



2010

DELTA SOUND CONNECTIONS

Natural history and science news from Prince William Sound and the Copper River Delta

Glaciers and rainforest form our backyard

An introduction to the region

Nancy Bird,
PWS Science Center

Welcome to the Prince William Sound and Copper River Delta region! The intricately indented coastline of the Sound is separated from the Gulf of Alaska by a ring of mountainous islands and is the northern boundary of the coastal temperate rainforest. Its scenic character owes much to the glacial sculpting of the land during the Ice Ages.

Today, over 20 glaciers terminate at sea level while numerous others cling to steep mountainsides at the heads of rocky fjords. Secluded coves, beaches and rocky tree-covered islands offer countless opportunities for exploration and discovery in the Sound.

The adjacent Copper River Delta is a 300-square mile band of grassy marshlands and tidal flats, the largest contiguous wetland on the Pacific Coast of North America. The Copper River itself is almost 290 miles long and is known for its enormous sediment

discharge rate, estimated at 61,000 cubic ft/sec, that drives production in the Gulf of Alaska. Depositing over 75 million tons of silt annually, the river has built a layer of silt over 600 feet deep over the past 800,000 years.

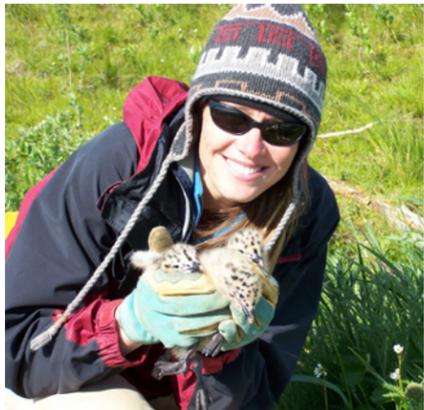
The Delta's vast wetlands provide rich bird habitat, making it the largest site in the Western Hemisphere Shorebird Reserve system. Two hundred and thirty-five species of birds have been identified and annually over 16 million migrating shorebirds and waterfowl stop here.

Hundreds of streams and intertidal waters support a large commercial salmon fishery. Ranked 12th in the U.S., the fishing port of Cordova annually catches an excess of 100 million pounds of fish, with an ex-vessel value exceeding \$50 million.

This area is among the most seismically active regions on Earth. The world's second largest recorded earthquake, at 9.2 Richter scale, was centered near Columbia Glacier in 1964. Some areas on the Delta rose as much as 10 feet while places in the southwestern Sound shifted as much as 35 feet.

The Chugachmiut and Eyak peoples lived here long before the arrival of the first Europeans in the mid-1700s. By 1800, Russia dominated the region in the trade of sea otter pelts. In the years that followed, the region's economic and social development varied. Trapping, gold and copper mining, fox farming, logging and fishing have each

Left: River Gates holds Glaucous-winged gull chicks in a field study conducted by the Prince William Sound Science Center. Photo by PWSSC.



A humpback whale feeding on herring takes these boaters by surprise. Photo by L. Butters.

played a role. Today, the Port of Valdez is the terminus of the Trans Alaska oil pipeline and transports about 15% of the total U.S. domestic oil production. On average, two supertankers per week transit the Sound's waters fully laden with North Slope crude oil. Visitors also support a significant part of our local economies.

Thanks for coming to explore and enjoy our region! It is truly one of the world's great places.

Welcome to our home!

We're glad you've picked up this second edition of Delta Sound Connections, an annual newspaper to inform you about the Prince William Sound and Copper River Delta regions. For more than 20 years, Prince William Sound Science Center (PWSSC) researchers have investigated questions about the biology, general ecology, and oceanography of these incredibly rich ecosystems.

Articles within this paper will introduce you to the region and also the myriad of research and education programs being conducted by PWSSC and other organizations, universities and agencies. We thank the many authors who generously contributed to this publication.

We also thank our business and other sponsors (Please take a moment to look at their names on the back page). It's their support which makes this publication possible.

Please let us know what you think about this paper! We welcome your membership in PWSSC and/or sponsorship of future publications. You can contact us at deltasound@pwssc.org.

Thank you for taking the time to learn more about this very special part of the world. Enjoy your travels!

Nancy Bird, *President*
PWS Science Center

Herring recovery spurs research

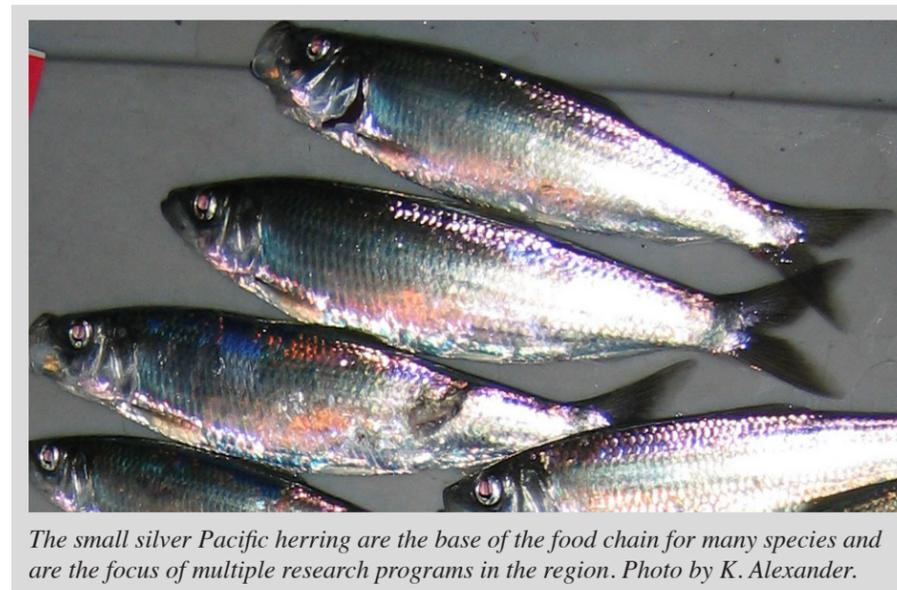
Lack of herring recovery spurs major research program

Dr. Scott Pegau,
PWS Science Center

In the decades prior to 1990 there was a robust Pacific herring population in Prince William Sound. Not only are these forage fish a key link in the complex food web of Prince William Sound, but they supported a lucrative early season commercial fishery that brought the communities of the Sound to life each spring. By 1993, that fishery was closed and only briefly reopened for two years. The current herring population of approximately 20,000 tonnes is tiny compared to the peak value of 150,000 tonnes or the long-term average of around 65,000 tonnes.

The cause of this dramatic decline in this fishery is still hotly debated. Was it the 1989 Exxon Valdez Oil Spill, disease, climate change, predation, natural cycles, or some combination of these factors? While the question of the reason for the decline remains debated, it is more important to understand what is preventing the herring population from recovering.

Today, researchers from multiple institutions and disciplines are working



The small silver Pacific herring are the base of the food chain for many species and are the focus of multiple research programs in the region. Photo by K. Alexander.

to determine why herring populations remain depressed. With funds from the Exxon Valdez Oil Spill Trustee Council, which oversees funds from a settlement between State/Federal government and Exxon, a group of 10 projects make up a comprehensive research program designed to better understand factors limiting herring recovery, in particular those affecting juvenile herring including; oceanographic conditions, availability

of food, disease, overwinter changes in energy content, and predation pressure.

The purpose of this multi-faceted study is to identify juvenile rearing bays; measure factors that limit juvenile herring growth and recruitment; and ultimately provide recommendations for future herring restoration and monitoring efforts in the region.

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Herring roe sticks to kelp and other surfaces in shallow, nearshore habitat around Prince William Sound. Photo by K. Alexander.

Pacific herring 101

Pacific herring (*Clupea pallasii*) have a blue-green upper body with silvery sides and are key forage fish in the Pacific marine foodweb.



Gathering herring roe on kelp has been a traditional subsistence practice in the Sound for generations. This photo shows someone gathering herring roe on kelp along the shore near Tatitlek. Photo by Glenora Zimmer, NVE.

Herring may grow up to 18 inches in length, but generally a 9-inch specimen is considered large.

Herring spawn each spring in shallow, vegetated areas along the coastline. Eggs attach to intertidal vegetation or fall to the bottom, while milt released by males drifts among the eggs. After 2-3 weeks eggs will hatch, releasing billions of larval herring to float freely throughout the water column.

In PWS, adult Pacific herring rarely spawn before their third year and their average life span is nine years. After spawning, most adults leave nearshore waters to feed on zooplankton in open water. They are seasonal feeders and accumulate fat reserves for periods of inactivity. Herring schools often follow a diel vertical migration pattern, where they spend daylight hours in deeper waters near the bottom, and migrate upward during the nighttime to feed.

Bird's eye view of nearshore habitat

ShoreZone provides a bird's eye inventory of the Sound's nearshore habitat Staff, NOAA Alaska Regional Office

The land-sea interface is a crucial realm for terrestrial and marine organisms, human activities, and dynamic processes. ShoreZone is a mapping and classification system that specializes in the collection and interpretation of aerial imagery of the coastal environment. Its objective is to produce an integrated, searchable inventory of geomorphic and biological features of the intertidal and nearshore zones which can be used as a tool for science, education, management, and environmental hazard planning and response.

ShoreZone attributes can be combined to predict habitat potential for species in areas that are not known or mapped. One example, developed by Harney *et al.* in 2009, examined the ShoreZone attributes associated with favorable herring spawning sites. Sites where

herring spawn almost every year were examined in terms of ShoreZone attributes (data provided by Alaska Department of Fish & Game) and showed that herring preferred spawning sites with sand and gravel flats or beaches.

The association of biobands with spawning sites was also examined and indicated a preference for sites with eelgrass. These attributes can then be used to predict locations within PWS that are likely to have a higher spawning potential. This model omits other important criteria for spawning, such as water quality parameters, but does provide a better understanding for biophysical characteristics of the nearshore environment preferred by herring and can inform future monitoring efforts. The results indicate that herring spawn is not habitat limited, instead, other factors are controlling the distribution of herring spawn in PWS.



Herring spawn and a herring ball in a small bay off of Port Etches on Hinchinbrook Island, Prince William Sound. Photo by Allen Marquette. More information, protocols and reports are available online at www.fakr.noaa.gov/maps/szintro.htm.

Herring populations remain depressed

Trends in adult and juvenile herring distribution and abundance in the Sound

Dr. Richard Thorne,
PWS Science Center

Adult and juvenile herring abundance and habitat utilization have been the focus of a three-year investigation by researchers at the Prince William Sound Science Center. Herring are a critical part of the food chain and their population has substantially declined since the early 1990's, just three years after the 1989 oil spill.

The goals of the Science Center's project, supported by the Exxon Valdez Oil Spill Trustee Council, were to continue a long-term database on the adult abundance and to better understand the factors that govern juvenile herring survival, particularly during their initial year when they

are most vulnerable. Hydro-acoustic instruments were used to determine fish abundance. These sophisticated tools are a scientific version of the sonar and depth sounders that commercial fishermen use to find fish. The Science Center has conducted the adult monitoring surveys every year since 1993. The spring 2009 survey produced an adult herring biomass estimate of 20,400 metric tons.

Our primary objective in the juvenile herring survey was to determine the distributional characteristics of first year herring, called "age-0". Our study design focused on pre- and post-winter sampling to investigate over-winter mortality. Our study complemented others that looked at the

young herring's health condition over the winter. We compared several areas throughout Prince William Sound. We found that the age-0 herring were typically located near the heads of bays in relatively shallow water and could often be identified from their hydro-acoustic characteristics, called "echo signature".

Greater abundances of age-0 herring were found in Whale Bay, Simpson Bay and Eaglek Bay. Whale Bay showed the smallest decrease in numbers over the winter, Simpson Bay the greatest. Whale Bay also had the smallest abundance of other fishes, which might be a key to the higher apparent over-winter survival at this location.



A hydro-acoustic system is deployed from the charter vessel Auklet. Photo courtesy of PWSSC.

For more information, contact Dr. Richard Thorne at rthorne@pwssc.org.

Sediments and freshwater impact plants and fish

Following Alaska's Coastal Current from British Columbia to the Aleutian Islands

Dr. Rob Campbell,
PWS Science Center

The oceanography of PWS is extremely dynamic: strong winds drive surface currents, large tidal currents rise and ebb twice daily, and water from the considerable rain and snowfalls enters from countless streams and rivers. The massive amount of water entering the margin of the Gulf of Alaska from the surrounding mountain ranges actually creates its own surface current: the Alaska Coastal Current, a current that begins in northern British Columbia and travels all along the coast of Alaska to the Aleutians.

The Copper River is the largest single source of fresh water to the Gulf of Alaska, and its waters travel along the coast and into PWS. Suspended in Copper River water is a large amount of sediment from the upper watershed, which includes several large ice sheets.

Numerous glaciers also discharge directly into PWS, and that water is also loaded with a large amount of suspended glacial flour (essentially "rock dust" from the grinding action of

the glaciers). Those suspended particles are extremely small, and though they are more dense than water, they sink very slowly and tend to stay in surface waters.

Suspended particles are potentially very important to the functioning of the ecosystem within PWS and the coastal Gulf of Alaska. Just like in a dust storm, particles suspended in the water absorb and scatter light, which can limit the light available to the aquatic plants that are found in surface waters.

Recent work by PWSSC researcher Shelton Gay has suggested that parts of the PWS with more suspended sediment support less plant growth, which in turn can affect organisms up the food chain, from feeder fish like Pacific herring up to predatory fish, sea birds and marine mammals.

More comprehensive studies are planned in the next few years to examine that effect more closely. Glacial flour also contains nutrients, particularly iron, which is the limiting nutrient in the offshore Gulf of Alaska.



A view of Prince William Sound from space. The light blue color in the water is glacial silt. Photo courtesy of NASA.

PWSSC researcher Dr. Rob Campbell has recently begun a project with geochemists from USGS to examine the role of iron inputs from the Copper River to marine ecosystem in the Gulf

of Alaska; cruises will begin in the 2010 field season.

For more information contact Dr. Rob Campbell, rcampbell@pwssc.org.

Ocean acidification

Herring, climate change and ocean acidification - problem or hype?

Jeep Rice,
NOAA/Auke Bay Lab

Herring have a lot to worry about - daily avoidance of predators being at the top of their list - but what about long term concerns from climate change and ocean acidification? Nothing stays the same, including climate change, a problem for all species on the planet, and, man's activities in the last century cause concern for what the future holds, for us and for herring.

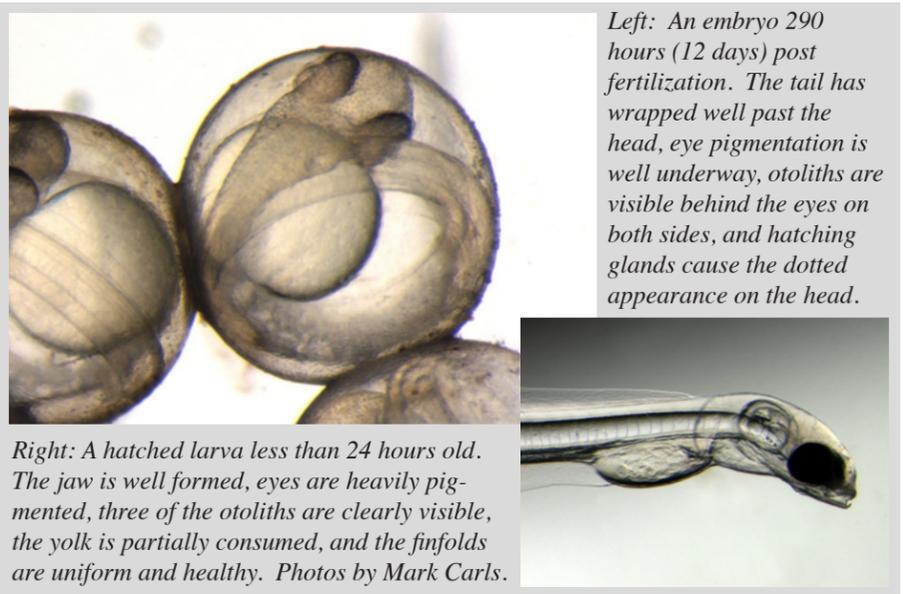
The slow creep of warming temperatures will not likely be a direct problem for herring, as the changes are well within the temperatures they encounter during the seasonal change from winter to summer each year, or in their range (herring exist as far south as California). However, if increases in carbon dioxide (the chief cause of warming via the "green house effect") continue, CO₂ will also dissolve in sea

water and will cause it to be more acidic than it is now. Changes will be slow over time, but may be faster than many species can adapt to.

The early life stages are probably the most sensitive life stage, and researchers Mark Carls and Fletcher Sewall (Auke Bay Laboratory) have been exposing herring embryos to different acidic levels of sea water. Embryos were vulnerable to acidic sea water, as shown by increased mortality and reduced growth.

Dose levels causing mortality are not expected in the near future; levels causing reduced growth (critical for survival) may occur by 2200 according to some projections. At this time, it is difficult to predict the changes that will likely happen in the ecosystem.

Some species will be winners, others will be losers, and those with the longest reproductive cycles may be less able to adapt.



Left: An embryo 290 hours (12 days) post fertilization. The tail has wrapped well past the head, eye pigmentation is well underway, otoliths are visible behind the eyes on both sides, and hatching glands cause the dotted appearance on the head.

Right: A hatched larva less than 24 hours old. The jaw is well formed, eyes are heavily pigmented, three of the otoliths are clearly visible, the yolk is partially consumed, and the finfolds are uniform and healthy. Photos by Mark Carls.

Herring decline carved in wood



Photo by Robert Cornellier.

Eyak Carver, Mike Webber, created this Shame Pole. A shame totem, used for public ridicule, is erected to shame another party for an unpaid debt. Webber's pole represented the unpaid debt that courts determined Exxon owed for the 1989 Exxon Valdez Oil Spill. The final appeals process was completed in late 2009 and Exxon was required to pay plaintiffs less than 10 percent of the original award.

"The Prince William Sound herring fishery crashed from a disease outbreak in 1993, the year that young herring from 1989 should have become adults. The population was further weakened by disease and the fishery has been closed indefinitely since 1998. For Cordova's people and economy and the wildlife of the Sound, the loss has created lasting and profound hardships."

- Excerpt taken from exhibit, on display at Cordova's Ilnaka Cultural Center.

Scientists collaborate to create one stop shopping for herring data

The Alaska Department of Fish & Game, with support from the Exxon Valdez Trustee Council, has developed the Prince William Sound Herring Data Portal.

The purpose of this portal is to consolidate and document scientific resources regarding herring in Prince William Sound and provide a gateway for scientists and the public

to access, interpret and visualize these resources.

Above is a screenshot of the portal, which can be accessed at: <http://www.pwsherringportal.org/>.

For more information, contact Steve Moffitt at ADF&G (steve.moffitt@alaska.gov) or Rob Bochenek of Axiom Consulting & Design (rob@axiomalaska.com).

Disease limits recovery

Infections and parasites limit Prince William Sound herring recovery

Paul Hershberger,
US Geological Survey

Infectious and parasitic diseases are suspected of limiting the recovery of Pacific herring in Prince William Sound, as diseases have been associated with massive fish kills in herring and other forage fish. Paul Hershberger (USGS - Marrowstone Marine Field Station) is leading a team of researchers to explore the prevalence and intensity of diseases in PWS herring as part of the larger juvenile herring study.

One disease of focus, viral hemorrhagic septicemia, or VHS, is extremely harmful to herring, often causing mortality several days after exposure to the causative virus. Herring undergoing active VHS disease are often lethargic and demonstrate external hemorrhages around the eyes, mouth, and fins. Upon

first exposure to the virus, herring are highly susceptible to VHS; however the fraction of individuals that survive the disease develop long-term resistance to subsequent disease outbreaks.

Parasites are also of concern. *Ichthyophonus* is a protist, or single-celled organism that has caused recurring massive disease outbreaks in Atlantic herring populations and currently occurs in high prevalence among Pacific herring. *Ichthyophonus* can kill herring directly (often causing 85% mortality within 4 weeks post-exposure) or cause chronic infections that result in fish with decreased condition, decreased swimming performance, and decreased ability to avoid capture by predators. It has also been shown that prevalence of the parasite increases with age of Pacific herring. Through field studies,

researchers hope to better understand the prevalence of disease and infections in PWS herring, as well as in Sitka and Puget Sound. Lab studies will shed light on the relationships between the host, pathogens and environmental conditions. For example, can pre-exposure to VHS help anticipate future disease outbreaks? Does change in water temperature change the virulence, or harmfulness, of the pathogens?

Findings for this project will help test current disease forecasting tools as well as develop other tools that can help resource managers predict the timing of disease outbreaks and potentially mitigate the impacts of disease on wild herring populations.

For more information on this topic contact Paul Hershberger at phershberger@usgs.gov.

Filling up to survive

A full tank is the key for herring survival through winter

Dr. Tom Kline,
PWS Science Center

Herring are seasonal feeders and accumulate fat reserves for periods of relative inactivity, including the long Alaskan winters in Prince William Sound. Past and current studies show that herring lose much of their accumulated energy between November and March, and suggest that in order to survive winter, herring need a certain level of energy before winter sets in.

To better understand over-winter survival, Tom Kline of the Prince William Sound Science Center is looking at the energy content of herring and their main food source, zooplankton; the species of zooplankton available as forage; and the role of oceanic zooplankton subsidies versus resident Prince William Sound zooplankton for herring and their competitors.

This component of the multi-faceted juvenile herring project will help improve our understanding of over-winter habitat utilization of age-0 herring. If researchers can determine habitat sites and conditions that reduce overwinter mortality, then this study can help identify sites for future projects to "plant" new herring populations in the Sound. Furthermore, by better understanding the relationship between herring and their food source, resource managers might be better able to predict years when herring could do better or worse based on what food is available.

For more information, contact Dr. Tom Kline at tkline@pwssc.org.



Above Left: A Pacific herring with external signs of *Ichthyophonus* infection, including augmented ulcers on the side. Above Right: External hemorrhages on a herring's head is a symptom of viral hemorrhagic septicemia. Photos by Paul Hershberger.

Pg.1 cont'd: Juvenile herring studies



Herring samples. Courtesy of CDFU.

Continued from Page 1

The purpose of this multi-faceted study is to identify juvenile rearing bays, measure factors that limit juvenile herring growth and recruitment, and ultimately provide recommendations for future herring restoration and monitoring efforts in the region.

Three approaches are being used to identify juvenile rearing bays. Aerial surveys cover the largest geographic area, and researchers document both the distribution and density of herring, spawn and predators. Boat surveys, conducted in partnership with the Cordova District Fishermen United by former commercial herring fishermen, sample a larger number of bays than can be sampled by research vessels. Acoustic surveys round out survey methodologies, allowing researchers to "see" areas not visible by air as well as better understand predatory fish not easily studied on the surface.

To better understand conditions that limit recruitment, or survival of herring to reproductive age, projects are

underway that look at oceanographic conditions, food availability, disease, overwinter energetics, and predation. Stationary moorings and samples taken by research boats will monitor oceanographic conditions such as temperature and salinity, and provide important information about conditions in the Sound to help inform other aspects of this program. Zooplankton, herring's primary food source, will be collected for identification and monitored to determine cycles in availability and differences in spatial concentrations.

Herring samples collected will be analyzed to assess disease and infection prevalence and intensity. Researchers will also be testing disease screening tools and working to identify environmental factors that can be used to forecast disease outbreaks in herring populations. Samples collected in the fall and spring will be compared to assess changes in herring energy levels over winter months. Two studies will explore herring energetics further. One will look at how different food sources affect energy levels in herring while the other will assess how growth rate relates to over-winter survival.

Finally, both bird and fish surveys will be conducted to better understand the role these predators play in limiting herring recovery. Researchers outside of this project are looking at predation pressure from marine mammals, such as sea lions and whales.

At the end of the 3 year study, researchers hope to have a better understanding of important habitat for herring, in particular for juvenile herring. This combined with a better understanding of factors that limit herring growth and recruitment can help with future projects for "planting" new herring populations in the region. Furthermore, researchers will be able to recommend effective survey methodologies and help future herring monitoring efforts be efficient with resources.

For more information, contact Dr. Scott Pegau at wspgou@pwssc.org.



Thomas C. Kline, Jr.

Far Above: Deploying the Multinet plankton sampling device. It has five codends that can be seen dangling in the water. Above: Sampling age-0 herring with a gillnet in Whale Bay. Photos courtesy of PWSSC.

Birds feast on herring spawn

Migrating birds feast on Pacific herring eggs in Prince William Sound

Dr. Mary Ann Bishop,
PWS Science Center

Every April, Prince William Sound comes alive with the noise of thousands of birds feasting on the eggs of Pacific herring. Spawning in the Northeast Sound often begins in late March, and attracts primarily wintering Glaucous-



Kittlitz's murrelets are one of many bird species that feed on herring. Photo by Milo Burcham.

winged Gulls and sea ducks including surf scoters, white-winged scoters, and long-tailed ducks.

Spawning at Montague Island occurs typically between 18 April and 1 May, and it is this spawn that attracts high numbers of migrating Surfbirds and Black Turnstone, two shorebirds associated with rocky shorelines. Both species winter south of Alaska and are transient migrants in spring. Surfbirds breed in alpine habitat throughout the interior of Alaska while Black Turnstones breed in a narrow band of coastal sedge meadows throughout western Alaska.

Interestingly, it was during the damage assessment surveys following the *Exxon Valdez* oil spill when scientists discovered that northern Montague Island was a major spring stopover area for both Surfbirds and Black turnstones.

So why do they stop at Montague Island? The reasons probably have to do with a combination of location and the physical geography of the island. For rocky, intertidal shorebird species, Montague Island is the first area of suitable habitat after several hundred kilometers of sandy beach and mudflat shorelines.

In spring 2010, Dr. Mary Anne Bishop will be leading a study of Black Turnstone and Surfbirds at Montague Island. As this goes to press, more than 40 birds have been radiotagged in Puget Sound and British Columbia. Working from skiffs, the team will determine how long the migrant shorebirds stay at Montague, and where their preferred foraging and resting habitats are.

For more information, contact Dr. Mary Ann Bishop at the PWS Science Center mbishop@pwssc.org.



Herring are critical to the winter food-supply for Steller sea lions and other marine mammals such as the humpback whales pictured below. Both are major predators, but the seasonal patterns differ in that sea lions concentrate on spawning in spring and whales consume herring in both the spring and fall. Photos: above by Dr. Richard Thorne, below by Milo Burcham.



Humpback whales chow on herring

Herring supply whales with energy for their annual trek to Hawaii

John Moran,
NOAA/ Auke Bay Lab

Humpback whales have big mouths which may explain why herring numbers remain so low in Prince William Sound. Humpback whales eat krill, a small shrimp-like invertebrate, and forage fish such as herring and capelin.

Scientists from NOAA, the University of Alaska/Southeast, Eye of the Whale and Chenega Bay have seen whales eating herring in Prince William Sound over the last few years. Herring supply whales with the energy they need for their annual trek to Hawaii. It takes a whale about a month to get there, they stay for another month mating and having young; then they return – all without eating.

Whales are not the only thing that eat herring, but they have the biggest mouths by far, holding as much as 15,000 gallons of water and fish in one big gulp. One big gulp is not that big a deal, but lots of gulps are. John Moran (NOAA) and Jan Straley (University of Alaska) found more than 100 whales feeding on herring in the fall and

winter of 2008-2009 in Prince William Sound. Ron Heintz (ABL) estimates these whales probably ate about as many herring as were caught in past commercial fisheries (which have been closed since 1997).

Humpback whale numbers are increasing about 5% per year right now, which means their population has doubled since the herring population crashed in 1993. Prince William Sound herring have it pretty tough with regards to whales. But the situation is not hopeless; Sitka Sound is a prime example. The presence of whales in Sitka Sound has not diminished herring populations. 2010 was another record harvest there for the herring sac roe fishery, demonstrating that whales, herring, and fisherman can coexist.



Left: A single humpback whale dives down, showing its tail fluke. Right top and bottom: Two humpback whales open wide to catch their meal. Photos by John Moran.



For more information on humpback whales, visit: <http://www.afsc.noaa.gov/ABL/Humpback/> and <http://www.alaskahumpbacks.org/flukeIDcatalog.html>.

Juvenile herring targeted by other fish

Herring survey program examines the effect of predation on PWS juvenile herring.

Brad Reynolds,
PWS Science Center

Twenty-one years have passed since the Exxon Valdez oil spill, and yet the Prince William Sound herring population has not recovered. In late 2009, the Prince William Sound Science Center began a four-year investigation into the potential causes limiting herring recovery.

As one part of this study, researchers are conducting longline and gillnet surveys in bays identified as critical overwintering grounds for juvenile

herring. The goal is to identify herring predators. Juvenile herring are eaten by multiple species of fish, and past research suggests that predators may have a significant impact on the success of juvenile herring populations.

However, studies have not previously examined this predation impact in PWS. During recent research cruises we identified several potential predators including walleye pollock and Pacific Cod, and we preserved the stomach contents from collected fish. Laboratory analysis of these stomach

contents will allow us to identify what the predators are eating which is the first step in modeling the impact of predation on juvenile herring.

The herring predator study is only one of several components in the broader Herring Survey Program which includes monitoring for disease, food resources, oceanographic conditions, and overwintering energetics.

For more information, contact Brad Reynolds at breynolds@pwssc.org.



Crystal Hightower holds a Pacific cod collected during a survey of juvenile herring predators in Eaglek Bay. Photo courtesy of PWSSC.

Monitoring hydrocarbons in the Gulf

Cordova high school students sample sediment for hydrocarbons

Craig Bailer, Jenny Rankin and Jessica Smyke, Cordova High School

The following is an excerpt from a scientific poster created by the students and displayed at the 2010 Alaska Marine Symposium in Anchorage, Alaska.

Baseline data is data that is used to document the current state of an ecosystem and can be for comparison with data collected in the future.



Craig Bailer, Jessica Smyke and Jenny Rankin board the plane after collecting sediment samples from the mouth of the Bering River. These samples were sent to Auke Bay Lab in Juneau, AK in order to be analyzed for hydrocarbon content and to potentially identify the sources of any hydrocarbons found in the samples. Photos courtesy of PWSSC.

Having baseline data of the sediment in the Southcentral Alaska will allow for comparison between what the sediment was like prior to any damage versus what it's like if there was ever to be a catastrophic event.

The Exxon Valdez Oil Spill that occurred March 24, 1989 created appalling damages in Prince William Sound. However, there wasn't baseline data that they could use to find out how much damage really was done. Since this event, organizations like PWS Regional Citizen's Advisory Council are collecting baseline data for PWS.

The Auke Bay lab in Juneau created a hydrocarbon database to maintain a record of hydrocarbon signatures for the region. This database maintains signatures for hydrocarbons from natural seeps or previous spills. A hydrocarbon signature is the ratio of the different types of hydrocarbon molecules found in a sample. Every hydrocarbon deposit has a unique ratio; therefore a hydrocarbon sample can be traced back to its source.

Samples were collected from the Cordova boat harbor and the mouth of the Bering River and consisted of both beach sediment and mussels living in

the area. Sediments will show what hydrocarbons have reached the area and settled out of the water. Mussels, as filter feeders, collect hydrocarbons in their tissue when filtering the water to collect food. They can also show how hydrocarbons are retained by organisms after initial contamination.

We found that the samples with the most hydrocarbons were in the Cordova Boat Harbor. Considering the harbor is constantly being polluted, this was expected. Samples taken by the pilings at the Bering River had some, but not a lot, and the samples taken from the river spit were mostly free of hydrocarbons. Preliminary review suggests the signature found at Chilkat can be linked to the Bering Coal Fields. Modeling weathering of oil on these samples could provide us with a better understanding of the sources of hydrocarbons found in these samples.

This project taught us about the baseline conditions of the Bering River on the eastern edge of the Copper River Delta. We can use the data we collected to compare hydrocarbon signatures from different sources. If there was to be a contamination in the future, the data could be used for differentiating the spilled oil from what was there



Jenny Rankin shows lingering oil from the Exxon Valdez Oil Spill found just under the surface of the beach on Latouche Island in June, 2009.

before. We would like to thank Auke Bay lab for their help, especially Jeep Rice, Mandy Lindeberg and Marie Larsen. This project was made possible by support from the Educational Legacy Fund and the Prince William Sound Science Center.

For more information on this project, please contact Kate Alexander at kate@pwssc.org.

Clam recovery delayed after spill

Clams and their habitat were affected in unexpected ways following oil spill clean up efforts

Dennis Lees, Littoral Ecological & Environmental Services

Clean-up methods used after the 1989 Exxon Valdez Oil Spill have had unintended effects on clams and their beach habitats. Studies between 1989 and 1996 have shown that the high-pressure beach washing used had lasting impacts on clams and on the gravel or cobble beaches they prefer (also called mixed-soft beaches).

The finding on clams was particularly important because hardshell clams are part of the diet of sea otters, humans, and other ecologically important animals in south-central Alaska. In 2002, a follow-up study was conducted to determine the extent of these injuries and gain insight into recovery rates.

This study confirmed that hardshell clam populations were severely injured and that a considerable proportion of the washed mixed-soft beaches in Prince William Sound remained extremely disturbed 13 years after the spill.

As a result, the clams were functionally impaired in terms of their ability to support foraging by humans or damaged nearshore vertebrate predators such as sea otters. Large, long-lived hardshell clams, primarily littleneck and butter clams (*Protothaca staminea* and *Saxidomus gigantea*), remained only one-third as abundant in oiled-and-washed beaches as in oiled-but-unwashed beaches.

In addition, the study suggested that

the rate of recovery was very slow. This study also suggested that a major cause for the delay was that beach washing had disrupted the organization (armoring) of a previously unrecognized type of gravel/cobble or mixed-soft beach. By protecting buried animals from wave action and predators, this armor layer allows rich assemblages of long-lived burrowers to develop in these sediments.

Based on the apparent rate of recovery in these studies and evidence of armoring rates following the 1964 Great Alaska earthquake, it appears that recovery of hardshell clam assemblages to pre-spill status will take at least 50 years on washed beaches in Prince William Sound.



Two littleneck clams, *Protothaca leukoma*. Photo by Dennis Lees. For more information contact Dennis Lees at Dennislees@cox.net.

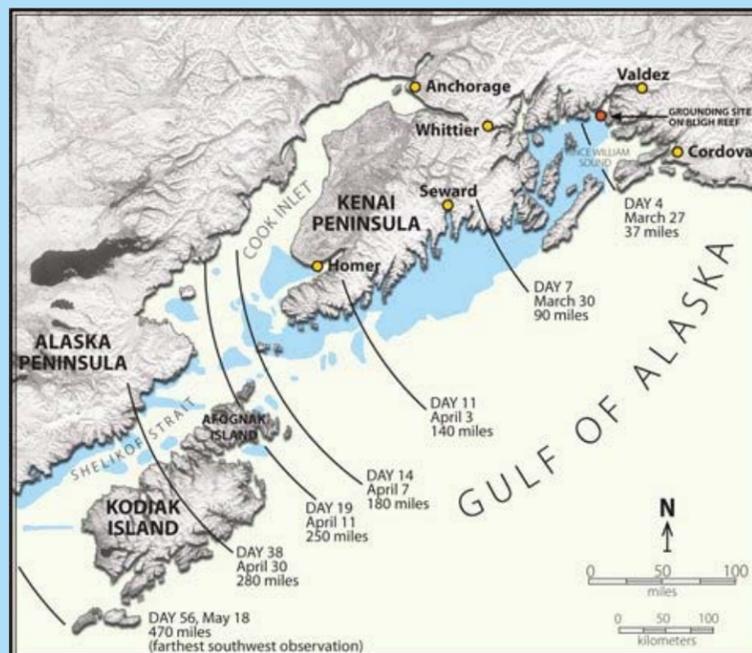
Exxon Valdez Oil Spill

On March 23, 1989, the oil tanker Exxon Valdez left the Valdez Marine Terminal at 9:12 pm, bound for California with a full load - approximately 53 million gallons - of North Slope crude oil. The tanker Captain, Joe Hazelwood, was granted permission to change course to avoid icebergs from nearby Columbia Glacier. He gave orders to the Third Mate to maneuver the tanker to the new course and then retired to his quarters. For reasons that remain unclear, the tanker was never returned to its proper course.

Just after midnight on March 24, the Exxon Valdez oil tanker grounded

on Bligh Reef, spilling at least 11 million gallons of crude oil into Prince William Sound, the largest oil spill in U.S. waters. The initial response to the spill was slow, uncoordinated, and ineffective. Seas and winds were calm for three days, but almost no response equipment was available. On March 27, a storm blew in with winds up to 70 mph, spreading the oil spill to the southwest along at least 1,400 miles of shoreline.

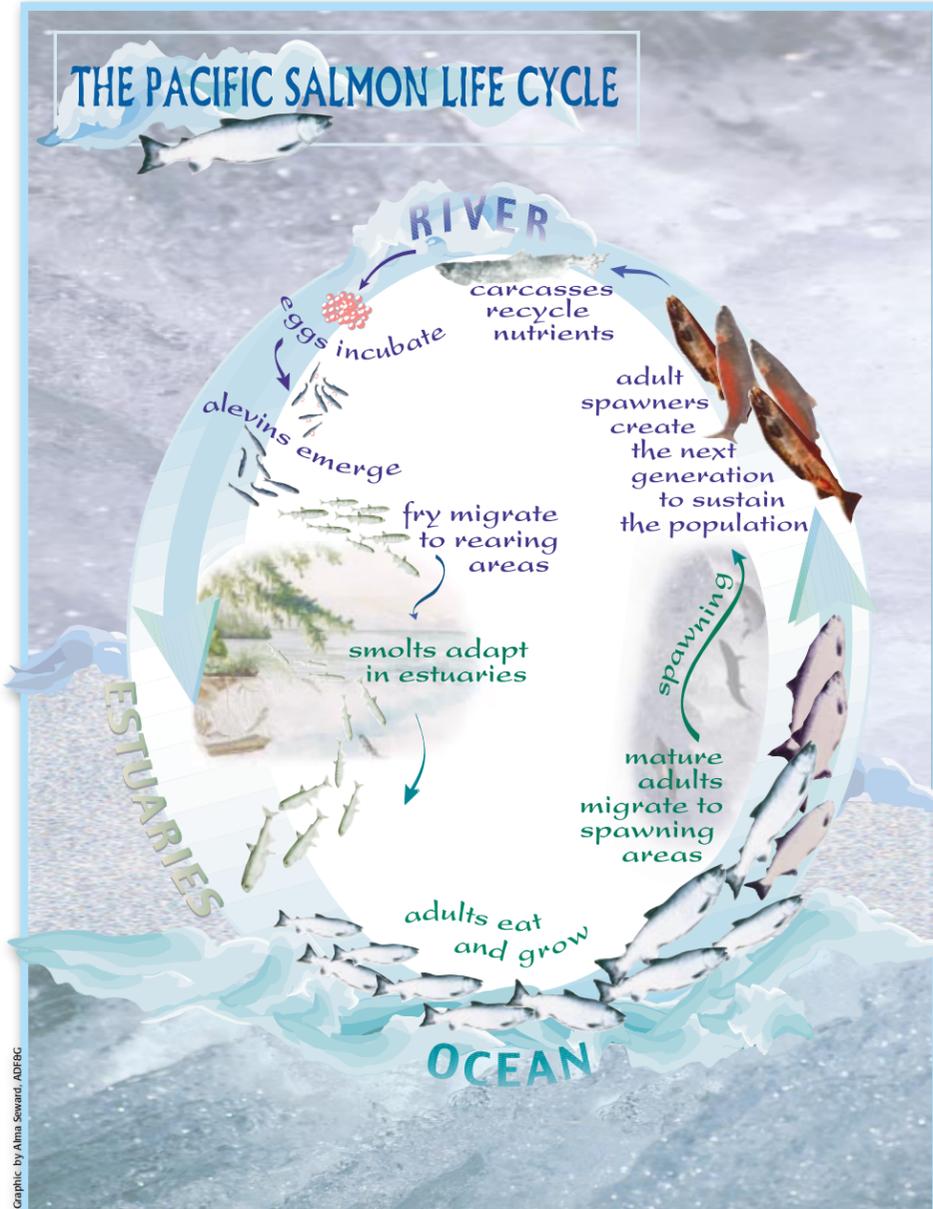
For more information on the immediate and long-term impacts of the spill, as well as links to other oil spill resources, visit www.pwssc.org and click on education and oil spill education.



Oil traveled an estimated 470 miles in 56 days, a distance roughly equivalent to a spill in NY harbor reaching South Carolina. Blue areas illustrate that the oil slick spread over 11,000 sq. miles. Map by ADEC.

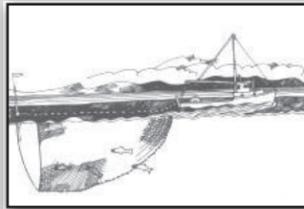
FISHERIES

SUMMER 2010



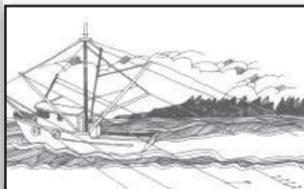
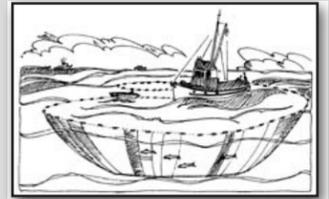
Graphic by Alma Seward, ADF&G

Commercial Fishing Gear & Techniques



GILLNETTING: The greatest number of Alaska Salmon are caught in gillnets. Drift and set gillnetting involves laying a net wall in the water in the path of the fish and waiting for the fish to put its head into the mesh. When it does, the gills become entangled in the webbing and prevent the fish from escaping. Most gillnetters are small one and two-man boats. All five species of salmon are caught in gillnets.

PURSE SEINING: A purse seine is a net which is set in a circle and can be drawn closed at the bottom. Because salmon migrate in tight schools, it is not unusual for an Alaskan seiner to “wrap up” 250 to 1500 fish or more with one set. Pinks and chums are caught by the seine fleet.



TROLLING: Trollers are small fishing vessels operated by one or two people who fish with a number of lines and hooks baited with herring or artificial lures. Coho, king and pink salmon are caught by the troll fleet.

Pictures and information courtesy of www.alaskaseafood.org.

LONGLINING: Longline gear is composed of groundline, buoy lines, and gangions, which are short pieces of line with hooks on the end. Longlines are set along the seabed, with baited hooks every few yards and long-line hooks are retrieved one at a time. Halibut and cod are caught using longlines. Fishermen release other species of fish and return them alive to the sea.

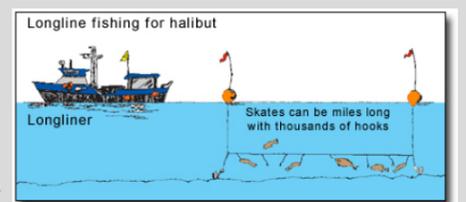


Photo courtesy of www.fishex.com

POTS: Pots are used to catch black cod and Pacific or Lingcod. Pots are large steel-framed cages covered in net mesh. The baited pots are placed on the seafloor where fish enter the traps through tunnels but cannot escape. Later the pots are retrieved and the fish are sorted on deck.

For more information on local salmon research, visit the websites or offices of the Native Village of Eyak (www.eyakfish.com), the Prince William Sound Science Center (www.pwssc.org), Alaska Department of Fish and Game (<http://www.adfg.state.ak.us/>) and the US Forest Service, Cordova Ranger District.

Fisheries enhancement

Dave Reggiani,
PWS Aquaculture Corporation

From its origin, the salmon enhancement program was intended to protect the fisheries from cyclical weaknesses in the wild salmon returns. During the 1970's, salmon runs were in decline throughout the state. In Prince William Sound, seining did not open at all in 1972 and 1974 because the wild returns were so low.

Under the leadership of Governor Egan and Governor Hammond from 1974 to 1982, the State of Alaska began a major effort to restore the State's salmon fisheries. The Department of Fish and Game created the Fisheries Rehabilitation, Enhancement and Development (FRED) Division. Additionally, a constitutional amendment provided the basis for passage of the private, non-profit (PNP) Hatchery Act in 1974.

Prince William Sound's salmon enhancement program has focused on the “ocean ranching” method of aquaculture, where eggs are collected each summer and fall from broodstock developed from local wild stock sources and incubated in the

controlled environment of a hatchery during the Sound's harsh winter months. In the spring, the fry emerge from their incubators and are released into the Sound. The salmon return to Prince William Sound to spawn after spending between one and six years in the Pacific Ocean depending on the specific species of salmon.

There are currently six operating salmon hatcheries within the PWS region: three were developed by the FRED division (Gulkana, Cannery Creek, and Main Bay) and three developed by the PNP associations (Armin F. Koernig, Wally Noerenberg, and Solomon Gulch). The hatcheries annually release approximately 600 million pink, 133 million chum, 30 million sockeye, and 6 million coho salmon smolt. On average, these provide approximately 30 million pink, 4 million chum, 1.3 million sockeye, and 600,000 coho adult salmon for the commercial, sport, personal use, and subsistence fisheries annually.

For more information: www.pwsac.com, and ADF&G <http://www.cf.adfg.state.ak.us/geninfo/enhance/enhance.php>

The life cycle of Pacific salmon is complex and relies upon healthy freshwater (blue text) and marine (green text) ecosystems. To complete their life cycle, Pacific salmon travel long distances and thus depend on migration corridors that connect freshwater and marine habitat.
-Alaska Department of Fish & Game

Salmon species in Alaska



KING (Chinook): The first species to return to the region, Copper River king salmon are prized for their color, high oil content, firm texture and succulent flesh. Average weight is approximately 20 pounds and length ranges from 30 to 40 inches.



SOCKEYE (Red): The second most abundant species, sockeye have a distinct, deep red flesh, rich flavor and firm texture. Average weight is approximately six pounds and they can grow to almost three feet in length.



COHO (Silver): The second largest of the species, coho have orange-red flesh, firm texture and delicate flavor. Average weight is 12 pounds and they range from 25 to 35 inches in length.

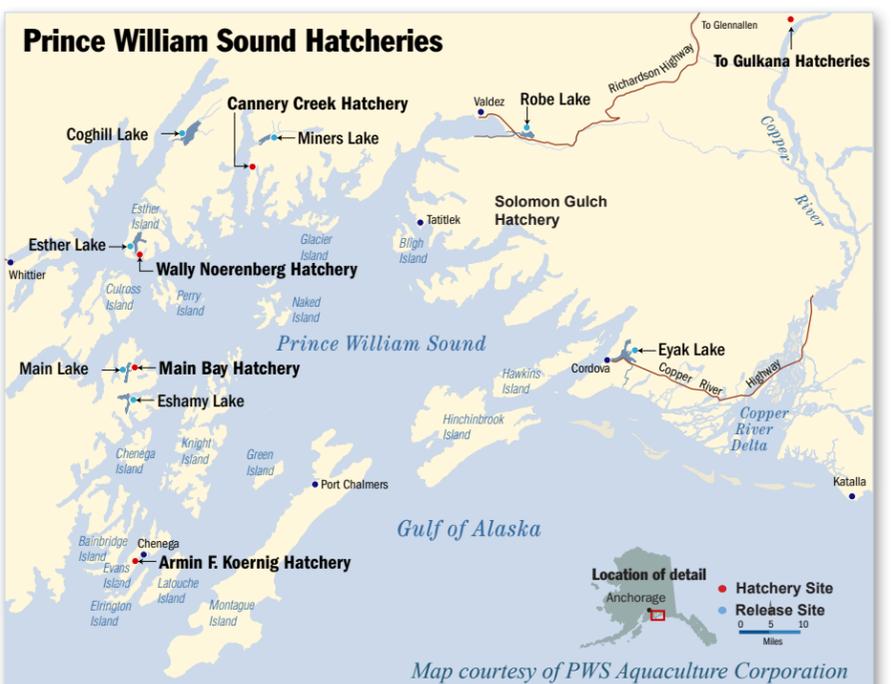


PINK (Humpy): Pinks are the smallest and most abundant of the species. Pinks are distinguished by their light, rosy pink-colored flesh, tender texture and delicate flavor. Average weight is two to three pounds.



KETA (Chum): Keta have a firm texture, orange-pink color and delicate flavor. Average weight is eight pounds and they can grow to be 25 to 27 inches long.

Photos and information courtesy of the Alaska Seafood Marketing Institute www.alaskaseafood.org.



Map courtesy of PWS Aquaculture Corporation

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Working to conserve fishery resources

Native Village of Eyak marks a decade and counting of meaningful intergovernmental cooperation for fishery research and conservation

Keith van den Broek,
Native Village of Eyak

The Native Village of Eyak's Fisheries Resource Monitoring Program, administered by the US Fish and Wildlife Service and US Forest Service, Office of Subsistence Management, helps fund technically sound projects throughout the State of Alaska that gather information to manage and conserve subsistence fishery resources.

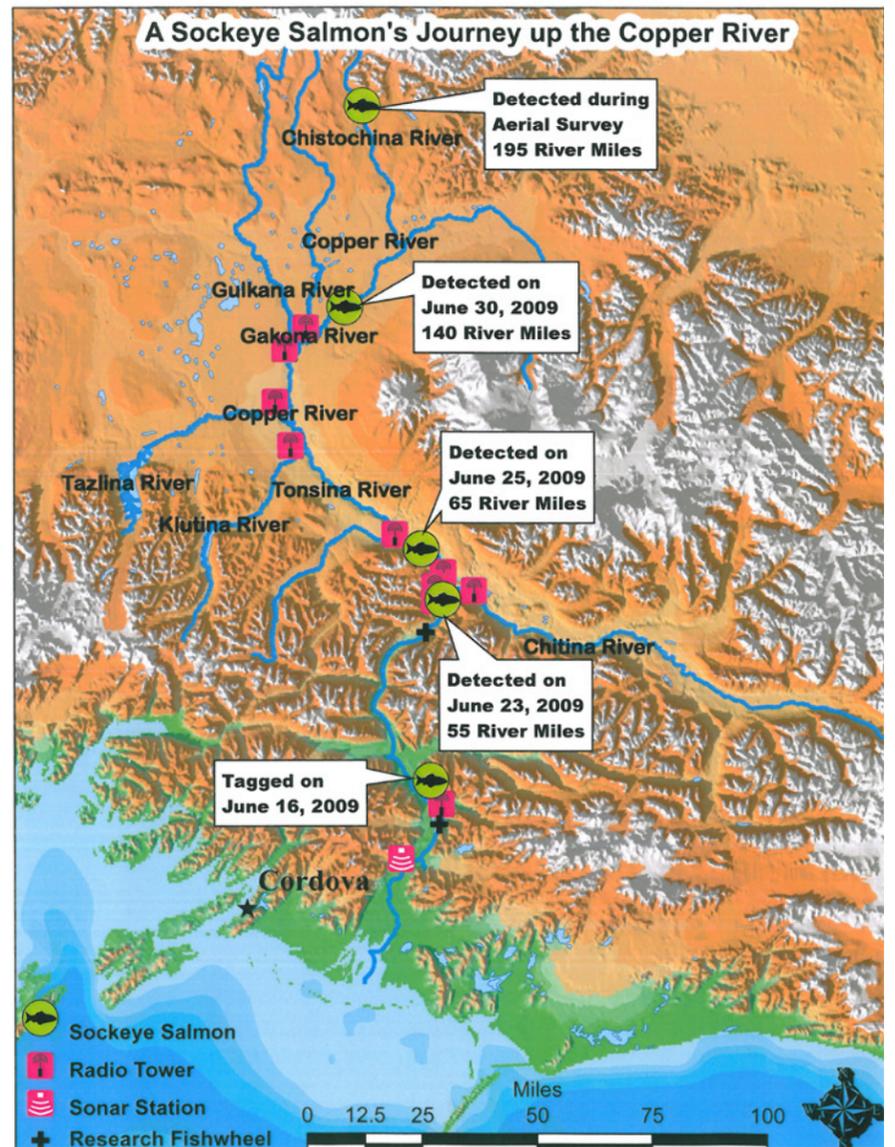
While helping meet the subsistence management mandate of ANILCA Title VIII, this program also develops capacity for Alaska Native Tribes and local non-governmental organizations to be directly and meaningfully involved in the monitoring and management of their resources.

The Native Village of Eyak (NVE), whose traditional use area encompasses Prince William Sound, Copper River

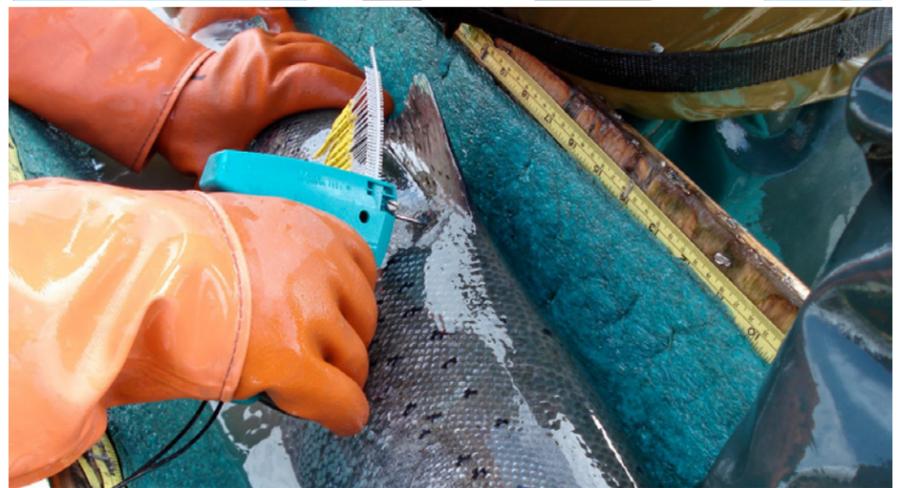
and the Gulf of Alaska, has been a partner in this program since 2001. NVE's numerous research projects on the Copper River have studied sockeye, Chinook and coho salmon and steelhead trout spawning distribution, lower river acoustic indexing, Chinook salmon genetics, Chinook and sockeye salmon abundance, eulachon harvest, and traditional knowledge of salmon runs.

The longest running program for NVE has been the annual census of Chinook salmon entering the river. Using fishwheels and mark-recapture techniques, NVE generates a reliable and accurate count of this valuable species, which is directly used by fishery managers to help ensure the long-term sustainability of the run.

For more information on the Native Village of Eyak's research, please visit their website: www.eyakfish.com.



Above: Native Village of Eyak technicians monitor salmon stocks with a fish wheel in Canyon Creek along the Copper River. Right: Fishery technicians tag and release salmon from their fish wheels to track and monitor abundance and run strength. Photos by NVE.



Migrating eyes on the ocean floor: Halibut spotlight

Halibut, found in coastal waters of Alaska, are the largest of all the flatfishes, and can exceed 400 lbs. In their larval stage, halibut have eyes on either side of their head.

When they reach about an inch in length their left eye migrates to the right side of the head and the color fades on the bottom side of the fish. By the time they are 6 months old, halibut settle to the bottom of nearshore environments.

They feed on plankton during their first year, but as they grow so does the size of their food. Fish make

up a larger part of their diet in later years, including pollock, sablefish, cod, and rockfish. Large halibut also eat octopus, herring, crabs, clams and smaller halibut.

Halibut maturity can vary amongst individuals, but in general males sexually mature by 8 years of age while females mature by age 11. They spawn at depths of 600-1500 feet from November through March, and return to nearshore feeding areas in early summer. Most halibut are caught at depths of 90-900 feet.

Left: This adult halibut coasts along the sandy ocean floor in search of its next meal. Photo by J. Rosenthal.

Measuring Bering glacial retreat

Controls on downwasting and retreat on Alaska's Bering Glacier

P. J. Fleisher, P. Bailey and E. Natel,
SUNY-Oneonta, New York

Measurements of ice front retreat, annual downwasting, and summer rates of daily glacier surface lowering have been under investigation along the eastern Bering piedmont lobe since 1998. GPS mapping, basic survey techniques, and the morphology of deglaciated foreland terrain



An Earthwatch volunteer bores a hole into the glacier with an ice auger. A tube will be placed in the glacier to measure surface melting.

have led to the recognition of several controlling factors to complement weather and climate.

Our data indicate that retreat is slowest (15-40 m/year) on slopes that are gently inclined away from the glacier where the ice front is relatively dry. Conversely, retreat is most rapid and variable (50-175 m/year) from wet slopes that face the glacier where small, ice-contact meltwater streams meander along the retreating ice front. Furthermore, highly fractured, thin ice will retreat by calving at rates on the order of 100-600 m/year into ice-contact lakes that exceed 30 m in depth. The rate of calving retreat is controlled by many factors and is highly variable.

Meter-long PVC pipes placed vertically within the glacier surface at multiple sites are subsequently exposed as the glacier surface is lowered by melting. The mid-summer downwasting rate varies between 4.3 and 10.9 cm/day. As anticipated, sunny and dry weather results in greater rates than does



The gently sloping glacier surface descends toward the retreating terminus, with the scientific crew shown for scale. Photos by P.J. Fleisher.

overcast and rainy conditions.

Heavy rain accelerates melting as does a consistent wind that blows onto the glacier from ice-free terrain.

Yearly ice surface surveys extending 1 km upglacier from the terminus show that the ice surface is lowered an average of approximately 10 m/year by melting. This rate appears to be linked to regional

climate conditions.

P. J. Fleisher, Dept. of Earth Sciences, SUNY-Oneonta, NY fleishpj@oneonta.edu; P. K. Bailey, Anchor Point, AK; E. M. Natel, Eastman Kodak R&D, Rochester, NY; all authors are affiliates of Prince William Sound Science Center, www.pwssc.org.

Rapid changes define Columbia Glacier

The world's most studied and most rapidly changing glacier

W. Tad Pfeffer,
INSTAAR/University of Colorado

Columbia Glacier is one of the world's most extensively studied glaciers and also one of the world's most rapidly changing glaciers. Originally more than 400 square miles in area, Columbia Glacier started a rapid retreat in 1982, which has reduced the glacier's size by 40 square miles, thinned its lowest reaches by more than a thousand feet, and today slides into the ocean at speeds of 60 feet per day, discharging one cubic mile of ice into Prince William Sound every year.

Columbia's dramatic retreat was predicted by scientists in the 1970s— in fact, it is the last of Alaska's 53 ocean-ending glaciers to do so — and that prediction and the subsequent close observation of the glacier's behavior is the longest and most detailed record of rapid glacier change ever assembled.

As the Earth's climate warms, other glaciers worldwide are starting to show the same kind of changes seen at Columbia, and the record from Prince William Sound is providing a crucial key to understanding future changes in the world's glaciers and ice sheets and predicting rising global sea level. Columbia Glacier also gives valuable clues for anticipating the environmental changes taking place as glaciers retreat and leave behind a new landscape, momentarily bare but soon to be colonized by plants and animals.

Tad Pfeffer is a glaciologist, teacher and photographer at the University of Colorado at Boulder. He is a Fellow of the University's Institute of Arctic and Alpine Research and Professor in the Department of Civil, Environmental, and Architectural Engineering. He has done field experiments and photographed glaciers for more than 30 years in Antarctica, Greenland, Iceland, Canada, Africa, and in Alaska, from the Southeast Alaska panhandle to the Alaska Range.

For more information on his work, visit: <http://tintin.colorado.edu>.

Photos of Columbia Glacier by W. T. Pfeffer, INSTAAR/University of Colorado.



SUMMER 2010

5 years
2 weeks
65 scientists
8 states

Sound Predictions

AOOS CONDUCTS a FIELD EXPERIMENT in the SOUND

Find the field experiment on the web at www.aos.org/regional/pws/index.html

Sun, science and wild seas

Our goal was to test the accuracy of model forecasts and demonstrated the utility of an ocean observing system for oil spill response, search and rescue, and fishery management.

The effort was huge: the observational infrastructure in the Sound, data management system, and forecast model development took five

years to complete and along with the field experiment assembled 65 scientists from eight states.

The experiment also provided researchers with a chance to test new sensors and platforms, and to evaluate models in context of other questions or applications such as fishery management, search and rescue, and oil spill response.

Five years in the making. Two weeks for execution. Sixty-five scientists hailing from eight states. Many, many volunteers lent a hand. *Sound Predictions* was a two-week field experiment in the waters of Prince William Sound in summer 2009. Researchers, students, and volunteers braved unseasonably stormy weather to work in the Sound and—ultimately—improve our ability to observe and forecast changes in the ocean off Alaska.

Power to the people

This field experiment would have been impossible without the support of these partners:

- Alaska Department of Fish and Game
- Alaska Experimental Forecast Facility
- Alaska Ocean Observing System
- Alaska Sea Grant
- Armin F. Koernig Hatchery
- Bill Bechtol
- CIRI
- Cordova Air Service
- David Janka
- ERA Helicopters
- EVOS GEM
- F/V Alena K
- F/V Auklet
- F/V Montague
- F/V Pandalus
- F/V Solstice
- Fishing and Flying
- Jet Propulsion Laboratory
- John Oswald and Associates
- Joint Institute for Regional Earth System Science and Engineering
- NASA
- National Weather Service
- Natural Resources Conservation Service
- NOAA Coastal Services Center
- NOAA CO-OPS
- NOAA Hazmat
- North Pacific Research Board
- Nuchek Spirit Camp
- Oil Spill Recovery Institute
- OSRI Board
- OSRI Scientific and Technical Committee
- Prism Helicopters
- PWS Aquaculture Corporation
- PWS Regional Citizens Advisory Council
- PWS Science Center
- Ted Otis
- Texas A&M University
- University of Alaska Fairbanks
- University of California Los Angeles
- US Coast Guard Kodiak Air Station
- US Forest Service
- US Geological Survey
- Village of Tatitlek
- Wally Noerenberg Hatchery

How did they collect the data?

Scientists and field assistants enjoyed some Alaska summer weather, but also braved unseasonably stormy weather and plenty of rough seas, rain and wind as they deployed, redeployed, installed, and repaired their data collection instruments. Data are used to improve model forecasts and to evaluate forecast skill. Here are some of the instruments that we used in the experiment.

REMUS AUV (top right) and Slocum Glider (bottom right) Autonomous underwater vehicles (AUVs) can collect nearly continuous measurements of temperature and salinity. These measurements contribute to a regional scale view of water column structure to 700 ft depths, and help evaluate and improve model performance.



Weather Buoys carry instruments that measure wind speed and direction, air temperature, air pressure, and sea surface temperature. Buoy data are used to predict ocean circulation.



High Frequency Radar uses Doppler frequency shifts to determine the speed of surface currents. Stations can transmit and receive radio waves traveling as far as 37 miles across the Sound.



Conductivity-Temperature-Depth (CTD) sensor is the primary tool for determining essential physical properties of sea water. It provides profile measurements of water column temperature, salinity, and density. Each of the vessels chartered for the Field Experiment carried a CTD to measure the salinity and temperature of surface water while traveling the Sound.

Parts of the observing system

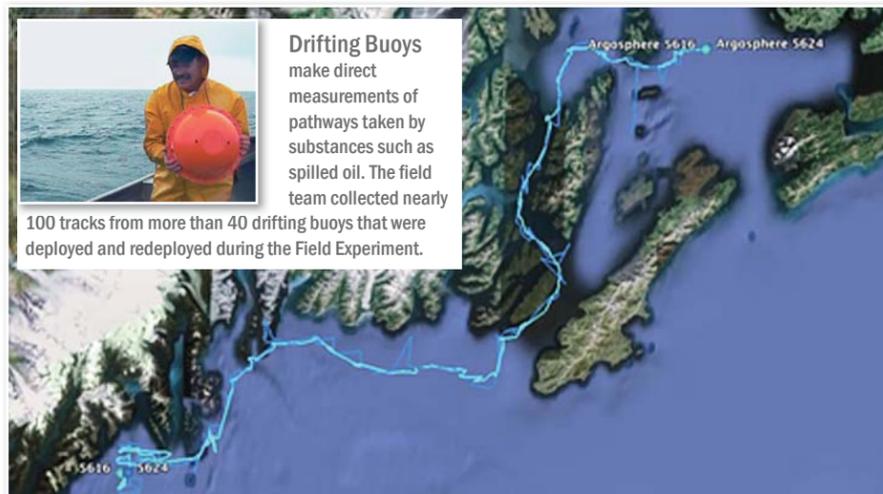
AOOS is a network of telemetered weather stations, wave gages, and ocean sensors throughout the Sound. Ocean sensors measure salinity and temperature, current speed and direction, and the chlorophyll within phytoplankton.

We use data collected by the network to develop and test the performance of numerical models so that we may more accurately forecast weather, waves, and ocean conditions for mariners.

Develop model. Collect field data. Refine model. Repeat.

During the experiment, we evaluated how models predicted actual conditions. For the two-week field period, the experiment added these instruments to supplement the fixed network of AOOS equipment:

- **high frequency radar** measured surface currents
- **vessel mounted instruments** measured temperature and salinity while underway
- **underwater drones** profiled the water column
- **drifting buoys** measured current speed and direction



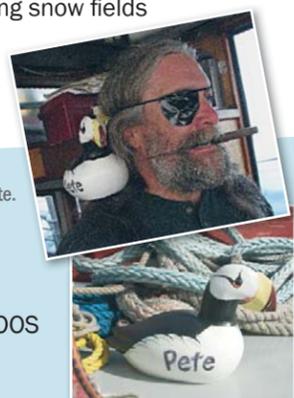
Those crazy buoys: wayward drifters escape Sound

We deployed, retrieved, and redeployed 40 drifting buoys through spring and neap tides. Additional deployments occurred around the Sound's edges to validate the velocity of surface currents forced by runoff from melting snow fields and glaciers. After the experiment ended, two of the drifters continued to transmit data. We tracked them as they traveled—they drifted into Cook Inlet, and one made it all the way to the Bering Sea!

Right: Arr! Capt. Dave Janka stands tall on the bridge of the F/V Auklet with Pete.



CELEBRITY PUFFINS Pete Puffin, made famous in the book "Pete Puffin's Wild Ride: Cruising Alaska's Currents" (left), accompanied researchers out on the water during the Field Experiment (right). Pete is a wooden Pacific horned puffin who accidentally slips off the side of a ship cruising to Alaska and recounts his yearlong ride in Alaska's currents. AOOS provided financial support for this children's book, published by Alaska Geographic. AOOS funds also ensured that every library and school in Alaska received a copy.



WAVES

The wave model over-predicts wave heights when waves are small (less than 2 ft). The model can more accurately predict larger waves.

WIND

The wind model has difficulty predicting wind direction when winds are light (less than 10 mph). The rugged coastal mountain topography is so variable that it directs winds in unpredictable ways.

Model predictions greatly improve offshore as this topographic effect "wears off." The model can accurately predict stronger winds.

DRIFTERS

The model correctly predicted where drifters would travel in the Sound.

Drifters could be considered substitutes for a man overboard or an oil spill, so model accuracy in this area will be a big help to search and rescue teams and oil-spill response personnel.



AOOS keeps watch on Alaska's coasts and oceans

The Alaska Ocean Observing System (AOOS) provides observations, data and information products to meet agency and stakeholder needs. AOOS is a regional network representing a consortium of all the research organizations and agencies in Alaska. AOOS is also part of the Integrated Ocean Observing System (national) and the Global Ocean Observing System (international). [Learn more at www.aos.org](http://www.aos.org).



Part of
a global
network
of ocean
observing

Improving Safety, Economy, Environment

SAFETY AOOS helps ensure the safety and security of Alaskans by ...

- Developing better severe weather predictions
- Improving search-and-rescue operations
- Improving the safety and efficiency of marine operations
- More effectively mitigating the effects of coastal erosion



ECONOMY AOOS helps unlock economic and business benefits of the ocean by ...

- Optimizing shipping routes
- Enhancing fisheries management
- Providing safe and efficient energy development



KNOWLEDGE IS SAFETY Anyone who goes out on the water or lives along Alaska's 47,000 miles of coastline can benefit from the work of the Alaska Ocean Observing System.

ENVIRONMENT AOOS protects our marine resources by ...

- More effectively protecting healthy coastal marine ecosystems
- Better enabling Alaskans to respond to climate change and its impacts
- Improving oil spill response and prevention

AOOS
Alaska Ocean Observing System

1007 W 3rd Avenue, Suite 100
Anchorage, AK 99501
907-644-6703
www.aos.org

What's AOOS working on?

Prince William Sound Demonstration Project

- Observing system in Prince William Sound to improve boater safety, oil spill trajectory forecasting, search and rescue operations, and ecological forecasting. Includes moorings, boat surveys, surface radar, and wind, wave, and ocean circulation forecasting models.
- System was tested in major field experiment in summer 2009; being reviewed for expansion into Cook Inlet and central Gulf of Alaska.

AOOS Data Management

- Regional warehouse for integrated coastal and ocean data and information products, consistent with national IOOS standards.
- AOOS web portal, www.aos.org, provides data discovery, access, archive, and visualization tools, and is now the primary single source for ocean data in Alaska.

Harbor Observation Network

Automated weather and ocean observing station designed for remote locations and tested at Seward Harbor. Collects weather, precipitation, soil temperature, wave, water and tide, and web cam observations. Read more about Harbornet below.

A prototype harbor observation system is in place at Seward, collecting atmospheric observations atop a 20-foot-tall tower on the harbor breakwater (below). It has been tested in severe conditions. Lessons learned here will be applied at later installations.



AOOS Project: Harbor Observation Network

A joint project
between



Alaska has sparse data on environmental conditions affecting transportation, especially along Alaska's huge and diverse coastal zone. The Alaska Harbor Observation Network is a program to provide harbor entrances across Alaska with data collection stations for reporting and archiving atmospheric and oceanic parameters useful for weather reports and forecasting, for planning and design of coastal works, and for community management of the coastal zone.

Why we collect data at a harbor

There are more than 100 harbors and boating facilities across Alaska where commercial or recreational activities take place. These facilities are focal points for human activity, commerce, and shoreline development. However, they can also be highly vulnerable to erosion, flooding, storm surge, and other coastal hazards. Establishing an environmental monitoring system to report and forecast weather and marine conditions can help improve safety and sustainability of coastal communities.

How it works

Wind and sun power a 12-volt battery at the base of the tower. To capture underwater conditions, 600 feet of telemetry cable extends to a set of marine sensors at a depth of 30 feet.

Data collected at the site are transmitted to the Alaska Harbor Observation Network database and to AOOS for processing and archiving, then on to the Harbormaster's office and other locations via Internet for display.

Hardware components are carefully selected to fit NOAA data specifications. They are also transportable, reliable, low-maintenance, and operable on minimum power. Stations cost about \$44,000 to build and install.

Learn more about the Harbornet project at <http://akharborobs.net>.

Data collected by the station

- Wind speed and direction
- Air temperature
- Barometric pressure
- Humidity
- Solar radiation
- Tide level
- Wave conditions
- Water temperature
- Salinity
- Web cams at harbor entrances

Who can use Harbornet data?

- Commercial and recreational boaters
- Security and disaster response workers
- Tsunami warning centers
- Climate scientists

Join Harbornet

We seek community partners to help this program grow. If you are interested in obtaining an observation station for your harbor, please contact:

Howard Ferren
howard_ferren@alaskasealife.org

Orson Smith
afops@uaa.alaska.edu



KNOWLEDGE IS SAFETY A modest investment in a robust observation station for Alaska harbors means better, real-time access to current conditions – and more safety – for boaters of all types.

Tracking lingcod in Prince William Sound

Scientists track lingcod to answer the age old question: Do adult lingcod just lay around all day or do they move about?

Brad Reynolds,
PWS Science Center

Several lingcod were recently abducted from their kelp beds in Port Gravina, and following a brief encounter with slimeless, finless organisms, found themselves returned to their beds where they swam somewhat wobbly among their now suspicious, albeit very curious fellows. One victim pointed a pectoral fin at his belly, and whispered

cautiously “one moment I’m staring in abject terror at a pocket protector, then I wake up with this sutured hole in my underbelly.” Little did this lingcod know he was now a part of the Census of Marine Life’s Pacific Ocean Shelf Tracking (POST) project...and he was being followed.

Joining in the abduction conspiracy were research staff at the Prince William Sound Science Center who spent several days aboard the mother ship, luring lingcod from their natural reefs in Port Gravina. Following capture, they surgically implanted these lingcod with small acoustic transmitters that transmit not only an individual ID number, but also information on swimming depths for several of those fish. Tracking the movements of these lingcod was accomplished by deploying several submerged acoustic receivers,

including a submerged receiver array that traverses the entire mouth of Port Gravina (fishermen can see these on their updated NOAA charts).

After a year and a half of tracking lingcod movements, pocket protector-wearing data analyzers were able to provide new information regarding the secret lives of lingcod, such as what do teenage lingcod do when hormones hit, and where do younger lingcod go when too many adults gather around? And they answer the age old question, do adults really just sit around all day? These insights, along with data to be collected at the next lingcod abduction site, Hinchinbrook Entrance, will allow researchers to further unravel the mysteries of lingcod life and how their habits vary depending on season and location.

For more information, contact Brad Reynolds at brad@pwssc.org.



Suturing an incision after surgically implanting an acoustic transmitter in a lingcod. Photos courtesy of PWSSC.



Scott Pegau deploys an acoustic receiver to track movements of acoustic-tagged lingcod in Port Gravina.

Scorpion fish are old

Diverse species of scorpion fish share extreme longevity

Sam Hochhalter,
Alaska Department of Fish & Game

Named for their venomous fin spines, scientific family name Scorpaenidae or “scorpion fish”, rockfish are among the most diverse and interesting marine fishes found in Alaska.

The 34 different species of rockfish found in Alaska express this diversity through different colorations, some of which can be incredibly vibrant such as china rockfish seen on the bottom right; a wide range of sizes, adult pygmy rockfish attain maximum lengths around 8 inches while adult rough eye attain lengths in excess of 40 inches; and occupy a variety of habitat types ranging from near-shore pelagic, or open water habitat, to off-shore benthic, or ocean floor habitat.

Perhaps the most astonishing aspect of rockfish is the great longevity of species such as short raker and rough eye rockfish. For example, short raker and rough eye rockfish caught in Alaskan waters have been aged at up to 157 and 205 years old! This means that rockfish caught by both sport and commercial anglers today could have been alive during the American



Civil War and perhaps even alive for the Lewis and Clark Expedition (1804-06)! Because many of the recreationally and commercially harvested rockfish species are long lived, the Alaska Department of Fish and Game has adopted conservative management strategies to ensure sustainable harvest.

Additionally, ADFG is conducting research on alternative release methods to improve survival of discarded rockfish. Results from this project will help ensure these amazing fish are around for future generations to enjoy.

For more information, visit: <http://www.sf.adfg.state.ak.us/Statewide/RockfishBrochure.cfm>.



Top: Black rockfish photo by Krissy Dunker. Above Left: Yelloweye rockfish photo by Brittany Blain. Above Right: China rockfish photo by Brian Marston.



Dr. Kenneth J. Goldman

Salmon sharks of the North Pacific Ocean

Dr. Kenneth J. Goldman,
Alaska Department of Fish & Game

Salmon sharks (*Lamna ditropis*) occur only in the North Pacific Ocean and are the largest fish predator in the upper water column, competing with seabirds and marine mammals for resources. While salmon sharks consume over 30 different species as prey, they are fantastic leapers in their pursuit of salmon.

They are a large shark, growing to lengths of roughly nine feet and up to 500 pounds. They segregate by size and sex, and are highly migratory, making journeys between Alaska and places like Hawaii and Baja, Mexico. Salmon sharks are amongst a small group of sharks that are endothermic, and possess body temperature elevations as high as 21.2°C over the surrounding water temperature.

Currently, the major cause of salmon shark mortality is as bycatch in several pelagic and nearshore fisheries, which is an important issue that must be made tangible in order to achieve

responsible management for this species. Differences in growth rates and age at maturity between salmon sharks in the eastern and western North Pacific must also be considered along with movements, migrations and stock structure for management to be successful.

Photos by Dr. Kenneth J. Goldman. For more information, contact Dr. Goldman at ken.goldman@alaska.gov or visit http://www.topp.org/species/salmon_shark.



Dr. Kenneth J. Goldman

Sea otter behavior tracked in Simpson Bay

Feeding is a sea otter's top priority

Allen Marquette,
 PWS Science Center

Sea otters are today seen relatively frequently, particularly on the east side of Prince William Sound. However, in the 1800's their population was almost decimated by commercial hunting practices prior to their protection under the International Fur Seal Treaty Act in 1911.

Behavioral studies on sea otters are now underway in Simpson Bay through a Texas A&M University program. Dr. Randall Davis leads these investigations with assistance



Researchers Ryan Wolt and Laurie Timm of Texas A&M University study sea otter behavior in Simpson Bay

from graduate and undergraduate students. Ryan Wolt, a student working on a master's degree, is gathering data to write a paper on the foraging behaviors of sea otters.

Wolt explained, "These time studies help researchers determine how much time otters spend resting, grooming, foraging, interacting with other otters, swimming at the surface, and patrolling their territory".

During one set of observations, ten males were watched continuously for 92 hours. More time was spent foraging, about 30% more than on any other activity, and foraging bouts were longer than all other activities too. The males interacted with females with pups about 59% of the time and with single females 41% of the time during the observation period.

Except for fur coloration, sea otters look pretty much the same so it can be hard to identify individuals from 50 to 100 meters away. One interesting



A sea otter feeds in Simpson Bay. Photos by Allen Marquette.

method researchers developed for distinguishing between individual sea otters is to photograph their nose. Apparently there are differences in nose coloration and distinct scars the animals attain during their lifetime which helps researchers more readily identify individuals. Other identifying characteristics

included broken and worn teeth and fur coloration differences.

Sea otters are interesting to watch. The next time you are out in PWS, stop for a minute and see what the sea otters are up to, and while observing, see if you can detect any scars or color differences on the sea otter's nose.

Alien invaders

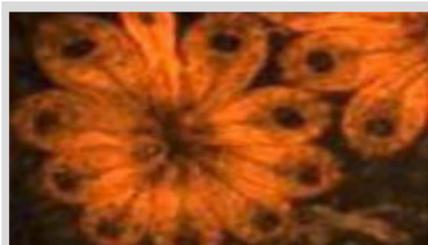
Invasive species threaten native aquatic populations in Alaska

Linda Robinson, Prince William Sound
 Regional Citizens' Advisory Council

Prince William Sound is a critical habitat for many subsistence and commercially harvested species such as salmon, crab, scallops, herring, walleye pollock, cod, rockfish, sablefish, squid and clams. It also is home for orca and humpback whales, Steller sea lions, Dall's and harbor porpoises, sea otters and many other animals that rely on its resources. The introduction of non-indigenous aquatic species, or alien invaders, into coastal waters of Alaska may pose serious threats to these native species.

Fifteen non-indigenous species (NIS) have already been found in the Sound, and are believed to have been transported in oil tanker ballast water, on vessel hulls and in sediment taken into ballast tanks during ballasting in shallow ports. With one exception (Atlantic salmon), it is not yet known whether these species pose a serious threat to the Sound's environment. It's important, however, to monitor all NIS and any negative effects they could have on indigenous species.

One NIS identified is tunicates, or sea squirts, that attach to hard surfaces



Botrylid tunicate, a "sea squirt" has already been found in Sitka, Ketchikan and Homer. Photo courtesy of ADF&G.



European green crab. Photo by D. Gilson.

such as rocks, piers, boats and docks. Composed mostly of water, they form a soft and slimy coating on these surfaces. These tunicates can damage aquaculture, fishing, or marine gear, and out-compete or suffocate native oysters and mussels.

Other invasive species that have not yet reached Alaska but are of great concern are the Chinese mitten crab and the European green crab. Already found along the West Coast of the United States, these crabs are considered a serious threat because of their invasion of waters relatively close to Alaska, their ability to survive and adapt in new environments, and the ecological harm they've done in areas already invaded.

A green crab monitoring network has been created in Alaska. Students and others in 12 communities set out traps and record their findings. Fortunately no green crabs have been found yet in Alaska.

For more information on Marine Invasive Species visit: <http://www.pwsrca.org/projects/NIS/index.html/>.

Restoring razors

Researching the potential for razor clam restoration in Orca Inlet

Dennis C. Lees & William B. Driskell
 Littoral Ecological
 & Environmental Services

We recently conducted a brief study of 11 sand bars in Orca Inlet and two beaches on the Gulf of Alaska in relation to razor clam habitats. The Native Village of Eyak sponsored the investigations to: 1) identify environmental characteristics important to the suitability of the razor clam habitats; and 2) assess the feasibility of restoring razor clam stocks in Orca Inlet to where they could support sustainable subsistence harvest.

Cordova's local radio station call letters – KLAM – recall the decades 80-90 years ago when Orca Inlet hosted a major commercial clam fishery. Cordova dubbed itself the "clam capitol of the world" until World War II; then the 1964 earthquake caused major disruptions.

Our study results indicate, with a few exceptions, that most sediment quality characteristics lie in ranges within which razor clams generally thrive in southcentral Alaska. Despite the apparent suitability of the habitats, recruitment appears to be temporally and spatially weak and patchy at the sampled locations. This is a cause for concern regarding potential restoration efforts.

We found sediments forming many bars in Orca Inlet that appear somewhat unstable and are probably still re-adjusting to the uplift caused by the 1964 Great Alaska earthquake. This instability reduces the suitability

of these habitats for razor clams as they prefer relatively stable sediments to thrive.

Predation pressure, an important consideration in evaluating habitat suitability, appears to be intense due to the recovered status of sea otter populations. Relative to restoration potential, sea otter predation is probably the biggest concern. Thus, sea otter predation pressure and sand bar instability are probably the most serious problems facing razor clam restoration efforts.

For more information, contact Dennis Lees at dennislees@cox.net.



Broken razor clam shells provide reasonable evidence of sea otter predation. Photo by Dennis Lees.

Methane biogas

Building biogas digesters in northern climates

Laurel McFadden,
University of Alaska Fairbanks

Cordova High School students are assisting a pilot project to produce biogas in the cold climate of the North. In collaboration with Cordova community members including the high school, UAF researchers are working with TH Culhane, founder of the Solar Cities NGO, to adapt biogas digesters to function in cold environments. The project is funded by the Denali Commission and a National Geographic Blackstone Ranch grant.

In traditional digesters, warm-loving mesophilic bacteria produce a burnable methane-based biogas. Our goal is to test Alaskan cold-loving psychrophilic bacteria from lake sediments to produce biogas in the cold climate of the North. The project was inspired by studies of methane seeps coming out of northern lakes year-round, including the hotspots commonly seen in the ice of Eyak Lake.

Digesters in China and India use cow manure as a basis for their bacterial environment. We are testing biogas production using a slurry of lake mud containing methanogenic bacteria that have been shown to produce methane down to 1°C. Cordova High School students assisted in building six digester systems to test efficiency of biogas production using different bacterial communities and temperatures (15°C and 25°C). Digester microbes are fed 1kg of organic food waste daily,



a fraction of which they convert to biogas. Successful biogas digester technology in the North has a number of benefits. Biogas is usable in any gas-burning technology (including stoves, heaters, and electric generators), and can help offset fossil fuel costs and transportation risks. These systems, which consume organic waste, help reduce the amount of material going into landfills.

Cannery waste could also potentially be fed to digesters to produce energy. The effluent (excess waste material) that comes out of digesters is known to be an excellent fertilizer. Ultimately, this cold adaptation will be a revolution in digester engineering that will also help mitigate greenhouse effects globally.

Project Partners: Clay Koplin, Cordova Electric Cooperative (ckoplin@cordovaelectric.com); Katey Walter Anthony, UAF INE (kmwalteranthony@alaska.edu); Adam Low, Cordova High School (alow@cordovasd.org); TH Culhane, Solar Cities (tculhane@ucla.edu); Laurel McFadden, UAF INE (lmcfadden@alaska.edu).



Above: Students and teachers helped to build methane digesters in Cordova.

Left: Methane bubbles through the ice on Eyak Lake.

Photos by
L. McFadden

Bird and Wildlife Checklist

u - uncommon

s - seasonal

Loons and Grebes

- Common loon
- Red-throated loon
- Pacific loon (s)
- Yellow-billed loon (s,u)
- Horned grebe
- Red-necked grebe

Shearwaters and Petrels

- Fork-tailed storm-petrel
- Sooty shearwater (u)

Cormorants

- Pelagic cormorant
- Double crested cormorant

Hérons

- Great blue heron

Waterfowl

- Surf scoter
- White-winged scoter
- Long-tailed duck
- Barrows goldeneye
- Common goldeneye
- Bufflehead
- Harlequin duck
- Mallard
- Canada goose
- Common merganser
- Red-breasted merganser

Shorebirds

- Black oystercatcher
- Semipalmated plover
- Least sandpiper
- Yellowlegs
- Red-necked phalarope (s)
- Surfbird (s)
- Plovers (s)
- Turnstone (s)
- Dunlin (s)
- Sandpipers (s)

Gulls/Terns

- Glaucous-winged gull
- Herring gull
- Mew gull
- Bonaparte's gull (s)
- Black-legged kittiwake
- Parasitic jaeger
- Pomerine jaeger
- Arctic tern (s)
- Aleutian tern (s,u)

Seabirds

- Tufted puffin (s)
- Horned puffin (s)
- Marbled murrelet
- Kittlitz's murrelet (u)
- Parakeet auklet (u)

Seabirds (cont'd)

- Pigeon guillemot
- Common murre

Raptors

- Bald eagle
- Peregrine falcon

Hummingbirds

- Rufous hummingbird (u)

Kingfishers

- Belted kingfisher

Passerines

- Tree swallow
- Violet green swallow
- Bank swallow
- Chestnut-backed chickadee
- Winter wren
- Common raven
- Northwestern crow
- Black-billed magpie
- Steller's jay
- Hermit thrush
- Varied thrush
- American robin
- Wilson's warbler
- Orange-crowned warbler
- Song sparrow
- Fox sparrow
- Savannah sparrow

Mammals

- Killer whale
- Humpback whale
- Minke whale
- Steller sea lion
- Sea otter
- Harbor seal
- Dall's porpoise
- Harbor porpoise
- Sitka black-tailed deer
- Black bear
- Brown bear
- Land otter
- Coyote
- Mountain goat
- Marmot
- Mink
- Weasel
- Beaver

Recommended bird/mammal guides:
"Sibley's Field Guide to Birds of Western North America" and the "Guide to Marine Mammals of Alaska" by Kate Wynne.

List compiled by the Prince William Sound Chapter of the Audubon Society.



Prince William Sound Stories:

Now accepting
submissions for a new
virtual visitor center!

Prince William Sound Stories is a project of the Chugach National Forest, in partnership with Alaska Geographic. Prince William Sound Stories endeavors to share the experience of Prince William Sound in words and images using the voices of the people who live, work and play in the region.

Through web-based storytelling and information sharing we will educate Prince William Sound users about the uniqueness of the region and its communities. Your stories can help conserve the Sound by guiding visitors to enjoy it in a sustainable and safe way, with minimal impact to the region's resources and residents.

Visit: www.explorethesound.org

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