RESILIENT COMMUNITIES, RESILIENT PLANET

PRINCE WILLIAM SOUND
SCIENCE CENTER

>$395MM LOST

IN THE PRINCE WILLIAM SOUND HERRING FISHERY EX-VESSEL VALUE SINCE THE *EXXON VALDEZ* OIL SPILL IN 1989

ESTIMATE BY DR. SARAH KRUSE, RESILIENT ECONOMICS LLC

>$75MM GENERATED

IN REVENUE BY THE SCIENCE CENTER SINCE OUR INCEPTION IN EARLY 1989

COVER PHOTO: "NIGHT LIGHTS AT SHERIDAN GLACIER" BY CHELSEA LYNN TRACY
FIRST PLACE, RICH LANDS, PWSSC PHOTO CONTEST

THE IMPORTANCE OF BOUNCING BACK

OIL SPILLS. EARTHQUAKES. CLIMATE CHANGE. MELTING GLACIERS. FIRES. ECONOMIC DOWNTURNS. VANISHED FISHERIES.

We've been through a lot here amongst the world's richest waters. Yet, through generations, our community remains resilient. Our mayor, Clay Koplin, recently said that resilience is the greatest export of this region. He may just be right.

Nearly 30 years ago—just months before the *Exxon Valdez* oil spill, the Prince William Sound Science Center was conceived based on the principle of resilience—the ability to predict shocks to systems, avoid them or adapt when they happen, and thrive. Our founders had no idea how soon our community would truly be put to the test.

Every region around the globe has unique cultures, environments and economies. Ours is no different. Pulling those pieces together to prepare for a changing world is at the heart of our mission and work. The stakes are no smaller than human health and well-being, and leaving behind a healthy environment for the generations to come.

We are situated in one of the world's most remote and inspiring living laboratories, and in places like this there's a responsibility to research, to discover, and to share what we learn. Our location, at the turning point of a 1,000-year global conveyor belt of water enriched with nutrients at the poles, gives us a unique vantage point to understand the climate change that has the world talking. Our long-term monitoring confirms that ocean temperatures have been warmer than usual—for almost three years running thanks to *The Blob* in the North Pacific Ocean. Fisheries returns are harder to predict; some fish are smaller than usual, while others return on a schedule that is increasingly unfamiliar. Rivers, forests and glaciers are changing before our eyes.

We humbly ask you to join our hopeful investigations, now and for the long-term, so that the promise of today remains the promise of tomorrow. Local business owner Sylvia Lange recently said that "life is boring when it's easy." Here, life is never boring as we explore what resilience means in Prince William Sound and beyond. In these uncertain times, so many of you have showed up to support our work. Thank you. We're glad to have you on our side.

Katrina Hoffman
President & CEO

P.S. We recently launched our new website, along with a short web film called *Resilience: Our Path to the Future.* Please visit our website and let us know what you think!

HIGHLIGHTS

CLIMATE RESEARCH

The northern Gulf of Alaska coast is losing ice mass at one of the fastest rates in the world. We look at many aspects of this challenge, including a focus on the Copper River watershed (the largest single source of freshwater in the northern Gulf of Alaska) to examine the compounds important to ecosystem productivity (carbon, nitrogen, phosphorus, and iron) from land to sea.

HATCHERY-WILD

Many questions remain about the interactions between wild and hatchery-released salmon. This past year, we continued our involvement in a multi-year collaboration between hatcheries, processors, and the Alaska Department of Fish & Game to determine the extent of straying by hatchery-origin Pink and Chum Salmon and whether such straying has an impact on the productivity of wild Pink and Chum stocks.

LONG-TERM MONITORING

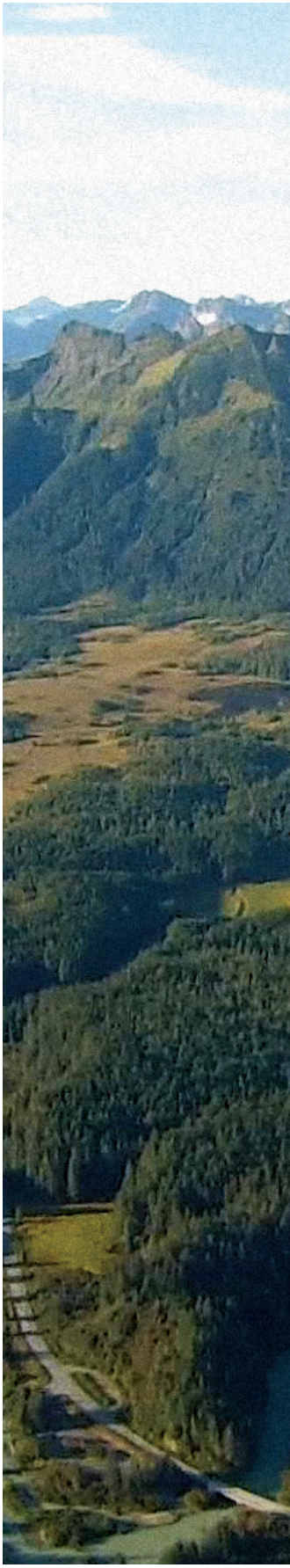
After a successful first five years, we were awarded a second contract to manage the multi-million dollar *Exxon Valdez* Oil Spill Trustee Council's Herring Research and Monitoring program, as well as their long-term monitoring program, Gulf Watch Alaska. Full recovery from the spill will take decades, and long-term scientific data is critical to understanding the true impacts of the event.

SCIENCE + INDUSTRY

More than 90 percent of the wild salmon harvested in the U.S. comes from Alaska, and our local fishing fleet produces world-renowned Copper River salmon. With funding from the Copper River/Prince William Sound Marketing Association, we installed sonar fish counters in the first month of the fishing season and streamed the data to the management agency and the fleet. This pilot is a model for how science and industry can partner for "triple bottom line" benefits.

EDUCATION

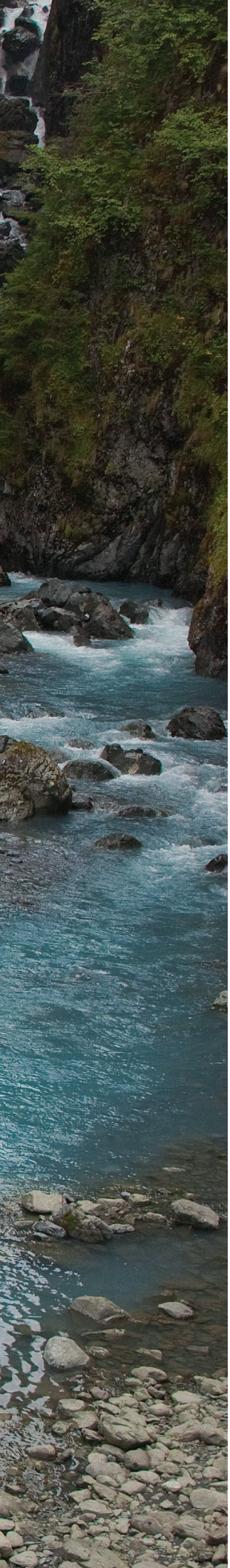
The National Fish and Wildlife Foundation and Wells Fargo extended $25,000 to PWSSC through their highly competitive Environmental Solutions for Communities grant program, which helped us establish the first-ever Delta Restoration Team (D.R.T.) camp for high school youth from around the country. Through PWSSC's guidance and in partnership with the U.S. Forest Service, our participating teens led restoration efforts resulting in the nomination of a new area to the state's Anadromous Waters Catalogue.



OUR REGION IS ONE OF THE WORLD'S MOST REMOTE AND GREATEST LIVING LABORATORIES; A STRONGHOLD THAT'S CRITICAL TO A THRIVING PLANET.

PHOTO: BY IDEAVILLE

WE PROVIDE PRACTICAL, RELEVANT INFORMATION SO RESILIENCE CAN BE PRACTICED HERE AND MODELED ANYWHERE.



RESEARCH

OUR LOCATION GIVES US A UNIQUE VANTAGE POINT TO UNDERSTAND THE EARTH DURING A TIME OF DYNAMIC CHANGE. STUDIES BY OUR RESEARCHERS SHED INSIGHT ON MANY CHALLENGES, INCLUDING: CLIMATE CHANGE, RESOURCE USE AND SUSTAINABILITY, FOOD WEBS, ECOSYSTEM MANAGEMENT, AND MORE. ULTIMATELY, WE SEEK TO UNDERSTAND HOW PLACES EVERYWHERE CAN MAINTAIN THEIR ENVIRONMENTS AND ECONOMIES FOR GENERATIONS TO COME.

MARY ANNE BISHOP, PH.D.

INFLUENZA IN SYNANTHROPIC GULLS: ARE CONGREGATION SITES HOTSPOTS FOR VIRAL EVOLUTION?

Lead: Mary Anne Bishop

Team: Anne Schaefer, Kirsti Jurica

Collaborators: Jonathan Runstadler & Nichola Hill, Massachusetts Institute of Technology

Summary: Gulls epitomize the growing challenge associated with human-wildlife interactions and offer a valuable model for testing hypotheses regarding dynamics of emerging disease. Within Prince William Sound the glaucous-winged gull forages extensively on offal produced by processors. This interaction deserves greater attention because of the potential for gulls to aid the spread of pathogens between urban and marine ecosystems, confounding disease control efforts. Our data suggest a link between the use of human settlement by gulls and magnitude of glaucous-winged gull outbreaks of Influenza A Virus (IAV) – a virus with a unique capacity to jump between hosts and seed outbreaks in poultry, humans, and recently, marine mammals. By capturing gulls in Cordova as well as gull chicks at nearby colonies this study has been testing whether the congregation of the gulls in Cordova promotes amplification and reassortment of influenza A virus.

OCEAN TRACKING NETWORK ACOUSTIC ARRAYS IN PRINCE WILLIAM SOUND

Lead: Mary Anne Bishop

Team: Brad Reynolds, Ben Gray

Collaborators: Ocean Tracking Network at Dalhousie University

Summary: Canada's Ocean Tracking Network maintains a global system of acoustic tracking arrays that generate information on aquatic animal movements. In March 2013, we deployed a curtain of acoustic receivers across the major entrances and passages between the Gulf of Alaska and Prince William Sound. In 2016, funding for additional receivers provided by the *Exxon Valdez* Oil Spill Trustee Council facilitated expansion of the arrays. Species in Prince William Sound that currently have acoustic tagged individuals include Pacific herring, Pacific cod, and salmon sharks. These acoustic arrays have radically changed our ability to determine population connectivity between fish populations in the Sound and the Gulf of Alaska.

CONNECTIVITY OF PRINCE WILLIAM SOUND PACIFIC COD POPULATIONS: GULF OF ALASKA MIGRANTS OR FJORD RESIDENTS?

Lead: Mary Anne Bishop

Team: Sean Lewandoski, Megan McKinzie

Summary: The Pacific cod fishery is currently ranked as the second largest fishery in both the U.S. and the state of Alaska. Pacific cod is known to exhibit complex seasonal migrations between winter spawning and summer feeding grounds. However, there is recent evidence to suggest that cod that reside in fjords and enclosed bays may be comprised of more resident, genetically-isolated populations. Currently, the Prince William Sound cod population is managed as part of the Gulf of Alaska stock; however, the movements and ecology of fjord-residing fish in the Sound remains unknown. For this project we are monitoring movements of individual acoustically tagged cod between Prince William Sound and the Gulf of Alaska, investigating residency, and examining spawning site fidelity to specific bays in the Sound. The results of this study will have important fisheries management implications for similar bay and fjord-dominated ecosystems found throughout the extensive range of the Pacific cod.

GULF WATCH ALASKA: LONG-TERM MONITORING OF SEABIRD ABUNDANCE AND HABITAT ASSOCIATIONS DURING LATE FALL AND WINTER IN PRINCE WILLIAM SOUND

Lead: Mary Anne Bishop

Team: Anne Schaefer

Summary: In subarctic waters, winter may be the period during which seabirds face the greatest environmental and physiological pressures. Using research 'ships of opportunity,' we are monitoring the relative abundance and distribution of marine birds from late fall through winter in Prince William

"SALMON RUN TO THE RIVER" BY AYSUN PATTERSON
SECOND PLACE, RICH WATERS, PWSSC PHOTO CONTEST

Sound. Three surveys were conducted between October 2015 and March 2016. Our study highlights the importance of considering species-specific temporal patterns throughout the non-breeding season to gain an understanding of seabird populations and habitat use.

PRINCE WILLIAM SOUND HERRING RESEARCH AND MONITORING: VALIDATION OF ACOUSTIC SURVEYS FOR PACIFIC HERRING USING DIRECT CAPTURE

Lead: Mary Anne Bishop

Team: Kirsti Jurica, Sean Lewandoski

Summary: This project supports several others in the Herring Research and Monitoring program by collecting juvenile and adult herring samples for studies on herring genetics, abundance, energetics, disease, and movements. The sampling is critical for being able to interpret acoustic surveys being conducted to determine juvenile herring populations. For our sampling work, we use three fishing techniques to provide the fish for the various projects: a mid-water trawl, gill nets, and cast nets.

ROB CAMPBELL, PH.D.

LONG-TERM MONITORING OF OCEANOGRAPHIC CONDITIONS IN PRINCE WILLIAM SOUND

Lead: Robert Campbell

Collaborators: Sonia Batten, Sir Alister Hardy Foundation for Ocean Science; Russ Hopcroft, Tom Weingartner, University of Alaska Fairbanks; Angela Doroff, University of Alaska Anchorage; Kris Holderied, NOAA Kasitsna Bay Laboratory; Seth Danielson, Hopcroft and Weingartner

PHOTO: BY IDEAVILLE

Summary: This project tracks changes in hydrography, biogeochemistry and plankton in Prince William Sound. With multiple cruises per year aimed at explaining the timing of the vernal and autumnal plankton blooms, a state-of-the-art profiling mooring is deployed in central Prince William Sound to conduct high frequency profiling of physical (temperature and salinity, turbidity and currents) and biological parameters (oxygen, chlorophyll-a fluorescence, nitrate concentration). The project continues to track lower trophic level productivity in the ecosystem, as well as provides a long time series to show how the region is changing over time.

HIGH FREQUENCY OBSERVATIONS OF THE SECONDARY PRODUCTION CYCLE IN PRINCE WILLIAM SOUND

Lead: Robert Campbell

Collaborators: Jules Jaffe, Paul Roberts, Scripps Institution of Oceanography

Summary: An in situ plankton camera was developed for the PWS profiling mooring, based on the design of the Scripps Plankton Cam, which is deployed on the Scripps Pier. The system was designed to observe mesozooplankton and large phytoplankton with an imaged volume of just under 1 liter and a pixel size of approximately 20 microns. The system collects images at 4Hz while the profiler is ascending, and does real-time extraction of regions of interest. The camera was first deployed on the profiler in 2016, and collected over 1.6 million images, totaling over 36 gigabytes. As well as allowing identification of different plankton taxa, the images are clear enough to provide information about individual plankers (e.g. gut fullness, and size of lipid reserves).

IMAGING SONAR DEPLOYMENT IN THE LOWER COPPER RIVER DELTA TO ENHANCE EARLY SEASON MANAGEMENT

Lead: Robert Campbell

Summary: Copper River salmon are the first major salmon fishery to go to market each year, and command a long time premium price; fishing opportunities in the early season, when prices are high, are an important driver of the local economy. The Alaska Department of Fish & Game uses imaging sonars at a site above the Copper River delta (~30 miles from the ocean) to estimate escapement, but there is a lag between when salmon enter the river (and are no longer available to the fishery) and when they are counted at the sonars. To improve escapement information available to the ADF&G managers, the PWSSC deployed an imaging sonar at the closest practical location to the ocean entry point (~10 river miles) in May 2017. Videos were posted to an online server in near real-time, and fish passage estimates posted online to provide the fishery managers with up-to-date information on fish passage in the lower river.

PRINCE WILLIAM SOUND WEATHER BUOY

Lead: Robert Campbell

Collaborators: Alan Sorum, Regional Citizens' Advisory Council; Richard Brown, Micro Specialties, Inc.

Summary: To provide better weather information for mariners (particularly the oil transportation industry), a small weather buoy is in development to be deployed to western Prince William Sound. The buoy will include the standard weather instrumentation (temperature, humidity, solar radiation, barometric pressure, wind speed and direction), a webcam, and surface current and water temperature sensors. Once the permitting process has been completed, current weather observations will be transmitted by the marine Automated Information System (AIS), so that mariners may access real-time weather information on AIS enabled devices.

MELTING ICE, HABITAT CHANGE, AND NUTRIENT FLUX: HYDROLOGICAL, BIOGEOCHEMICAL AND BIOLOGICAL LINKAGES BETWEEN THE COPPER RIVER WATERSHED AND THE COASTAL GULF OF ALASKA

Lead: Robert Campbell

Team: John Crusius, US Geological Survey; Santiago Gásso, NASA/Morgan State; Andrew Thomas, University of Maine; Andrew Schroth, University of Vermont; Jeffrey Welker, University of Alaska Anchorage

Summary: The northern Gulf of Alaska coast is currently losing ice mass at one of the fastest rates in the world.

We are focusing on the Copper River watershed (the largest single source of freshwater in the northern Gulf of Alaska), and are examining the biogeochemical fluxes of compounds important to ecosystem productivity (carbon, nitrogen, phosphorus, and iron) from land to sea, as well as describing the oceanography of the Copper River plume in the coastal Gulf of Alaska.

SHELTON GAY, PH.D.

CIRCULATION STUDY OF PORT VALDEZ, ALASKA

Lead: Shelton Gay

Technician: Kirsti Jurica

Collaborators: Scott Pegau, PWSSC; Jeremy Robida, PWS Regional Citizens' Advisory Council

Summary: This project involves circulation experiments performed in Port Valdez, Alaska using drifters at the surface, and 1-meter, 10-meter, and 40-meter depths. Data on currents, temperature, and salinity are also being collected using an acoustic Doppler current profiler (ADCP) and a conductivity, temperature and depth (CTD) profiler, respectively. The goals of the study are to determine the major patterns in circulation within the fjord during the early summer, fall and late winter, and how these conditions may affect the fate of spilled oil, with dispersants applied to it, to either remain within the Port or be flushed out into Prince William Sound. Two experiments were conducted in June and September 2016.

The results show that horizontal gradients in water density (caused by varying combinations of temperature and salinity) create a background circulation around Port Valdez that interacts with the tides to form moderate baroclinic currents (i.e. fluctuating with depth) that in June reached maxima of 10 to 15 centimeters per second in the upper 15 meters. In September, however, the currents increase in both speed (25 to 35 centimeters per second) and depth (25 to 30 meters). This is due to partial mixing and deepening of the seasonal changes in the water column temperature and salinity, which in turn intensify horizontal density gradients. In contrast, the surface and 1-meter drifter patterns show surface currents

are primarily driven by combinations of estuarine flow, caused by freshwater flowing over sea water, and either up-fjord sea-breeze winds in June or by down-fjord winds in September. The ADCP data also show persistent closed mid-fjord counterclockwise circulations at 7 to 15-meter depths in June that intensify down to 30 meters in September. Rapid and lengthy excursions of the surface and 1-meter drifters indicate that materials at these depths may quickly disperse within the Port, whereas the deeper flows may move material in slower eddy motions.

PHOTO: MILO BURCHAM

KRISTEN GORMAN, PH.D.

JUVENILE HERRING CONDITION MONITORING

Lead: Kristen Gorman

Team: Kirsti Jurica, Julia McMahon, Megan Roberts

Collaborators: Tom Kline and Scott Pegau, PWSSC; Fletcher Sewall and Ron Heintz, NOAA Auke Bay Labs; Tim Howe and Norma Haubenstock, Alaska Stable Isotope Facility; Dave Beam, Montague Marine Research; Cordova District Fishermen United, F/V Cape Fear, F/V Kokenhenic, F/V Wingham

Summary: The Pacific Herring (Clupea pallasii, hereafter herring) population of Prince William Sound, Alaska remains an injured resource following the *Exxon Valdez* oil spill, as the population biomass has remained at ~20,000mt since 1998 and continues below a level that would allow a commercial catch. Survival of juvenile (age-0) herring through their first

winter is considered a potential limiting factor regarding strong recruitment to the spawning population, and is therefore the focus of this research project. Juvenile herring were collected seasonally from nursery bays throughout PWS in the fall (November) and spring (March) between 2007 and 2016. Research has shown several techniques to reliably measure correlates of energetic state in juvenile herring including Whole Body Energy Density (WBED) calculated from dry/wet and C/N stable isotope data, in addition to WBED calculated from bomb calorimetry, % lipid as measure of energy storage, RNA/DNA ratios as a measure growth, and diet composition. Our work has demonstrated that small herring present in fall were rare by spring due to size-dependent winter mortality. Further, during fall, juvenile herring reared in northern and western regions of PWS were more energy dense and had more depleted 13C values that reflect a Gulf of Alaska carbon source. Taken together, research has been important for advancing our understanding of juvenile herring winter energy budgets, mortality risks, and environmental drivers of energy content in PWS, Alaska.

JUVENILE HERRING INTENSIVE CONDITION MONITORING

Lead: Kristen Gorman

Team: Kirsti Jurica, Julia McMahon, Megan Roberts

Collaborators: Tom Kline and Scott Pegau, PWSSC; Fletcher Sewall and Ron Heintz, NOAA Auke Bay Labs; Tim Howe and Norma Haubenstock, Alaska Stable Isotope Facility

Summary: Juvenile Pacific Herring (Clupea pallasii) were sampled monthly from August to the following June at multiple sites in the vicinity of Simpson Bay, eastern Prince William Sound, Alaska for multiple indicators of condition and feeding. RNA/DNA and gut content analyses suggested that young of the year and likely older juvenile year classes feed during the winter. Feeding may take place at small spatial scales. Very few herring in this study had energy levels less than ~3 kJ/g wet mass suggesting an alternative mortality threshold value to that previously used. Minimum energy levels appear to increase during autumn, with highest values in November. Minimum energy levels decreased for the next two to three months and then leveled out until March. The decreasing minimum energy value suggested that feeding is not sufficient to maintain energy levels attained during autumn, thus there must be some energy stress. An increase in minimum size observed during the second half of the observation period suggests the potential for growth as well as size-dependent attrition. A high 13C value near -18 observed for many herring was well outside the previously observed range that consisted primarily of non-winter observations. Benthic production is posited to drive the herring winter food chain base in Simpson Bay.

STREAM INTERACTIONS AMONG HATCHERY AND WILD PINK AND CHUM SALMON IN PRINCE WILLIAM SOUND

Lead: Kristen Gorman

Team: Ben Americus, Garrett Dunne, Neil Durco, Penelope Haas, Albina Kanzeparova (visiting researcher from Russia), Julia McMahon, Darren Roberts, Megan Roberts, Chrissy Skorkowsky

Collaborators: Pete Rand and Eric Knudsen, PWSSC; Alaska Hatchery Research Program Science Panel, Alaska Department of Fish & Game, Gene Conservation Lab, Cordova and Juneau Mark, Age and Tag Labs; Rick Busch, Resource Data, Inc.; Dave Janka., Auklet Charter Services; Brad von Wichman, Babkin Charters; and Terry Kennedy, Alaska Wilderness Air

Summary: Prince William Sound Science Center has been under contract to Alaska Department of Fish & Game since 2013 to manage the agency's field studies of interactions among hatchery and wild Pink and Chum (Oncorhynchus gorbuscha and O. keta) salmon in Prince William Sound, Alaska. In 2016, the project sampled five study streams in PWS for Pink Salmon otoliths and heart tissue to determine the hatchery or wild status of fish and their genetic profiles. These data will be used to test hypotheses regarding the differential survival of offspring relative to the hatchery or wild status of their parent. Molecular data based on single nucleotide polymorphisms will be analyzed using pedigree by researchers at Alaska Department of Fish & Game's Gene Conservation Lab.

COMPARATIVE PERFORMANCE IN MIGRATION AND REPRODUCTION AMONG WILD AND HATCHERY PINK SALMON IN PRINCE WILLIAM SOUND USING STABLE ISOTOPE ANALYSIS

Lead: Kristen Gorman

Team: Ben Americus, Sarah Hoepfner (student intern from Humboldt State University), Kirsti Jurica, Albina Kanzeparova (visiting researcher from Russia), Julia McMahon, Chrissy Skorkowsky

Collaborators: Pete Rand and Eric Knudsen, PWSSC; Joy Matthews, University of California, Davis Stable Isotope Facility

Summary: This project is a one season pilot study that will test the null hypothesis that hatchery-origin Pink Salmon (Oncorhynchus gorbuscha) are similar in their at-sea foraging strategies to their wild conspecifics in Prince William Sound based on tissue-specific carbon and nitrogen stable isotope (SI) values (13C and 15N) and therefore similar in their migratory timing, body condition, and spawning performance. Our work is motivated by ongoing studies of interactions among PWS wild and hatchery Pink Salmon by Alaska Department of Fish & Game that are focused on quantifying fractions of hatchery fish on spawning streams and understanding possible impacts hatchery spawning has on the survival of wild offspring. Our project adds a mechanistic perspective to the current work by considering at-sea foraging determinants of performance in migration and reproduction that might shape individual fitness. The at-sea life histories of Pacific salmon are not well understood and few studies have used SI techniques to test ideas about within-species variation in foraging and relationships with performance factors. We expect this project to advance our general knowledge of salmon oceanic ecology, but also hold relevance to management within the context of ocean-climate variability and impacts to Pink Salmon foraging and performance as these important issues are key to both ecotypes.

KATRINA HOFFMAN, M.M.A.

INTERACTIONS OF WILD AND HATCHERY PINK AND CHUM SALMON IN PRINCE WILLIAM SOUND AND SOUTHEAST ALASKA

Leads: Katrina Hoffman, Eric Knudsen, Kristen Gorman, Pete Rand

Summary: Many questions remain about the interactions between wild and hatchery released salmon. This project explores: the extent and annual variability in straying of hatchery Pink Salmon in Prince William Sound and Chum Salmon in Prince William Sound and Southeast Alaska; the genetic stock structure of these species in each region; and the impact on fitness of wild Pink and Chum Salmon stocks due to straying of hatchery Pink and Chum Salmon. The objectives are being achieved through extensive stream sampling in PWS to collect DNA of salmon for genetic pedigree studies and otoliths for determination of hatchery straying rates.

GULF WATCH ALASKA: PROGRAM MANAGEMENT OF THE LONG TERM MONITORING PROGRAM OF THE *EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL

Leads: Katrina Hoffman, Molly McCammon, Kris Holderied

Collaborators: Donna Aderhold, Rob Bochenek, Matt Jones, Russ Hopcroft, Tom Weingartner, Seth Danielson, Rob Campbell, Angie Doroff, Sonia Batten, Mandy Lindeberg, Heather Coletti, Craig Matkin, Kathy Kuletz, Mary Anne Bishop, Brenda Ballachey, Jan Straley, John Moran, Katrin Iken, Brenda Konar, Tom Dean, Mark Carls, Robb Kaler, Ben Weitzman, Kim Kloecker, Mayumi Arimitsu, John Piatt, Dan Olsen, Lisa Sztukowski

Summary: Separating the changes in an ecosystem caused by a sudden event from those caused by natural variation requires long-term records of environmental variability. This five-year research program sustains and builds upon many existing time series in the *Exxon Valdez* oil spill affected region that examine oceanographic and intertidal conditions, and species at all trophic levels. We are also working on improved approaches for monitoring of species and ecosystems, and providing data and information to managers

and the public. Observing changes in the ecosystem is possible through the coordination of many diverse research projects. PWSSC is providing fiscal oversight to ensure all administrative, outreach, and scientific activities are completed so the program can meet its objectives.

SCOTT PEGAU, PH.D.

PRINCE WILLIAM SOUND OCEAN OBSERVING SYSTEM

Lead: W. Scott Pegau

Summary: This project covers activities of the Alaska Ocean Observing System in Prince William Sound. In partnership with the Oil Spill Recovery Institute, Snotel weather stations in Prince William Sound are maintained. Additional work focuses on retrieval of historic data collected by PWSSC for archiving, expanding the tide station to include salinity measurements, supporting the acoustic tracking array, and supporting a circulation study in Port Valdez. These activities provide valuable measurements in support of spill trajectory modeling, boating safety, climate monitoring, and fisheries research in Prince William Sound.

HERRING RESEARCH AND MONITORING COORDINATION

Lead: W. Scott Pegau

Collaborators: Mary Anne Bishop, Hayley Hoover, Kristen Gorman, Pete Rand, Dick Thorne, PWSSC; Rob Bochenek, Axiom Consulting and Design; Kevin Boswell, Florida International University; Trevor Branch, University of Washington; Jeff Guyon, Ron Heintz, Fletcher Sewall, J.J. Vollenweider, Sharon Wildes, NOAA; Paul Hershberger, U.S. Geological Survey; Kathy Kuletz, U.S. Fish and Wildlife Service; Steve Moffitt, Alaska Department of Fish & Game

Summary: This project coordinates activities within the Herring Research and Monitoring program. The program aims to improve prediction of herring stocks through research and monitoring. This will be accomplished through improving inputs to the population model, synthesizing existing information, testing assumptions in measurements, and testing new approaches to herring research. Achieving the objectives is only possible through the contributions of many individual projects.

PETE RAND, PH.D.

ALASKA HATCHERY RESEARCH PROGRAM

Lead: Pete Rand

Team: Kristen Gorman, Eric Knudsen, Julia McMahon, and a talented team of technicians, interns, vessel charter captains and crew, and volunteers

Collaborators: Alaska Fish & Game, NOAA Fisheries, seafood processors, Alaska aquaculture industry, and University of Alaska Fairbanks

Summary: In 2016 we continued our involvement in a multi-year, collaborative project investigating interactions between natural- and hatchery-origin Pink and Chum Salmon in Prince William Sound. The project is focused on measuring biological differences between salmon that originate from natural spawning and those that are raised in hatcheries and released as fry into PWS. As part of this effort, we provided a research internship experience for a Russian fishery biologist, Ms. Albina Kanzeparova, through a grant from the Trust for Mutual Understanding.

ACOUSTIC MONITORING OF JUVENILE AND ADULT PACIFIC HERRING

Lead: Pete Rand

Collaborators: Scott Pegau and EVOS Herring Research and Monitoring PIs

Summary: We continued focusing on juvenile and adult Pacific herring in PWS. We conducted the last of five years of surveys of juvenile herring in selected bays in PWS in November 2016 – this included acoustic and trawl surveys in important nursery areas through PWS. We also continued our spring adult survey in PWS during March and April 2016; this project is a key element of the adult monitoring effort of the EVOS Herring Research and Monitoring Program.

COPPER RIVER SOCKEYE SALMON MIGRATION STUDY

Leads: Pete Rand and Kristen Gorman

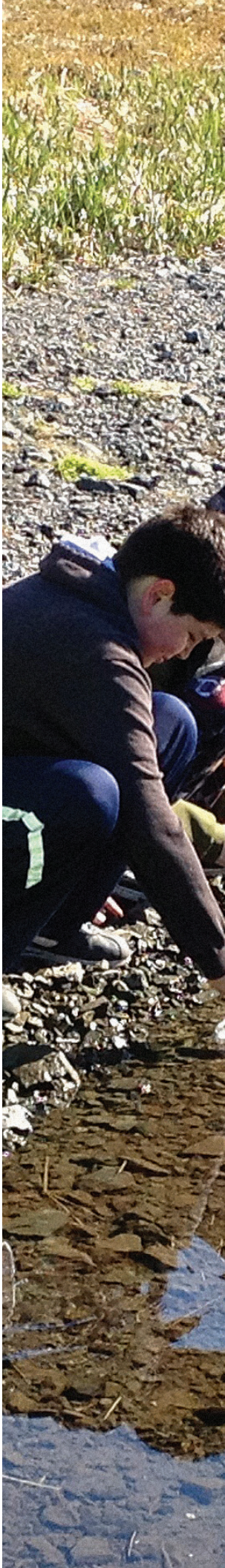
Collaborators: Native Village of Eyak, National Park Service, and Alaska Department of Fish & Game

Summary: We worked closely to initiate new studies of Copper River Sockeye Salmon, including a small pilot project while seeking long-term funding for this work out of concern about recent declines in individual sizes of returning sockeye salmon to this important river system. We feel this trend may have important implications on the long-term sustainability of the fishery. We recently entered into a collaborative agreement with the Native Village of Eyak to facilitate our work in the field, particularly at their Baird Canyon field station in the lower Copper River. We have also established a relationship with staff at the Wrangell-St. Elias National Park to work together at two of their weir sites to provide an opportunity to observe and sample fish near their upriver spawning grounds. Personnel at the Cordova office of the Alaska Department of Fish & Game have also helped us collect fish in the field and have offered important insight into our work.

PHOTO: BY IDEAVILLE

EDUCATION

WE USE AN INNOVATIVE COMBINATION OF FORMAL AND INFORMAL EDUCATIONAL PROGRAMS TO INSPIRE LIFE-LONG PASSION FOR SCIENCE AND COMMITMENT TO EVIDENCED-BASED DECISION MAKING. THROUGH OUR EFFORTS, WE HELP STUDENTS AND ADULTS DEVELOP THE NECESSARY SKILLS TO SUCCEED IN THE 21ST CENTURY, INCLUDING COMMUNICATION, TEAM WORK, PROBLEM SOLVING, AND CRITICAL THINKING.



WE DELIVER THEME-BASED EDUCATION PROGRAMS FOR ALL SECTORS OF SOCIETY, FROM K-GREY.

DISCOVERY ROOM

Science Center educators guided Cordova's 4th-8th grade classrooms through theme-based curricula that use local ecosystems as a natural learning laboratory. There were 116 student participants in 2016. Using scientific instruments, students learned to observe, record and interpret data, and present what they have learned. Across all grade levels, students learned about the scientific process and data management, developed observation skills, engaged in peer-to-peer teaching, and contributed to long-term data sets. Fourth-graders explored food web dynamics in our marine habitat and the role Pacific herring play in the ecosystem, while fifth-graders focused on salmon ecology, biology, economics, and the cultural importance of salmon. Sixth-graders designed, built, and tested remotely operated vehicles and responded to a mock oil spill, while seventh- and eighth-graders collected environmental data at marine, estuarine, and freshwater sites during monthly field trips.

DISCOVER CORDOVA

Throughout spring and summer, our six Discover Cordova "mini-explorations" reached 105 children and adults of all ages. From tidepooling to bug tracking to native plant identification, these two-hour programs engage our entire community and encourage hands-on exploration of different local organisms and ecosystems.

DISCOVERY OUTREACH

Our educators traveled out of Cordova and to some remote locations to teach environmental science education; this year, we delivered science, technology, engineering, and math (STEM) education programs to 239 students from Unalaska, Akutan, Homer, and Seldovia through our Discovery Outreach learning programs.

NATIONAL OCEAN SCIENCES BOWL

Our education coordinator coached the Cordova High School team in twice-weekly training sessions from September to February focusing on all-things-ocean. The team wrote a research paper on coastal resilience and presented their research in an oral report at the competition.

ROV OIL SPILL CHALLENGE

Our educators brought our remotely operated vehicle (ROV) design/build/test program to the 2016 National Ocean Sciences Bowl—Tsunami Bowl competition in Seward as an enrichment opportunity for the participants. Forty-five students and teachers from seven high schools designed, built and tested ROVs to respond to a mock oil spill.

PROGRAM HOSTING

Our campground facilities on the periphery of the Copper River Delta are used by a variety of institutions as a base camp. When requested, we provide lectures and classes on regional ecosystems and sustainability. In 2016, visiting students from City University of New York and trail crew members affiliated with the U.S. Forest Service used our facilities for an outdoor classroom and to stage summer restoration work in the bioregion, respectively.

SUMMER PROGRAMS

HEADWATERS TO OCEAN DAY CAMP

Campers age 7-10 joined education staff for a week full of exciting adventures on the Copper River Delta. Each day was spent exploring a different part of Cordova's amazing landscape. We hiked in the rainforest and collected plants to press, caught predacious diving beetles in the wetland, made "flubber" to understand how glaciers move as we visited Sheridan Glacier, and ended the week with an overnight on the delta.

DELTA RESTORATION TEAM (D.R.T.)

High school students from all over the country came to Cordova to participate in our residential service-learning camp. The camp, nicknamed DRT Camp, focused on restoration activities, ecosystem stewardship, and leadership development. As part of our stewardship building ethic, students gained experience in a wide range of careers that involve outdoor restoration work. While partnering closely with the U.S. Forest Service Cordova Ranger District, campers revegetated Dusky Canada Goose nest islands, created overwintering habitat for juvenile salmonids, improved a local hiking trail, and much more. The weeklong outdoor experiential-learning camp revolved around the ultimate goal of creating great stewards. The knowledge, skills, and attitudes gained at camp were taken back to the campers' communities and will hopefully stay with them for years to come.

COPPER RIVER STEWARDSHIP PROGRAM

How do we ensure that our future leaders understand the contribution that complex natural systems make to a healthy society? With multiple partner organizations, we supported 13 high school student leaders (seven from coastal and six from upriver Copper River communities) as they studied the ecosystems of the Copper River watershed. They spent time in both the upper basin's boreal forest and the delta's rainforests, connecting it all by rafting the length of the Copper River from Chitina to Cordova.

CORDOVA BLUEGRASS YOUTH CAMP SCIENCE DAY

We add value to other programs by providing education programs about our region's ecosystems. We balanced science and the arts by teaching 24 Cordova 4H music camp students about the water cycle and salmon life cycle through hands-on activities.

EDUCATION PARTNERS

Our education partners include: Alaska Department of Fish & Game, Alaska Sea Grant Marine Advisory Program, Prince William Sound/Copper River Marketing Association, Copper River Watershed Project, Cordova Arts, Cordova School District, GCI, KCHU radio, Kenny Lake School District, Native Village of Eyak, the Oil Spill Recovery Institute, PWS Audubon, Prince William Sound Community College, U.S. Forest Service, and the Valdez School District.

ENGAGEMENT

OUR OUTREACH AND COMMUNITY ENGAGEMENT EFFORTS BENEFIT SCIENTISTS AND NON-SCIENTISTS ALIKE, WITH THE GOAL OF BUILDING A RESILIENT PLANET, PEOPLE, AND COMMUNITIES.

"SWARMING SALMON" BY TODD BLAISDELL
FIRST PLACE, RICH WATERS, PWSSC PHOTO CONTEST

17TH ALASKA BIRD CONFERENCE

Led by our internal team of Kristen Gorman, Mary Anne Bishop, Ann Harding, and Anne Schaefer, PWSSC hosted the 17th Alaska Bird Conference at the Cordova Center. The first Alaska Bird Conference was held in 1985 in Anchorage. It grew from the oft-expressed need for exchange of information among those in government, universities, non-government organizations, and the private sector working with Alaska's diverse and abundant bird species. The conference has been held on an approximately biannual basis ever since. In 2016, the conference attracted ~100 participants, including many students, reporting on their latest findings and new initiatives. Keynote seminars were led by Dr. Steve Beissinger (UC Berkeley) and Dr. Cheryl Rosa (Deputy Director of the U.S. Arctic Research Commission). Dr. Robert Ritchie (ABR, Inc.) was acknowledged with the Isleib Award for Avian Conservation for outstanding contributions to bird conservation in Alaska. Our collaborators in conference coordination included Milo Burcham, Erin Cooper, and Melissa Gabrielson (U.S. Forest Service, Cordova); Cathy Long (Cordova Chamber of Commerce); Kate McLaughlin (Alaska Hummingbird Project); John Pearce (Alaska Science Center - USGS); Charlotte Westing (Alaska Department of Fish & Game); and John Whissel (Native Village of Eyak).

68° NORTH – CITY UNIVERSITY OF NEW YORK (CUNY) PHOTOGRAPHY STUDENT TRIP TO ALASKA

For almost two weeks in July 2016, a select group of commercial photography students visited Cordova as part of a study away experience. CUNY faculty members Scott Sternbach and Lidiya Kan led the group, which was hosted by PWSSC and had support from Kristen Gorman (PWSSC) and Josh Williams (Virgina Institute of Marine Science/PWSSC). CUNY students explored the diverse ecosystems and effects of climate change on the region. Through photography and video, students documented the entirety of this unique trip.

HERRING OUTREACH

Much of the PWSSC's research and outreach focuses on herring, which were greatly impacted by the *Exxon Valdez* oil spill. Our efforts include web, print, radio, and podcast outreach. Print publications include articles in *Delta Sound Connections* and *the Breakwater* e-newletter. The *Field Notes* program, led by Hayley Hoover, is a summary of our research condensed into a 3- to 5-minute radio segments distributed via the web, podcasts, and on-air via KCHU. We also lead public lectures and herring-centric education lessons through the Cordova school district and our Discovery Room program.

DELTA SOUND CONNECTIONS

Our free, full-color science news magazine highlights current research and education programs in Prince William Sound, the Copper River watershed, and the northern Gulf of Alaska. We distributed twelve thousand copies to visitors and residents of southcentral Alaska at various visitor hotspots. Each year, *Delta Sound Connections* is a much-anticipated source of inspiration for readers from our region and beyond.

LECTURE SERIES

Citizens and scientists connect directly through our science lecture series. In 2016, hundreds of community members attended dozens of science talks given by PWSSC staff and visiting scientists and experts. The lecture series dates back to 1999, when PWSSC and partners Alaska Sea Grant Marine Advisory Program and PWS Audubon began convening experts from around the world to share their research and findings with the communities of Cordova and Valdez. Learn something new from one of the many videos of these talks that are archived on our YouTube channel.

SOCIAL MEDIA

Science and science-education efforts often seem to fly under the radar. Nowdays, interested people from around the world can stay up-to-date with our ongoing projects that are featured on Facebook, Instagram, and Twitter. Get inspired by our field work in Prince William Sound and the Copper River Delta by connecting with us through social media.

ANCHORAGE FRIENDRAISER + FUNDRAISER

In October 2016, friends both old and new filled a banquet room in Anchorage for the official unveiling of our new website and short film, *Resilience: Our Path to the Future*. The event helped us break a record for year-end unrestricted fundraising in support of general operations and our education program.

COPPER RIVER NOUVEAU

Hosted in June each year, Copper River Nouveau is our region's premier dining experience and fundraiser. It's a celebration of regional resilience, science education, ecosystem research, wild salmon, and community. While enjoying incredible Alaska seafood, including locally caught Copper River salmon, we celebrate with federal and regional elected leaders, scientists, educators, fishermen, and others dedicated to maintaining renewable natural systems. Corporate and individual sponsorships, silent and live auctions, and dinner ticket sales help raise funds for our research and education. In 2016, our honorary hosts Senator Lisa Murkowski and Lieutenant Governor Byron Mallott shared their excitement about our mission with leaders in attendance from the academic, commercial fishing, seafood processing, oil and gas, mining, transportation, and food and beverage sectors, to name a few. Generous contributions by artists, craftspeople, merchants, and Alaskan leaders enabled the success of our fundraising efforts, with revenues exceeding $100,000.

FISHERIES ACHIEVEMENT AWARD

Each year we acknowledge an individual or a group of individuals who make a significant contribution toward the sustainable use of fishery resources in the region. We honor individuals for their innovation, perseverance, dedication, and hard work. The awardee(s) are guests of honor at Copper River Nouveau. In 2016, we honored Rhey Velasco for his years of commitment to supporting high-quality production at the Ocean Beauty processing plant in Cordova. Thanks to people like Rhey and their expertise, Cordova's seafood industry sets the standards for quality, value, innovation, and sustainability.

JOURNAL PUBLICATIONS

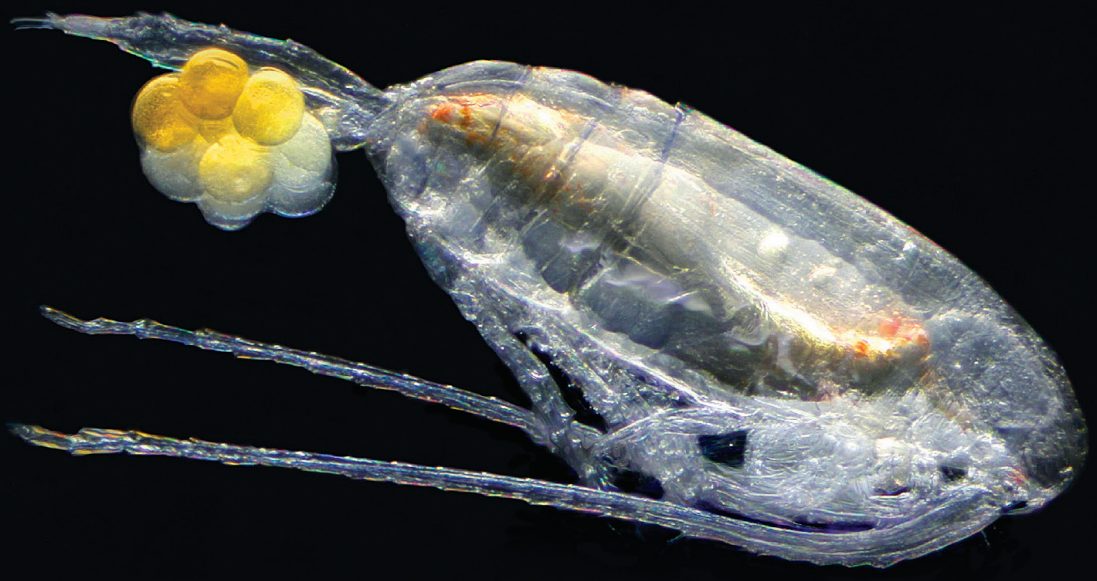
In addition to the items listed above, our scientists continually publish their research findings in peer-reviewed journals. See our *Publications* section for more detail.

PHOTO CONTEST

We asked our community: What do you find intriguing, beautiful, or inspiring about our rich waters, lands, and cultures in this region? How do you explore this place? How do you engage with it? We challenged folks to capture these moments and share them through our 2016 photo contest. One hundred and thirty-one photos were entered through our Facebook photo submission application. Ten winners were awarded cash prizes for "best in show" across three categories: rich waters, rich land, and rich culture.

PUBLICATIONS

PUBLICATIONS, POSTERS, AND ORAL PRESENTATIONS BY PWSSC STAFF



MICROSCOPE IMAGE OF FEMALE COPEPOD (PSEUDOCALANUS, 1.5MM) WITH EGGS. BY: CAITLIN MCKINSTRY, PWSSC

MARY ANNE BISHOP, PH.D.

PUBLICATIONS

Bishop, M.A., J.B. Buchanan, B. McCaffery & J.A. Johnson. 2016. Spring stopover sites used by the Red Knot Calidris canutus roselaari in Alaska, USA: Connectivity between Copper River Delta and the Yukon-Kuskokwim River Delta. Wader Study 123 (2): 143-152. DOI 10.18194/ws.00035

Bishop, M.A., J.T. Watson, K. Kuletz, T. Morgan. 2015. Pacific herring consumption by marine birds during winter in Prince William Sound, Alaska. Fisheries Oceanography. 24:1-13.

Bishop, M.A., and J. Eiler. In press. Migration patterns of post-spawning Pacific herring in a subarctic sound. Deep Sea Research II. DOI 10.1016/j.dsr2.2017.04.016

Dawson, N.M., M.A. Bishop, K.J. Kuletz, A.F. Zuur. 2015. Using ships of opportunity to assess winter habitat associations of seabirds in subarctic coastal Alaska. Northwest Science 89(2):111-128.

Eiler, J., and M.A. Bishop. 2016. Determining the post-spawning movements of Pacific herring, a small pelagic forage fish sensitive to handling, with acoustic telemetry. Transactions of American Fisheries Society. 145:2, 427-439, DOI 10.1080/00028487.2015.1125948

Lewandoski, S. and M.A. Bishop. In review. Distribution of juvenile Pacific herring in relation to environmental and geospatial factors in Prince William Sound, Alaska. Deep Sea Research II (submitted September 2016).

Stocking, J., M.A. Bishop, and A. Arab. In review. Spatio-temporal distributions of piscivorous birds in a subarctic sound during the nonbreeding season. Deep Sea Research II (submitted November 2016).

Weiser, E.L., R.B. Lanctot, S.C. Brown, J.A. Alves, P.F. Battley, R. Bentzen, J. Bêty, M.A. Bishop, et al. 2016. Effects of geolocators on hatching success, return rates, breeding movements, and change in body mass in 16 species of Arctic-breeding shorebirds. Movement Ecology 4:12. DOI 10.1186/s40462-016-0077-6

ORAL PRESENTATIONS

Bishop, M.A., J. Buchanan, B. McCaffery, and Jim Johnson. Red Knot Calidris canutus roselaari spring stopover sites in Alaska. 2016 Alaska Bird Conference. December 2016, Cordova.

Kuletz, K.J., H. Renner, R. Kaler, J. Parrish, B. Bodenstein, J. Piatt, and M.A. Bishop. Seabird Die-off events, 2014-2016. Workshop on Unusual Mortality Events. Alaska Marine Science Symposium January 2016, Anchorage.

Taylor, A.R., M.A. Bishop, A. Schaefer, R. Porter, and K.Sowl. Now you see me, now you don't: Shifts in Black Turnstone migration patterns in Prince William Sound, AK. 2016 Alaska Bird Conference. December 2016, Cordova.

POSTERS

Bishop, M.A., Y. Suzuki, and D.D. Roby. Limiting factors for Caspian Tern colony growth on the Copper River Delta. 2016 Alaska Bird Conference. December 2016, Cordova.

Bishop, M.A., K. Kuletz, J. Stocking, and A. Schaefer. Spatial and temporal patterns of winter marine bird distribution in Prince William Sound, AK. Alaska Marine Science Symposium, January 2016, Anchorage.

Bishop, M.A., K. Kuletz, J. Stocking, and A. Schaefer. Winter marine bird distribution in Prince William Sound: Spatial and temporal patterns. 2016 Alaska Bird Conference, December 2016, Cordova.

Lindeberg, M., M. Artmitsu, M.A. Bishop, D. Cushing, R. Kaler, K. Kuletz, et al. Population Trends of Top Predators and Prey in Prince William Sound. Alaska Marine Science Symposium January 2016, Anchorage.

ROB CAMPBELL, PH.D.

PUBLICATIONS

Campbell, R.W. In review. Hydrographic trends in Prince William Sound, Alaska, 1960-2016. Submitted to Deep Sea Res. II. November 2016.

Crusius, J., Schroth, A.W., Resing, J.A., Cullen, J. and R.W. Campbell. In press. Seasonal and spatial variabilities in the

northern Gulf of Alaska surface water iron concentrations driven by shelf sediment resuspension, glacial meltwater, a Yakutat eddy, and dust. Global Biogeochemical Cycles. Accepted 5/4/2017. DOI 10.1002/2016GB005493

Schroth, A.W., Crusius, J., Gassó, S., Moy, C.M., Buck, N.J., Resing, J.A. and R.W. Campbell. In press. Aleutian Low position drives dramatic inter-annual variability in atmospheric transport of glacial iron to the Gulf of Alaska. Geophys. Res. Lett. Accepted 5/4/2017.

Batten, S.D., Moffitt, S., Pegau, W.S. and R. Campbell. 2016. Plankton indices explain interannual variability in Prince William Sound herring first year growth. Fisheries Oceanography 25:420-434. DOI 10.1111/fog.12162

ORAL PRESENTATIONS

Campbell, R.W. Effects of the 2013-2016 warm anomaly in Prince William Sound, Alaska. Alaska Marine Science Symposium, January 2017, Anchorage.

Campbell, R.W. Surface layer and bloom dynamics observed with the Prince William Sound Autonomous Profiler. ASLO/AGU Ocean Sciences Meeting, February 2016, New Orleans.

Campbell, R.W. Surface layer and bloom dynamics in Prince William Sound. Alaska Marine Science Symposium, January 2016, Anchorage.

Campbell, R.W. Effects of the 2013-2015 warm anomaly in Prince William Sound, Alaska. Pacific Anomalies Workshop 2, 2016, Seattle.

SHELTON GAY, PH.D.

PUBLICATIONS

Gay, S.M. and DiMarco, S. In review. Effects of glacial and oceanic advection on spatial patterns of freshwater contents and temperatures in the late spring and summer in Prince William Sound, Alaska. Cont. Shelf Res.

Gay, S.M. In review. Seasonal and annual variation in physical properties among fjords in Prince William Sound, Alaska used as nurseries by juvenile Pacific herring (Clupea Pallasi). Deep-Sea Research II.

POSTERS

The Effects of Glacial and Oceanic Advection on Spatial Patterns of Freshwater Contents and Temperatures of Small Fjords and Major Basins in Prince William Sound, Alaska. ASLO/AGU Ocean Sciences Meeting, February 2016, New Orleans.

KRISTEN GORMAN, PH.D.

PUBLICATIONS

Gorman, K.B., T.C. Kline, M.E. Roberts, F.F. Sewall, R.A. Heintz, and W.S. Pegau. Spatio-temporal variation in winter condition and stable carbon and nitrogen isotope signatures of juvenile herring (Clupea pallasii) in Prince William Sound, Alaska: Teleconnections with the Gulf of Alaska. Deep-Sea Research II (submitted November 2016).

Gorman, K.B., S.L. Talbot, S.A. Sonsthagen, G.K. Sage, M.C. Gravely, W.R. Fraser and T.D. Williams. Population genetic structure and gene flow of Adélie penguins (Pygoscelis adeliae) breeding throughout the western Antarctic Peninsula. Antarctic Science (submitted January 2016).

REPORTS

Knudsen, E., P. Rand, K. Gorman, J. McMahon, B. Adams, and V. O'Connell, and D. Bernard. 2016. Interactions of wild and hatchery Pink Salmon and Chum Salmon in Prince William Sound and Southeast Alaska. Prince William Sound Science Center Final Report 2015 to Alaska Department of Fish & Game, Contract IHP-13-013.

Knudsen, E., M. Buckhorn, K. Gorman, P. Rand, M. Roberts, B. Adams, and V. O'Connell, and D. Bernard. 2015. Interactions of wild and hatchery Pink Salmon and Chum Salmon in Prince William Sound and Southeast Alaska. Prince William Sound Science Center Final Report 2014 to Alaska Department of Fish & Game, Contract IHP-13-013.

ORAL PRESENTATIONS

Gorman, K.B., T.C. Kline, R.A. Heintz, F.F. Sewall, M.A. Bishop, and W.S. Pegau. Ecological factors influencing the overwinter survival of age-0 herring in Prince William Sound, Alaska. Prince William Sound Science Center Tuesday Night Lecture Series. Cordova, Alaska, April 2016.

Heintz, R.A., M.A. Bishop, K.B. Gorman, F.F. Sewall, W.S. Pegau. Ecological factors influencing the overwinter survival of age-0 herring in Prince William Sound, Alaska. Alaska Marine Science Symposium, Anchorage, AK, January 2016. Presented by R. Heinz.

Knudsen, E., M. Buckhorn, K.B. Gorman, V. O'Connell and B. Adams. Field studies of the interactions of wild and hatchery Pink and Chum Salmon in Prince William Sound and southeast Alaska for the Alaska hatchery research program. Northeast Pacific Pink and Chum Salmon Workshop, Richmond, BC, February 2015. Presented by E. Knudsen.

POSTERS

Gorman, K.B., B. Adams, and E.E. Knudsen. Sex differences in hatchery-stray fractions among Chum and Pink Salmon spawning in Prince William Sound, Alaska. American Fisheries Society Meeting. Portland, Oregon, August 2015.

BEN GRAY, M.S.

PUBLICATIONS

Gray BP, Norcross BL, Blanchard AL, Beaudreau AH, Seitz AC. 2016. Variability in the summer diets of juvenile polar cod (Boreogadus saida) in the northeastern Chukchi and western Beaufort Seas. Polar Biology 39(6):1069–1080. DOI 10.1007/s00300-015-1796-7

Gray BP, Norcross BL, Beaudreau AH, Blanchard AL, Seitz AC. 2016. Food habits of Arctic staghorn sculpin (Gymnocanthus tricuspis) and shorthorn sculpin (Myoxocephalus scorpius) in the northeastern Chukchi and western Beaufort Seas. Deep-Sea Research II: Topical Studies in Oceanography 135:111–123. DOI 10.1016/j.dsr2.2016.05.013

SCOTT PEGAU, PH.D.

PUBLICATIONS

Wang, D. W., H. W. Wijesekera, E. Jarosz, W. J. Teague, and W.S. Pegau. 2016. Turbulent diffusivity under high winds from acoustic measurements of bubbles, Journal of Physical Oceanography, 46, 1593-1613. DOI 10.1175/JPO-D-15-0164.1

Batten, S.D., S. Moffitt, W.S. Pegau, and R. Campbell. 2016. Plankton indices explain interannual variability in Prince William Sound herring first year growth, Fisheries Oceanography, 25, 420-432.

REPORTS

Pegau, W.S., J. Garron, and L. Zabilansky. 2016. Detection of oil on-in-and-under ice – Final Reports 5.3, Arctic Response Technology Joint Industry Program Final Report, International Oil and Gas Producers, pp. 406.

ORAL PRESENTATIONS

Pegau, W.S., and HRM research team. Herring Research and Monitoring in Prince William Sound. Alaska Marine Science Symposium. January 2016, Anchorage.

Pegau, W.S., Remote sensing of oil in and under ice. Alaska Forum on the Environment. February 2016, Anchorage.

Jarosz, E., D.W. Wang, H.W. Wijesekera, W.S. Pegau, and J.N. Moum, Flow Variability within the Alaska Coastal Current in winter. ASLO/AGU Ocean Sciences Meeting, February 2016, New Orleans.

Wang, D.W., H.W. Wijesekera, E. Jrosz, W.J. Teague, and W.S. Pegau. Acoustic Backscatter Measurements from Breaking-wave Turbulence under High Winds. ASLO/AGU Ocean Sciences Meeting, February 2016, New Orleans.

CAITLIN MCKINSTRY, M.S.

PUBLICATIONS

McKinstry, C., and R. Campbell. In Review. Seasonal variation of zooplankton abundance and community structure in Prince William Sound, Alaska, 2009-2016. Deep-Sea Research II.

ORAL PRESENTATIONS

McKinstry, C. Zooplankton: Big talk about tiny critters. PWSRCAC's Science Night. December 2016, Anchorage, AK.

POSTERS

Campbell R. and C. McKinstry. Effects of the 2013-2015 warm anomaly in Prince William Sound, Alaska. Alaska Marine Science Symposium, January 2016, Anchorage, AK.

Doroff, A., Campbell, R., and C. McKinstry. Zooplankton Assemblages in lower Cook Inlet and Kachemak Bay 2012-2014. Alaska Marine Science Symposium, January 2016, Anchorage, AK.

PHOTOS

North Pacific Research Board's Annual Photography Contest. Adult Honorable Mention: Microscope image of female copepod (Pseudocalanus) with eggs.

PETE RAND, PH.D.

PUBLICATIONS

Zhivotovsky, L.A., A.A. Yurchenko, V.D. Nikitin, S.N. Safronov, M.V. Shitova, S.F. Zolotukhin, S.S. Makeev, S. Weiss, P.S. Rand, and A.Y. Semenchenko. 2015. Eco-geographic units, population hierarchy, and a two-level conservation strategy with reference to a critically endangered salmonid, Sakhalin taimen Parahucho perryi. Conservation Genetics 16:431-441 DOI 10.1007/s10592-014-0670-4

Rand, P.S., A.M. Zenone, and K.M. Boswell. Dynamics of juvenile Pacific herring within and between nursery areas during 2012-2015 in Prince William Sound, Alaska. Deep Sea Research II (accepted with revisions).

ANNE SCHAEFER, M.S.

PUBLICATIONS

Schaefer, A. L., P. M. Lukacs, and M. L. Kissling. 2015. Testing factors influencing the identification rates of similar species during abundance surveys. The Condor: Ornithological Application 117: 60–472.

REPORTS

Schaefer, A.L. 2016. Winter Species in Prince William Sound, Alaska, 1989-2016. Final report to Prince William Sound Regional Citizens' Advisory Council. Contract No. 910.16.01. 28pp. (Final report)

Schaefer, A. L. 2015. Sensitivity of Black Turnstones to Coastal Threats. Report to the Oil Spill Recovery Institute, Cordova, AK.

ORAL PRESENTATIONS

Schaefer, A. L., P. M. Lukacs, M. L. Kissling, S. B. Lewis, C. Parenteau, O. Chastel, S. A. Berk, C. W. Breuner. 2016. The influence of ocean productivity on stress and parental investment in a long-lived seabird. Alaska Marine Science Symposium, Anchorage, AK, January 2016 and Alaska Bird Conference, Cordova, AK, December 2016.

POSTERS

Bishop, M. A., K. Kuletz, J. Stocking, A. Schaefer. 2016. Spatial and temporal patterns of winter marine bird distribution in Prince William Sound, Alaska. Alaska Marine Science Symposium, January 2016, Anchorage, AK.

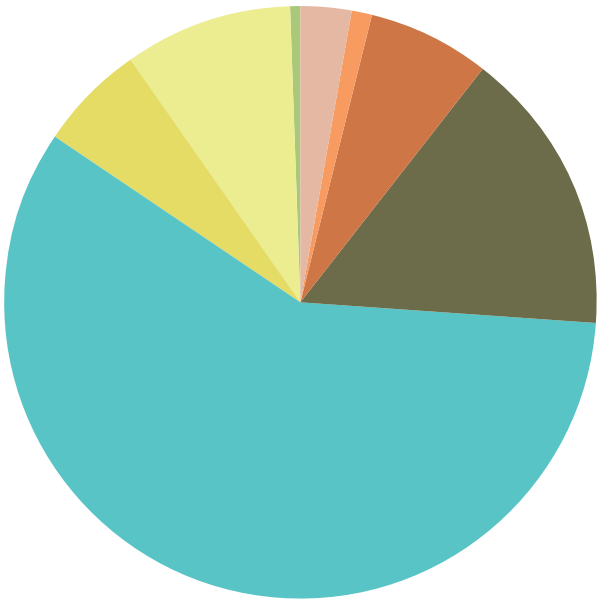
Bishop, M. A., K. Kuletz, J. Stocking, A. Schaefer. 2016. Winter marine bird distribution in Prince William Sound: spatial and temporal patterns. Alaska Bird Conference, December 2016, Cordova, AK.

FINANCIAL SUMMARY

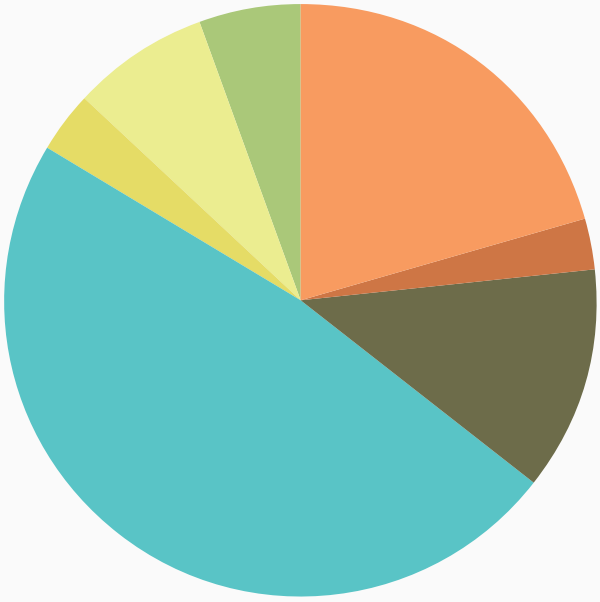
REVENUES	2016
Individual/Small Business/Membership/Special Events	$146,439
Investment & Other Income	$68,331
Corporations/Foundations/Non-Profits	$339,799
OSRI Grants & Contracts	$796,282
EVOS Grants & Contracts	$3,000,422
Federal Grants & Contracts	$299,488
State Grants & Contracts	$467,989
Other Grants & Contracts	$27,937
	$5,146,687

EXPENSES	2016
Administration & Operations	$1,053,369
Education (Private/OSRI/Federal)	$132,552
OSRI Grants & Contracts	$616,604
EVOS Grants & Contracts	$2,432,407
Federal Grants & Contracts	$172,191
State Grants & Contracts	$373,925
Other Grants & Contracts	$275,357
	$5,056,405

REVENUES



EXPENSES



DONORS & FUNDERS

RESEARCH FUNDERS

*Fiscal year 2016 expenditures

$3,000,000+
Exxon Valdez Oil Spill Trustee Council (EVOSTC)

$450,000+
Alaska Department of Fish & Game

$250,000+
North Pacific Research Board

$100,000+
Oil and Gas Producers

$75,000+
PWS Regional Citizens' Advisory Council

$50,000+
Copper River/Prince William Sound Marketing Association

$30,000+
Alaska Ocean Observing System

$25,000+
Dalhousie University

$10,000+
Alaska Bird Conference

$7,500+
National Fish and Wildlife Foundation
Trust for Mutual Understanding

$500+
The City University of New York
ConocoPhillips

EDUCATION FUNDERS

$50,000+
Oil Spill Recovery Institute

$25,000+
National Fish and Wildlife Foundation / Wells Fargo Environmental Solutions for Communities

$10,000+
BP Alaska
PWS Regional Citizens' Advisory Council

$5,000+
ConocoPhillips Alaska
EVOSTC Herring Research and Monitoring

$2,000+
Alaska Glacial Mud Co.
EVOSTC Gulf Watch Alaska

$1,500+
Alyeska Pipeline Service Company
Alaska Ocean Observing System
University of Alaska Fairbanks

$1,000+
North Pacific Research Board

$500+
Dan Hull and Nancy Pease

$250+
Alaska Good Time Charters
Auklet Charter Services
City of Cordova
Rogue's Garden
Stan Stephens Cruises

$100+
Cordova District Fishermen United
Cordova Wireless Communications
Lazy Otter Charters
Native Village of Eyak

$50+
Copper Oar Rafting
Pangaea Adventures

GENERAL DONORS

*Calendar year 2016 donations

$5,000+
CoBank
Edison Chouest Offshore
Eyak Corporation
Fairweather LLC
Trident Seafoods

$3,000+
Alyeska Pipeline Service Company

$2,500+
Birch, Horton, Bittner & Cherot
Lynden
Ocean Beauty Seafoods
UIC Arctic Response Services

$2,000+
Margaret Stock
North Pacific Seafoods

$1,500+
John Garner
Katrina Hoffman and Mike Webber

$1,000+
Thomas and Sheila Barrett
Cascadia Cross-Border Law Group
Doug Causey
Cordova Telephone Cooperative
Cordova Wireless Communications
Rick and Cyndie Fox
Meacham Foundation
Clarence Pautzke and Maureen McCrea
Peter Pan Seafoods
Roemhildt Holdings
Andrew Smallwood
Walt Wrede

$700+
Caryn Rea
GreatBig.org
Bill Rome

$500+
Alaska Tanker Company
Howard and Jean Baumann
Brena, Bell & Clarkson
Copper Valley Wireless
Mike and Linda Leary
Chuck Meacham
Mike and Laura Meadors
Sylvia Lange and Greg Meyer
Don Moore
Odom Corporation
Dan Hull and Nancy Pease
Rasmuson Foundation
Shoreside Petroleum
Bert Stammerjohan

$350+
Brennan and Rebecca Cain
Clay and Lila Koplin
Laura's Liquor Shop

$300+
Aeonian Group
Mary Anne Bishop
Duncan Fields
RJ and Barclay Kopchak
Dick Thorne
Mead Treadwell

$250+
Robert and April Beedle
Nancy Bird and Karl Becker
Judith Crotty
Kate Dugan
Scott Hicks
Marsha Burns and Lynn Highland
Eric Knudsen and Judy Farrar
Carol Kreader and Brian Wrenn
Mike Mahoney
Heather McCarty
Sen. Lisa Murkowski and Verne Martell
Office of Senator Lisa Murkowski
Alex Slivka
John Wilson

$200+
Betty Bang
Derek Blake
Alex and Carol Bryner
Bill and Sara Hoffman
Vince and Jennie Kelly
Montague Marine Research
PWS Regional Citizens' Advisory Council
Casey Pape
Monika Reghetti
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