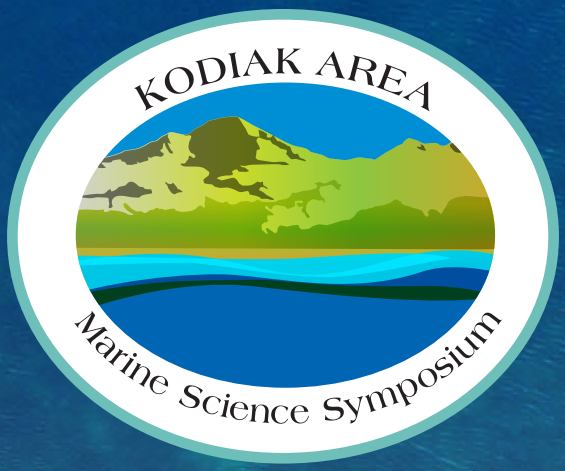

2021

Kodiak Area Marine Science Symposium

Program and Abstracts

April 19–23, 2021
Online

Sea Grant
Alaska

CAMA'I. As we gather together for the Kodiak Area Marine Science Symposium we acknowledge that we come together on the Alutiiq/Sugpiaq homeland. We thank and acknowledge the sustained efforts of the ten tribes of the Kodiak Alutiiq Region in maintaining sovereignty, culture and opportunity for their members. The heritage and culture of the Alutiiq people continue to enrich all of us. We find beauty, peace and livelihood from the Kodiak lands and waters, and give thanks for the stewardship of these resources.

Kodiak Area Marine Science Symposium

Hosted by the Alaska Sea Grant Marine Advisory Program with support from regional partners and contributors, KAMSS provides a forum for researchers to share findings within the research community and to the general public. The symposium offers the opportunity for stakeholders to engage and understand how Kodiak's marine environment and resources function, change, and affect our lives and livelihoods and provides a venue for researchers to plan for integrated, cooperative and community-inspired marine research.

ALASKA SEA GRANT is a partnership between NOAA and the University of Alaska Fairbanks. Sea Grant has been serving Alaska for over 50 years. Our work supports healthy coastal resources, strong economies, and vibrant communities. We do this through research, education, and outreach via Marine Advisory Program agents who live and work in eight coastal communities across Alaska. More information is available on our website or by contacting your local agent.

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University of Alaska Fairbanks, Alaska Sea Grant Marine Advisory Program, Kodiak

Julie Bonney
Alaska Groundfish Data Bank, Kodiak

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NOAA Fisheries, Alaska Fisheries Science Center, Kodiak

Jo Ellen Lottsfeldt
Resident and MA student through Miami University, Kodiak and Anchorage

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Alutiiq Museum, Kodiak

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Cindy Trussell
University of Alaska Anchorage, Kodiak College, Kodiak

Matthew Van Daele
Sun'aq Tribe of Kodiak, Kodiak

Nathan Weber
Kodiak Regional Aquaculture Association, Kodiak

AGENDA

Virtual Symposium via Zoom
April 19–23, 2021

Monday, April 19, 2021

5:30–6:00 pm	Welcome and opening remarks	**Julie Matweyou**, University of Alaska Fairbanks, Kodiak, AK
6:00–7:00 pm	Keynote Address: Heatwave impacts on the Gulf of Alaska Pacific cod *Abstract p. 9*	**Steve Barbeaux**, NOAA Alaska Fisheries Science Center, Seattle WA

Tuesday, April 20, 2021

Session 1: Fisheries Then and Now

Julie Bonney, session chair

9:00–9:05 am	Opening remarks and announcements	
9:05–9:25 am	Ocean climate and Gulf of Alaska salmon: where have we been, where are we now, and where are we going? *Abstract p. 10*	**Mike Litzow**, NOAA Alaska Fisheries Science Center, Kodiak, AK
9:25–9:45 am	Adaptive fish culture practices in a changing environment *Abstract p. 11*	**Trenten Dodson**, Kodiak Regional Aquaculture Association, Kodiak, AK
9:45–10:05 am	Intertidal fish traps of the Kodiak Archipelago *Abstract p. 12*	**Molly Odell**, Alutiiq Museum and Archaeological Repository, Kodiak, AK
10:05–10:25 am	Improving discard mortality rate estimates of Pacific halibut (*Hippoglossus stenolepis*) in the directed longline fishery *Abstract p. 13*	**Claude Dykstra**, International Pacific Halibut Commission, Seattle, WA
10:25–10:45 am	Subsistence harvest and Kodiak Island communities *Abstract p. 14*	**Jackie Keating**, Alaska Department of Fish and Game, Anchorage, AK

10:45–11:05 am	Characterization of the Buskin River Nearshore Area: a four-year study of bathymetry, salinity, marine ecological succession, and human use *Abstract p. 15*	**Leyla Arsan**, Birch Leaf Consulting, LLC Anchorage, AK
11:05–11:30 am	Facilitated Q & A and discussion	**Jo Ellen Lottsfeldt**, Miami University, Kodiak, AK
11:30 –1:00 pm	**Break**	
Session 2: What's Blooming in Your Waters? *Brian Himelbloom, session chair*		
1:00–1:05 pm	Opening remarks and announcements	
1:05–1:35 pm	Saxitoxin and the Cold War *Abstract p. 16*	**Patricia Tester**, Ocean Tester, LLC, Beaufort, NC
1:35–1:55 pm	Effectiveness of butter clam cleaning practices to reduce PSP risk *Abstract p. 17*	**Julie Matweyou**, University of Alaska Fairbanks, Kodiak, AK
1:55–2:15 pm	Community based monitoring of harmful algal blooms and ocean acidification *Abstract p. 18*	**Andie Wall**, Kodiak Area Native Association, Kodiak, AK
2:15–2:35 pm	Paralytic shellfish toxins in fish and invertebrates of Southcentral and Southwest Alaska *Abstract p. 19*	**Steve Kibler**, NOAA National Ocean Service, Beaufort, NC
2:35–3:00 pm	Facilitated Q & A and discussion	**Jo Ellen Lottsfeldt**, Miami University, Kodiak, AK

Wednesday April 21, 2021

Session 3: Eyes on Marine Birds and Mammals

Cindy Trussell, session chair

9:00– 9:05 am	Opening remarks and announcements	
9:05– 9:25 am	Nearshore marine bird and mammal surveys in the Kodiak Archipelago, 2014-2016 *Abstract p. 20*	**Robin Corcoran**, U.S. Fish and Wildlife Service, Kodiak, AK
9:25– 9:45 am	Alutiiq use of birds during the Ocean Bay Period at Rice Ridge (49-KOD-363), Kodiak Island *Abstract p. 21*	**Madonna Moss**, University of Oregon, Eugene, OR
9:45–10:05 am	The diet composition of Aleutian tern chicks in the Kodiak Archipelago, Alaska *Abstract p. 22*	**Jill Tengeres**, Oregon State University, Corvallis, OR
10:05–10:25 am	Marine die-offs in a warming ocean: working together to witness change *Abstract p. 23*	**Jackie Lindsey**, University of Washington/COASST, Seattle, WA
10:25–10:45 am	Current marine mammal stranding response on the Kodiak Archipelago *Abstract p. 24*	**Matthew Van Daele**, Sun'aq Tribe of Kodiak, Kodiak, AK
10:45–11:15 am	Facilitated Q & A and discussion	**Jo Ellen Lottsfeldt**, Miami University, Kodiak, AK
11:15–6:00 pm	**Break**	
6:00–6:05 pm	Welcome and opening remarks	
6:05–7:00 pm	Invited address: 23 January 2018 magnitude 7.9 offshore Kodiak earthquake: what we learned and ongoing studies *Abstract p. 25*	**Natalia Ruppert**, University of Alaska Fairbanks, Fairbanks, AK

Thursday, April 22, 2021

Session 4: Getting Crabby

Mike Litzow, session chair

9:00–9:05 am	Opening remarks and announcements	
9:05–9:25 am	Feeling the heat: snow crab in a warming ocean *Abstract p. 26*	**Erin Fedewa**, NOAA Alaska Fisheries Science Center, Kodiak, AK
9:25–9:45 am	Red king crab stock enhancement experiments in Kodiak *Abstract p. 27*	**W. Christopher Long**, NOAA Alaska Fisheries Science Center, Kodiak AK
9:45–10:05 am	Tracking king crabs with drones *Abstract p. 28*	**Leah Zacher**, NOAA Alaska Fisheries Science Center, Kodiak, AK
10:05–10:25 am	Tanner crab population in the Kodiak District of the Westward Region *Abstract p. 29*	**Kally Spalinger**, Alaska Department of Fish and Game, Kodiak, AK
10:25–10:45 am	Effects of ocean acidification on Alaskan crabs: Updates from the Kodiak Lab *Abstract p. 30*	**W. Christopher Long**, NOAA Alaska Fisheries Science Center, Kodiak AK
10:45–11:15 am	Facilitated Q & A and discussion	**Jo Ellen Lottsfeldt**, Miami University, Kodiak, AK
11:15–1:00 pm	**Break**	

Session 5: One Fish, Two Fish, Rockfish, Codfish

Matt Van Daele, session chair

1:00–1:05 pm	Opening remarks and announcements	
1:05–1:25 pm	Rockfish knowledge project: what have we learned from the Kodiak community about rockfish fisheries and management? *Abstract p. 31*	**Jesse Gordon**, University of Alaska Fairbanks, Juneau, AK
1:25–1:45 pm	The impact of Gulf of Alaska marine heatwaves on early life stages of Pacific cod *Abstract p. 32*	**Benjamin Laurel**, NOAA Alaska Fisheries Science Center, Newport, OR
1:45–2:05 pm	High ocean temperatures linked to apparent recruitment failure for juvenile Pacific cod *(Gadus macrocephalus)* in the western Gulf of Alaska *Abstract p. 33*	**Alisa Abookire**, Alaska Coastal Observations and Research, Kodiak, AK

Session 5 continues on next page

2:05–2:25 pm	Evaluating thermal effects on spawn timing and early growth of Gulf of Alaska Pacific cod: Implications for survival and recruitment *Abstract p. 34*	**Jessica Miller**, Oregon State University, Newport, OR
2:25–3:15 pm	Panel discussion: Effects of warming oceans on Gulf of Alaska Pacific cod – a conversation	**Jessica Miller**, Oregon State University, **Benjamin Laurel**, NOAA AFSC, **Steve Barbeaux**, NOAA AFSC, **Lauren Rogers**, NOAA AFSC, **Alisa Abookire**, Alaska Coastal Observation and Research
3:15 pm	**Closing Comments**	**Julie Matweyou**, University of Alaska Fairbanks, Kodiak, AK

Partnered Activities

Kodiak 4-H Marine Debris Fish Project • on display April 19–23, 2021

Kodiak 4-H partnered with Alaska Sea Grant to bring Kodiak youth the opportunity to come together, clean up our beaches and make a statement with their art during the Kodiak Area Marine Science Symposium and for Earth Day. The art will be displayed during the entire week of KAMSS (April 19–23) downtown at the Kodiak History Museum and the Kodiak Wildlife Refuge Visitor Center. Photos of the display will be shared through the KAMSS 2021 poster page and on the 4-H event page. Join us in celebrating our youth advocacy. http://www.alaska4h.org/at-home-kits1.html

Buskin Beach Cleanup • Friday, April 23, 2021 • 4:00–6:00 pm

Sponsored by Sun'aq Tribe of Kodiak, Alaska Sea Grant, and Island Trails Network

In celebration of Earth Day 2021 the Suna'q Tribe of Kodiak and Alaska Sea Grant are organizing a beach cleanup. Meet at Buskin Beach Parking Lot and check in at 4:00 pm. Dress for the weather and bring a pair of gloves. Trash bags and hand sanitizer will be provided. Volunteers can assist with cleanup or help sort the debris for recycling. We will encourage social distancing and recommend masks as appropriate if you will be working alongside others. Day use parking fee will be waived for this event.

Kodiak Public Library • April 19–23, 2021

The Kodiak Public Library will be sharing marine resources and activities throughout the week. A children's glow-in-the-dark jellyfish craft event will be held Tuesday, April 20, at 4:00 pm on Zoom; packets are ready for pick up. Join us outside for a story walk featuring Baby Whale's Journey and sea poems. A display of children's books about whales and sea life is available in the children's room and YouTube StoryTime will feature *Humphrey The Lost Whale*. Please visit the library website for details. https://www.city.kodiak.ak.us/library

Kodiak National Wildlife Refuge • April 19–23, 2021

The Kodiak National Wildlife Refuge will be sharing marine fun facts, photos and art activities. Check out the Kodiak Refuge Facebook page during the week. Art supplies for take home activities are available at our door and the Kodiak 4-H marine debris exhibit will be displayed. Find us at the Kodiak Refuge Visitor Center on 402 Center Avenue. https://www.facebook.com/kodiakrefuge/

Posters

Investigating Aleutian tern breeding season movements using satellite telemetry *Abstract p. 35*	**Robin Corcoran**, U.S. Fish and Wildlife Service Kodiak, AK
Investigating Aleutian tern non-breeding season movement patterns using satellite telemetry *Abstract p. 36*	**Robin Corcoran**, U.S. Fish and Wildlife Service Kodiak, AK
Application of quantitative molecular methods to characterize abundance and distribution of Alexandrium cysts for NOAA's HAB forecasting—Year 1 update *Abstract p. 37*	**Julie Matweyou**, Alaska Sea Grant, University of Alaska Fairbanks Kodiak, AK
Community-based PSP testing for shellfish—Kodiak Region summary *Abstract p. 38*	**Julie Matweyou**, Alaska Sea Grant, University of Alaska Fairbanks Kodiak, AK
Stream side settlement of the Karluk River, Kodiak Island, Alaska *Abstract p. 39*	**Molly Odell**, Alutiiq Museum and Archaeological Repository Kodiak, AK
Identification of physiological growth signatures in skeletal muscle of Pacific halibut *(Hippoglossus stenolepis)* for monitoring population growth patterns *Abstract p. 40*	**Josep V. Planas**, International Pacific Halibut Commission Seattle, WA
Assessment of reproductive development in female Pacific halibut *(Hippoglossus stenolepis)* *Abstract p. 41*	**Teresa Fish**, International Pacific Halibut Commission Seattle, WA
Too hot to handle: Effects of thermal variability on juvenile Pacific cod foraging and growth in Gulf of Alaska nursery habitats *Abstract p. 42*	**Hillary Thalmann**, Oregon State University Newport, OR

Abstracts - Keynote Speaker

Heatwave impacts on the Gulf of Alaska Pacific cod

***Steven Barbeaux**, steve.barbeaux@noaa.gov*
***Kirstin Holsman**, kirstin.holsman@noaa.gov*
***Stephani Zador**, stephani.zador@noaa.gov*

Alaska Fisheries Science Center, NOAA Fisheries, Seattle, WA

Pacific cod (*Gadus macrocephalus*) has been an important food and economic resource in Alaska for millennia. Ominously the Aleut name for Pacific cod translates into "the fish that stops." The first commercial Gulf of Alaska (GOA) Pacific cod fishery began in 1863, however the fishery collapsed by the mid-1940s. The modern Pacific cod fishery developed in the 1980s as the population experienced a rapid increase peaking in 1990. The population declined through the mid-2000s, however a series of high recruitments starting in 2006 helped the stock recover. In the beginning of 2014 the future for Pacific cod in the GOA looked bright with the fishery earning on average $103 million.

In 2014–2016 an unprecedented warming event triggered changes in the GOA ecosystem. The marine heatwave was noteworthy in its geographical extent, depth range, and persistence, with evidence of shifts in species distribution and reduced productivity. In 2017 surveys indicated that GOA Pacific cod had experienced a 71% decline in abundance from the previous survey resulting in an 80% reduction in the quota for 2018. Continued declines resulted in the closure of the fishery in 2020. The sudden decline may be attributable to higher mortality due to increased metabolic demand and reduced prey during the heatwave. In addition historically low recruitment during the heatwave has resulted in continued low abundance. This talk describes how changes in the ecosystem during the heatwave affected the GOA Pacific cod stock and how this stock may fare in a warming world.

Dr. Steven Barbeaux, a graduate of the University of Washington, School of Fisheries, works as a research fisheries biologist at the Alaska Fisheries Science Center in Seattle, and is the lead stock assessment author for the Gulf of Alaska Pacific cod stock. Steve was raised in a fishing family on the Great Lakes and still has close family fishing ties there. He began his career with NOAA as a contracted fisheries observer in Alaska in 1996 and has been employed as a research fisheries biologist with the Status of Stocks and Multispecies Assessment Program since 2002.

Ocean climate and Gulf of Alaska salmon: where have we been, where are we now, and where are we going?

***Michael Litzow**, NOAA Alaska Fisheries Science Center, Kodiak, AK, mike.litzow@noaa.gov*

The Gulf of Alaska experienced unprecedented warm temperatures during 2014-2019. Some acute salmon responses to this warming include the 2016 pink salmon failure, poor 2019 chum returns in Southeast, unusual sockeye run timing, and increased variability in sockeye run strength. Our best scientific understanding is that temperatures experienced during 2014-2019 would have been impossible without human-caused global warming. This event appears to signal a transition in Gulf of Alaska climate: after decades of stable temperatures and high salmon production, climate models indicate that we have embarked on a period of persistent warming, which implies increased uncertainty for salmon fisheries. This talk will give a brief overview of our understanding of how ocean climate affected salmon run strength in past decades, and how the novel climate that has appeared in recent years may be affecting salmon. By recognizing changing patterns of ocean climate-salmon interactions during the historical record, we may be able to build understanding of how salmon fisheries will fare in a rapidly changing world.

Adaptive fish culture practices in a changing environment

***Trenten Dodson**, Kodiak Regional Aquaculture Association, Kodiak, AK, trent.dodson@kraa.org*

Water temperature plays a pivotal role in all aspects of the salmon life cycle. Temperature can speed or slow development and metabolism and, in some cases, cause death. In recent years, increases in water temperature and reduction in precipitation have made fish culture in Kodiak difficult. We will discuss how high temperature and low water have altered KRAA's fish culture practices and overall production and how we have (or haven't) tackled those challenges.

Intertidal fish traps of the Kodiak Archipelago

***Molly E. Odell**, molly@alutiiqmuseum.org*
***Patrick G. Saltonstall**, patrick@alutiiqmuseum.org*
***Amy F. Steffian**, amy@alutiiqmuseum.org*

Alutiiq Museum and Archaeological Repository

Anthropologists have long known that the Alutiiq people practiced barrier fishing. The use of barricades to harvest salmon from Kodiak's streams is noted in ethnographic accounts, reported by Alutiiq elders, and preserved in v-shaped stone weirs in the upper Karluk River. Recent archaeological surveys illustrate that Alutiiq fishermen also built intertidal fish traps—stone walled features used to trap salmon massing around stream mouths. In 2019, museum archaeologists documented three such traps on the coasts of Afognak and Kodiak islands. Each trap is adjacent to a late prehistoric settlement, suggesting intertidal barrier fishing developed during the Koniag tradition—ca. 500 years ago. Two of the traps are associated with a unique style of petroglyph, pits and lines cut in stream-side boulders. The data suggest that barrier fishing was a new way of harvesting large quantities of salmon to feed the growing Native community and accumulate stores to fuel a status-based economy.

Improving discard mortality rate estimates of Pacific halibut *(Hippoglossus stenolepis)* in the directed longline fishery

Claude Dykstra [1], *claude.dykstra@iphc.int*
Timothy Loher[1], ***Ian J. Stewart***[1], ***Allan C. Hicks***[1], ***Nathan Wolf*** [2], ***Bradley P. Harris***[2] *and* ***Josep V. Planas***[1]

1. International Pacific Halibut Commission, Seattle, WA
2. Alaska Pacific University, Anchorage, AK

Regulations require that all sublegal size Pacific halibut in the directed longline fishery be returned to the sea with minimal injury. Accurate understanding of the types and relative levels of injuries and stresses that Pacific halibut experience during the capture and discarding process can be instrumental in helping better estimate the probability of resultant mortality, and to inform the development of best discard practices. In the fall of 2017, we conducted a field study to begin investigating injury severity resulting from different hook release techniques (careful shake, gangion cut, and hook stripper) along with associated physiological condition measures. Physiological parameters collected included condition status at capture (round weight, fat reserves) and blood samples to evaluate post-handling levels of stress indicators (glucose, lactate, and cortisol). Additionally, we tagged and released 79 Pacific halibut with accelerometer pop-up archival transmitting tags to assess near term (96 days) survival, and 1,048 fish with wire tags to investigate longer term survival. Preliminary results and relationships will be presented. Similar research on discard mortality of Pacific halibut in the charter recreational fleet planned for 2020 will also be discussed.

Subsistence harvest and Kodiak Island Communities

***Jacqueline Keating**, Alaska Department of Fish and Game, Anchorage, AK, jacqueline.keating@alaska.gov*
***Lauren Sill**, Alaska Department of Fish and Game, Division of Subsistence, Juneau, AK, lauren.sill@alaska.gov*

Participation in subsistence activities is an integral component of life on Kodiak Island. Access to subsistence resources is constantly changing due to a variety of environmental, social, and regulatory factors. The Alaska Department of Fish and Game Division of Subsistence employs a combination of quantitative and qualitative research methods to provide a holistic understanding of the role of subsistence activities in local economies and ways of life. This presentation will explain why the Division of Subsistence collects subsistence harvest data, methods used to document harvest, findings from the most recent comprehensive harvest surveys conducted in Larsen Bay, Akhiok, and Old Harbor, and how to access and use published harvest data. Finally, we will share plans for upcoming subsistence research for Kodiak City and road-connected communities, and ways to get involved with research and regulatory processes.

Characterization of the Buskin River Nearshore Area: a four-year study of bathymetry, salinity, marine ecological succession, and human use

Leyla Arsan[1], *leyla.arsan@gmail.com*
T. Lance[2], ***E. McCall Valentine***[3], *and* ***K. Krueger***[2,4]

1. Birch Leaf Consulting, LLC
2. Sun'aq Tribe of Kodiak
3. The Scholar Ship
4. Alaska Department of Fish and Game

The Buskin River Marine Zone Study (BRiMS) was a four-year, post-construction monitoring effort lead by the Sun'aq Tribe of Kodiak as part of the Kodiak Airport Runway Safety Area Expansion mitigation package. The study had four main components and objectives.

- Physical: document basic bathymetry and features at the river mouth and nearshore.
- Chemical: record the character (salinity and temperature) and geographic extent of the Buskin River freshwater plume.
- Biological: monitor recruitment and colonization of invertebrates and algae on the new armor rock.
- Cultural: document contemporary human use of the Buskin River nearshore area.

A summary of the four years of data collection will be presented for all four aspects of the project. This study provides information regarding nearshore marine disturbance recovery in hard-bottom habitats in southcentral Alaska. The colonization rate of rock armor and the timeframe to develop higher ecological functions are important because of the potential impacts of rock armor on aquatic habitats, on both local and cumulative landscape scales. The need and quantity of mitigation for projects that disturb marine substrates or add new fill to existing substrates is currently based on assumptions. This project provides data to better inform mitigation decisions in the future.

This study also provides information to better understand how tribal and community members use the Buskin River area and how they may be affected by changes to the Buskin River fisheries and subsistence use area.

Abstracts - Session 2: What's Blooming in your waters?

Saxitoxin and the Cold War

Patricia Tester[1,2], *Beaufort, NC, ocean.tester@yahoo.com*
Julie Matweyou[2,3], *Kodiak, AK, julie.matweyou@alaska.edu*
Brian Himelbloom[3], *Kodiak, AK, brian.himelbloom@alaska.edu*
Bruce Wright[4], *Palmer, AK, bwright@kniktribe.org*
Steven Kibler[5], *Beaufort, NC, steve.kibler@noaa.gov*
Wayne Litaker[5], *Chapel Hill, NC, wayne.litaker@gmail.com*

1. Ocean Tester, LLC
2. University of Alaska Fairbanks
3. Alaska Sea Grant, Kodiak Seafood and Marine Science Center
4. Knik Tribe of Alaska
5. NOAA National Ocean Service

A contract for clams and a shipping receipt to the US Army's Biological Warfare Laboratories at Fort Detrick, Maryland were discovered during a data rescue mission of hundreds of mouse bioassay records found in Kodiak. These records were related to paralytic shellfish poisoning projects conducted near Ketchikan, Alaska (1947–1958). The contract raised a question about whether Alaskan clams were the source of saxitoxin used by the United States Central Intelligence Agency in their search to find a replacement for the standard cyanide L-pill issued to agents in hazardous situations. Yes, saxitoxin from these clams appears to have been used, at least, on one occasion. Francis Gary Powers, a U-2 pilot, carried a saxitoxin-filled, grooved needle inside a silver dollar when he departed on an ill-fated surveillance flight across Russia, 1 May 1960.

Effectiveness of butter clam cleaning practices to reduce PSP risk

Julie Matweyou[1,2], *Kodiak, AK, julie.matweyou@alaska.edu*
Steven Kibler[3], *Beaufort, NC, steve.kibler@noaa.gov*
Wayne Litaker[3], *Chapel Hill, NC, wayne.litaker@gmail.com*
Bruce Wright[4], *Palmer, AK, bwright@kniktribe.org*
D. Ransom Hardison[3], *Beaufort, NC, rance.hardison@noaa.gov*
Patricia Tester[1,5], *Beaufort, NC, ocean.tester@yahoo.com*

1. University of Alaska Fairbanks
2. Alaska Sea Grant, Kodiak Seafood and Marine Science Center
3. NOAA National Ocean Service
4. Knik Tribe of Alaska
5. Ocean Tester, LLC

Bivalve shellfish remain a dietary and culturally important food source for many Kodiak Island residents, despite risks of Paralytic Shellfish Poisoning (PSP) from eating untested shellfish. In attempt to reduce risk of PSP some harvesters 'clean' butter clams by removing tissues with known or suspected toxins. This study assessed the distribution of saxitoxins in butter clam tissues and evaluated three traditional clam cleaning methods. Tissues were separated and analyzed by high performance liquid chromatography which provides total toxin concentrations and quantification of the different saxitoxin congeners. Results showed that distribution of toxins within butter clam tissues varied seasonally, with high concentrations of gonyautoxins in the gut during Alexandrium blooms and high saxitoxins and neosaxitoxins in the siphons after the bloom season. Cleaning studies show toxicity of butter clams can be reduced by removal of the siphon tip and the gut, as well as other tissues. However, removal of these tissues does not guarantee processed butter clams will be toxin-free and toxin levels can remain above regulatory limits in the cleaned meat. Alaska Sea Grant publication MAB-78 disseminates the findings of the study.

Abstracts - Session 2: What's Blooming in your waters?

Community-based monitoring of harmful algal blooms and ocean acidification

***Andie Wall**, Kodiak Area Native Association, Kodiak, Alaska, andie.wall@kodiakhealthcare.org*

This session will dive into current efforts to develop harmful algal bloom baseline data for the Kodiak Region. Attendees will be able to review data collected from four locations along the Kodiak road system and learn about the project's projected next steps. The presentation will conclude with a brief overview of ocean acidification and highlight the local monitoring efforts on Kodiak Island.

Paralytic shellfish toxins in fish and invertebrates of Southcentral and Southwest Alaska

Steve Kibler[1]* *steve.kibler@noaa.gov*
Bruce Wright[2], ***Xiuning Du***[3], ***Rob Campbell***[4], ***Kris Holderied***[5], ***Julie Matweyou***[6], ***Mayumi Arimitsu***[7]

1. NOAA National Ocean Service, Beaufort Laboratory, Beaufort, NC
2. Knik Tribe of Alaska, Palmer, AK
3. Oregon State University, Hatfield Science Center, Newport, OR
4. Prince William Sound Science Center, Seward, AK
5. NOAA National Ocean Service, Kasitsna Bay Laboratory, Seldovia, AK
6. Alaska Sea Grant, Kodiak Seafood and Marine Science Center, University of Alaska Fairbanks, Kodiak, AK
7. USGS Alaska Science Center, Anchorage, AK
**Corresponding author*

In Alaska paralytic shellfish poisoning (PSP) is caused by ingestion of seafood products containing saxitoxins, potent neurotoxins produced by the dinoflagellate *Alexandrium catenella*. PSP is usually caused by consumption of toxin-containing bivalves (mussels, clams, etc.), but there is growing evidence that toxins can also be transferred to other biota during *Alexandrium* blooms, including species that do not feed directly on shellfish. Here, we report preliminary results from two concurrent projects examining the potential occurrence of PSP toxins in marine fish and invertebrates across southcentral and southwest Alaska. Samples were collected at a variety of sites in Lower Cook Inlet, Prince William Sound, the Kodiak Islands, the Alaska Peninsula, the Aleutians and the Pribilof Islands, and were analyzed for PSP toxin concentrations by ELISA and HPLC. Resulting data indicate toxin concentrations in forage fishes (saxitoxin equivalents, STX Eq.) reached the highest levels in Dolly Varden (*Salvelinas*, 208 µg 100 g-1), Pacific Herring (*Clupea*, 428 µg 100 g-1) and Pacific Sand lance (*Ammodytes*, 758 µg 100 g-1). Toxins were also present in the organs of predatory fishes, with maximum concentrations in the kidney (170 µg 100 g-1), liver (103 µg 100 g-1) and digestive organs (49 µg 100 g-1). In contrast toxin levels in muscle tissue and roe were very low (≤13 and ≤8 µg 100 g-1, respectively). Among invertebrates tested, the highest toxin concentrations were recorded in crabs (1,650 µg 100 g-1), sea stars (672 µg 100 g-1) and predatory snails (483 µg 100 g-1), but with notable levels in detritivorous amphipods (171 µg 100 g-1), urchins (99 µg 100 g-1), octopus (71 µg 100 g-1) and tunicates (63 µg 100 g-1). Regional and interspecific differences in toxin levels among fish and invertebrates were examined, along with implications for high level marine predators and Alaskan seafood.

Nearshore marine bird and mammal surveys in the Kodiak Archipelago

***Robin Corcoran**, U.S. Fish and Wildlife Service Kodiak National Wildlife Refuge, Kodiak, AK, robin_corcoran@fws.gov*

The goals of the Kodiak National Wildlife Refuge nearshore marine bird and mammal survey were to determine archipelago-wide population estimates, long-term trends, and an index to annual productivity for key marine bird and mammal species relevant to Refuge management objectives and to contribute data to a regional monitoring program for birds throughout the Gulf of Alaska. The survey included systematic sampling from a random start point and transects surveyed represented 19-21% of the nearshore survey zone and 4-5% of the offshore survey zone. Due to the length of coastline the archipelago was divided into three survey zones (East, West, and Afognak) requiring three years for a complete survey. The first round of surveys were conducted from 2011-2013 (Corcoran 2016). In the second round of surveys, conducted from 2014-2016, we identified 68 marine bird and eight marine mammal species. Black-legged Kittiwake, Glaucous-winged Gull, Tufted Puffin, Common Murre, Harlequin Duck, Pigeon Guillemot, Mew Gull, and Marbled Murrelet were the most frequently encountered species and accounted for 88% of all nearshore marine birds observed across the three summers. The Kodiak Archipelago is an important breeding area for Marbled Murrelet and the June 2014-2016 archipelago-wide population estimate of 26,118 (95% CI: 17,708-34,528) was lower than the June 2011-2012 estimate of 38,926 (95% CI: 33,704-44,148). The June 2014-2016 population estimate for another species of conservation concern, the Black Oystercatcher was 1,958 (95% CI: 1,425-2,490), which represents 18% of the estimated North American population for this species.

Alutiiq use of birds during the Ocean Bay period at Rice Ridge (49-KOD-363), Kodiak Island

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Rice Ridge (49-KOD-363) is a deeply stratified archaeological site on Kodiak Island, with well-preserved faunal remains dated to the Ocean Bay tradition (7600-4200 cal BP). The site contained an extensive bird bone assemblage that has not been analyzed before now. Casperson (2012) studied bird bones from Mink Island (49-XMK-030), located off the nearby Alaska Peninsula, and found that birds played important roles in the lifeways of Ocean Bay groups, even though these people have been conventionally portrayed as primarily dependent on marine mammals and fish. With this contemporary assemblage from Rice Ridge, we show that birds, especially cormorants, ducks, murres, and geese, were vital to Alutiiq ancestors on Kodiak Island, and that the relative abundance of bird taxa changed over three occupations within the Ocean Bay period. Alutiiq ancestors consumed birds as food, but also processed quantities of birdskins for clothing that was crucial to their survival.

The diet composition of Aleutian tern chicks in the Kodiak Archipelago, Alaska

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Aleutian terns *(Onychoprion aleuticus)* are one of Alaska's most rapidly declining and mysterious seabird species, and the causes of their precipitous decline remain unclear. Due to the low nesting propensity and hatching rates of this species in recent years, there is little data available about how chick diet is related to breeding success. From 2017-2020, we used trail cameras and video cameras to remotely monitor Aleutian tern nests at colonies across the Kodiak Archipelago, Alaska. Cameras were placed a meter from the nest, and programmed to take a picture at a timed interval and when motion activated. Thirty-three camera nests successfully captured chick feeding events. At these nests, we documented 1,339 chick provisioning events over this four-year period. In all years, Pacific sand lance *(Ammodytes hexapterus)* and greenling *(Hexagrammos spp.)* were the most common prey types, and salmon *(Oncorhynchus spp.)* were observed in abundance at one colony in 2019. Both Pacific sand lance and greenling were present in chick diet during the 70s; however, capelin *(Mallotus villosus)* were present in much larger proportions than in our modern study. Declines of capelin in Aleutian tern diet track other seabird diets in this region and appear to reflect a reorganization of the marine forage fish community since the late 1970s. The long term implications of the loss of this valuable prey type for Aleutian tern productivity and population trajectory are uncertain but concerning.

Abstracts - Session 3: Eyes on Marine Birds and Mammals

Marine die-offs in a warming ocean: working together to witness change

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Since 2014 seabird mass mortality events have occurred at least annually in the North Pacific, affecting a breadth of species and large marine ecosystems. These events were coincident with heightened sea-surface temperature anomalies compared to long term averages in each impacted region. In this presentation, we use data from a citizen science program focused on beached birds (COASST), contributions from coastal community members, the US Fish and Wildlife Service, and National Park Service, to provide an overview of seabird mortality events affecting the North Pacific over the last six years, and draw comparisons with historically documented events that occurred in the same regions. Our aim is to draw attention to the need for a better understanding of the mechanisms causing seabird die-offs, and for growing a network of scientists, local community members, resource management agency personnel, and outreach specialists to detect and share information about these events in the future.

Current marine mammal stranding response on the Kodiak Archipelago

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In 2016, both NOAA-authorized Marine Mammal Stranding Network (MMSN) agreement holders who were based in Kodiak retired, which significantly reduced the ability for marine mammal stranding responses throughout the Kodiak Archipelago. To rectify this situation, in 2017 NOAA asked Sun'aq Tribe of Kodiak (Sun'aq) to consider joining the Alaska Region MMSN, and in 2018 Sun'aq successfully became a member of the network.

This presentation will discuss the Alaska Region MMSN; an overview of stranding responses in 2020 despite the COVID pandemic; the ongoing "gray whale Unusual Mortality Event;" and the key role our network of partner agencies, MMSN volunteers, and members of the public have in helping us fulfill our response and data collection obligations as an Alaska Region MMSN member organization.

23 January 2018 magnitude 7.9 Offshore Kodiak earthquake: What we learned and ongoing studies

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The Alaska-Aleutian subduction zone spans 3,800 km from the Gulf of Alaska westward to the Kuril-Kamchatka trench. It is one of the most active subduction regions in the world and has produced four magnitude 8+ earthquakes in the last century, including the magnitude 9.2 1964 Great Alaska earthquake and the magnitude 8.2 1938 earthquake southwest of Kodiak Island. In addition, this region is frequented by moderate to strong earthquakes that occur in diverse geological settings, including crustal seismicity, intraslab and interface events, as well as in the outer rise region (e.g., 2018 M7.9 Offshore Kodiak earthquake). Some of these earthquakes are capable of producing damaging local and trans-Pacific tsunamis.

The 2018 magnitude 7.9 Offshore Kodiak earthquake was a complex rupture of the oceanic lithosphere. It initiated as a strike-slip earthquake on a N-S oriented fault, with predominant propagation to the north, but also some propagation to the south. However, instead of simply continuing along this path, the rupture bifurcated into a conjugate fault plane westward. The source complexity is evidenced by the aftershock distribution, which extends over a 100x100-km region and includes several well-defined N-S lineations and some E-W trends. The GPS modeling also required significant motions on the westerly-trending fault plane. The Alaska Amphibious Seismic Community Experiment (AACSE) is a major shoreline-crossing project aimed at studying various aspects of the subduction process in the region between Kodiak and the Shumagin Islands. The project's main activity was a 15-month-long deployment of 75 ocean bottom and 30 land-based broadband seismometers between May 2018 and September 2019. We are using these data for detailed analysis of the 2018 aftershocks. While major earthquakes in the oceanic plates are rare occurrence, they may have significant implications for seismic hazard and tsunami potential, especially in Alaska.

Dr. Natalia Ruppert obtained her Ph.D. in Geophysics from the University of Alaska Fairbanks in 2001 and has been working as a Seismologist with the UAF Alaska Earthquake Center since. Natalia has been involved in various aspects of the Center's activities throughout the years and is currently concentrating her efforts on studying Alaska earthquakes and tectonics. Presently, she also serves as a Commissioner on the Alaska Seismic Hazards Safety Commission.

Feeling the heat: snow crab in a warming ocean

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Recent historic lows in sea ice and cold pool extent in the Bering Sea have been linked to large-scale biogeographic shifts, and continued warming is expected to drive a northward contraction of range in southeastern Bering Sea (EBS) snow crab *(Chionoecetes opilio)*. The National Marine Fisheries Service EBS bottom trawl survey data from 1988-2019 were used to examine EBS snow crab temperatures occupied, areal extent and centers of distribution to assess the role of climatic conditions on range shifts. The northern Bering Sea (NBS) was also surveyed in 2010 and 2017-2019, allowing us to examine NBS snow crab population structure relative to potential climate-driven range contraction into the NBS. During the 32-year time series, trends in snow crab occupancy temperatures in the EBS were tightly coupled with average bottom temperatures, suggesting that snow crab may have been unable to maintain thermal preferences during recent warming events. Furthermore, we found that increased temperatures and a reduced, more southerly cold pool extent resulted in a smaller area occupied across ontogenetic stages, although there was no evidence for a directional shift in centers of distribution. Despite this finding, survey abundance estimates suggested a ~ 600% increase in male snow crab (61-120 mm carapace width) in the NBS between 2018 and 2019. Substantial shifts in NBS snow crab population structure in 2019 may have future management implications for EBS snow crab and highlight the potential to support subsistence and commercial snow crab fishery opportunities in northern latitudes.

Red king crab stock enhancement experiments in Kodiak

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Red king crab *(Paralithodes camtschaticus)* was commercially important around Kodiak, in the 1960s and 1970s; however, the stock crashed in the late 1970s and the fishery was closed but has failed to recover. The use of hatchery-reared juveniles has been considered to help bolster the wild population. We examined the effects of release density and release timing on survival of hatchery-reared red king. Juveniles were released in Trident Basin at three densities, 25, 50, and 75 m-2 in the first year, and at three times, June, August and September in the second year. We monitored densities inside and outside of release plots for 5 months using quadrat counts to determine loss and emigration rates. Relative predation risk was determined using tethering experiments, and predator densities were quantified using quadrat counts and predator transect counts. Initial mortality over the first 24 hours was high at about 40-70%. Loss rates after the initial mortality did not differ among density treatments but did differ with release time and were a combination of mortality and emigration. Relative predation risk of tethered crabs decreased with time from release in both years, but did not vary among density treatments. Mortality rates were higher in the first year than in the second, did not differ with density, but did change with release time. Survival of hatchery-reared juveniles was similar to that of wild individuals in a commercially harvested population in southeast Alaska, indicating that stock- enhancement may be ecologically viable, at least during the early juvenile phase.

Tracking king crabs with drones

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King crab legs are greatly appreciated when they are on our plates (dipped in butter), but what are they up to when still attached to a crab roaming the ocean floor? In the Bering Sea we have a good picture of the distribution of red king crabs in the summer, however where they scuttle off to at other times of the year is mostly a mystery. It is important to understand where crabs go and what habitats they use to set appropriate fishing regulations, like closure areas. Our research involves attaching acoustic tags to Bristol Bay red king crab and tracking them with a sailboat-like drone to better understand their movement, distribution, and habitat use. Specifically, we are working to discover where the crabs that are observed in NOAA's annual summer survey end up in other seasons and what habitats and environmental conditions, like temperature, they are experiencing. Thus far, tagged crabs have stayed highly aggregated and moved an average of 40 miles over four months. An impressive feat for a crab walking on six gangly legs.

Tanner crab population in the Kodiak District of the Westward Region

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Tanner crab stocks around Kodiak Island have been monitored with a large-mesh bottom trawl survey conducted annually by Alaska Department of Fish and Game since 1988. This survey provides data for management of commercially important groundfish and crab stocks. Estimated Tanner crab abundance is highly variable with greater than five-fold variation in abundance among years. In the Kodiak District variability in abundance since the late 1990s has been driven by four cohort groups approximately five to seven years apart. Current abundance is high, compared to the last 30 years, although the number of legal males is low. Juvenile crab first seen in 2017 and 2018 are persisting in survey catches. Males are starting to reach maturity and are predicted to become legal-size in the next one to two years, potentially contributing to harvest if survival is good. Adult female abundance is estimated to be at one of the highest levels in the survey timeseries.

The harvest strategy in effect through 2021 used 1968–1998 abundance, estimated from various methods to reconstruct the population. Alaska Department of Fish and Game proposed a harvest strategy update, using current, consistent trawl survey abundance estimates from 1988–2020 to provide new thresholds that include recent abundance trends. Additionally, the need for minimum guideline harvest levels in regulation and the utility of including female abundance when considering harvest limits for the male only Tanner crab fishery was evaluated.

Effects of ocean acidification on Alaskan crabs: updates from the Kodiak Lab

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Ocean acidification, a decrease in ocean pH with increasing anthropogenic CO2 concentrations, is expected to affect many marine animals. We determined the effects of ocean acidification on snow crab embryos and larvae and golden king crab (GKC) juveniles. Crabs were tested at three treatment pHs, ~8.1 (Ambient), 7.8, and 7.5.

Egg-bearing snow crabs were held for two years to determine the effect on embryo development, morphology, and hatching success. When larvae hatched, they were reared with the same pH treatments to test the effects on their survival and condition. Embryo development and mortality and hatching success were unaffected by pH during both years. In the first year but not the second, pH reduced larval survival. Larvae hatched from embryos held at pH 7.5 had lower calcium content in the first year but not the second year. Snow crab embryos and larvae seem to be very tolerant of low pH.

Thirty juvenile GKC were held in each treatment for 127 days, and growth and mortality were recorded. Mortality was highest at pH 7.5 and lowest at Ambient pH. Crabs at pH 7.5 were smaller at the end of the experiment, both in terms of carapace length and wet mass, had a smaller growth increment after molting, and had a longer intermolt period. Carapace morphology was not affected by pH treatment. Decreased growth and increased mortality suggest that lower pH could affect golden king crab stocks and fisheries. Future work will examine if larval rearing conditions affect the juvenile response to low pH.

Abstracts - Session 5:
One Fish, Two Fish, Rockfish, Codfish

Rockfish knowledge project: what have we learned from the Kodiak community about rockfish fisheries and management?

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Over the past few decades, nearshore rockfishes (*Sebastes spp.*) have experienced increased pressure from multiple fisheries throughout the Gulf of Alaska, including Kodiak. The unique life history traits of rockfish pose a host of challenges that make them difficult to monitor and vulnerable to overfishing. Rockfishes are ecologically and culturally important to coastal communities in the Gulf of Alaska. Therefore, the inclusion of fishers' knowledge in rockfish management is necessary to form regulations that address both the needs of the growing fishery and the biology of the fish. Our study brings together fishery data from Alaska Department of Fish & Game and fishers' knowledge to 1) synthesize perspectives on the recent history of recreational and commercial rockfish fisheries in the Gulf of Alaska; and 2) highlight the strengths and challenges of stakeholder engagement and stewardship in Alaskan fisheries management. We will share results from our interviews with fishermen and agency staff in Kodiak and explore the complimentary attributes of fishers' knowledge and fishery data to create a more complete understanding of Kodiak's rockfish fisheries.

Abstracts - Session 5: One Fish, Two Fish, Rockfish, Codfish

The impact of Gulf of Alaska marine heatwaves on early life stages of Pacific cod

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The recent Gulf of Alaska (GOA) marine heatwaves (2014-16, 19) corresponded with a significant reduction in Pacific cod biomass that eventually led to the closure of the 2020 federal fishery. Adult cod experienced high rates of natural mortality during this period, but it is unclear how marine heatwaves impacted early life stages that have not yet recruited to the fishery. The Kodiak beach seine survey (2006–present) targets 0-group Pacific cod and is the only time series with archived samples of juvenile cod spanning the pre- and post-'warm blob' years in the GOA. The survey appears to be strongly linked with GOA recruitment events of cod, suggesting that nearshore assessments could potentially be used to predict future production. Using these data and other early life history information, NOAA Alaska Fisheries Science Center and outside partners are using improved mechanistic understanding of marine heatwave impacts on cod to develop early warning indicators.

Abstracts - Session 5: One Fish, Two Fish, Rockfish, Codfish

High ocean temperatures linked to apparent recruitment failure for juvenile Pacific cod (*Gadus macrocephalus*) in the Western Gulf of Alaska

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A cooperative research project between the Alaska Fisheries Science Center, the University of Alaska Fairbanks, and the nonprofit organization Alaska Coastal Observations and Research was undertaken to better understand the factors regulating condition and survival for age-0 Pacific cod *(Gadus macrocephalus)* across the western Gulf of Alaska. Beach seine locations were established in 13 bays along the eastern side of Kodiak Island, the Alaska Peninsula, and in the Shumagin Islands, and sampling occurred in July and August of 2018, 2019, and 2020. All fish were counted and measured in the field, and samples were retained for investigations on condition, diet, age, and population genetics. Habitat, temperature, and salinity data were also collected.

Recruitment of age-0 Pacific cod failed following extremely warm temperatures in winter 2019 (mean CPUE = 2 cod/haul), which contrasted with strong recruitment in 2018 (mean CPUE = 84 cod/haul) and 2020 (mean CPUE = 57 cod/haul), when the extreme winter temperatures were absent. Reduced abundance during the heatwave in 2019, coupled with poor age-0 recruitment during the 2014-2016 marine heatwave, supports the hypothesis that the cod stock is prone to recruitment failure when ocean temperatures are too high. Furthermore, the absence of age-0 cod in our 2019 catches indicates that mortality occurred pre-settlement in that year. Post-settlement body condition was measured in the laboratory, and our analyses indicate that increased values of cod condition corresponded with warmer water temperatures. Thus, when age-0 cod survive and successfully recruit to the nearshore as juveniles, their body condition appears to increase with ocean temperature. Continued sampling of this joint research project will further our understanding of the processes regulating recruitment of Pacific cod in the Gulf of Alaska.

Evaluating thermal effects on spawn timing and early growth of Gulf of Alaska Pacific cod: implications for survival and recruitment

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Understanding the effects of environmental variability on Pacific Cod recruitment is critical for sound management. Variation in the abundance of Pacific Cod in the Gulf of Alaska (GOA) is related to water temperature and a dramatic reduction in Pacific Cod abundance was observed after a prolonged 2013-2016 marine heatwave. Thus, a better understanding of the consequences of thermal variation on Pacific Cod spawning phenology, early growth, and patterns of mortality is critical.

A research approach that integrates across life stages can provide a more comprehensive understanding of the mechanisms regulating recruitment. We are initiating a project that builds upon extensive field collections of Pacific Cod larvae (32 years) and juveniles (13 years) within the GOA. We will combine structural analysis of otoliths with field and laboratory data to estimate spawn timing, size and timing of hatch, and reconstruct growth during the pelagic stage as well as in coastal nursery habitats. We will incorporate age and size information in temperature-dependent models of developmental and growth rates and environmental data to address hypotheses about how early life history processes influence recruitment. Understanding how this important species responds to thermal variation is integral for disentangling processes regulating growth and survival to recruitment.

This informal panel discussion will explore how current Kodiak Island Pacific Cod research fits into a conceptual model of factors influencing growth and survival.

Investigating Aleutian tern breeding season movements using satellite telemetry

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Aleutian Tern *(Onychoprion aleuticus)* counts at known breeding colonies in Alaska have declined dramatically over the last several decades. Unfortunately, conservation planning is limited by the lack of information on breeding season site fidelity, formation of new colonies, and within-season dispersal after colony failure and abandonment. At two colony sites in the Kodiak Archipelago, ten Aleutian Terns were fitted with 2g satellite telemetry tags early in the 2019 breeding season. Eight tags provided movement data throughout the breeding season. Three tagged terns displayed extended fidelity to their capture location, with the maximum distance from their respective capture sites ranging from 60 to 190 km until the onset of migration from late July to mid-August. However, five tagged terns moved widely throughout the northeastern Gulf of Alaska, covering distances ranging from 300-760 km. One tagged individual visited the Yakutat region and spent nearly three weeks in the Copper River Delta, near known active Aleutian Tern colonies. Tagged terns also visited two sites within the Kodiak Archipelago that potentially represent previously undocumented colony sites. Around Kodiak, terns foraged across the continental shelf with some trips to the shelf break up to 150 km offshore. Our initial results demonstrate that satellite telemetry tags are useful tools to study movements of Aleutian Terns and can help assess within-season colony attendance patterns, identify previously unknown colony sites, and help characterize important foraging habitats.

Investigating Aleutian tern non-breeding season movement patterns using satellite telemetry

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Aleutian Tern *(Onychoprion aleuticus)* counts at known breeding colonies in Alaska have declined dramatically over the last several decades, and the species was recently elevated to "vulnerable" by the International Union for Conservation of Nature and Natural Resources. The winter range was completely unknown until the late 1980s, and migration routes were poorly documented. In part to fill these data gaps, at two colony sites in the Kodiak Archipelago, ten Aleutian Terns were fitted with 2-g solar satellite telemetry tags (Microwave Telemetry, Inc.) early in the 2019 breeding season. Seven individuals that had working tags at the time of migratory departure displayed steady long-distance migrations to Southeast Asia, with two utilizing the eastern coast of Japan as a migratory route instead of passing between Hokkaido and Honshu. Five individuals transmitted from presumed overwinter locations, with three transmitting consistently from Indonesia (two in the Strait of Malacca, and one on the NW coast of Sumatra), one from the Philippines (vicinity of the Semirara Islands and SW coast of Mindanao Island), and one from Papua New Guinea (Massau, Rambutyo, New Hanover, and Bauddisson islands). The two individuals associated with the Philippines and Papua New Guinea islands displayed larger scale overwinter movements than previous years, and the individuals associated with Indonesia overwinter locations.

Application of quantitative molecular methods to characterize abundance and distribution of *Alexandrium* cysts for NOAA's HAB forecasting—year 1 update

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Forecast tools are being developed to mitigate human health risks and negative economic effects of shellfish closures due to seasonal blooms of *Alexandrium catenella*, the toxic dinoflagellate that causes paralytic shellfish poisoning along the Pacific and Atlantic coastlines of the U.S. and Canada. Resting cysts are a dormant life stage of *A. catenella* and allow the species to survive unfavorable conditions during the winter. When conditions become favorable for growth in the spring, cysts germinate into vegetative cells to seed the next bloom. Forecasting efforts are therefore dependent on the wintertime abundance of *Alexandrium* resting cysts in the sediment at bloom locations. The current protocol for cyst enumeration by fluorescent microscopy is time consuming and requires highly specific training. This project will develop new quantitative polymerase chain reaction (qPCR) and fluorescent in situ hybridization (FISH) assays for *A. catenella* cysts that will be evaluated against current microscopy protocol with the goal of producing more rapid, accurate cyst abundance data. Sediment samples from the Gulf of Maine, Puget Sound and Alaska are being collected for interlaboratory and method comparisons, and for cyst mapping. This poster introduces the project team and objectives, and highlights the project progress in Kodiak. The project is funded by NOAA National Centers for Coastal Ocean Science; results will be applied to NOAA's Harmful Algal Bloom Operational Forecast System and methods will be made widely accessible.

Community-based PSP testing for shellfish—Kodiak Region summary

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Subsistence shellfish harvesters in southwest Alaska can be exposed to high paralytic shellfish poisoning (PSP) risks due to their dependency on and cultural tradition of shellfish resources. Kodiak shellfish are known to have very high levels of PSP toxins that have caused severe illness and deaths. Three communities in the Kodiak region were integral members of the NPRB 1616 project that was developed to provide tools to inform local shellfish harvesting decisions through community-based toxin monitoring, investigation into traditional clam cleaning methods, and development of a new PSP test kit. This poster was created to be shared with our community partners: the Alutiiq Tribe of Old Harbor, the City of Ouzinkie and the Sun'aq Tribe of Kodiak, and highlights engagement and key results. Shellfish monitoring demonstrated that PSP toxin levels in butter clams increase dramatically in the summer months but toxins are routinely above the FDA regulatory limit, even in the winter. Monitoring is an effective strategy to provide critical information about PSP risk to coastal residents and we recommend continuation. In response to harvester-specific questions, this study also addressed the difference in toxicity between whole and cleaned butter clams. We explored the seasonal distribution of saxitoxin congeners in butter clam tissues and evaluated cleaning methods used by harvesters. The cleaning studies show toxicity of butter clams can be reduced by removal of the siphon tip and the gut, as well as other tissues. However, there was not a 100% removal of toxins. Alaska Sea Grant publication MAB-78 disseminates the findings of this cleaning study. We conclude our project with a tremendous thank you to our community partners and continue to look for opportunities to support safe subsistence shellfish harvest.

Stream side settlement of the Karluk River, Kodiak Island, Alaska

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The Karluk river valley has been home to Alutiiq people for more than 6000 years. Surveys from the river mouth to the head of Karluk Lake illustrate that the entire drainage has a prolonged and intense history of settlement. To better understand how Kodiak's maritime societies used inland environments, the Alutiiq Museum and Koniag, Inc. are partnering on a long-term research program aimed at studying the evolution of settlement patterns, the season and duration of settlement, and connections to the coast. A 2019 pilot excavation at the outlet of Karluk Lake uncovered two rooms in a late prehistoric multi-room house and a sample of the associated midden. Notable discoveries include a substantial sod structure that was repeatedly re-used, extensive evidence of food processing inside the house, and faunal remains indicating significant contact with and/or travel to the coast.

Identification of physiological growth signatures in skeletal muscle of Pacific halibut *(Hippoglossus stenolepis)* for monitoring population growth patterns

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The International Pacific Halibut Commission has reported changes in the size-at-age (SAA) of Pacific halibut *(Hippoglossus stenolepis)* for almost 100 years. However, our understanding of the potential causes for the long-term variability in SAA is limited. Although several factors could contribute to this variability, recent analyses have suggested that temperature variation may have been a contributing factor to the observed changes in SAA. Therefore, a better understanding of the physiological effects of temperature on growth in this species is needed. To address this issue, we investigated the effects of temperature-induced growth manipulations on white skeletal muscle in juvenile Pacific halibut. Two groups of juveniles were acclimated for 8 weeks at 2°C and 9°C, after which half of the individuals from the 2°C group were gradually acclimated to 9°C and held at that temperature for an additional 6 weeks. Initial acclimation at 2°C resulted in a significant reduction in the specific growth rate (SGR) of juvenile Pacific halibut when compared to fish acclimated only at 9°C. Following the first acclimation period, the group initially acclimated at 2°C and subsequently acclimated to 9°C displayed a significant increase in SGR when compared to fish that were constantly held at 9°C, demonstrating compensatory growth. We performed transcriptomic, proteomic and stable isotope analyses of white skeletal muscle collected from these experimental groups to identify growth-related processes that are regulated by temperature. The resulting physiological signatures of temperature-regulated growth should be useful to monitor growth patterns in the Pacific halibut population.

Assessment of reproductive development in female Pacific halibut *(Hippoglossus stenolepis)*

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Current maturity estimates in female Pacific halibut are derived from macroscopic visual criteria of the ovaries collected in the field. In order to improve maturity estimates and to provide updated estimates of maturity-at-age, the International Pacific Halibut Commission (IPHC) is conducting studies destined to improve our knowledge on reproductive development in female Pacific halibut. In an initial study, Pacific halibut females from three geographical locations throughout the distribution range of the species were collected during the summer, or nonspawning season, and during the winter, or spawning season. Histological examination of ovaries of winter- and summer-caught females evidenced differences in oocyte size distribution and predominant oocyte stages that appeared to be relatively consistent with females sexually maturing in the winter and with females undergoing vitellogenesis in the summer, as a prerequisite for spawning in the winter. Current studies are devoted to describe the entire annual reproductive cycle of the species and to study in detail morphological, histological, endocrine and functional changes in both female and male gonads. These studies will lead to a better understanding of the temporal and spatial progression of sexual maturation in Pacific halibut females, and to a better estimate of maturity for stock assessment purposes.

Too hot to handle: effects of thermal variability on juvenile Pacific cod foraging and growth in Gulf of Alaska nursery habitats

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The Gulf of Alaska (GOA) ecosystem is influenced by thermal variability related to climatic phenomena, background warming, and anomalous warming events such as the 2014–2016 and the 2019 marine heatwaves, both of which produced temperature anomalies > 2.5° C. Extreme thermal variability, particularly heatwaves, negatively impacts Pacific cod *(Gadus macrocephalus)*, a commercially and ecologically significant GOA fishery. Estimated adult abundance of Pacific cod declined by ~75% following the marine heatwave events, leading to the closure of the federal fishery in 2020 and highlighting a need to better understand the species' response to warming. Early life stages of Pacific cod may be particularly susceptible to warming, including age–0 juveniles during periods of rapid summer growth in central GOA nursery habitats. Elevated temperatures in nearshore nurseries may influence juvenile Pacific cod foraging patterns, growth, body condition, and selective mortality during their first summer in the nursery. To evaluate the potential consequences of extreme thermal variability on juvenile Pacific cod, we assessed the diet composition, size, and growth of juveniles collected from Kodiak Island between 2008 and 2019. Preliminary results indicate that juvenile Pacific cod were larger and exhibited faster growth rates during warmer conditions. Pacific cod prey community composition varied between pre-heatwave conditions and heatwave conditions, with smaller prey items such as small copepods and cladocerans common in years prior to the heatwaves, and larger prey items, including polychaete worms and shrimps, common during the heatwaves. Prey community composition between the two heatwave events shared characteristics of both pre-heatwave and heatwave prey communities. These results suggest that larger, faster-growing age–0 Pacific cod may have a survival advantage during heatwave conditions, and that the larger sizes of surviving juvenile Pacific cod during heatwave conditions may help to drive the patterns in diet composition observed during marine heatwave events. Understanding the effects of thermal variability on juvenile Pacific cod during their first summer in the nursery has important implications for overwinter survival and recruitment into the commercial fishery, and may be useful in managing the species in the face of future warming.


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