bringing these pieces under one umbrella will make them more useful overall than individually. Ocean information will be available to more people, helping to solve regional and national problems faster.



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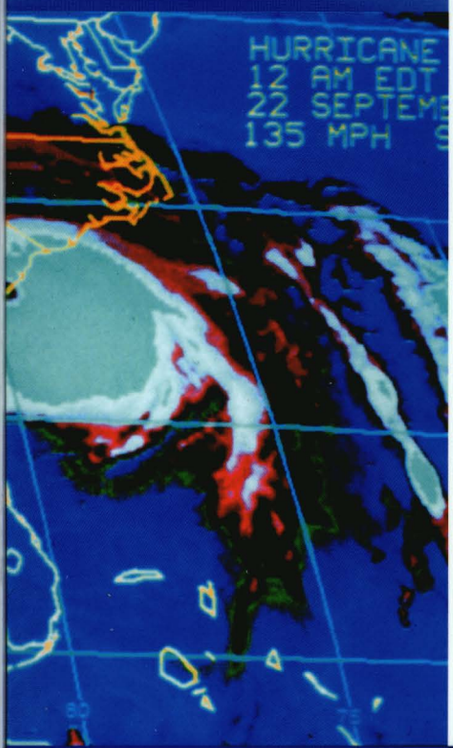
## About Ocean.US

Ocean.US, the "National Office for Integrated and Sustained Ocean Observations," was established by the Congressionally-created National Oceanographic Partnership Program.

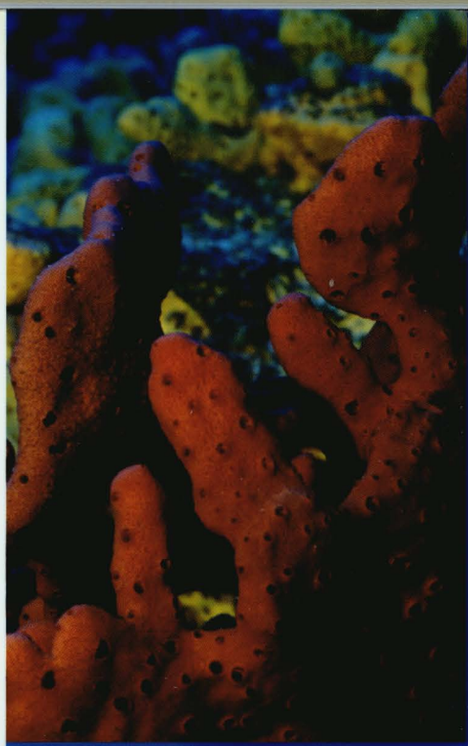
Since its establishment in 2000, Ocean.US has catalyzed the coordinated development of the IOOS, the U.S. contribution to a Global Ocean Observing System.




## Ocean observation: Waves of new information

All of human understanding is based—at some level—on observation. What we know about the land, the air and even space is based on shared observations over time.

Our ability to see into the ocean and to measure its properties improved dramatically during the 20th century. Just as the science of meteorology has given us the means to quickly observe and forecast the weather, the marine sciences are giving us the means to quickly detect and foresee changes in the marine environment — abilities that are vital to the safety, health and well being of people. The establishment of a sustained network of atmospheric measurements has produced rapid advances in meteorology. Likewise, a sustained network of ocean observations will mean more rapid advances in the marine sciences.

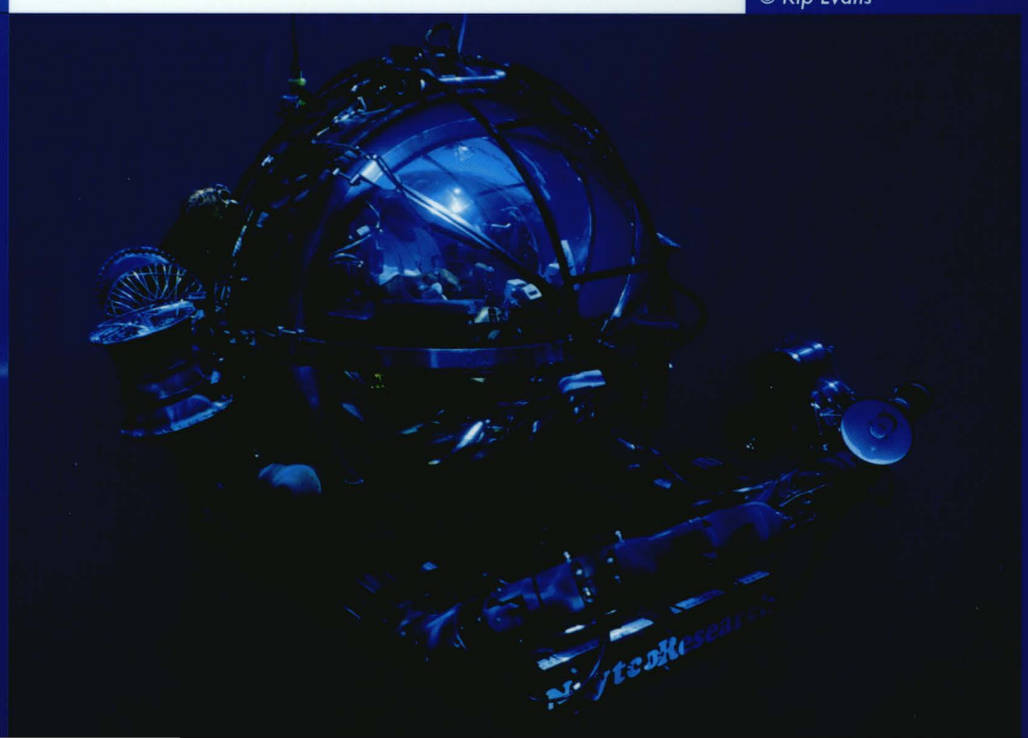






## "All we do is touched with ocean."

— Richard Purdy Wilbur,
Poet Laureate
of the United States



# Informing and inspiring

For centuries, the oceans have captured our imagination, inspired our culture, and motivated great scientific and technological discoveries.

Today we see the dawn of a new era. Sustained ocean observations are revolutionizing the way we experience the oceans — to be in the oceans with all our senses alive. Child and grandparent alike will marvel at the oceans' power and mystery, understand our mutual dependence and commit to stewardship. Youth will be inspired to contribute their energy and talent in careers in science and technology.

# Improving quality of life

Once mature, the ocean observing system will enable the nation to achieve seven important societal goals more effectively.

### Predict weather and climate

Tracking ocean properties that influence weather and climate will help managers reduce damage to property, the economy and even human lives.

### Facilitate safe and efficient marine operations

All maritime enterprises, from transportation to recreation, will benefit from improved predictions of marine conditions.

### Ensure national security

Military activities will benefit from data about wind, waves, visibility, currents, icebergs and sea level gathered by the nationwide system.

### Manage resources for sustainable use

Continued observations of the effects of fishing, pollution and changes in the oceans will help us properly manage these and other living and non-living resources for future generations.

### Preserve health and restore degraded ecosystems

The system will give early warnings of environmental stress and let us lessen or prevent negative impacts before it's too late.

### Mitigate natural hazards

Lives and property will be saved when we can better forecast and prepare for hurricanes, floods, droughts and storm surges using measurements from the system.

### Ensure public health

Information about ocean currents from the network will help us identify pollution sources and reduce or prevent dangerous impacts on humans and the food we eat.

# Understanding Ecosystem Processes in the *Bering Sea*

A HISTORIC SIX-YEAR PARTNERSHIP BETWEEN THE NORTH PACIFIC RESEARCH BOARD AND THE NATIONAL SCIENCE FOUNDATION 2007-2012

Todd Warshaw/NPRB

bsierp.nprb.org

SEPTEMBER 2008

BERING SEA INTEGRATED ECOSYSTEM RESEARCH PROGRAM

BERING ECOSYSTEM STUDY

The North Pacific Research Board and the National Science Foundation are supporting a comprehensive, $52 million study of the eastern Bering Sea ecosystem from 2007–2012. Ninety-four federal, state, university, and private institution scientists are studying a range of issues in the Bering Sea—from atmospheric forcing and physical oceanography to humans and communities—including the attendant economic and social impacts of a changing ecosystem.

The scientific foundations for this large, innovative program are the National Science Foundation's 2005 Bering Ecosystem Study (BEST) Program Implementation Plan and the North Pacific Research Board's Bering Sea Integrated Ecosystem Research Program (BSIERP), which is based on NPRB's 2005 Science Plan. This foundation supports research to improve understanding of how the Bering Sea may respond to climate change, particularly as mediated through changes in seasonal sea ice cover.

### Work supported by the National Science Foundation (NSF)

- **Climate, oceanography, and lower trophic levels:** Benthos, primary production near sea ice, nutrients, modeling, meso-zooplankton, micro-zooplankton, euphausiids, biophysical moorings, and physical oceanography
- **Social science research:** Relationships between a changing marine environment and Bering Sea communities

### Work supported by the North Pacific Research Board (NPRB)

- **Climate, oceanography, and lower trophic levels:** Benthos, micro-zooplankton, biophysical moorings, and physical oceanography
- **Forage species:** Euphausiids, myctophids, and capelin
- **Fish:** Arrowtooth flounder, Pacific cod, and walleye pollock
- **Marine mammals:** Fur seals, walrus, and broad-scale whale distribution
- **Seabirds:** Thick-billed murres, black-legged kittiwakes, and broad-scale seabird distribution
- **Local and traditional knowledge (LTK):** Subsistence harvest and LTK ecosystem perspectives
- **Education, outreach, and communication**

### Work supported by NSF and NPRB

- **Ecosystem modeling**
- **Data management**

## Bering Sea

stormy, cold, bountiful

Eli Gurarie

Todd Warshaw / NPRB

Carrie Eischens

# Why

## Why Study the Bering Sea?

Alaska's Bering Sea fisheries provide nearly half of the seafood consumed in the U.S., forming a powerful economic engine for fishing communities and the core of an ocean-based subsistence lifestyle.

Whales, seals, and seabirds travel from afar to feed and mate here. Fur seals breed on island rookeries, while walrus haul out on sea ice to bear young. Whales and porpoises feast on huge schools of smaller fishes and tiny planktonic crustaceans. Orcas hunt other whales, seals, or salmon. Sea otters forage in kelp forests, plucking invertebrates from the seafloor.

Nearly half of Alaska's seabirds live in ten colonies in the Bering Sea. Some 36 million seabirds breed here, including shearwaters, fulmars, kittiwakes, albatrosses, storm-petrels, puffins, and murres.

Climate change and reduced ice cover could significantly impact the Bering Sea ecosystem. We seek to understand the mechanisms that create and sustain this highly productive ecosystem, and how they may be altered over time as our climate changes.

Background: Mark Rauzon / NPRB

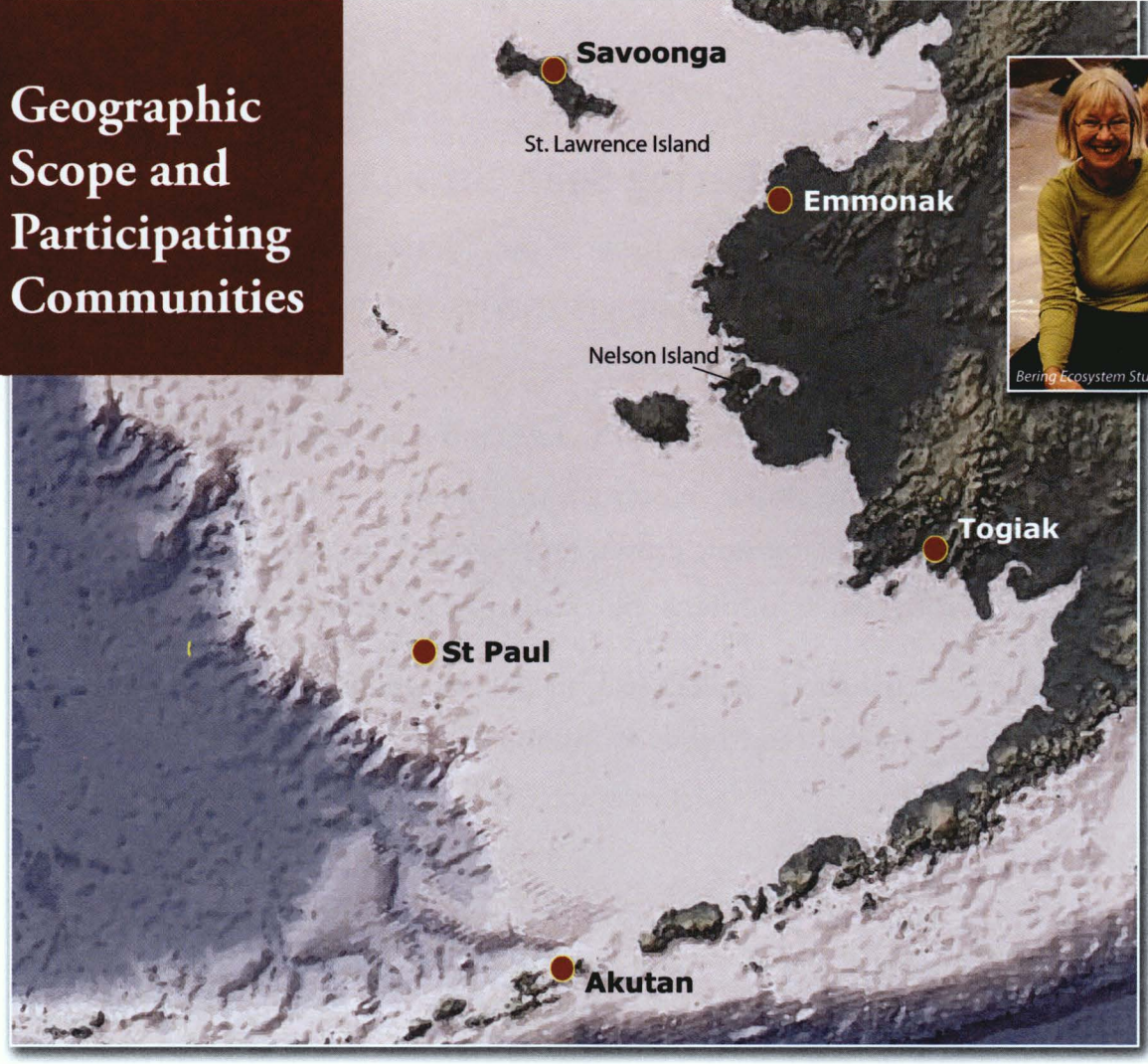
Tom Van Pelt

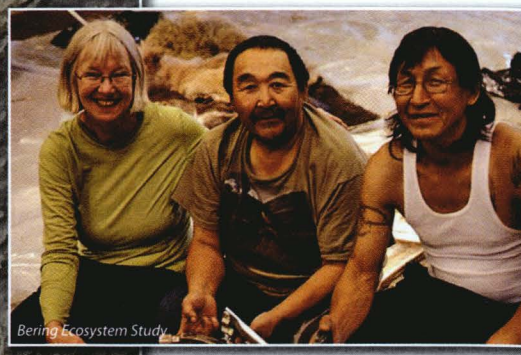
John Platt

Russ Hopcroft


Alaska Ocean Observing System / NOAA

# Geographic Scope and Participating Communities

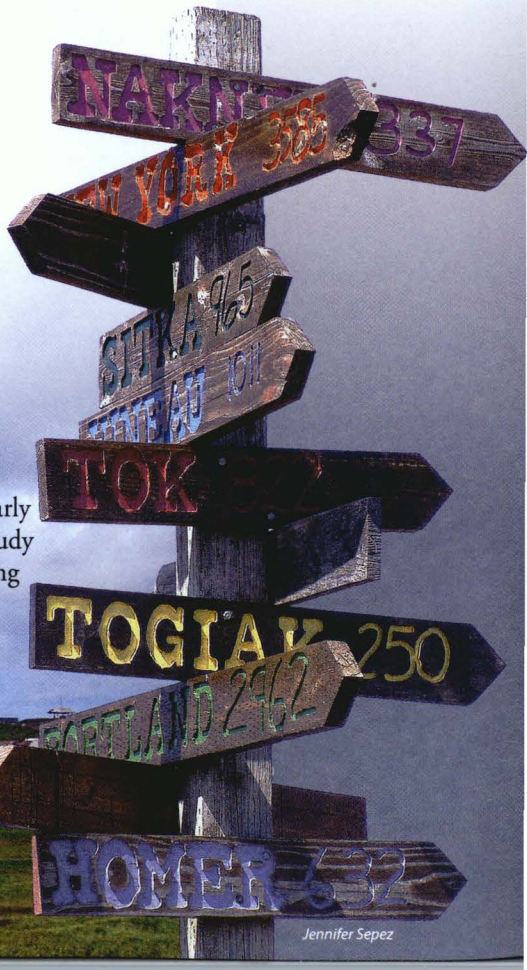




Bering Ecosystem Study

Research is taking place on the eastern Bering Sea shelf between the Aleutian Islands and St. Lawrence Island. Communities participating in this study are Savoonga, Emmonak, Togiak, St. Paul, and Akutan, as well as several communities in the Nelson Island area. All have a history of research on local and traditional knowledge and/or subsistence harvest surveys, which will provide useful information and a basis for identifying long-term trends and changes.

Local and traditional knowledge (LTK) involves information, understanding, and wisdom accumulated over time based on experience and often shared within a group. This knowledge forms the basis for people's beliefs and practices concerning their environment. In the Bering Sea, indigenous communities have thrived since time immemorial, based in large part on understanding where to find and how to use the resources provided by the ecosystem. Particularly for a region such as this, where scientific research is comparatively recent and access for such study is often difficult and expensive, LTK offers a substantial contribution to collective understanding of the ecosystem, its changes, and the implications for people and their environment.


Michael Downs

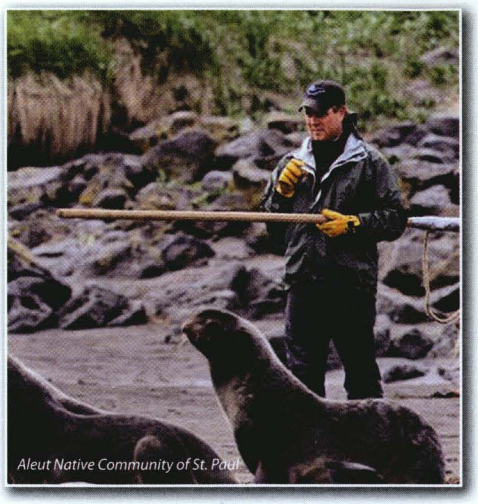


Jennifer Sepez

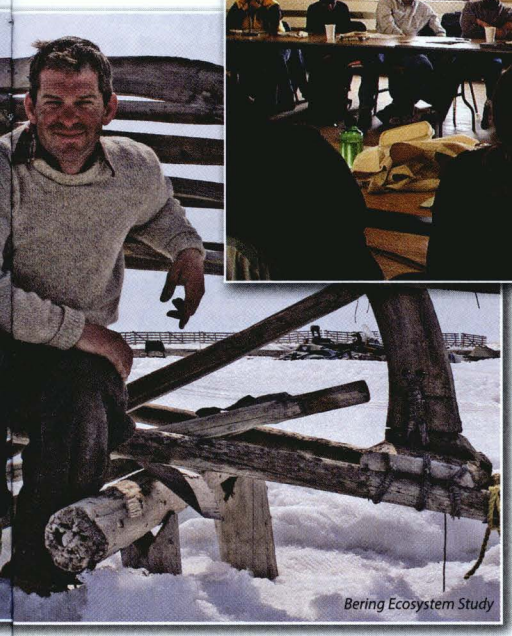
## LEARNING ABOUT CHANGES

In these communities, the LTK component is documenting existing knowledge, fostering collaborative analysis, generating research hypotheses, collaborating with other projects in the program, and recording observations.

This project examines all animal species harvested by residents of the partner communities. In particular, this focus is on species that are significant subsistence resources (nutritionally, culturally, or otherwise) and that are also focal species for other program components. For example, we plan to examine the cultural and subsistence practices regarding walrus in Savoonga, fur seals in St. Paul, and seabirds in all communities, as well as other species or environmental parameters identified through discussion with other program researchers.

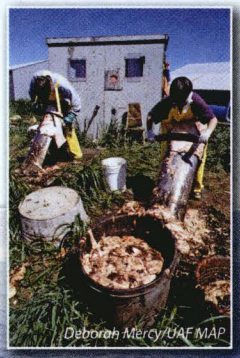

Aleut Native Community of St. Paul

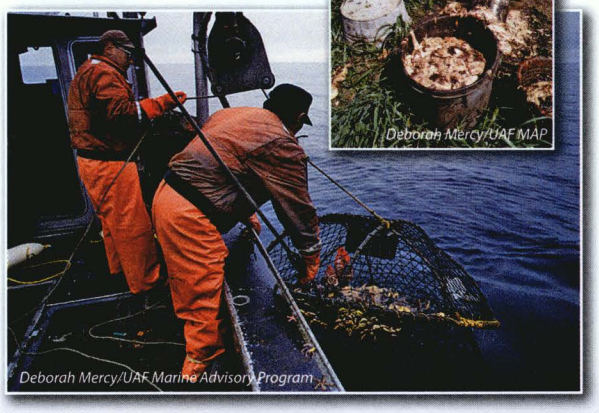

Astrid Scholz


Bering Ecosystem Study

### Community and Regional Advisory Boards

In each community, local research coordinators are assisting in studies on recent changes in subsistence, and on understanding traditional knowledge of elders and experienced hunters about environment and species, such as marine mammals and birds. Community advisory boards work closely with a regional advisory board for the project to help guide LTK research.


Deborah Mercy/UAF MAP


Deborah Mercy/UAF Marine Advisory Program

**Savoonga** (St. Lawrence Island)
Population: 786; Language/culture group: St. Lawrence Island Yup'ik

**Emmonak** (Yukon-Kuskokwim Delta)
Population: 900
Language/culture group: Central Yup'ik

**Togiak** (Bristol Bay)
Population: 987
Language/culture group: Central Yup'ik

**St. Paul** (Pribilof Islands)
Population: 470
Language/culture group: Unangan (Aleut)

**Akutan** (Aleutians)
Population: 80; Language/culture group: Unangan (Aleut)

**Nelson Island** (Yukon-Kuskokwim Delta)
Population 1,065 (total of Nightmute, Toksook Bay, and Tununak);
Language/culture group: Central Yup'ik

# Focal Areas: "From Physics to Fish ... and Beyond"

We are studying the Bering Sea ecosystem from atmospheric forcing and physical oceanography to humans and communities, as well as the socio-economic impacts of a changing marine ecosystem. Innovative ecosystem modeling, sound data management, and exciting education and outreach activities will unite the program.

## Contribution to fisheries management

We hypothesize that changing climate-ocean conditions will affect the abundance and distribution of commercially important fish, and thus impact the fisheries that depend upon them. For commercial fishermen, this could lead to a change in home ports. Vessels may also have to travel further, incurring greater fuel costs and peril at sea.

Our goal is to provide a better understanding of how fish abundance and distribution will change. Such knowledge should enable commercial fishermen to more successfully prepare for and adapt to anticipated changes with minimal income loss, and ensure continued safety at sea.

## Humans

- Interview community residents to conceptualize ecosystem in Native Alaskan terms
- Study subsistence and use patterns

Investigators: Jim Fall, Ann Fienup-Riordan, Eugene Hunn, Henry Huntington, Mark John, Sarah Kruse, George Noongwook, Astrid Scholz, Jennifer Sepez, Josh Wisniewski, Phil Zavadil

## Marine Mammals

- Broad-scale visual surveys
- Patch Dynamics: Foraging studies of fur seals, walrus, and their prey
- Retrospective analyses

Investigators: Phil Clapham, Nancy Friday, Chad Jay, Sue Moore, Franz Mueter, Andrew Trites, Alex Zerbini

## Seabirds

- Broad-scale visual surveys
- Patch Dynamics: Foraging studies of thick-billed murres, black-legged kittiwakes, and their prey
- Chick diet and condition studies
- Retrospective analyses

Investigators: Vernon Byrd, David Irons, Sasha Kitaysky, Kathy Kuletz, Franz Mueter, Daniel Roby

## Fishes, Forage Species, and Trophic Interactions

- Acoustic surveys
- Fish stomach analysis
- Surface and bottom trawl surveys
- Forage species and trophic interactions
- Retrospective analysis of pollock, seabird, and fur seal productivity
- Persistence of foraging "hotspots"
- Seasonal bioenergetics

Kerim Aydin, Kevin Bailey, Kelly Benoit-Bird, Steve Barbeaux, Lorenzo Ciannelli, Ned Cokelet, Alex DeRobertis, Scott Heppell, Anne Hollowed, John Horne, Ed Farley, Stan Kotwicki, Gordon Kruse, Kathy Kuletz, Robert Lauth, Franz Mueter, Sandra Parker-Stetter, Patrick Ressler, Mike Sigler, Phyllis Stabeno, Chris Wilson

## Benthos and NPZ*

*nutrients-phytoplankton-zooplankton

- Benthic studies
- Ichthyoplankton (larval fish)
- Energetics of juvenile fish
- Nutrients
- Micro- and meso-zooplankton; euphausiids
- Primary production
- Sea ice studies

Investigators: Carin Ashjian, Robert Campbell, Lee Cooper, Ken Coyle, Allan Devol, Janet Duffy-Anderson, Lisa Eisner, Rolf Gradinger, Jacqueline Grebmeier, Ron Heintz, Rodger Harvey, Nicola Hillgruber, Tom Hurst, Ben Laurel, Evelyn Lessard, Michael Lomas, Ann Matarese, Brad Moran, Jeff Napp, Alexei Pinchuk, Ray Sambrotto, Barry Sherr, Evelyn Sherr, David Shull, Dan Sigman, Rolf Sonnerup, Dean Stockwell, Diane Stoecker, Terry Whitledge

## Atmosphere, Ice, and Ocean

- Year-long biophysical oceanographic moorings
- Sea ice studies
- Stratification and circulation
- Spring and summer ocean conditions
- Retrospective analyses of sea ice and ocean processes

Investigators: Knut Aagaard, Carin Ashjian, Bodil Bluhm, Robert Campbell, Rolf Gradinger, Katrin Iken, Calvin Mordy, Jeff Napp, Jim Overland, Barry Sherr, Evelyn Sherr, Rolf Sonnerup, Phyllis Stabeno, Dean Stockwell, Tom Weingartner, Terry Whitledge, Rebecca Woodgate, Jingfeng Wu, Jinlun Zhang

## Ecosystem Modeling

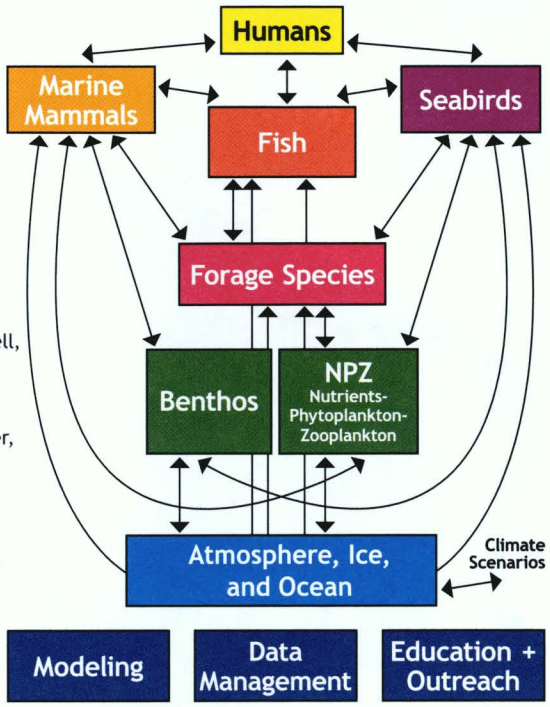
Investigators: Kerim Aydin, Nicholas Bond, Enrique Curchitser, Michael Dalton, Georgina Gibson, Alan Haynie, Kate Hedström, Albert Herrmann, Jim Ianelli, Gordon Kruse, Marc Mangel, Franz Mueter, Andre Punt, Mike Sigler, Rebecca Woodgate, Jinlun Zhang

## Data Management

Investigators: Ken Coyle, James Moore, Gregory Stossmeister, Steve Williams

## Education, Outreach, and Communication

Investigator: Nora Deans




### What is patch dynamics?

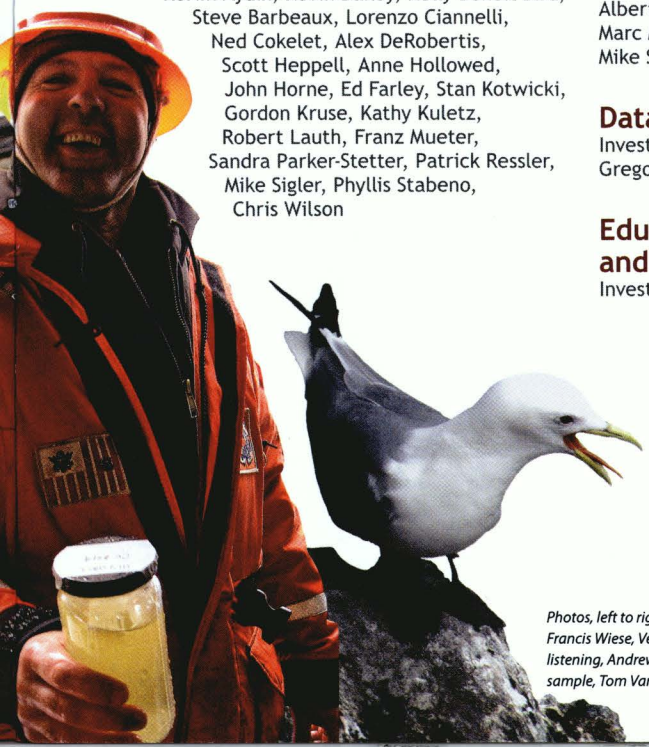
We will use fine-scale studies of birds, mammals, and their forage base to determine how spatial patterns (patches) affect interactions of predators and prey.

We seek to learn what controls the abundance, distribution and population trends of some of the Bering Sea's top predators, and to provide models with data to predict how and why these species will respond to environmental changes.

### What are forage species?

"Forage" species form the middle of the food web and include fishes and invertebrates such as capelin *(Mallotus villosus)*, euphausiids (krill), eulachon *(Thaleichthys pacificus)*, Pacific sand lance *(Ammodytes hexapterus)*, and juvenile Pacific herring *(Clupea pallasi)*, salmon *(Onchorhynchus* sp.*)*, and walleye pollock *(Theragra chalcogramma)*.

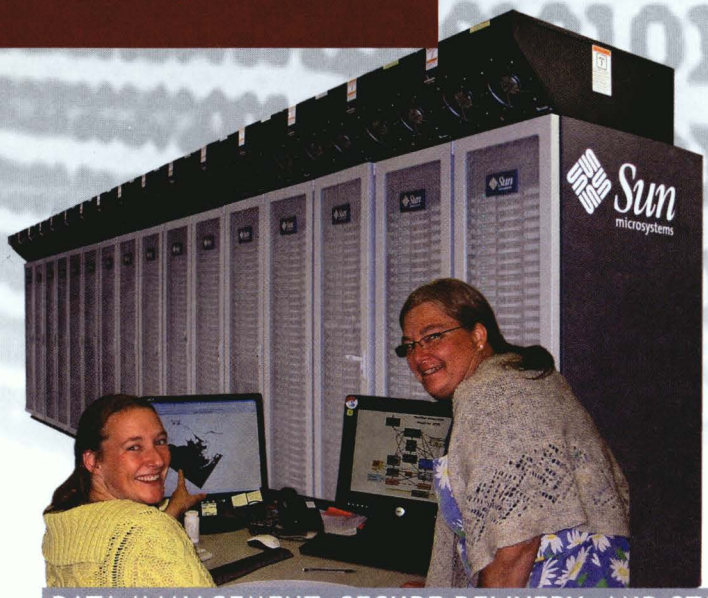
Forage species are distinguished by schooling behavior, relatively short life spans, and local abundance. They are both prey for larger fish and marine mammals, as well as predators of ichthyoplankton (larval fish) and zooplankton.



*Photos, left to right: Rolf Gradinger drilling ice, Christian Morel; pollock, NPRB; Francis Wiese, Vernon Byrd, and Mike Sigler in fog, Nikolai Konyukhov; Sue Moore listening, Andrew Trites; fur seals, Carrie Eischens; Alexei Pinchuk with zooplankton sample, Tom Van Pelt; black-legged kittiwake, Carrie Eischens.*

# Modeling and Data Management

Ecosystem modeling will link climate, physical oceanography, lower and upper trophic levels, and economic outcomes, and attempt to predict the impacts of climatic change on the Bering Sea ecosystem.




The goal of ecosystem modeling is to improve our ability to predict the production and spatial distributions of lower trophic level and forage species, fishes, seabirds, and marine mammals, as well as local impacts on communities and the economy.

Vertically linked models allow two-way coupling between ecosystem components and allow forecasts of economic effects for fisheries contingent on climate scenarios (e.g., increased operating costs for pollock vessels due to ocean warming effects on the southeast Bering Sea pollock population). Models also allow the depiction of uncertainty in forecasts. Rigorous model validation, continuous full-model feedbacks, and a variety of model comparisons will help ensure reality-based results.

## DATA MANAGEMENT, SECURE DELIVERY, AND STORAGE

Management of large and diverse datasets generated by investigators from multiple institutions and backgrounds poses huge challenges for large research projects.

The vision of this data management program is to ensure consistency of data access, data retention, awareness by researchers of data availability, secure access and analysis platforms, and short delays between data acquisition and dissemination.

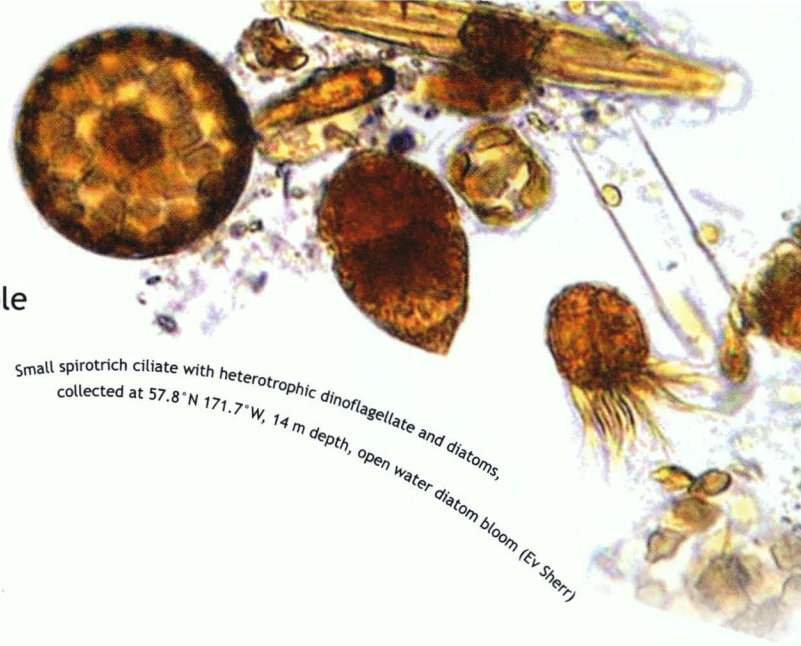
Data managers will provide tools and security for data perusal, access and documentation of project activities. Tools include the Earth Observing Laboratory data and metadata archival and distribution system, an online field catalog aboard the USCGC *Healy,* and a GIS mapserver application to provide an interactive map with links to data and other information.

Managers will also collect preliminary and final datasets from investigators for interim archival, with final datasets and metadata staged to a long-term archive center; and collect and archive supplementary data from other shipboard instruments.

*Photos, top to bottom: Sun supercomputer "Midnight", Arctic Region Supercomputing Center; Georgina Gibson and Kate Hedström, Rachel Potter; St. Paul coastline, Sarah Kruse.*

*Coasts*
refuge and habitat

# Program Management



Small spirotrich ciliate with heterotrophic dinoflagellate and diatoms, collected at 57.8°N 171.7°W, 14 m depth, open water diatom bloom (Ev Sherr)

The Bering Sea Project program office is responsible for program coordination and communication, website development, and meeting planning.

## Science Advisory Board

The Science Advisory Board meets regularly and provides scientific leadership, encouragement, and oversight in program integration, data exchange, and synthesis. It also provides scientific input to the respective program offices and helps with dispute resolution. This group is composed of six members, three each from BSIERP and BEST, elected by the respective principal investigators.

In addition, BSIERP lead investigators and interested BEST investigators meet monthly to communicate the progress of each project and to highlight recent results.

**Current members (1-year terms)**

- Kerim Aydin (BSIERP)
- Rolf Gradinger (BEST)
- Phyllis Stabeno (BSIERP)

**Current members (2-year terms)**

- Carin Ashjian (BEST)
- Rodger Harvey (co-chair, BEST)
- Mike Sigler (co-chair, BSIERP)

## Principal investigator meetings

Annual principal investigator meetings allow investigators to share results; plan cruises, community visits, and other fieldwork. The meetings also allow investigators to make small adjustments to methods and schedules, and provide everyone with a "big-picture" look at the progress and integration of the program.

## Program organization

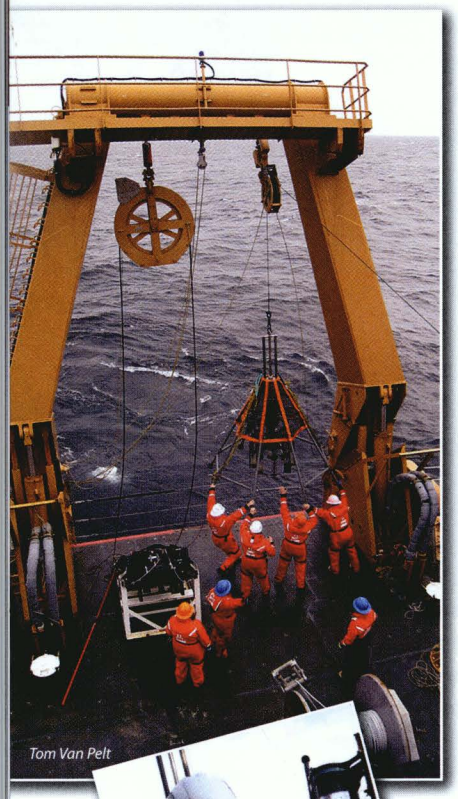

Water

fresh and salty, life-sustaining

Background: Deborah Mercy / UAF Marine Advisory Program

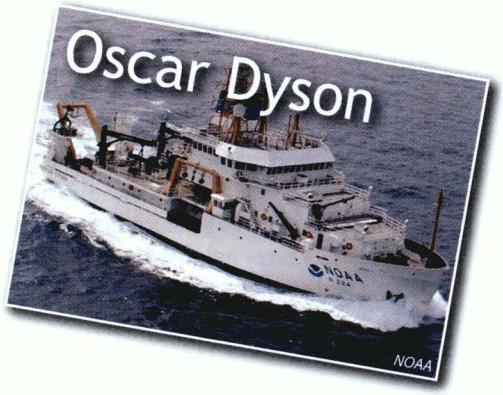
# Scientific Cruises

Many collaborative research cruises to the eastern Bering Sea are planned during the course of the program. Offshore travel in the Bering Sea and Aleutian Islands regions is a tremendously expensive logistical effort. The areas of interest are remote, and storms, winds and large waves make for challenging working conditions. Sea ice, present in winter and early spring, calms the waves, but presents its own challenges for research operations.

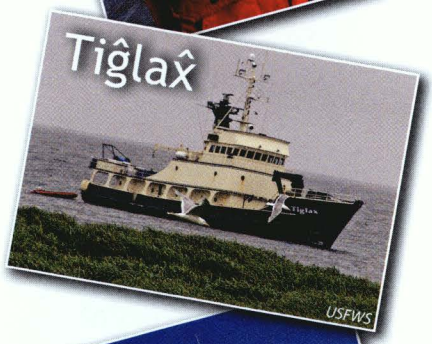


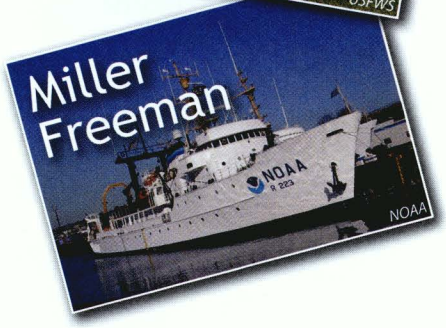

Oceangoing vessels must be large and sturdy enough to withstand tempestuous seas and sea ice. The U.S. Coast Guard icebreaker *Healy* is instrumental in this research. Designed to conduct a wide range of research activities in the unforgiving conditions of Arctic waters, she can break 4½ feet of ice continuously at a speed of three knots and can operate in temperatures as low as -50°F.

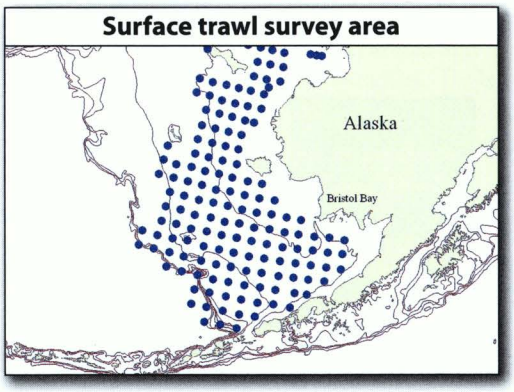
Other vessels, such as NOAA's *Oscar Dyson* and *Miller Freeman,* the USFWS *Tiĝlax̂*, and chartered fishing boats such as the *Frosti* and the *Aldebaran* are also being deployed to conduct oceanic work.



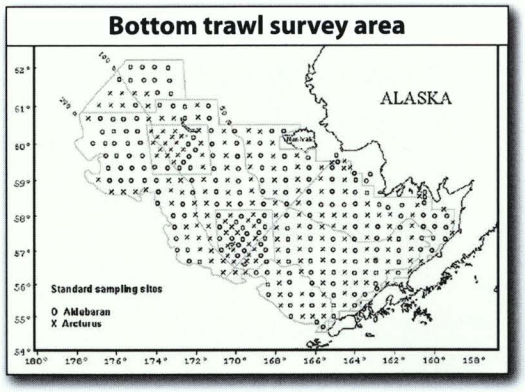




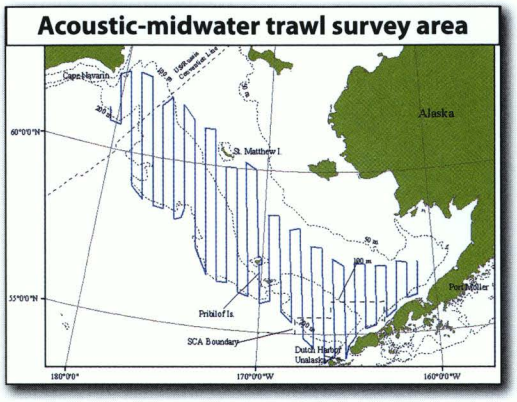



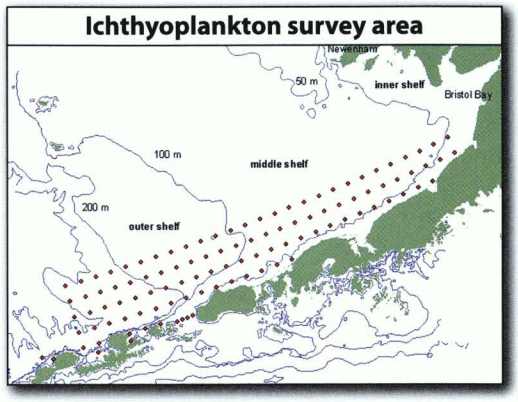

**Objective:** To monitor the condition of eastern Bering Sea continental shelf fishes living in the top layers of the ocean.




**Objective:** To monitor the condition of the eastern Bering Sea continental shelf fauna immediately above the seafloor.




**Objective:** To identify processes influencing the distribution of forage fish, their predators, and competitors relative to ocean habitat conditions; and to evaluate how climate change may impact forage fish movement and seasonal distribution.




**Objective:** To examine interactions among climate, weather, and the recruitment of fishes in the eastern Bering Sea by describing larval fish assemblages and determining how physical and biological factors affect transport and survival of fish larvae.

## ANNUAL CRUISE SCHEDULE, 2008-2010

| Vessel | Scientific Survey / Fishing | Planned Dates |
|---|---|---|
| F/V *Arcturus*[1] | Pollock A season fishing | 20 Jan–31 Mar |
| NOAA *Miller Freeman* | Winter climate-modulated fishery recruitment cruise (winter ichthyoplankton survey) | 16–26 Feb |
| USCGC *Healy* | Spring cruise concentrating on benthic studies south of St. Lawrence Island and walrus tagging and tracking | 13–26 Mar |
| USCGC *Healy* | Spring cruise measuring ocean conditions and food web productivity on eastern Bering Sea shelf | 29 Mar–6 May |
| NOAA *Oscar Dyson* | Spring climate-modulated fishery recruitment cruise (spring ichthyoplankton survey) | 11–20 May |
| F/V *Aldebaran*[1] | Eastern Bering Sea crab and groundfish survey (bottom trawl survey) | 27 May–28 Jul |
| NOAA *Oscar Dyson* | NOAA acoustic survey in eastern Bering Sea | 31 May–31 Jul |
| M/V *Tiĝlax̂*[1] | Summer cruise to Bogoslof Island for colony-based seabird and fur seal studies | 16–18 Jul |
| USCGC *Healy* | Summer cruise measuring productivity on eastern Bering Sea shelf | 20 Jun–18 Jul |
| F/V *Frosti*[1] | Summer cruise examining the distribution and composition of forage fish patches around the Pribilof Islands | 15 Jul–15 Aug 2008, 2009 |
| R/V *Melville* | NOAA EcoFOCI fall hydrography and plankton survey | 24 Aug–11 Sep |
| F/V *Sea Storm*[1] NOAA *Oscar Dyson* | NOAA surface trawl survey (BASIS) | 12 Aug–20 Sep; 10–30 Sep |
| NOAA *Miller Freeman* | NOAA EcoFOCI fall ichthyoplankton and juvenile fish survey | 10–20 Sep |

[1]or equivalent contract vessel
*See the most current cruise calendar at **bsierp.nprb.org.**

Background: Nora Deans



**Typical Bering Sea Cruise Track of the USCGC *Healy***

Background: Carin Ashjian

# Education, Outreach, and Communication

Education, outreach, and communication strategies for the Bering Sea project focus on sharing information with diverse regional and national audiences about how scientists and local communities are learning about changes in the vital Bering Sea ecosystem.


## Communicating about science

The multi-layered website (left) changes with each new report from the field. Chief scientists, PolarTREC educators-at-sea, radio journalists and NPRB staff are all helping to tell the story of this innovative field science and ecosystem modeling partnership through blogs, photographs and cruise reports.

Researchers give community presentations, radio interviews, participate in "webinars" with college and elementary classes from ships far out in the ice, and later send in maps that show where tagged walrus, fur seals and kittiwakes go in search of food.

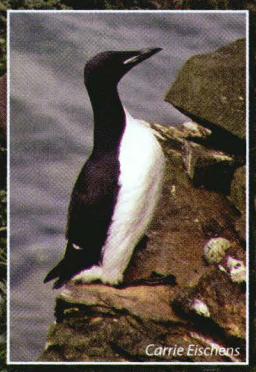

*PolarTREC teacher Craig Kasemodel (above right) gave students and teachers across the country a glimpse of his experiences helping researchers aboard the icebreaker* Healy.

## Bering Sea in schools

Middle school teachers updating the Alaska's Seas and Rivers curriculum are incorporating aspects of the Bering Sea Project into their case studies, which are featured online at **seagrant.uaf.edu/marine-ed/curriculum/.**

## Broadening our reach

Researchers and program staff use posters, brochures, and other media to share overviews of program activities with colleagues at conferences and in communities.



Carrie Eischens

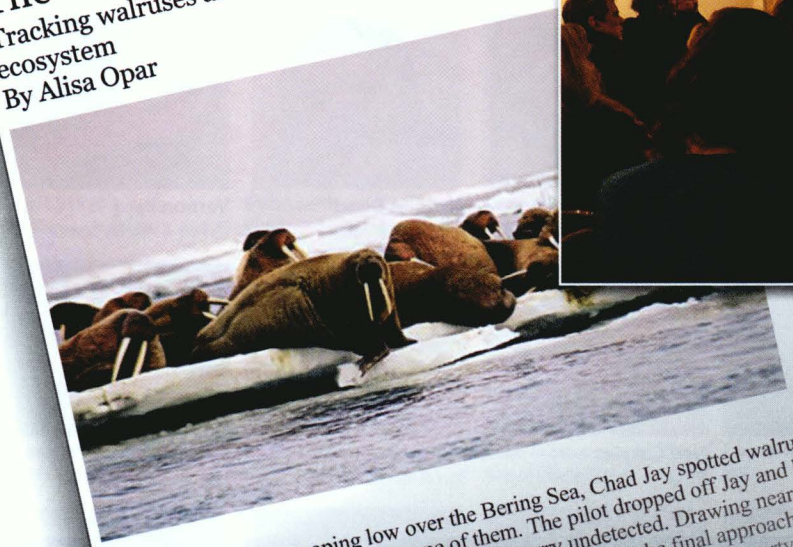
Background: Carrie Eischens

PLENTY
IT'S EASY BEING GREEN

# The walrus and the researcher

## Tracking walruses and what they eat sheds light or ecosystem

By Alisa Opar

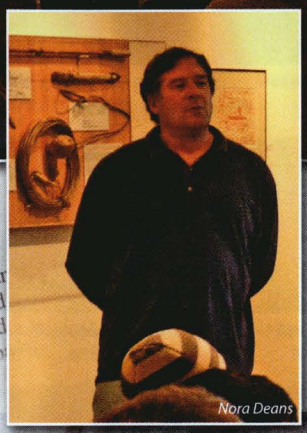


From a helicopter swooping low over the Bering Sea, Chad Jay spotted walruses resting on an expar of sea ice and decided to go after one of them. The pilot dropped off Jay and his companions a good distance away so they could approach their quarry undetected. Drawing near, they paused to unload their equipment and ready their crossbow, and then began the final approach. Suddenly, the large p of ice the walrus was sitting on began to shift and drift away from the party.

"It started taking our walrus away from us," recalls Jay. "He went right into the water."

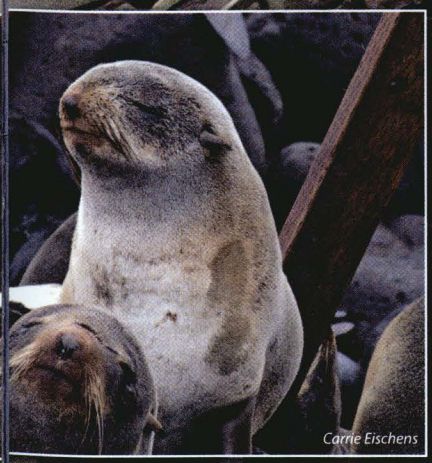
That creature got away, but Jay's team hit ten others on the two- Island, located west of mainland Alaska in the Bering however; They're walrus researchers who the animals for six to eight way to track their

Nora Deans



Nora Deans

*Scientist Lee Cooper and others shared the Bering Sea project with the Dutch Harbor community before setting sail for the early spring cruise of the USCGC* Healy.



Carrie Eischens

Radio journalist Elizabeth Arnold records sounds of fur seals on St. Paul Island, (this page) and waits with field biologist Alexis Will for tagged thick-billed murres to return to the colony (far left).

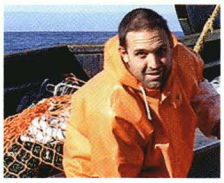
*Background: Carrie Eischens*

# Principal Investigators

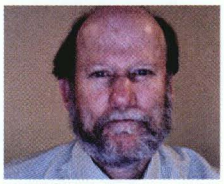
This research would not be possible without the efforts of 94 principal investigators and their collaborators, who hail from ten states and two countries.

**Knut Aagaard**
Univ of Washington

**Carin Ashjian**
Woods Hole Oceanog Inst



**Kerim Aydin**
NOAA

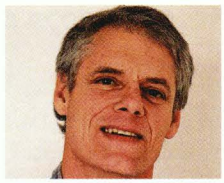


**Kevin Bailey**
NOAA

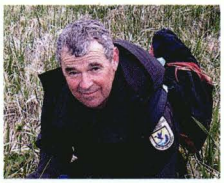
**Steven Barbeaux**
NOAA

**Kelly Benoit-Bird**
Oregon State Univ

**Bodil Bluhm**
Univ of Alaska Fairbanks



**Nicholas Bond**
Univ of Washington

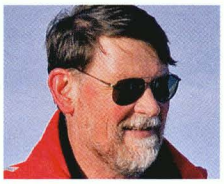


**Vernon Byrd**
US Fish + Wildlife Service

**Robert Campbell**
Univ of Rhode Island

**Lorenzo Ciannelli**
Oregon State Univ

**Phil Clapham**
NOAA



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Univ of Maryland/CES

**Ken Coyle**
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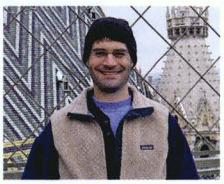

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**Nora Deans**
North Pacific Research Board

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**Allan Devol**
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**Lisa Eisner**
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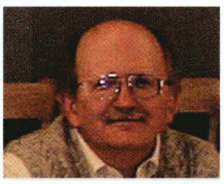

**Jim Fall**
Alaska Dept of Fish + Game

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NOAA

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Calista Elders Council

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Univ of Alaska Fairbanks

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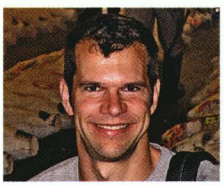

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**Scott Heppell**
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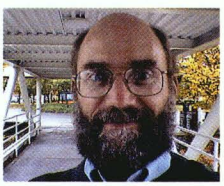

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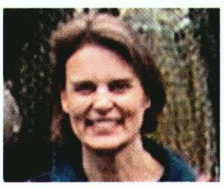
Univ of Alaska Fairbanks



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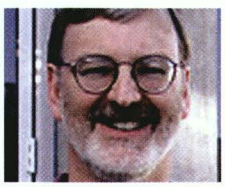
NOAA



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**Eugene Hunn***
Univ of Washington

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Huntington Consulting



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**James Ianelli**
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Univ of Alaska Fairbanks



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US Fish + Wildlife Service



**Chad Jay**
US Geological Survey

**Mark John**
Calista Elders Council

**Sasha Kitaysky**
Univ of Alaska Fairbanks

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NOAA

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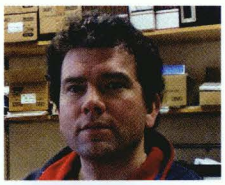
Ecotrust

**Gordon Kruse**
Univ of Alaska Fairbanks

**Kathy Kuletz**
US Fish + Wildlife Service



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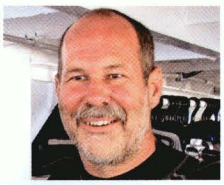

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NOAA

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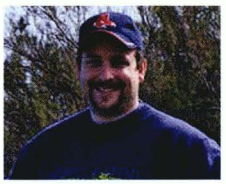
Univ of Washington



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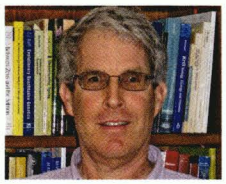

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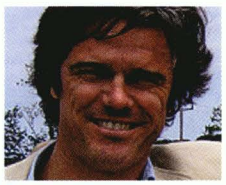
NOAA

**Sue Moore**
NOAA



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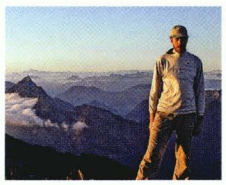
Univ of Rhode Island

**Calvin Mordy**
NOAA



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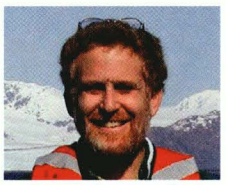
Sigma Plus



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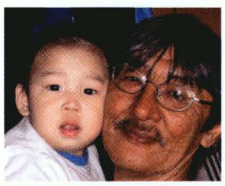
NOAA



**George Noongwook**
Native Village of Savoonga

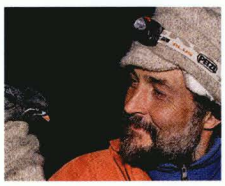
**Jim Overland***
NOAA

**Sandra Parker-Stetter**
Univ of Washington

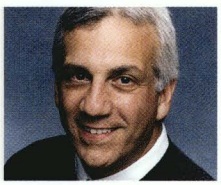
**Alexei Pinchuk**
Univ of Alaska Fairbanks

**Andre Punt**
Univ of Washington

**Patrick Ressler**
NOAA



**Dan Roby**
Oregon State Univ



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Columbia Univ

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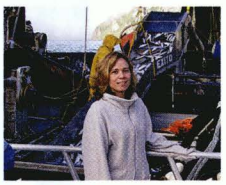
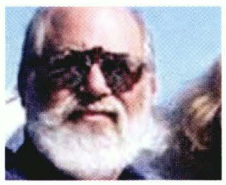


**Jennifer Sepez**
NOAA



**Barry Sherr**
Oregon State Univ

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Oregon State Univ

**David Shull**
Western Washington Univ

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NOAA

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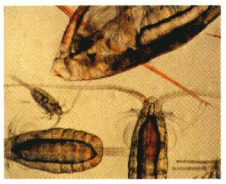
Princeton Univ



**Rolf Sonnerup***
Univ of Washington

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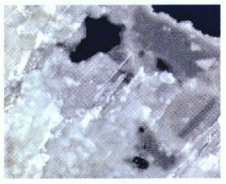
NOAA



**Dean Stockwell***
Univ of Alaska Fairbanks

**Diane Stoecker**
Univ of Maryland

**Greg Stossmeister***
Natl Ctr for Atmospheric Rsrch

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Univ of British Columbia

**Thomas Weingartner**
Univ of Alaska Fairbanks



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Univ of Alaska Fairbanks



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NOAA



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Univ of Alaska Fairbanks



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Univ of Washington



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Univ of Alaska Fairbanks



**Phil Zavadil**
Aleut Native Cmty of St. Paul



**Alex Zerbini**
NOAA



**Jinlun Zhang**
Univ of Washington

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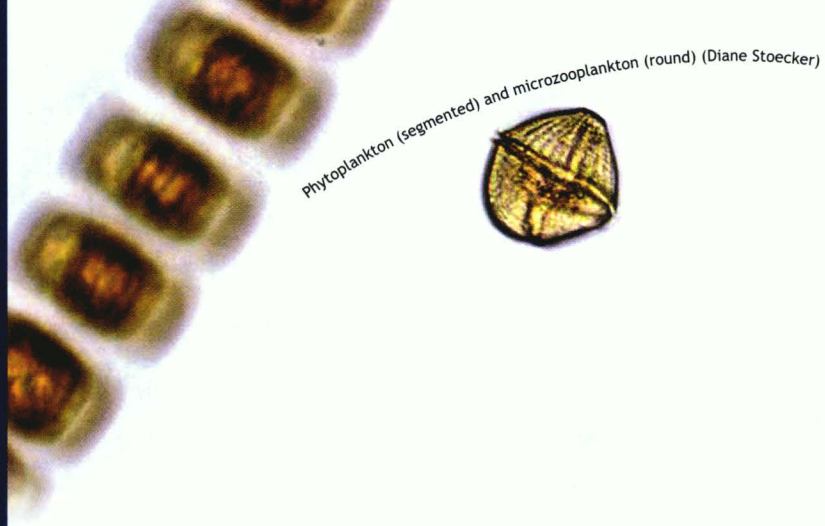

Phytoplankton (segmented) and microzooplankton (round) (Diane Stoecker)

BERING SEA INTEGRATED ECOSYSTEM RESEARCH PROGRAM

BERING ECOSYSTEM STUDY

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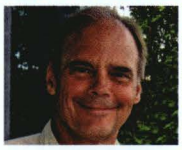

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**Nora Deans,** Senior Outreach Manager

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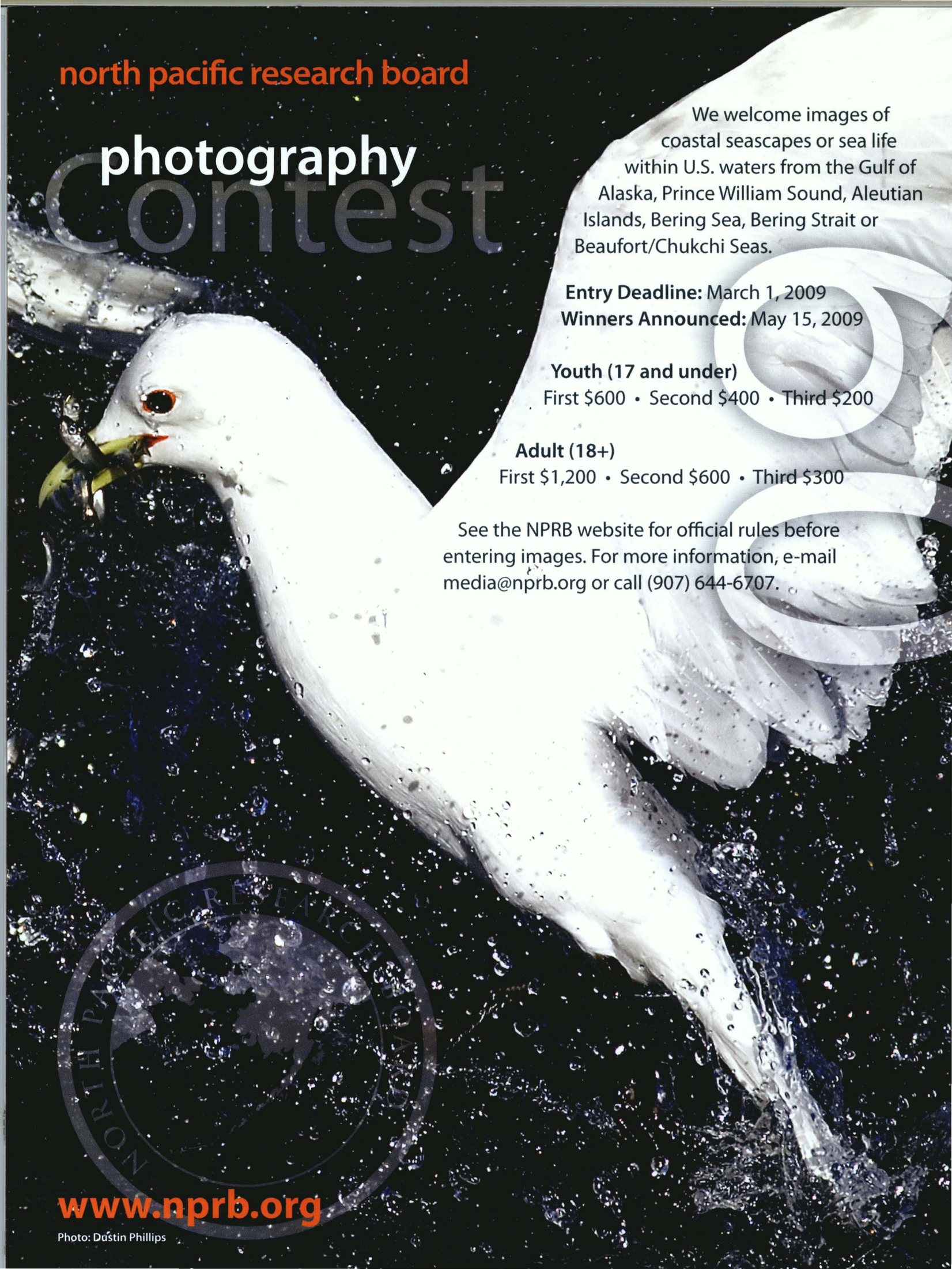
**Alison York,** Project Manager, ARCUS



**bsierp.nprb.org**

**Bering Sea Project Program Office**
1007 West Third Avenue, Suite 100
Anchorage, AK 99501
tel (907) 644-6700 • fax (907) 644-6780

Published by NPRB under NOAA Grant No. NA05NMF4721198.
Design: Carolyn Rosner, NPRB.
Printing: Northern Printing, Anchorage, AK. September 2008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photography
contest
We welcome images of coastal seascapes or sea life within U.S. waters from the Gulf of Alaska, Prince William Sound, Aleutian Islands, Bering Sea, Bering Strait or Beaufort/Chukchi Seas.
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Winners Announced: May 15, 2009
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# 2009 graduate student Research Awards

**The North Pacific Research Board is offering Graduate Student Research Awards to encourage students to pursue scientific and scholarly research that addresses management issues in northern seas.**

## Applications

Qualified masters and doctoral students may apply for one of **five awards of $20,000 each.** Awards will be given for the opportunity to address scientific, technological, and socio-economic issues relating to the research themes identified in the 2005 NPRB Science Plan.

## Eligibility

To be eligible, you must be enrolled in or accepted by a graduate degree program at an accredited university or college. Your graduate research topic must be relevant to the research themes and issues identified in the 2005 NPRB Science Plan.

## Important Dates

Online submission begins: **December 15, 2008.**

Application deadline: **February 13, 2009.** Winners announced: **May 5, 2009**

## How to Apply

Visit **www.nprb. org** and complete the online submission process by February 13, 2009 at 4:00 p.m. Alaska Standard Time.

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