Pollock Conservation Cooperative Research Center

Background

The Pollock Conservation Cooperative Research Center (PCCRC), established in February 2000, is an industry-funded cooperative research center managed by the UAF College of Fisheries and Ocean Sciences to improve knowledge about the North Pacific Ocean and Bering Sea through research and education, focusing on the commercial fisheries of the Bering Sea and Aleutian Islands.

Our Mission

The PCCRC provides: (1) grants to faculty and research stipends to graduate students for research on pollock, other groundfish species, the fisheries for these species, and on marine mammals; (2) funding for marine education, technical training, and equipment.

PCCRC Advisory Board

- Dr. Nettie La Belle-Hammer, Vice Chancellor for Research, UAF
- Dr. S. Bradley Moran, Dean, CFOS, UAF
- Stephanie Madsen, At-Sea Processors Association
- Trent Hartill, American Seafoods Group
- Shannon Carroll, Trident Seafoods
- Dr. Chris Siddon, Alaska Department of Fish & Game
- Dr. Keith Criddle, PCCRC Director, CFOS, UAF

Research Priorities

I. Fisheries Management and Incidental Catch — Research dedicated to improved biological data on species incidentally caught in North Pacific groundfish fisheries (sharks, skates, octopus, squid, sculpins, crab, halibut, salmon, etc.) to better quantify potential effects on those stocks and to improve estimates of discard mortality. Research dedicated to evaluating current fisheries management strategy and the potential need for regulatory flexibility to adapt to ever-changing environmental conditions.

II. Pollock Biology — Research dedicated to improved biological data on the pollock stock.

III. Resource Utilization and Market Development — Research is desired to create additional products and derive greater product value from existing harvests.

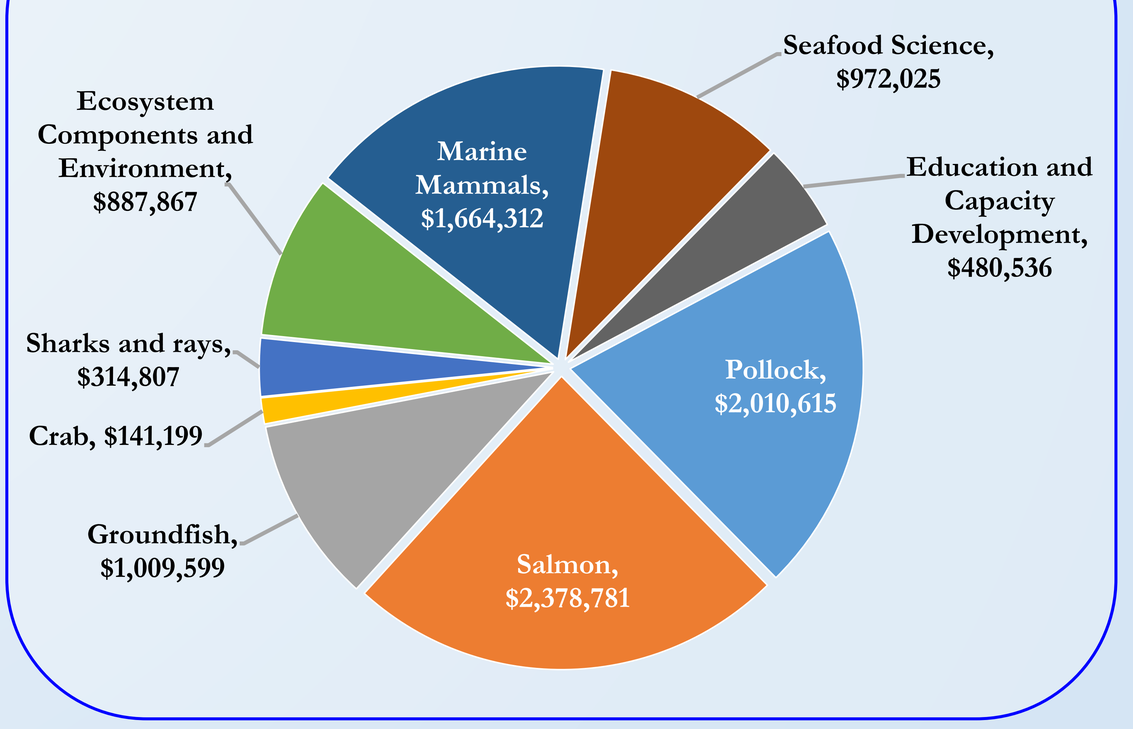
IV. Habitat, Ecosystems, and Protected Species — Research dedicated to evaluating habitat and ecosystem considerations and investigating the factors influencing the sustainability of protected species. Of primary interest to PCCRC is the Pribilof Island fur seal stock. However, research on Steller sea lions and other Endangered, Threatened, or Protected species will also be considered.

Keith Criddle, PCCRC Director
Phone: (907) 796-5449
Email: PCCRC@sfos.uaf.edu
Website: https://www.pccrc.org

Accomplishments

Through 2022, the PCCRC has supported over $16.8 million in marine research and education programs in Alaska. PCCRC-funded research projects have provided financial support for 53 graduate students and post-docs. Support for the PCCRC comes from earnings on a $1.4 million endowment managed by the UA Foundation and annual gifts by PCC member companies through the UA Foundation to the PCCRC research spendable account.

Funded Research, 2000-2023



Current Projects

1. Evaluation of spatio-temporal methods for standardizing data from multiple fishery-independent surveys in the Gulf of Alaska, Bering Sea and Aleutian Islands (Curry Cunningham, James Thorson, Meaghan Bryan, Cindy Tribuzio)
2. Phytoplankton, nutrition, and genomics: nutritional consequences of changes in phytoplankton community structure (Sarah Mincks, Jeanette Gann)
3. Spatiotemporal dynamics of chum salmon bycatch in the Bering Sea (Megan McPhee, Pat Barry, Jordan Watson, Chris Kondzela, Ellen Yasumiichi)
4. Decomposing the influence of climate and fisheries on pollock body size and growth (Krista Oke, Peter Westley, Mike Litzow, Jim Ianelli)
5. Development of value-added pollock coproducts: pollock roe as a source of anti-inflammatory peptides for human health improvement (Quentin Fong, Christina DeWitt, Jung Kwon)
6. Genetic composition of Bering Sea Pacific herring aggregations (Andreas Lopez, Jessica Glass)
7. Getting ahead of bycatch spikes: using species distribution models to predict Chinook salmon and walleye pollock fleet overlap (Andy Seitz, Noelle Yochum, Jordan Watson, Sabrina Garcia)
8. Where have all the Chum salmon gone? An assessment of marine critical periods for Yukon River and Norton Sound Chum salmon*
   (Ed Farley, Phyllis Stabeno, Calvin Mordy, Alexei Pinchuk, Katherine Howard)
   ** partial support of NPRB Project #2059 through MOU.*
9. Linking climate and early life history to recruitment of Yukon River Chum salmon (Megan McPhee, Katie Howard, Katherine Miller, Courtney Weiss)
10. The environmental ratchet, revisited: the role of temperature and predation in controlling abundances of snow crab in the Bering Sea (Franz Mueter, Cody Szuwalski, Ben Daly)

PCCRC Graduate Research Fellows, Graduate Assistants, and Post-Docs

www.pccrc.org

Through research projects and fellowships, the PCCRC has provided financial support for 53 graduate students and post-doctoral fellows. These former students are well represented in state and federal agencies, and at the University.

NOAA Fisheries (7), ADF&G (8), UA staff (5), *UA students* (5), US FWS (2), Other Alaska (6), Other Universities/Research Centers (2), Business (4)

Keita Abe, *Sydney Almgren*, Alison Banks, **Cheryl Barnes**, **Pat Barry**, **Michael Courtney**, **Curry Cunningham**, Elena Fernandez, **Elizabeth Figus**, **Jeanette Gann**, **Sabrina Garcia**, **Michael Garvin**, Gretchen Geiger, **Cory Graham**, Sharon Hall, Cathy Hegwer, **Clara Hintermeister**, Angela Hunt, *Kaitlin Junes*, David Kemp, **Mandy Keogh**, **Jinhwan Lee**, **Justin Leon**, **Zhouzhou Li**, **Kaitlyn Manishin**, **Joel Markis**, **Jennifer Marsh**, Garrett McKinney, *Rufa Mendez*, Heidi Mendoza-Islas, Gregory Merrill, **Daniel Michrowski**, **Sara Miller**, **Tessa Minicucci**, **Matt Myers**, **Kevin Nelson**, **Julie Nielsen**, Shannon O'Brien, **Krista Oke**, **Katie Palof**, *Tristan Sebens*, **Haixue Shen**, **Jared Siegel**, Stacy Smith, Jennifer Stahl, **Hank Statscewich**, **Erin Steiner**, **Wesley Strasburger**, **James Strong**, **Jane Sullivan**, *Tadayasu Uchiyama*, Kray VanKirk, **Rachel Wadsworth**, Brian Walker, *Courtney Weiss*, **Adam Zaleski**

Kaitlyn Manishin (7/1/2016 – 12/31/2018) *Under what scenarios could salmon shark predation impact Chinook salmon production*

Summary: Declines in productivity of Chinook salmon stocks have led to severe restrictions on subsistence, commercial and recreational fisheries. A recent satellite tagging investigation provided direct evidence of predation by salmon sharks on large, immature ocean-stage Chinook salmon. This project will investigate scenarios in which salmon shark predation could influence Chinook salmon productivity. I will estimate the total consumption of Chinook salmon by salmon sharks using previously published information and bioenergetics modeling. Those results will be used in a stage-structured population dynamics model to assess the stock-specific consequences of mortality on productivity of Chinook salmon. Understanding the potential impact of salmon shark predation on immature, oceanic life stage of Chinook salmon will advance the working knowledge of natural mortality of Chinook salmon during the marine phase. This information will more fully describe the ocean phase of the Chinook salmon life history, allowing for improved abundance-based management.

Elizabeth Figus (7/1/2014 – 6/30/2018) *Monitoring incidental catch species utilizing local fisheries knowledge*

Summary: This project explored the impacts of four alternatives for monitoring incidental catch in the Pacific halibut fleet in Southeast Alaska. This work combines local knowledge of fishermen with fisheries-independent survey data. Methods include semi-directed interviewing, factor analysis, logistic regression, text analysis, and the analytic hierarchy process. Interview responses were incorporated into a multiple criteria decision aid using the analytic hierarchy process. This allowed for assessment of impacts of monitoring alternatives on fishermen and biological sustainability for common incidental catch species.

Cory Graham (7/1/2015 – 12/31/2016) *Evaluation of growth, survival, and recruitment of Chinook salmon in southeast Alaska Rivers*

Summary: Chinook salmon are culturally and economically important in southeast Alaska. Recently, spawning run sizes of Chinook salmon have been dramatically reduced across Alaska, prompting researchers to identify the cause of these declines. Previous research suggests that salmon abundance is mediated by size-dependent mortality, with the time period during freshwater and early marine residence being critical for influencing survival patterns and, ultimately, recruitment to the spawning stock. I used a time series of freshwater and marine scale growth patterns to determine the effects and relationships of freshwater and marine growth on survival to the age of reproduction for female Chinook salmon by brood year in the Taku and Unuk rivers in southeastern Alaska.

Julie Nielsen (7/1/2013 – 6/30/2016) *Multi-scale movement of demersal fishes in Alaska*

Summary: In the summer of 2013, we deployed 25 Pop-up Satellite Archival Tags (PSATs) on halibut in the Glacier Bay National Park marine protected area (MPA)to determine seasonal movement patterns. Fifteen of the halibut were also tagged with acoustic transmitters and actively tracked during the summers of 2013 and 2014. Home range behavior and interannual site fidelity at spatial scales <5 km were observed for the majority of tagged fish. A small proportion (6/21 fish) departed the MPA on winter migrations during December 2013. A majority (4/6) of those fish returned to the MPA after an average of 57 days. Migration timing generally coincided with existing winter commercial fishery closures. The annual movement patterns of tagged halibut suggest that the MPA serves as a year-round refuge from commercial harvest for both residential and migratory halibut. If halibut behavior is similar in other areas, MPAs may be efficacious despite the migratory nature of halibut.

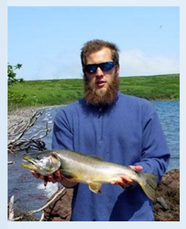
James Strong (7/1/2013 – 6/30/2014) *Bioeconomic model of eastern Bering Sea pollock*

Summary: A model of domestic and international markets for fillets, surimi, and roe of Alaska pollock was developed to examine the effect of variability in landings and prices and revenues. From the changes in product mix on first wholesale commencement of Americanization in the mid-1970s through the joint venture era of the 1980s and following full Americanization in early 1990s, U.S. producers of Alaska pollock focused mainly on selling surimi and roe to Japan. Passage of the AFA unleashed an economic transformation that more than doubled fishery revenues without increasing exploitation rates or catches. The increased value came about because freedom from the race for fish allowed fishers and processors to increase product quality, improve product recovery rates, diversify their mix of product forms, and develop new markets in the USA and Europe. Model results indicate that first wholesale revenues are maximized when harvests are maximized, but the value of the harvest is particularly sensitive to changes in the demand for Alaska pollock harvested in Russian waters, price differentials between fillet and surimi, and Japanese inventories of Alaska pollock products.

Tadayasu Uchiyama (7/1/2012 – 6/30/2014) *Dynamics of walleye pollock and their predators and competitors in the eastern Bering Sea*

Summary: The objective of this study was to develop age-aggregated multispecies models that describe biomass dynamics of some commercially and ecologically important groundfish species in the eastern Bering Sea by accounting for trophic interactions. We developed a multispecies biomass dynamics (MBD) model and a multispecies delay-difference (MDD) model. Both models were able to capture observed trends in survey biomass data over 1982–2009. Although the MDD model fit the survey biomass estimates better, its maximum likelihood parameters produced biologically unrealistic biomass projections at values of instantaneous fishing mortality. Strong positive correlations among many of the predation parameters resulted in highly uncertain parameter estimates. Consistent with previous studies, both multispecies models predicted the multispecies B_0, MSY, and F_{MSY} to be lower than the sum of the estimates from single-species assessment models. The MBD model provides estimates of natural mortality and tactical advice on the implications of single-species harvest strategies for the broader groundfish community in the eastern Bering Sea.

Adam Zaleski (7/1/2011 – 6/30/2013) *Factors influencing the sustainability of Steller sea lion populations*



Summary: The western stock of Steller sea lions experienced a dramatic decline particularly in the western Alaskan and Asian portions, which have continued to decline or stabilized at low levels. Multiple causes for this decline have been proposed and may include anthropogenic contamination from organo-halogen contaminants (OCs). These include polychlorinated biphenyls (PCBs) and dichlorodiphenyltrichloroethane (DDT), which have not been ruled out as a potential cause for the lack of recovery. The objective of this study was to determine the effects of OCs on survival and movement probabilities estimated in program MARK using resighting data collected from 2003 to 2009. PCBs and DDTs were measured in whole blood from 136 (74 males and 62 females) individually marked, free-ranging pups from four Russian Far East rookeries. While PCBs and DDTs were detected, survival and movement were most affected by age and location rather than OCs.

Sarah Miller (7/1/2009 – 6/30/2011) *How oceanographic conditions affect the growth, health, and survival of pink salmon in their first few months in the ocean*

Summary: Regional coastal conditions have a strong influence on juvenile salmon survival during their critical first months in the marine environment. Salmon survival has been thought to be favored within the high latitude downwelling domain if water column stabilities increase, whereas stability may have the opposite effect in upwelling-dominated lower latitudes. In this study, the relationships between water column stabilities during early marine residence of pink salmon in both the upwelling and downwelling domains of the northeast Pacific Ocean and marine survival rates for hatchery stocks ranging from Vancouver Island, British Columbia, to Kodiak Island, Alaska, were explored. Contrary to expectation, there was no clear difference in the effect of stability on marine survival rates in the downwelling and upwelling domains. In both domains, marine survival rates increased for pink salmon stocks that experienced below-average stability on the inner shelf during early marine residence. Stability effects from the outer shelf showed no consistent relationship to marine survival within the northeast Pacific.

Kray Van Kirk (7/1/2009 – 6/30/2011) *Assessing the role of predation on walleye pollock populations in the Gulf of Alaska using a multispecies age-structured assessment approach*

Summary: Performance of a multispecies age-structured assessment model in the Gulf of Alaska relative to changes in data and model assumptions was examined through simulation exercises. Species included arrowtooth flounder, Pacific cod, walleye pollock, Pacific halibut, and Steller sea lion. Age specific predation mortality was estimated as a flexible function of predator and prey abundances and fitted to diet data. Simulated data sets were constructed by applying random error to estimates of catch, survey, and diet data from an operating model, whose structure was identical to that of the estimating model. Simulations explored the effects of data variability, mismatched assumptions regarding model structure, and lack of diet data on model performance. Model misspecification and uninformative diet data had the greatest influence on model performance. Given the current emphasis on the development of ecosystem-based models and management, prioritizing the rigorous sampling of diet data would best facilitate the development of predation models useful to management agencies.

PCCRC Projects—Pacific Salmon

($2.4 million, 2000-2023)

www.pccrc.org

Current Projects

Linking climate and early life history to recruitment of Yukon River Chum salmon (Megan McPhee, Katie Howard, Katherine Miller, Courtney Weiss; 7/1/2023—6/30/2026)

Abstract: There are numerous potential causes for dismal recruitment of Yukon chum salmon in recent years. Correlations between juvenile abundance in their first summer at sea and subsequent adult recruitment suggest that recruitment variability has been driven strongly by processes happening early in the chum salmon's life cycle. Here, we propose to investigate two early periods in Yukon River chum salmon: 1) fry stage at marine entry; 2) very early marine life. Building on a time series begun in 2014, we will quantify mean and variation in body length of Yukon fall chum fry as they exit the Yukon River delta and relate annual variation in size to indicators of environmental variability to determine if years of poor growth can be anticipated by leading climate indicators. Second, we will compare back-calculated size at marine entry from otoliths of juveniles captured in the late summer/early fall Northern Bering Sea survey to the distribution of sizes sampled at the delta to determine if larger individuals are overrepresented in the latter sample, as predicted under the critical size, critical period hypothesis. A shift toward larger sizes in survivors would point to size-selective mortality acting early in Yukon chum's marine phase (i.e., immediately following marine entry or not long after) and would suggest that factors such as escapement quality and environmental conditions during winter incubation and spring migration are contributing to recruitment variability in Yukon fall chum salmon.

Where have all the Chum salmon gone? An assessment of marine critical periods for Yukon River and Norton Sound Chum salmon* (Ed Farley, Phyllis Stabeno, Calvin Mordy, Alexei Pinchuk, Katherine Howard; 1/1/2023 — 9/30/2026)

* *partial support of NPRB Project #2059 through MOU*

Abstract: Alaska salmon stocks have responded differently to recent changes in the North Pacific Ocean (NPO). Record low run sizes of Chum salmon were observed in the Yukon River and Norton Sound during 2021, but record high run sizes of Sockeye salmon were present in Bristol Bay. The differential survival response of salmon to changes in the marine ecosystem highlights the importance of understanding species and stock level differences in the marine ecology of salmon and its impact on critical survival periods. We propose a focused study on the marine ecology of Yukon River and Norton Sound Chum salmon by examining critical periods during their first year at sea and over winter. Early marine life history data come from a time series (2002 to present) of bio/physical oceanographic and fish collections on the northern Bering Sea shelf. Winter marine ecology data come from International Year of the Salmon (IYS) surveys in the Gulf of Alaska (GOA) during 2019 and 2020. An IYS survey within the NPO by Parties to the North Pacific Anadromous Fish Commission during winter 2022 will enable collections of bio/physical oceanographic data and Pacific salmon on a broader scale. These data will be used to examine climate impacts on critical periods for western Alaska Chum salmon during their early life history stage to their first winter in the NPO by testing the following hypotheses: 1) the GOA and eastern NPO serve as winter habitat for immature western Alaska Chum salmon stocks; 2) winter conditions and forage resources for immature Chum salmon are sufficient to stave off starvation.; and 3) competition among salmon is greater during winter relative to other competitive pressures.

Getting ahead of bycatch spikes: using species distribution models to predict Chinook salmon and walleye pollock fleet overlap (Andrew Seitz, Noelle Yochum, Jordan Watson, Sabrina Garcia; 4/1/2022 — 6/30/2025)

Abstract: Chinook salmon, an important subsistence and commercial resource across Alaska, is caught as bycatch during the walleye pollock fishery in the Bering Sea. Chinook salmon is considered a Prohibited Species Catch, therefore avoiding Chinook salmon is one of the most pressing concerns in the fishery. We propose a study consisting of two components to facilitate a future dynamic ocean management approach to reduce bycatch of Chinook salmon. In the first component, we will create a species distribution model (SDM) for Chinook salmon that incorporates multiple data streams, including walleye pollock bycatch data, research survey data, satellite telemetry data, and environmental variables. This comprehensive, multi-source approach represents a novel integration of fishery-dependent and -independent data sets that aims to generate predictive surfaces that show the probability of Chinook salmon presence throughout the year based on environmental variables. In the second component, the SDM will be used to assess overlap with walleye pollock fishing effort and potentially identify features, such as bottom depth and water temperature, where Chinook salmon bycatch is likely to be high and can therefore be avoided by walleye pollock fishermen. The products of this proposal will be provided to walleye pollock fleets to inform decisions of where to fish to minimize Chinook salmon bycatch, which directly addresses PCCRC 2022 research priority II.5- Cooperative industry research designed to mitigate bycatch and PSC through gear modification and changes in fishing practices.

Spatiotemporal dynamics of chum salmon bycatch in the Bering Sea (Megan McPhee, Patrick Barry, Jordan Watson, Chris Kondzela, Ellen Yasumiishi; 5/1/2020 — 8/30/2023)

Abstract: Periodically high rates of chum salmon bycatch in the US walleye pollock fishery continue to concern residents of western Alaska who have relied on chum salmon since time immemorial. Management of the pollock fishery is continually evolving in response to salmon prohibited species catch (PSC), but the ability to anticipate and mitigate PSC risk is complicated by the interactions between salmon abundance and distribution dynamics and the dynamic behavior of the pollock fleet. Since 2011, systematic sampling of genetic and scale samples from the chum salmon PSC has been in place, but these data have yet to be fully applied to modeling PSC patterns. Here, we will capitalize on recent advances in genetic stock identification methods to retrospectively model age- and stock-specific distributions of chum salmon PSC in response to a suite of environmental factors hypothesized to affect both biological processes (abundance and distribution of chum salmon stocks) and pollock fleet behavior. Our ultimate goal is to identify indicator variables that could be used in near real-time to minimize salmon PSC without unduly sacrificing pollock catch.

Completed Projects

Toward shipside salmon stock identification: is nanopore sequencing accurate enough? (Megan McPhee, Patrick Barry; 9/1/2019 — 9/15/2020)

Summary: High rates of bycatch of chum salmon in the Bering Sea walleye pollock fishery along with declining returns of chum salmon to Western Alaska have prompted food security concerns among Alaska Native communities. The incidental harvest of chum salmon produced by Asian hatcheries is of less concern to Alaskans than is bycatch of chum salmon originating from Western Alaska. NOAA currently produces annual stock composition estimates for incidentally harvested chum salmon using 11 microsatellite loci. Incentive plan agreements for the fishery require vessels to avoid areas and times where chum salmon encountered are likely to be from western Alaska, but each year these times and places are different, and prolonged delays between sample collection, genotyping, and data analysis of the microsatellite panel mean that decisions are likely based on data several years out of date. This study was designed as a proof of concept to evaluate if MinION-based nanopore sequencing could be used to produce accurate stock composition estimates in real time, such that fishing pressure could be directed away from stocks of concern. We made use of an existing genetic baseline based on variability at the control region of the mitochondrial genome (mtDNA). Here, we show that mtDNA-based stock composition estimates are concordant with estimates made with the microsatellite panel, albeit with much greater uncertainty in the point estimates. Despite efforts to enrich DNA extractions for mtDNA, the majority of sequencing reads (99.9%) from the MinION came from the nuclear genome. When sequences were obtained from the mitochondrial control region, they were > 95% accurate (4.71% error rate); however, the sequencing coverage and depth (number of times a region was sequenced) varied within and among individuals. The effective implementation of the MinION pocket sequencer for Bering Sea chum salmon stock identification hinges on increasing the depth of reads for the control region.

Improved resolution of chum salmon genetic stock identification (Megan McPhee, *Garrett McKinney*, Jim Seeb, Lisa Seeb; 6/1/2017 — 12/31/2018)

Further examination of the movement, behavior and predation of Chinook salmon in the Bering Sea (Andrew Seitz, *Michael Courtney*; 7/15/2017 — 3/31/2019)

Using a stage structured population dynamics model to determine key environmental and fishery-related drivers of AYK Chinook salmon survival (Milo Adkison, Curry J. Cunningham, Peter Westley, Erik Schoen; 9/1/2015 — 12/31/2018)

Determining the effects of Asian pink and chum salmon on growth and maturation of Alaskan populations of chum and Chinook salmon in the Bering Sea (Megan McPhee, *Tessa J. Minicucci*, *Jared Siegel*, Brian Beckman; 9/1/2014 — 5/31/2018)

Freshwater growth and survival in AYK Chinook salmon: maternal health, predation mortality, and the ultimate effects on stock productivity (Milo Adkison, Lara Dehn, Megan McPhee, Shannon Atkinson, Amanda Rosenburger, Trent Sutton, *Justin Leon*, *Brian Walker*; 4/1/2010 — 12/31/2014)

Developing DNA markers for the analysis of chum salmon bycatch in Alaskan trawl fisheries (Anthony J. Gharrett, *Michael Garvin*; 7/1/2004 — 6/30/2007)

Factors affecting nearshore survival and production of juvenile sockeye salmon from Kvichak Bay (Stephen Jewett, Paul Rusanowski, Max Hoberg, T. Christopher Stark, Milo Adkison, Franz Mueter; 4/15/2001 — 4/14/2002)

DNA analysis of the origins of Chinook salmon bycatch in Alaskan trawl fisheries (Anthony J. Gharrett, *Zhouzhou Li*, V.A. Brykov; 3/1/2001 — 3/31/2004)

Graduate Fellowships

Under what scenarios could salmon shark predation impact Chinook salmon production (Kaitlyn Manishin; 7/1/2016 — 6/30/2018)

Evaluation of growth, survival, and recruitment of Chinook salmon in southeast Alaska Rivers (Cory Graham; 7/1/2015 — 12/31/2016)

How oceanographic conditions affect the growth, health, and survival of pink salmon in their first few months in the ocean (Sarah Miller; 7/1/2009 — 6/30/2011)

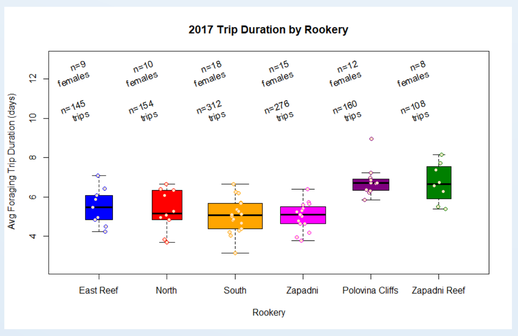
PCCRC Projects—Marine Mammals

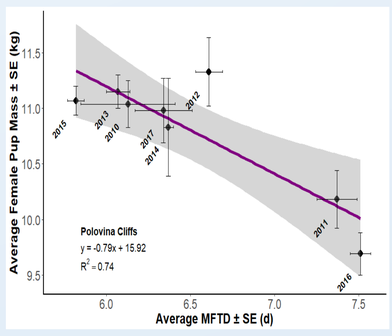
($1.7 million, 2000-2023)

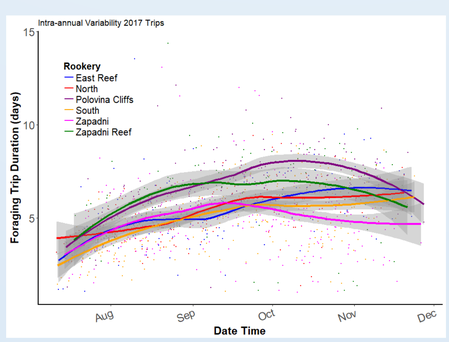
www.pccrc.org

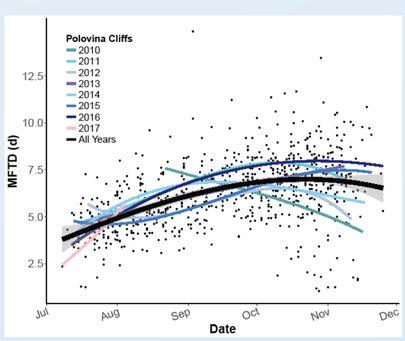
Maternal foraging trip duration of northern fur seals as an index to prey availability in the eastern Bering Sea ecosystem (Jennifer Burns, Ward Testa; 7/1/2016-6/30/2019)

Summary: Numerous studies have demonstrated a link between maternal foraging trip durations (MFTD) of fur seals in the Bering Sea and various indicators of prey abundance, particularly of walleye pollock. MFTD is also correlated with the transfer of energy to growing pups and their rate of growth, which is an important determinant of post-weaning pup survival. We propose to monitor MFTD as an index of foraging conditions for northern fur seals in 3 colonies known to forage in 3 different oceanic domains around the Pribilof Islands: the middle shelf, outer shelf, and shelf break/basin. This study will establish VHF data-logging receiver stations and deploy 75 pulse-coded, multiyear VHF flipper tags on lactating fur seals at 3 rookeries to estimate maternal foraging trip durations in late season 2016, and full breeding seasons in 2017 and 2018. The length of the foraging trips will be examined with respect to metrics of environmental and oceanographic conditions, prey availability from NMFS surveys and fisheries data, and pup mass. This will allow us to characterize the spatial and temporal variability in these relationships and test hypotheses about how environmental changes may influence northern fur seal reproductive success.









Foraging movements and diving behavior of "resident"-type killer whales in the western and central Aleutian Islands – Are killer whales competing with Steller sea lions and commercial fisheries as an important consumer of Atka mackerel? (Lorrie Rea, Paul Wade; 4/1/2016-6/30/2019)

Summary: The relatively high abundance of "resident"-type (fish-eating) killer whales in the western and central Aleutian Islands suggest that the consumption of fish by these killer whales is on the same order of magnitude as commercial fisheries in the region. We propose to study the foraging movements and diving behavior of these whales using satellite-linked tags. We also propose to conduct stable isotope analyses of existing killer whale and fish samples to assess, in particular, whether killer whales are a major consumer of Atka mackerel, and therefore a potential competitor with Steller sea lions and commercial fisheries in this region. This research will improve our understanding of which commercially important prey species are dominant in the diet of resident-type killer whales and will assess the quantity of fish removed by resident type killer whales in the context of other upper trophic level members, including Steller sea lions and commercial fisheries. Stable isotope data generated for Aleutian prey species would also contribute to ongoing diet modeling studies for western and central Aleutian Island Steller sea lions.

Investigating the foraging and diving behavior of transient killer whales in the central and western Aleutians to determine predation on Steller sea lions (Russel Andrews, Paul Wade, Joe Durban; 4/1/2013 – 6/30/2016)

The effects of variation in fishing restrictions and environmental conditions on vital rates of Steller sea lions from Russian rookeries with contrasting population trends (Russel Andrews, Vladimir Burkanov, Tom Gelatt, Don Calkins; 4/1/2013 – 3/31/2015)

Reproduction, survival and depredation of Steller sea lions from the declining western Aleutian Islands in relation to the stable eastern Gulf of Alaska region - Phase 2 (JoAnn Mellish, Markus Horning; 8/1/2013 – 6/30/2016)

Augmenting two existing Steller sea lion projects with additional field time (Greg Walker; 3/1/2012 – 2/28/2013)

Evaluation of diet composition and plane of nutrition of free-ranging harbor seals from Tugidak Island, Alaska in warm and cool climatic periods (Shannon Atkinson, Gail Blundell, James Carpenter, Jason Waite, Kate Wynne ; 4/1/2011 – 3/31/2012)

The effect of organohalogen contaminants on western Steller sea lion survival and movement in the Russian Far East (Adam Zaleski, graduate research fellow; 7/1/11 – 6/30/13)

Impact of health and maternal investment on survival of endangered Steller sea lion pups (Shannon Atkinson; 5/1/2009 – 12/31/2010)

Consummate and consumed predators: Assessing killer whale predation on juvenile Steller sea lions in the Gulf of Alaska (JoAnn Melish, Markus Horning; 4/1/2009 – 3/31/2012)

Assessment of the behavioral and physiological effects of long-term tracking methods in Steller sea lions (JoAnn Melish; 4/1/2008 – 3/31/2009)

What is causing the northern fur seal decline? A literature review and critical analysis (Alan Springer; 4/1/2007 – 12/31/2008)

Local and Traditional Knowledge of the Nature and Extent of Interactions between Fishermen and Steller Sea Lions in the Gulf of Alaska and Bering Sea (Gordon Kruse, Henry Huntington; 8/1/2006 – 7/31/2008)

Changes in Steller sea lions skull sizes: testing the nutritional stress and Killer Whale predation hypotheses (Andrew Trites, Sylvia Brunner, Takeomi Isono; 4/1/2005 – 3/31/2006)

Predation on northern fur seals in the Pribilof Islands a baseline study (Kate Wynne; 6/15/2005 - 11/30/2006)

Assessing the Extent of Competition between Steller Sea Lions and Commercial Fisheries (Alan Springer, Edward Gregr, Andrew Trites, Zohrab Mawani; 1/1/2001 – 3/1/2002)

An Investigation into the Possible Relationship between Killer Whale Predation and the Continuing Decline of the Steller Sea Lion Population (Graham Worthy, Markus Horning, Marilyn Dahlheim; 3/1/2001 – 2/28/2002)

Thyroid Hormones and Plasma Leptin Concentrations during Food Deprivation and Satiety Use as an Index of Metabolic Condition in Free-Ranging Steller Sea Lions (Shannon Atkinson; 10/1/2000 – 9/30/2003)

Capture and holding of transient juvenile sea lions (Shannon Atkinson, JoAnn Melish, Michael Castellini; 10/1/2000 – 9/30/2002)

Validating the Use of Satellite-Linked Mortality Transmitters in Rehabilitated California Sea Lions (Markus Horning, Don Calkins; 11/1/2000 – 2/28/2003)

Do Steller Sea Lions Have Enough to Eat (Alan Springer, Alexander Kitaysky; 12/1/2000 – 2/28/2003)