



PRINCE WILLIAM SOUND
**SCIENCE
CENTER**

WORLD'S RICHEST WATERS

2013 ANNUAL REPORT



PHOTO: NASA

**WE ARE COMMITTED TO UNDERSTANDING
HOW ONE PLACE ON EARTH CAN MAINTAIN
A RELIABLE ECONOMY AND NATURAL
ENVIRONMENT FOR THE LONG-TERM.**

**WELCOME TO ONE OF THE LAST, BEST PLACES,
HOME OF THE WORLD'S RICHEST WATERS.**

LOCAL RESEARCH, GLOBAL RELEVANCE

If you put a pin on a map, we challenge you to find another place with more dramatic scenery and compelling ecosystems within 100 miles: glaciers, coastal temperate rainforests, rocky shorelines, and rivers full of world-famous salmon, not the least of which is the Copper River, whose delta forms the largest contiguous wetland system on the Pacific Coast of North America. We are situated adjacent to the edge of the continental shelf in the northern Gulf of Alaska, nursery to some of the nation's most productive fisheries.

We are the only non-governmental research institute based in this globally relevant place. That gives us some unique advantages: It makes it easier for us to collect data from key sites with great regularity, and we get to converse and collaborate with people in the community, such as commercial fishermen, whose livelihoods are intricately tied to the subjects of our research. Our goal is to look at the big picture and pull it all together. We're an access point for folks who want to study or learn about the compelling ecosystems in our region. We are also the administrative home of the Oil Spill Recovery Institute (OSRI), established by Congress through the Oil Pollution Act of 1990. OSRI supports research, education, and demonstration projects designed to respond to and understand the effects of oil spills in Arctic and sub-Arctic marine environments.

Perhaps what's most unexpected is our depth and breadth of research. With only five principal investigators and a variety of administration, education and support staff, we engaged in 28 different research projects in FY13, all of them summarized in this report, not to mention a multitude of education programs and community engagement efforts near and far. Looking ahead, we seek to extend beyond our marine and aquatic efforts to the many other aspects of the ecosystems here that deserve to be better studied: carbon, climate change, terrestrial regions, and the economy. There's lots of room to grow, and it's our sincere hope you grow with us.



Meera Kohler
BOARD CHAIR



Katrina Hoffman
PRESIDENT & CEO

2013 HIGHLIGHTS

IMPLEMENTED THE 5-YEAR GULF WATCH ALASKA RESEARCH PROGRAM TO MONITOR THE NATURAL RESOURCES AFFECTED BY THE *EXXON VALDEZ* OIL SPILL.

LED A 5-YEAR MULTIAGENCY, MULTIDISCIPLINARY HERRING RESEARCH AND MONITORING PROGRAM IN PRINCE WILLIAM SOUND.

SECURED A CONTRACT FROM THE ALASKA DEPARTMENT OF FISH & GAME TO IMPLEMENT A MULTIYEAR STUDY OF INTERACTIONS BETWEEN HATCHERY AND WILD SALMON.

OUR MULTIYEAR CLIMATE RESEARCH PROJECT, FUNDED BY NASA, CONTINUES TO INVESTIGATE CONNECTIVITY BETWEEN THE UPPER COPPER RIVER BASIN AND OCEAN PRODUCTIVITY IN THE GULF OF ALASKA.

RESEARCH

STUDIES CONDUCTED BY OUR RESEARCHERS SPAN DIVERSE SUBJECTS, INCLUDING: RESOURCE USE AND SUSTAINABILITY, ECOSYSTEMS THAT SUPPORT COASTAL & INLAND ECONOMIES, AND POPULATIONS OF COMMERCIALY IMPORTANT SPECIES. ULTIMATELY, ALL OF OUR WORK IS FOCUSED ON ONE OUTCOME: TO UNDERSTAND HOW A PLACE CAN MAINTAIN BOTH ITS ENVIRONMENT AND ECONOMY FOR GENERATIONS TO COME. HERE WE PRESENT OUR RESEARCH, ORGANIZED BY LAST NAME.

BISHOP

PWS HERRING SURVEY: TOP-DOWN REGULATION BY PREDATORY FISH ON JUVENILE HERRING

PROJECT LEAD: Mary Anne Bishop

PROJECT TEAM: Brad Reynolds, Jordan Watson

COLLABORATORS: Sean Powers (Co-PI), University of South Alabama

SUMMARY: Predation can be a major factor in the population dynamics of many marine species and has been suggested to be important in the decline of Pacific herring in Prince William Sound. Using longlines we found that the bottom fish assemblages are dominated by relatively few species: Pacific cod (41%), yellowfin sole (15%), walleye pollock (9%), big skate (6%), and great sculpin (6%). Pacific cod was the most important herring predator within the bays. Other important herring predators include walleye pollock, yellowfin sole, big skate, and Pacific halibut.

OCEAN TRACKING NETWORK ACOUSTIC ARRAYS IN PRINCE WILLIAM SOUND

PROJECT LEAD: Mary Anne Bishop

PROJECT TEAM: Brad Reynolds, Megan McKinzie, Darren Roberts

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 from the Gulf of Alaska into Prince William Sound. Species in Prince William Sound that currently have acoustic tagged individuals include Pacific herring, Pacific cod, and salmon sharks. The new acoustic arrays have radically changed our ability to determine population connectivity between fish populations in the Sound and the Gulf of Alaska.

PWS HERRING RESEARCH AND MONITORING: TRACKING SEASONAL MOVEMENTS OF ADULT PACIFIC HERRING IN PRINCE WILLIAM SOUND

PROJECT LEAD: Mary Anne Bishop

PROJECT TEAM: Brad Reynolds, Megan McKinzie

COLLABORATORS: John Eiler, NOAA Auke Bay Lab; Sean Powers, University of South Alabama

SUMMARY: Adult herring are known to exhibit seasonal migrations between spawning, feeding and wintering areas. One of the important knowledge gaps for the Pacific herring population in Prince William Sound is where adult herring go after spawning. In April 2013 at Port Gravina, we surgically implanted acoustic tags in 69 adult herring. Forty-one of these herring were later detected by the listening array in Hinchinbrook Entrance and Montague Strait. These preliminary results demonstrate the exceptional opportunity to document migration patterns by herring, and specifically the connectivity between the Gulf of Alaska and Prince William Sound.

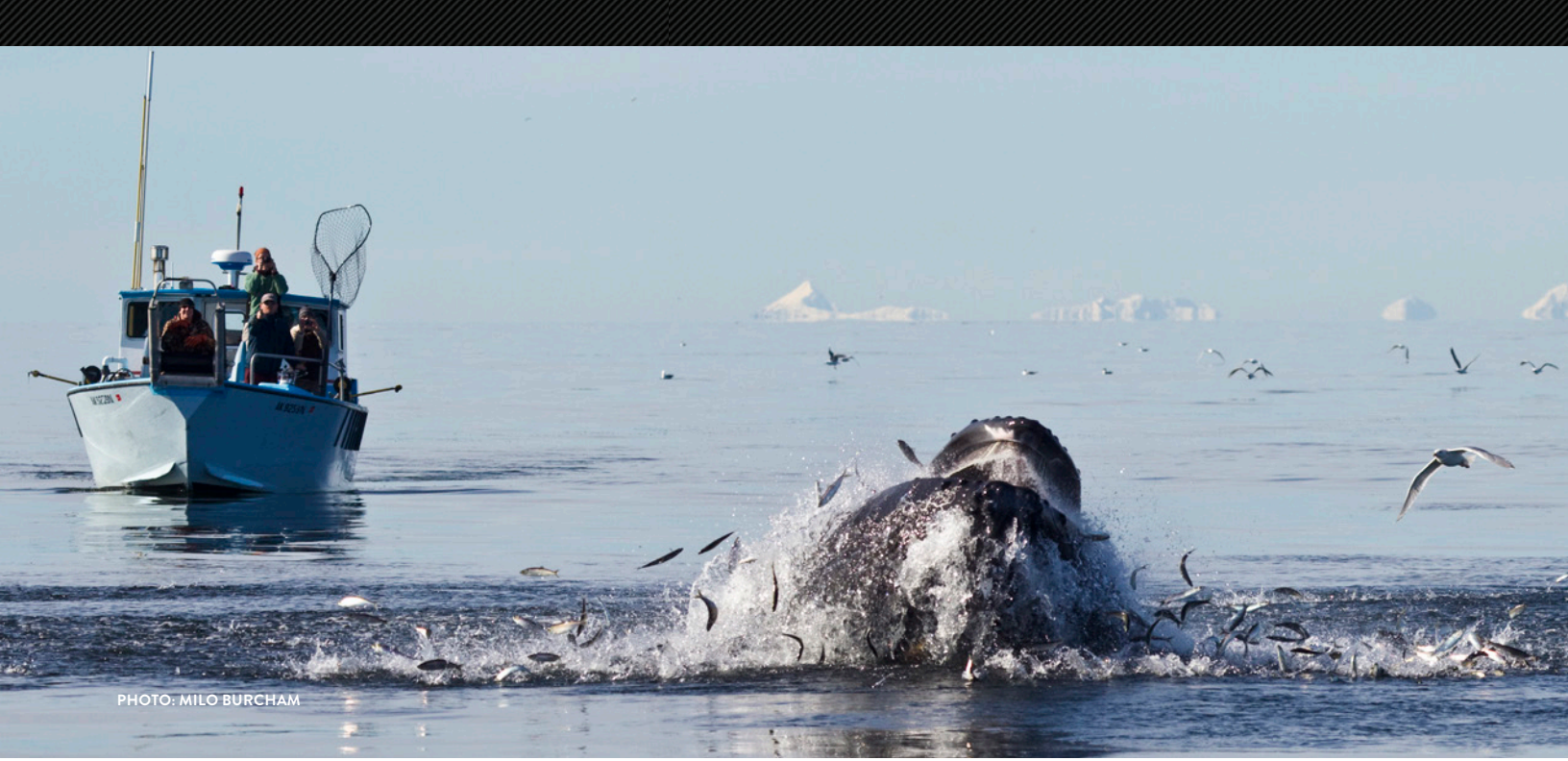


PHOTO: MILO BURCHAM

AVIAN INFLUENZA IN GULLS

PROJECT LEAD: Mary Anne Bishop

PROJECT TEAM: Jessica Stocking, Kirsti Jurica

COLLABORATORS: Jonathan Runstadler, Massachusetts Institute of Technology

SUMMARY: Infectious diseases that can be transmitted or shared by animals and humans are known as zoonotics. Gulls are a means for influenza reassortment—they can develop new influenza strains by recombining genetic material. Since 2009, Dr. Mary Anne Bishop of PWSSC has been working with Dr. Jon Runstadler of the Massachusetts Institute of Technology to examine the prevalence and diversity of influenza viruses in gulls. Sampling begins in mid to late April to coincide with spring migration, continues throughout the summer both in Cordova as well as at Egg Island, a major breeding colony, and ends in early September when most gulls head south for the winter.

PWS HERRING SURVEY: SEASONAL AND INTERANNUAL TRENDS IN SEABIRD PREDATION ON JUVENILE HERRING

PROJECT LEAD: Mary Anne Bishop

PROJECT TEAM: Tawna Morgan, Bobby Hsu, Jessica Stocking

COLLABORATORS: Kathy Kuletz (Co-PI), US Fish and Wildlife Service; Richard Thorne, PWSSC

SUMMARY: The collapse of the Prince William Sound herring fishery has impacted not only the economy and well-being of PWS communities, but also several species of seabirds that depend on herring. From November 2009 to March 2012 we investigated seabird abundance and distribution during the winter months of November and March in juvenile herring nursery bays. Bird compositions in bays were significantly different between the two months with differences driven primarily by the numbers of common murre, the most abundant bird on our surveys, marbled murrelet, and gulls. In addition, the abundance of large gulls in November as well as common murre in March were each positively related to fish biomass in bays.

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

PROJECT LEAD: Mary Anne Bishop

PROJECT TEAM: Bobby Hsu, Jessica Stocking

COLLABORATORS: Michele Buckhorn, PWSSC; John Moran, NOAA

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 Sound. Four surveys were conducted between October 2012 and March 2013. 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.

PWS HERRING RESEARCH AND MONITORING: VALIDATION OF ACOUSTIC SURVEYS FOR PACIFIC HERRING USING DIRECT CAPTURE

PROJECT LEAD: Mary Anne Bishop

PROJECT TEAM: Megan McKinzie, Jessica Stocking, Megan Roberts

COLLABORATORS: Michele Buckhorn, PWSSC

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, gillnets and cast nets.

EYAK LAKE WATERSHED RESTORATION MONITORING

PROJECT LEAD: Mary Anne Bishop

PROJECT TEAM: Brad Reynolds, Kirsti Jurica

COLLABORATORS: Copper River Watershed Project

SUMMARY: In 2009, a series of habitat restoration activities were undertaken by the Copper River Watershed Project to improve fish habitat in the Eyak Lake watershed and Eccles Creek for pink salmon, coho salmon, sockeye salmon, cutthroat trout and Dolly Varden. From 2009-2012 we collected data on spawning habitat quality and salmonid utilization prior to and following improvements to habitat at each restoration site. Overall, restoration activities resulted in increased abundance and diversity of salmonids in the restored habitats. The impacts of high flows associated with

flood events were mitigated by new culverts at Eccles and Whiskey Creeks as well as a new culvert at Power Creek Road.

BLACK TURNSTONE: A POPULATION DECLINE OR STOPOVER SHIFTS IN PRINCE WILLIAM SOUND?

PROJECT LEAD: Mary Anne Bishop

PROJECT TEAM: Jessica Stocking

COLLABORATORS: Audrey Taylor (Co-PI) University of Alaska Anchorage; Kristine Sowl, Yukon Delta National Wildlife Refuge

SUMMARY: A 2010 study showed a decline in black turnstone numbers stopping at Prince William Sound’s Montague Island, the most important migration stopover site for the species. This project is designed to understand if the decline in the observed population represents a true population decline or if the reduced numbers reflect a shift in the migration route and change in stopover sites used in Prince William Sound. To track black turnstone movements, in 2013 we captured black turnstones during March at Oak Harbor, Washington, and in June at Yukon Delta National Wildlife Refuge Alaska. Birds received a small device that periodically records light levels, from which latitude and longitude can be calculated. Black turnstones typically return to the same breeding and wintering sites year after year, and we plan to recapture birds at the same sites in 2014.

BUCKHORN

EXPANDED ADULT HERRING SURVEYS

PROJECT LEAD: Michele Buckhorn

PROJECT TEAM: Dick Thorne

COLLABORATORS: Mary Anne Bishop/Megan McKinzie

SUMMARY: Prince William Sound herring stock biomass estimates from hydroacoustic surveys provide a direct measure of the stock abundance and are a primary input into the age-structured assessment (ASA) model that is the forecasting tool used for management. Since 1993, PWSSC has been conducting annual acoustic surveys near the primary

herring spawning grounds. The objective of this study is to increase the current survey area of adult spawning populations beyond the Port Gravina and Fidalgo areas to include smaller spawning stocks throughout PWS in order to provide a more accurate estimate of herring biomass.

JUVENILE HERRING ABUNDANCE INDEX

PROJECT LEAD: Michele Buckhorn

COLLABORATORS: Mary Anne Bishop/Megan McKinzie

SUMMARY: One of the biggest gaps in our ability to predict the herring biomass is knowing approximately how many fish will recruit to the spawning stock. Current knowledge suggests that most mortality of juvenile herring occurs during the first year of life, so the relative recruitment may be set by the end of the first year. Consequently, estimates of relative abundance of age 1 and age 2 fish should provide an index of future recruitment. To establish this index we annually survey eight bays in Prince William Sound for juvenile herring using hydroacoustics with direct capture using a mid-water trawl to ground truth the hydroacoustic data.

JUVENILE HERRING INTENSIVE SURVEYS

PROJECT LEAD: Michele Buckhorn

COLLABORATORS: Mary Anne Bishop/Megan McKinzie

SUMMARY: Fish movement into and out of a sampling area can greatly affect our seasonal estimates of the numbers of juvenile herring and our subsequent estimates of overwintering mortality. We are examining the repeatability of the survey estimates of juvenile herring over short (daily), medium (two weeks), and long (fall and spring) time periods to provide a measure of the survey precision and impact of fish movements on the population estimates. This information will then be used when estimating overwintering mortality using historic survey data.

PINK AND CHUM SALMON HATCHERY-WILD INTERACTIONS OCEAN TEST FISHERY

PROJECT LEAD: Michele Buckhorn (PI for Ocean Test Fishery) and Eric Knudsen (Project Manager)

PROJECT TEAM: Megan McKinzie, Darren Roberts, Martin Schuster, Katrina Hoffman

COLLABORATORS: Victoria O'Connell, Sitka Sound Sci-

ence Center; Thomas Kline, Jr., PWSSC

SUMMARY: The ocean test fishery is a component of the hatchery-wild program. The ocean test fishery uses systematic fishing effort at stations in Hinchinbrook Entrance and Montague Strait to assess the proportion of hatchery and wild pink and chum salmon returning to PWS. The data collected also provides near real-time run information to fisheries managers.

CAMPBELL

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

PROJECT LEAD: Robert Campbell

PROJECT 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

COLLABORATORS: Mary Anne Bishop/Megan McKinzie

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.

PWS HERRING SURVEY: PLANKTON AND OCEANIC OBSERVATIONS IN PRINCE WILLIAM SOUND

PROJECT LEAD: Robert Campbell

COLLABORATORS: Paul Hershberger, US Geological Survey; Evelyn Brown, Flying Fish Ltd.

SUMMARY: In order to track the bottom-up factors (food and environment) that may be important for herring overwintering, regular surveys of the PWS region were conducted at monthly to bimonthly frequency between late 2009

and 2012. The surveys covered the entrances to PWS, central PWS, and the four bays extensively studied by the Sound Ecosystem Assessment project (Eaglek, Simpson, Whale, and Zaikof Bays), and consisted of basic oceanographic and biological measurements (temperature and salinity; chlorophyll-a, nitrate, and zooplankton concentrations).

LONG-TERM MONITORING OF OCEANOGRAPHIC CONDITIONS IN PRINCE WILLIAM SOUND

PROJECT LEAD: Robert Campbell

COLLABORATORS: Sonia Batten, Sir Alister Hardy Foundation for Ocean Science; Russ Hopcroft, Tom Weingartner, University of Alaska Fairbanks; Angela Doroff, Alaska Department of Fish and Game

SUMMARY: This project is a follow on to prior work done as part of the PWS herring survey (Plankton and oceanic observations in Prince William Sound). As well as multiple cruises per year aimed at explaining the timing of the vernal and autumnal blooms, a state-of-the-art profiling mooring is being 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.

GAY

PHYSICAL OCEANOGRAPHIC FACTORS AFFECTING PRODUCTIVITY IN JUVENILE PACIFIC HERRING

PROJECT LEAD: Shelton Gay

COLLABORATORS: Thomas Kline, Jr., Richard Thorne and Robert Campbell, PWSSC

SUMMARY: Oceanographic conditions were monitored in four bays around Prince William Sound. The measurements were analyzed to examine the differences in oceanographic properties associated in different regions. By

examining the short and long term variability in oceanographic properties we can begin to understand the differences in the quality of these habitats of juvenile herring and other marine organisms.

DISSERTATION – ESTUARINE CONDITIONS AND WATER EXCHANGE IN FJORDS OF PRINCE WILLIAM SOUND, ALASKA

PROJECT LEAD: Shelton Gay

COLLABORATORS: Advisors Dr. Steve DiMarco and Dr. David Brooks

SUMMARY: The spatial variation in physical properties of small fjords in Prince William Sound (PWS), Alaska between 1994 and 1997 was examined. Circulation and water exchange in Simpson Bay was also determined. Most of the variability in properties was found to be caused by freshwater input and vertical mixing. The more detailed measurements in Simpson Bay showed the importance of deep water exchange for establishing conditions in the region. This research shows why habitat conditions are highly variable in time and space within PWS fjords and how that may impact nutrients, phytoplankton, zooplankton, and juvenile herring.

HALVERSON

OSRI OCEANOGRAPHY

PROJECT LEAD: Mark Halverson

COLLABORATORS: Clint Winant, Scripps; Shelton Gay, PWSSC; Claude Belanger

SUMMARY: Analysis of oceanographic data collected between 2006 and 2010 was completed. A manuscript was submitted describing the tidal and atmospherically-forced exchange of water between the Gulf of Alaska and Prince William Sound. Manuscripts describing circulation in the central portion of Prince William Sound, seasonal transport through the entrances to PWS, and seasonal changes in oceanographic conditions in PWS were published in Continental Shelf Research. These papers, along with others from the 2009 Sound Predictions exercise, have greatly updated our knowledge and understanding of circulation in the region.

HOFFMAN

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

PROJECT LEADS: Katrina Hoffman, Eric Knudsen, Thomas Kline, Jr., Michele Buckhorn, Victoria O'Connell

COLLABORATORS: Scott Harris

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 an ocean test fishery in Prince William Sound to identify the numbers of returning hatchery and wild salmon. Extensive stream sampling in both regions collect DNA of adult and juvenile salmon for genetic 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

PROJECT LEADS: Katrina Hoffman, Molly McCammon, Kris Holderied

COLLABORATORS: Tammy Neher, Rob Bochenek, Matt Jones, Tuula Hollmen, Russ Hopcroft, Tom Weingartner, Rob Campbell, Angie Doroff, Sonia Batten, Mandy Lindeberg, Heather Coletti, Craig Matkin, David Irons, Kathy Kuletz, Mary Anne Bishop, Brenda Ballachey, Jan Straley, John Moran, Katrin Iken, Brenda Konar, Tom Dean, Mark Carls

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 ecosys-

tems, 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.

KLINE

PWS HERRING SURVEY: HERRING ENERGETIC RECRUITMENT FACTORS

PROJECT LEAD: Tom Kline

COLLABORATORS: Ron Heintz, Fletcher Sewall, J.J. Vollenweider, NOAA

SUMMARY: This component of the PWS Herring Survey program examined the condition of young-of-the-year herring in the fall and spring to determine how the winter fasting period can affect herring survival. Models based on the observations collected show that the energy loss of wild fish is less than laboratory measurements indicated. Based on the condition of fish in the fall it was shown that the condition and survival of juvenile herring could be predicted.

HERRING RESEARCH AND MONITORING: CONDITION MONITORING

PROJECT LEAD: Tom Kline

COLLABORATORS: Ron Heintz, Fletcher Sewall, J.J. Vollenweider, NOAA

SUMMARY: This component of the Herring Research and Monitoring program examined the condition of young-of-the-year herring in the fall and spring to determine the loss of energy associated with fasting. Monitoring of the condition of young-of-the-year herring provides a means to determine the role of early growth and feeding on the survival through the winter and the potential recruitment of herring into the spawning stock.

HERRING RESEARCH AND MONITORING: CONDITION MONITORING

PROJECT LEAD: Tom Kline

COLLABORATORS: Ron Heintz, Fletcher Sewall, J.J. Vollenweider, NOAA

SUMMARY: This component of the Herring Research and Monitoring program examined assumptions with the timing of condition measurements. Monthly sampling in Simpson Bay demonstrated that the fish reached maximum energetic condition in November and then steadily fasted until after March. This demonstrated that the period selected for condition monitoring was appropriate for the hypotheses being tested.

PINK AND CHUM SALMON HATCHERY-WILD INTERACTIONS PRINCE WILLIAM SOUND STREAM SAMPLING

PROJECT LEAD: Thomas Kline, Jr. (PI for PWS Stream Sampling) and Eric Knudsen (Project Manager)

PROJECT TEAM: Daniel Crowther, Katie Froning, Megan Roberts, Benjamin Americus, Rachel Ertz, Mike Records, Chantel Caldwell, Rina Hauptfeld, Alexandra Russo, Megan Milligan, Jessica Stocking, Sophia Myer, Darren Roberts, Elliot Johnson

COLLABORATORS: Victoria O'Connell, Sitka Sound Science Center; Michele Buckhorn, Katrina Hoffman, PWSSC

SUMMARY: Prince William Sound stream sampling is a component of the hatchery-wild program. Various streams are sampled to assess the relative composition of wild salmon versus hatchery strays through extensive otolith collection, and a select set of streams are intensively sampled for DNA pedigree analysis to address questions about the potential impacts of straying on fitness.

PEGAU

PWS HERRING SURVEY: COMMUNITY INVOLVEMENT, OUTREACH, LOGISTICS, AND SYNTHESIS

PROJECT LEAD: W. Scott Pegau

COLLABORATORS: Mary Anne Bishop, Michele Buckhorn, Dick Thorne, Lindsay Butters, Rob Campbell, Shelton Gay, Tom Kline, PWSSC; Evelyn Brown, Flying

Fish Ltd.; Ron Heintz, Fletcher Sewall, J.J. Vollenweider, NOAA; Paul Hershberger, US Geological Survey; Kathy Kuletz, US Fish and Wildlife; Sean Powers, University of South Alabama

SUMMARY: This was the final year of a four year program conducting research and monitoring of the early life of herring. We completed a synthesis that describes what we know about the first year of life of herring and issues related to recruitment. Since the 1990s Prince William Sound has not had a herring population that would sustain a fishery. By understanding factors limiting recruitment we can determine appropriate restoration activities, or better predict the conditions that will lead to the fishery opening.

HERRING RESEARCH AND MONITORING COORDINATION

PROJECT LEAD: W. Scott Pegau

COLLABORATORS: Mary Anne Bishop, Michele Buckhorn, Lindsay Butters, Dick Thorne, Tom Kline, 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, US Geological Survey; Kathy Kuletz, US Fish and Wildlife Service; Steve Moffitt, Alaska Department of Fish and 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.

PRINCE WILLIAM SOUND OCEAN OBSERVING SYSTEM

PROJECT 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, a hydro-

logical modeling project is underway and 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, and supporting the acoustic tracking array. These activities provide valuable measurements in support of spill trajectory modeling, boating safety, climate monitoring, and fisheries research in Prince William Sound.

BOTTOM STRESS IN HIGH WIND ENVIRONMENTS

PROJECT LEAD: W. Scott Pegau

COLLABORATORS: Hemantha Wijesekera, David Wang, Naval Research Lab; Jim Moum, Oregon State University

SUMMARY: PWSSC provided support to the Naval Research Laboratories research project examining how wave energy moves through the water column in large storms. This collaboration provided an opportunity to develop new research relationships and provided observations of the oceans during conditions that do not normally permit measurement. The location of the experiment relative to the Kayak Island scallop beds provides an opportunity to learn about larval retention associated with those beds.

MCKINSTRY

LABORATORY RENOVATIONS

PROJECT LEAD: Caitlin McKinstry

PROJECT TEAM: Katrina Hoffman, RJ Kopchak

COLLABORATORS: Megan Roberts, Rob Campbell, PWS-SC; Paul Jensen, Old Town Enterprises

SUMMARY: Laboratory renovations were completed to maximize utility of the available space and improve safety for people working in the lab. By reworking the layout of the space we now have more room for sample analysis. The old and ineffective fume hood was replaced. The new fume hood allows us to handle chemicals and biological samples such as dead fish in a manner that improves safety and the workplace environment.



EDUCATION

FOR OVER 24 YEARS, OUR EDUCATORS HAVE DEVELOPED AND DELIVERED THEME-BASED EDUCATION PROGRAMS FOR ALL SECTORS OF SOCIETY, FROM K-GREY. WE USE AN INNOVATIVE COMBINATION OF FORMAL AND INFORMAL EDUCATIONAL PROGRAMS TO INSPIRE LIFE-LONG PASSION FOR SCIENCE AND THE ECOSYSTEMS THAT SUPPORT COMMUNITIES.

WE INTERACT WITH ALL SECTORS OF SOCIETY TO BROADEN THEIR UNDERSTANDING OF HOW WE AFFECT AND ARE IMPACTED BY THE ENVIRONMENT AROUND US. THROUGH OUR EFFORTS, WE HELP STUDENTS OF ALL AGES DEVELOP THE SKILLS TO SUCCEED IN THE 21ST CENTURY, INCLUDING COMMUNICATION, TEAMWORK, PROBLEM SOLVING AND CRITICAL THINKING.

K-12 EDUCATION

DISCOVERY ROOM: In our Discovery Room programs, educators guided Cordova's 3rd-6th grade classrooms through theme-based curricula that use local ecosystems as a natural learning laboratory. There were 97 student participants in FY13. Using scientific instruments, students learn to observe, record and interpret data, and present what they have learned. Across all grade levels, students learn about the scientific process, data management, develop observation skills, engage in peer-to-peer teaching, and contribute to long term data sets.

Third graders monitored weather conditions and video teleconferenced with 3rd graders collecting similar measurements in Kenny Lake. This provided an opportunity for comparing conditions between communities in the upper

and lower Copper River watershed. Wild salmon drive our economy and ecology, so fourth graders focused on salmon ecology and biology. With partners, we provided a salmon-rearing tank for the Cordova elementary school. Caring for salmon as they develop from egg to alevin to fry, culminating in a release event in the wild, deepens the students' understanding of the relationship between the environment and healthy salmon. Fifth grade students collected and learned the value of long-term datasets, measuring temperature, pH, dissolved oxygen, salinity, turbidity and more as part of our citizen science monitoring network. They study the potential impacts of climate change and ocean acidification on ocean ecosystems, culminating in the use of microscopes to observe and correlate herring scale growth rates to ocean temperature data. Sixth grade students designed, built, and tested remotely operated vehicles (ROVs) in a mock oil spill cleanup exercise after learning about Arctic ecosystems, technology used to study the ocean, and effects of oil spills on fragile marine environments.

DISCOVERY OUTREACH: Our educators traveled to remote locations to teach environmental science education; this year, 70 students from Kodiak, Valdez and Chenega Bay participated in our Discovery Outreach learning programs.

NATIONAL OCEAN SCIENCES BOWL (NOSB): Educators coached two Cordova High School teams (11 students) in 48 practice sessions with seven sessions led by guest scientists. Our teams finished 4th and 21st overall at the regional competition.

ROV OIL SPILL CHALLENGE: Our educators brought our ROV design/build/test program to the 2013 NOSB Tsunami Bowl competition in Seward as an enrichment opportunity for the participants. 140 students and teachers from 18 high schools formed teams and designed, built and tested ROVs to respond to a mock oil spill.

POST-SECONDARY

INTERNSHIP: This year we offered our Science Education Assistant internship, an 11-month career development experience in environmental education for a



PHOTO: COPPER RIVER WATERSHED PROJECT

young professional, in partnership with the Southeast Alaska Guidance Association (SAGA) and AmeriCorps.

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 ecosystem and sustainability issues. In FY13, visiting students from Warren Wilson College helped build a new cabin at our camp while they used our region as a natural learning laboratory. Members from the national Sierra Club organization were given “campfire” lectures during their stay at our campground. The US Forest Service and Alaska Department of Transportation used our facilities to stage field crews conducting summer restoration work in the bioregion.

SUMMER PROGRAMS

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 10 high school student leaders (five each from coastal and

upriver Copper River communities) as they studied the ecosystems of the Copper River watershed by raft, boat and vehicle. Alaskan writer and storyteller Jack Dalton led this year’s students in “Writing through the Watershed” and helped them develop portable information displays about the region’s ecology. Students also helped build a new cabin at our campground.

THEME-BASED CAMPS: Through adventure, leadership and science-based day camps such as “Inquisitive Minds” and “Scientists in Motion,” we guided 73 summer campers through enriching activities including invasive plant eradication, visits to glaciers, ecosystem hikes, making muffins from local berries, and overnight campouts at the Science Center campground.

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 25 Cordova 4H music camp students about the water cycle through hands-on activities.

ENGAGEMENT

OUR ROLE AS A COMMUNITY-BASED NONPROFIT ORGANIZATION IS TO CONNECT SCIENCE TO SOCIAL AND ECONOMIC NEEDS THROUGH EDUCATION AND ENGAGEMENT. OUR APPROACH BENEFITS SCIENTISTS AND NON-SCIENTISTS ALIKE, AND IT IS OUR INTENTION THAT THE VAST MAJORITY OF OUR WORK IS SIGNIFICANT TO REGIONAL ENTITIES AND DECISION-MAKERS. IN ADDITION TO OUR KEY PARTNERSHIPS, WE ALSO PLAY THE ROLE OF REGIONAL CONVENER, USING WORKSHOPS, WEB PORTALS AND OTHER MEANS TO PROMOTE COMMUNICATION BETWEEN LOCAL AND REGIONAL RESEARCHERS, RESIDENTS AND RESOURCE MANAGERS.

OUTREACH

DELTA SOUND CONNECTIONS: Our annual full-color science news magazine highlights the research being conducted in the region. Our 2013 theme on the economics of a bioregion explored the connections between our ecosystems and communities. Thirty-four contributors provided insight into their research and outreach. We printed 20,000 copies for free distribution.

LECTURE SERIES: Our science lecture series directly connects citizens to scientists. In 2013, over 600 community members attended 32 lectures by Science Center staff and visiting scientists and experts. Topics as diverse as Climate Change on the Copper River, Biofuels in Alaska, and Marine Mammals of Prince William Sound were delivered to local audiences, broadcast live to Valdez, and posted on our website, YouTube station and our local GCI channel.

FIELD NOTES: These 3 to 5 minute long science radio programs air on local NPR affiliate KCHU with a listening base of 10,000. Field Notes programs keep communities informed about the ecosystems around them.

PROJECT PROFILES: These easy-to-understand descriptions of ongoing and recent research by our scientists and partners describe why we are conducting particular research projects and what we are learning from them. Available in-house and online, they are an easy way to learn more about our body of research.

THE BREAKWATER: Our newsletter is published seasonally online and circulated to hundreds of subscribers.

JOURNAL PUBLICATIONS: In addition to the items listed above, our scientists are continually publishing their research findings in peer-reviewed journals. See p. 16.

EVENTS

COPPER RIVER NOUVEAU: On June 15, 2013, we celebrated our 14th annual benefit dinner at the historic Orca Adventure Lodge. At Nouveau, the attention of all attendees is focused on the research and education that embodies the Science Center's mission. Leaders from commercial fishing, seafood processing, oil and gas, mining, transportation, the food and beverage industry, academia and beyond shared an afternoon and evening recognizing leaders in sustainable fisheries and raising money for the Science Center. A cadre of local volunteers makes the annual fundraising event a success — soliciting auction contributions, serving as wait staff, providing entertainment and more. Generous contributions by artists, craftsmen, merchants and Alaskan leaders enabled the success of both silent and live fundraising auctions. Our 2013 dinner and auction was our greatest success to date with revenues exceeding \$100,000 and expanding our previous year's Nouveau revenues by nearly 40 percent.



PHOTO: MILO BURCHAM

FISHERIES ACHIEVEMENT AWARD: This year we acknowledged Bill Bailey, co-founder and managing partner of Copper River Seafoods, for his significant contributions to advancing the quality and marketability of Copper River and Prince William Sound salmon. Senator Lisa Murkowski, who has served as honorary host for Copper River Nouveau since 2003, presented the award at our community dockside reception during day-long Nouveau activities. Chef Laura Cole of 229 Parks later presented a 5-course gourmet meal highlighting wild Copper River king and sockeye salmon to the sold-out crowd.

NOUVEAU SOUTH: On May 21, 2013 we hosted Copper River Nouveau: South at Ponti Seafood Grill in Seattle. Our co-hosts for the event were Sue Coliton, Vice President, Paul G. Allen Family Foundation, and Anne Kroeker and Richard Leeds of the Educational Legacy Fund. CEO Katrina Hoffman made a brief media presentation on our mission and ongoing research. Through increased familiarity and communication between PWSSC and potential partners, supporters and sponsors, we began to formulate strategies on how we might collaborate with Pacific Northwest partners on research, monitoring, data management and synthesis from Puget Sound to Prince William Sound and beyond. Among the 45 attendees were guests from the University of Washington, the Bering Sea Crabbers Association, Washington Sea Grant, the Pacific Science Center, the Marine Stewardship Council, Pacific Fishing Magazine, Vulcan, Audubon and many more. Although not intended as a fundraiser, new members and sponsors generated nearly \$3,000 in support.

COPPER RIVER DELTA SHOREBIRD FESTIVAL: Forty-four students and their teachers learned about shorebirds and wetlands ecology from our educators. They joined our research biologists in the field as they captured and removed sandpipers from a mist net, measured and recorded data, and banded birds prior to release. Kids took sample mud cores to explore the invertebrate food sources for shorebirds in the rich tidal flats of Hartney Bay.

OCEAN SCIENCE FESTIVALS: Valdez (2013) and Cordova (2012): Our festivals, made possible through many partnerships, highlight the research and education being conducted in the region. In Valdez, about 250 youth and adults attended the Ocean Science Festival, where they engaged with the technology used to gather data, including underwater robots, balloons that use remotely operated cameras to look for spilled oil, and transmitters used to track marine mammals and fish.

COPPER RIVER WILD! SALMON FESTIVAL: Each year our community celebrates our sustainable salmon fisheries with food, music, games and learning programs. Over 600 visitors attended, with 150 children and adults participating in the “Small Fry” learning activities coordinated by our educators.

EARTH DAY HARBOR CLEAN-UP: Our AmeriCorps education intern organized a harbor clean up and recruited 45 people who collected 50 bags of trash from the Cordova Harbor.

PUBLICATIONS

HERE ARE OUR REPORTS AND PAPERS
PUBLISHED IN PROFESSIONAL
JOURNALS, AND PRESENTATIONS /
POSTERS DELIVERED IN FY13.

STAFF PUBLICATIONS

Mackas D, Galbraith M, Faust D, Masson D, Young K, Shaw W, Romaine S, Trudel M, Dower J, **Campbell R**, Sastri A, Bornhold Pechter EA, Pakhomov E, El-Sabaawi R (2013) Zooplankton time series from the Strait of Georgia: Results from year-round sampling at deep water locations, 1990-2010. *Prog Oceanogr* 115:129-159. <http://dx.doi.org/10.1016/j.pcean.2013.05.019>

Quigg A, Nunnally CC, McInnes AS, **Gay S**, Rowe GT, Delapenna TM, Davis RW (2013) Hydrographic and biological controls in two subarctic fjords: an environmental case study of how climate change could impact phytoplankton communities. *Mar Ecol Prog Ser* 480:21-37. <http://dx.doi.org/10.3354/meps10225>

Musgrave DL, **Halverson MJ**, Pegau WS (2013) Seasonal Surface Circulation, Temperature, and Salinity in Prince William Sound, Alaska, *Cont Shelf Res* 53:20-29. <http://dx.doi.org/10.1016/j.csr.2012.12.001>

Halverson MJ, Ohlmann JC, Johnson MA, Pegau WS (2013) Disruption of a cyclonic eddy circulation by wind stress in Prince William Sound, Alaska, *Cont. Shelf Res.*, 63: S13-S25. <http://dx.doi.org/10.1016/j.csr.2011.12.002>

Kline TC Jr. (2013) Mesoscale eddies as a climate-linked mechanism for driving inter-annual variability in ocean survival of pink salmon, *N. Pac. Anadr. Fish Comm. Tech. Rep. No.* 9:205-208

McKinstry CAE, Westgate AJ, Koopman AN (2013) Annual variation in the nutritional value of Stage V *Calanus finmarchicus*: implications for right whales and other copepod predators. *Endang Species Res* 20:195-204. <http://dx.doi.org/10.3354/esr00497>

PRESENTATIONS AND POSTERS

Bishop, MA, Suzuki Y, Roby D. Caspian Terns breeding on the Copper River Delta: more to come? 15th Alaska Bird Conference, Anchorage, AK, October 2012. Alaska Marine Science Symposium, Anchorage, AK, 2013.

Bishop MA, **McKinzie M**, Eiler J, Reynolds B, Powers S. Using acoustic telemetry to monitor Pacific herring during spring spawning. Alaska Marine Science Symposium, Anchorage, AK, 2013.

Hsu B, **Bishop MA**, Kuletz KJ, Thorne R. Linking hydroacoustic surveys for juvenile herring with winter seabird distribution in Prince William Sound. 15th Alaska Bird Conference, Anchorage, AK, October 2012.

Campbell R. State of the Sound: Trends in the oceanography of Prince William Sound. Alaska Marine Science Symposium, Anchorage, AK, 2013.



PHOTO: MILO BURCHAM

Gay S. Temporal variation in the physical properties of four fjords in Prince William Sound, Alaska used as nursery habitat by juvenile Pacific herring (*Clupea pallasii*). Alaska Marine Science Symposium, Anchorage, AK, 2013.

Halverson M. Atmospheric and tidal exchange between Prince William Sound and the Gulf of Alaska. Gordon Research Seminar on Coastal Ocean Circulation: Biddeford, ME, 2013.

Kline TC Jr. High-latitude pelagic food web shifts inferred from stable isotope analysis at seasonal, inter-annual, and inter-decadal time scales. ASLO Aquatic Sciences Meeting, New Orleans, LA, 2013.

Kline TC Jr. A comparative ecology approach to predicting how salmonid fishes will respond to climate change in Arctic Alaska. 28th Wakefield Symposium, Responses of Arctic Marine Ecosystems to Climate Change, Anchorage, AK, 2013.

Kline TC Jr. Mesoscale eddies as a climate-linked mechanism for driving inter-annual variability in ocean survival of pink salmon. North Pacific Anadromous Fish Commission Third International Workshop on Migration and Survival Mechanisms of Juvenile Salmon and Steelhead in Ocean Ecosystems, Honolulu, HI, 2013.

Pegau WS. Herring research team, Prince William Sound Herring Survey Program Results. Alaska Marine Science Symposium, Anchorage, AK, 2013.

Pegau WS. Connecting herring research and spill response, Alaska Forum on the Environment, Anchorage, AK, 2013.

Pegau WS. OSRI sponsored research for Arctic spill response, Alaska Forum on the Environment, Anchorage, AK, 2013.



FINANCIAL SUMMARY

REVENUES

	2012	2013
● Members/Sponsors/Special Events	149,643	147,864
● Investment & Other Income	225,886	101,729
● Corporations/Foundations/Non-Profits	280,266	81,282
● OSRI Grants & Contracts	657,754	673,106
● EVOS Grants & Contracts	2,223,527	2,602,381
● Federal Grants & Contracts	760,910	523,610
● State Grants & Contracts	155,738	1,031,754
● Other Grants & Contracts (Private/University)	22,770	53,372

TOTAL REVENUE

4,476,494

5,215,098

EXPENSES

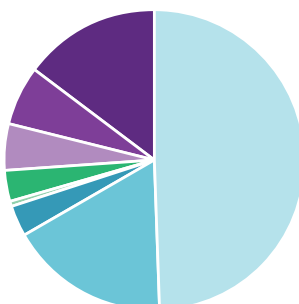
	2012	2013
● Administration & Operations	993,966	1,003,922
● Education (Private/OSRI/Federal)	140,870	130,345
● OSRI Grants & Contracts	620,638	479,576
● EVOS Grants & Contracts	1,469,453	2,131,685
● Federal Grants & Contracts	592,263	456,994
● State Grants & Contracts	120,912	916,861
● Other Grants & Contracts (Private/University)	40,107	59,052

TOTAL EXPENSES

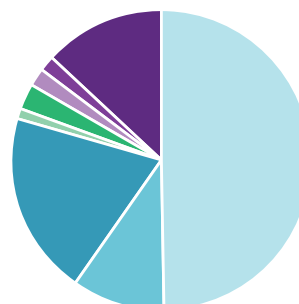
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5,178,435

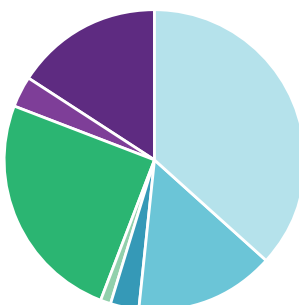
2012 REVENUES



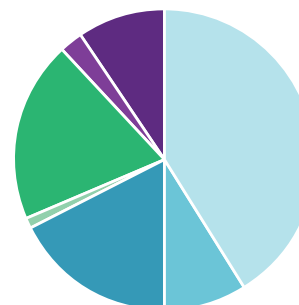
2013 REVENUES



2012 EXPENSES



2013 EXPENSES



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\$1,000,000+

Alaska Department of Fish & Game

\$300,000+

NASA

\$60,000+

Alaska Ocean Observing System

\$50,000+

ConocoPhillips Alaska
US Office of Naval Research

\$30,000+

Dalhousie University
National Fish and Wildlife Foundation

\$20,000+

Copper River Watershed Project
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Harborside Pizza
Herring Research and Monitoring

\$1,000+

Alaska Conservation Foundation
Alaska Ocean Observing System
American Seafoods Company
Gulf Watch Alaska

\$500+

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