Glacial waters help trigger abundance

RJ Kopchak, PWS Science Center

Welcome to the Prince William Sound/Copper River Delta. Bioregion, the northernmost corner of the Pacific coast, and northern boundary of the coastal temperate rainforest. Over 250 inches of precipitation fall on portions of Montague Island in Prince William Sound. On the Copper River Delta annual precipitation exceeds 170 inches. Winter temperatures average from 17° to 32°F, summer temperatures average 49° to 63°F. The region supports all five species of Pacific salmon, along with halibut, cod, and other valuable commercial species. Marine and land mammals and bird populations are diverse.

The Copper River is 290 miles long, and is the single largest source of fresh water to the Gulf of Alaska. The sediment laden waters flow out into the northern Gulf of Alaska, and are swept into Prince William Sound by the westward-flowing Alaska Coastal Current. These glacial waters contain minerals that help trigger plankton blooms, making the northern gulf region the world’s richest waters. Over thousands of years, the sediment from the river system has created barrier islands and delta systems. The 700,000-acre Copper River Delta is the largest contiguous wetland on the Pacific coast of North America, and the largest site in the Western Hemisphere Shorebird Reserve system. Annually it serves as staging grounds for millions of migrating shorebirds and waterfowl, one of the largest seasonal assemblies of birds in the western hemisphere. During the peak of migration, on a single day there may be over 1,200,000 shorebirds along the 75 miles of Delta habitat. Two hundred and thirty-five species of birds have been identified on the Delta, including 42 species of shorebirds.

In Prince William Sound over 20 glaciers terminate at sea level; numerous others cling to steep mountainsides. There are hundreds of bays, fjords and islands with over 3,000 miles of shoreline. The complex assembly of shore zone types provide diverse intertidal and kelp habitats for shorebirds and waterfowl, and spawning grounds for herring. The Sound supports transient and local populations of marine mammals such as federally endangered Steller sea lions, harbor seals, harnessed whales, and otters. Benthic habitats support large populations of herring, salmon, rockfish, and halibut.

Commercial fishing is the region’s largest employer. The port of Cordova is listed as supporting the 12th largest fishery in the United States, with landings in excess of 100 million pounds and an ex-vessel value exceeding $50 million. Another estimated 50 million pounds of fish harvested in the region are processed in ports outside the bioregion.

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. Trapping, gold and copper mining, fox farming, logging and fishing have each played a role in the region’s economic and social development. Today, the Port of Valdez in Prince William Sound is the terminus for the Trans-Alaska Oil Pipeline.

Visitors also support a significant part of our local economies. Thank you for coming to explore and enjoy our region! It is truly one of the world’s great places.

Receding ice sheets influence oceanography

Rob Campbell, PWS Science Center

The waters of the Gulf of Alaska (GoA) are some of the most productive in the world and are home to some of the United States’ most important commercial and recreational fisheries. Alaska’s Copper River drains an area over 7.3 million hectares (about the size of West Virginia) and is the single largest source of freshwater to the GoA, receiving the cumulative meltwater from the vast glaciers and ice sheets of the Wrangell and Chugach mountains. One of the main drivers of productivity in the region is the availability of nutrients: river inputs bring in new nutrients, and oceanographic processes operating on freshwater layers at the surface bring up nutrient-rich water from the depths. Beyond the continental shelf, productivity is limited by the availability of micronutrient iron, which is transported to the open ocean in dissolved forms from rivers, as well as in dust during windstorms.

As the regional climate shifts, we can expect to see changes throughout the watershed: ice sheets will recede (as they have already been doing for many years), which will change the hydrology of the watershed. The new habitats exposed by receding glaciers present opportunities for colonizing plants, which will in turn change the type, timing and abundance of nutrients released into river waters. Those changes will be telegraphed to the coastal GoA by the Copper River, with changes in productivity in the coastal ocean, which has implications for the many plankton and fish seaward of the Copper River Delta.

Predicting changes in the region is tricky, because it has not been well studied in the past. In 2010, a large multidisciplinary team began a joint study of the watershed-ocean system, funded by the US Geological Survey. Studies include cataloging ice mass in

Welcome!

We’re pleased you’re reading this third edition of Delta Sound Connections. To learn about our home, the Prince William Sound and Copper River Delta regions. Established in 1989, the non-profit Prince William Sound Science Center (PWSSC) investigates questions about the biology, general ecology, and oceanography of these incredibly rich ecosystems.

The Center’s educators offer diverse, informative and fun science programs throughout the year. Articles within this paper will introduce you to the many 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 (see their names on the back page) It’s their support which makes this publication possible.

Please consider joining as a member of PWSSC to help ensure the sustainability of the Sound and Delta resources. We value individual memberships because they demonstrate our community support base. You’ll find a membership form on the back page. Thank you for taking time to learn more about this very special part of the world. Please share your thoughts on our publication by completing a short survey at www.surveymonkey.com/s/DSC2011. You will be entered into a drawing for PWSSC goodies. Enjoy your travels!

Nancy Bird, President
Prince William Sound Science Center
Moorings monitor the exchange of waters

Sub-surface oceanographic moorings monitor exchange between PWS and Gulf of Alaska

Mark Halverson, PWS Science Center

Oceans circulation in Prince William Sound is partly driven by what happens at its two major connections to the Gulf of Alaska: Hinchinbrook Entrance and Montague Strait. The water flowing through these entrances also impacts the local ecosystem by importing and exporting organisms such as juvenile fish and zooplankton, and pollutants such as crude oil. For example, water from the Copper River can enter the Sound through Hinchinbrook, making this a true Delta-Sound connection!

The Oil Spill Recovery Institute and the Alaska Ocean Observing System funded an oceanographic mooring program to monitor the exchange of water between the Gulf of Alaska and Prince William Sound from 2005 – 2010. The moorings were equipped with sensors fixed at strategic depths to measure ocean currents, temperature, and salinity.

The current-measuring instruments work by sending pulses of high frequency sound waves. When the waves reflect from moving water, their frequency changes – a phenomenon known as the Doppler effect (think of how an ambulance siren changes pitch as it whizzes past). The instrument determines the water speed by measuring how much the frequency changed. The temperature/salinity sensors measure electrical conductivity to determine salinity.

We’ve learned many interesting things from the moorings. For example, in summer, a “river” of dense water flows into Prince William Sound via an indentation in the continental shelf which leads to Hinchinbrook Entrance (see figure). However, in winter, the deep inflow disappears altogether.

In the future, we will study how the exchange varies between seasons, and also how it differs between years in response to climate oscillations such as El-Nino.

For more information, contact Dr. Mark Halverson at the PWS Science Center, mhalverson@pwssc.org.

Mixed layer depth varies seasonally

Lack of solar heating and freshwater runoff allows for deeper mixing in water

Dave Musgrave, Musgrave Oceanographic Analysis

Ever wonder how deep oil or oil dispersants would mix down into the water if there was an oil spill at the surface in Prince William Sound? Well, the Prince William Sound Regional Citizens’ Advisory Council did, and they asked the Prince William Sound Science Center to help them in answering this important question.

Mark Halverson and Scott Pegau of the PWSSC and Dave Musgrave of Musgrave Oceanographic Analysis used data collected in the Sound since the early 1970s to look at the Mixed Layer Depth (MLD), which is the depth over which surface properties are mixed. They found that fresher and warmer water near the surface in the summer is not present. The strong winds can easily mix the water to great depths leading to MLDs of 30 to 75 meters (90 to 225 feet) deep.

For more information contact Dr. Dave Musgrave, fbksalve@gmail.com.

Ice sheets (cont’d from pg 1)

The watersheds from historical images, measuring hydrologic changes and nutrients in river waters, and measuring the type and availability of iron in the watershed and in the marine waters off the Copper River Delta. The study is also describing the oceanography and nutrients in the marine plume of the Copper River and making first observations of plankton and fish in the zone where fresh and marine waters meet. All the data are being fed into oceanographic and ecosystem models that will be used to predict how the coastal ocean will change as the climate continues to shift.

Preliminary results show large changes in nutrient availability attributable to watershed type and time of year, and suggest that we can expect to see large changes in the nutrients that make their way into the rivers as glaciers recede. Fish catches in the plume suggest that juvenile salmon may make use of very specific parts of the plume as they migrate out from the Copper into the ocean.

Field work continues in 2011, as a complimentary NASA project comes on line that will add: work on atmosphere-terrestrial-freshwater links near receding glaciers, satellite remote sensing of the coastal ocean, and measurements of aerosol dust transport from the watershed to the ocean as well as the amount and type of iron in that dust. For more information contact Dr. Rob Campbell, rcampbell@pwssc.org.
Sensitivity of plants documented living in PWS

Kate Mohatt, Erin Cooper & Betty Charron, Chugach National Forest

Prince William Sound (PWS), Alaska is known worldwide for its amazing wildlife and scenery, but the wide varieties of plants that inhabit this area are little understood.

In 2009, the Glacier and Cordova Ranger Districts on the Chugach National Forest collaborated to inventory plant species along PWS shorelines. Results from the survey have greatly increased the understanding of the presence and distribution of sensitive plants in PWS and will be useful for a variety of natural resource and human use project assessments.

During the surveys of 100 random points, a total of 364 plant species were documented. Prior to this project, 181 plants were known in PWS, and through this survey we identified an additional 200 distinct plants bringing the total number in PWS to at least 381.

Of particular importance are new sightings of sensitive plant species, including four distinct populations of Sessileaf scurvygrass and a single collection of Unalaska mist-maid. Sessileaf scurvygrass has never been documented before on National Forest System lands and this is only the third documented occurrence of Unalaska mist-maid on the Chugach National Forest, which only has 29 occurrences world-wide. Additionally, we found three species designated as rare by the Alaska Natural Heritage Program, including two orchids and Pacific buttercup. Range extensions were also documented for three species including the Pacific buttercup.

In 2010, we conducted more targeted surveys in areas with unique geologies or habitats that were under-represented, such as sandy or recently de-glaciated gravelly sites to yield an even greater understanding of the plant species and their distribution in PWS.

For more information on this project, contact Kate Mohatt, kmohatt@fs.fed.us.

Looking at plants around the Sound

Plants in the Sound are some of nature’s best gifts.

Patience Andersen Faulkner, Native Village of Eyak

Welcome to the land of wonderful plants!

Visiting the Sound is so delightful with all the green surrounding us. Figuring out how to identify plants can be a challenge. Let me make it easier so that you are not just picking a bouquet which fades in a day but harvesting some of nature’s best gifts.

I harvest about ten plants to make massage oil, balm and lip balm. I don’t overharvest an area so I can preserve some for the coming years. I also stay off the trafficked paths as the purest live there. I piggyback a harvesting session when traveling about for other purposes; it only takes fifteen minutes. Take advantage of the peaceful harvesting time. It makes the trip worthwhile.

The season starts with cottonwood buds, then flows into dandelion and elderberry blossoms, on to plantain, alder, willow, spruce tips, fireweed, wormwood, chamomile and berry leaves/blossoms. Select one plant and get to know it well. It has many uses and you will readily be able to identify its many life stages. Using fresh or drying for later use is an option.

There are many good resource books available to take the mystery out of making your own herbal products. How to process these dried plants into essential oil can be addressed by contacting me at: andersenpatc@ctcak.net. Happy harvesting!

The year of forests

Welcome to the International Year of Forests, 2011!

Chugach National Forest, United States Forest Service

Welcome to the International Year of Forests, 2011. That United Nations declaration means that people all over the world are working to raise awareness of important issues on our forests: not only about the forests’ essential resources, but also about increasing political, social, and environmental pressures they face.

International Year of Forests is an opportunity to reflect on how forests affect our lives and what we gain by protecting these valuable resources. The Chugach and Tongass National Forests, the two largest single forests in the National Forest system, are working together throughout 2011 to bring attention to the critical resources and innovative programs that allow individuals to explore their backyard, celebrate their heritage and find their inspiration every day.

Today, Alaska’s Forests, like those around the world, are reframing the way people look at them. Our forests are a critical part of our state’s important cultural, natural and historical resources, as well as home to world-class recreational opportunities.

In southcentral Alaska, the Chugach provides a critical nesting ground for more than 16 million migrating shorebirds in the western hemisphere and is a critical habitat for world-renowned Kenai, Russian, and Copper River wild Alaskan Salmon.

In 2011, International Year of Forests, take a fresh look at all that your forest has to offer and celebrate with us. To see all that we have planned for the year, visit myalaskaforests.com.

Collect all four posters throughout the year. Pick them up at any Chugach or Tongass Forest Service office.

Above: A typically picturesque day on Lost Lake Trail, Kenai Peninsula. Right: Prime Beach front at Double Bay cabin in Prince William Sound. Photos by USFS.

Above: Botanist Helen Cortes-Burns identifies plants in a Prince William Sound fen. Inset: Drosena anglica (top), and wild iris, Iris setosa (bottom). Big photo by Erin Johnson. Inset photos by Kate Mohatt. Below: Spruce tips are a good source of vitamin C. Photo by Auklet.com.

DELTA SOUND CONNECTIONS
SUMMER 2011

Collect all four posters throughout the year. Pick them up at any Chugach or Tongass Forest Service office.

Above: A typically picturesque day on Lost Lake Trail, Kenai Peninsula. Right: Prime Beach front at Double Bay cabin in Prince William Sound. Photos by USFS.

Above: A typically picturesque day on Lost Lake Trail, Kenai Peninsula. Right: Prime Beach front at Double Bay cabin in Prince William Sound. Photos by USFS.
The 2010 season was the most successful season yet with 212 birds banded and 51 recaptures, and a record foreign recapture. A recapture is a bird that has been banded by another birder. On June 28 a mature female Rufous Hummingbird was caught banded with a foreign number sequence. Expecting to find that this bird was banded in the SW U.S., it was a surprise to learn that she was banded as a first year adult in Tallahassee, Florida on January 13, 2010. This capture stands to be the world’s distance record for a banded hummingbird of any species to be caught on both sides of its migration - a distance of over 3,500 miles in a straight line.

By early August, barely more than three months since they arrived, the hummingbird feeders hang abandoned. It’s nice to think of these tiny flying jewels enjoying the sunshine and warmth of the southeastern U.S. as I slogged through the rain putting the feeders away until next year.

**Exploring river otter social behavior**

*When the planet warms up, will social relationships cool down?*

Merav Ben-David, University of Wyoming

Following the 1989 Exxon Valdez oil spill in Prince William Sound our studies of coastal river otters revealed a unique social organization. Most males in our study were highly social, with groups of up to 18 individuals, whereas most females were solitary. Using a variety of methods we set out to uncover “why are males more social than females?”

Social males were not all related, did not have increased reproductive success, or reduce their risk of predation by killer whales, sea lions, or Bald Eagles. Instead, social otters had a different diet than solitary ones, feeding on schooling pelagic fishes (such as salmon and herring) whereas solitary ones feed on intertidal fishes (such as rockfish, greenling, and rockcods). Our research suggests that otters form groups for the benefits of cooperative foraging on schooling fishes.

When schooling fishes arrive in the nearshore environment, most females are raising young and restricted to the area of their natal den, while locations of fish schools are unpredictable. Male groups are able to follow the fish but females are unable to leave their young for extended periods.

With increasing temperatures, we expect to see an increase in sea surface temperatures in the nearshore of the North Pacific that will decrease prey abundance. Because otter sociology is solely driven by the benefits of foraging on schooling fishes, we expect sociality in otters to decline as well. Should we care whether river otters are social or not? All otters visit their activity sites, called latrines, with different frequencies. They deposit their waste and fertilize terrestrial vegetation such as spruce trees. We found some trees growing on latrines with nearly 2.5 times higher photosynthetic capacity than those growing on non-latrine sites. They also produced larger quantities of seeds, an important contribution to the seed bank beyond the latrine boundaries. Changing otter sociality will alter the surrounding landscape and the coastal forest’s resiliency in adapting to future climate changes.

This research is sponsored by the PWS Oil Spill Recovery Institute. For more information contact Dr. Merav Ben-David, Department of Zoology and Physiology, University of Wyoming, bendavid@uwyo.edu.

**Geolocators will reveal information about Black Turnstone migration**

Mary Anne Bishop, PWS Science Center

Most people associate shorebirds with mudflats or sandy beaches. But have you ever seen a shorebird on a breakwater or on a rocky shore? Black Turnstone and Surturd are two species that inhabit these somewhat inaccessible habitats, making them difficult birds to study! Both species have been rated as “species of high concern”. Global sea level rise, increasing human development, and spills associated with the production and transportation of oil on the Pacific coast are potential threats to both species during the nonbreeding season when they live on rocky coastlines.

Very little is known about where Surturd or Black Turnstone stop during spring and fall migrations. Historically, Montague Island in Prince William Sound has been the most important known spring stopover for both species, so in 2010 we set out to Montague Island in spring in order to monitor migrant shorebirds.

We found dramatically lower numbers for both Black Turnstone and Surturd compared with surveys conducted in the mid-1990’s at Montague Island. This suggests that either their populations are declining or the birds are now stopping at different areas.

Light-level geolocators are a relatively new technology now available for tracking movements of small birds such as shorebirds. Originally developed by the British Antarctic Survey engineers for recording the behavior of the Wandering Albatross, geolocators record the change in light levels at different latitudes and longitudes, enabling scientists to determine where the bird has been. In spring 2011, a pilot study by the Prince William Sound Science Center and Windbird Resources will capture Black Turnstone wintering in Puget Sound and attach geolocators. The birds will be recaptured in fall 2011 at the same site allowing researchers to determine where, when, and for how long birds are stopping during spring and fall migrations.

The 2010 project was funded by Alaska Department of Fish & Game Wildlife Diversity Program, National Fish & Wildlife Foundation, and PWS Oil Spill Recovery Institute. For more information contact Dr. Mary Anne Bishop, mbishop@pwsx.org.
Caspian Terns expand their range northward

Copper River Delta colony of Caspian Terns discovered on barrier islands

Mary Anne Bishop, PWS Science Center

With a massive, bright red bill and a wing-span approaching 17 inches, the highly vocal Caspian Tern is a relatively new species to Alaska. This species first appeared in Prince William Sound and on the Copper River Delta in 1983. Despite numerous attempts to locate Caspian Tern nests, it was not until June 2005 that local fishers first discovered a breeding colony on one of the Copper River Delta’s barrier islands. Since 2008, researchers from the Prince William Sound Science Center and Oregon State University have been monitoring this colony. In summer 2010, more than 180 nests were counted. Interestingly, Caspian Terns previously color-band while nesting at colonies in Oregon and in California have been observed at the Copper River Delta colony. Currently, the largest Caspian Tern breeding colony in North America is located on Oregon’s Columbia River. Scientists predict that in the near future, the Copper River colony will continue to grow as a result of intensive management practices being used to displace terns at the Oregon colony. This project sponsored by the U.S. Fish and Wildlife Service Coastal Program. For more information on this project, please contact Dr. Mary Anne Bishop at mbishop@pwssc.org.

Marbled Murrelet population declining in the Sound

Are birds at risk during winter months?

Allen Marquette,
PWS Science Center

Marbled Murrelets are robin-sized seabirds that have a short neck and tail and are brown above and light brown with gray marbled colors below in the summer. In the winter they are black above and white below with a white wing patch and collar. During both summer and winter, Marbled Murrelets are one of the most abundant winter resident seabird species in Prince William Sound. In the 1970’s, more than 235,000 Marbled Murrelets resided in Prince William Sound during summer. Since then, the murrelet population has declined 85%. The crash of adult herring population stocks in the Sound in the mid 1990’s affected many species of mammals and seabirds. Juvenile herring are critical to the Marbled Murrelets’ diet. Studies conducted between 1977-1999 indicated weights of these small birds decreased during summer months. If this is still the case, it could put them at risk going into winter.

During winter, Marbled Murrelets in Alaska are almost entirely confined to marine waters and face extreme weather conditions, including increased daily food requirements, reduced food abundance and shorter days for foraging.

Dr. Mary Anne Bishop, a Research Ecologist with the Prince William Sound Science Center and Dr. Kathy Kuletz a Seabird Biologist at the U.S. Fish and Wildlife Service, have been studying Marbled Murrelets to document the diet, body condition, and physiological stress levels of murrelets in winter.

This research is sponsored by the North Pacific Research Board. For more information, please contact Dr. Mary Anne Bishop, mbishop@pwssc.org or Dr. Kathy Kuletz, Kathy_kuletz@fws.gov.

Left: Birds flock near spawning herring in spring in PWS. Photo by Auklet.com. Above & Right: Common Murres are the most abundant winter resident, often seeking shelter inshore to escape winter storms in the Gulf of Alaska. Photos by Milo Burcham.

Boat surveys provide insight into winter use of Prince William Sound by seabirds

Neil Dawson,
PWS Science Center

The vast majority of marine science is focused on events of summer – plankton blooms, spawning fish and breeding seabirds. Yet the cold winter, when food may be scarce and conditions extreme, has the potential to regulate wildlife populations. Studying seabirds in winter is not easy because they are not tied to breeding sites and few ever touch land.

The Prince William Sound Science Center has been conducting winter seabird surveys regularly since 2007 to determine seabird densities in relation to herring abundance and to understand seabird habitat associations in the Sound. Numbers of Common Murre, the most abundant seabird in winter, peak in March. Winter storms in the Gulf of Alaska during January and February appear to be driving the murres to fly inshore.

Glaucous-winged Gull, is the most common winter gull but their numbers can fluctuate dramatically. During some winters, this bird will almost disappear from the Sound in March, especially in years when eulachon (a smelt) are running up the rivers of the Copper River Delta to spawn. During winter in Prince William Sound you never know what the next day will bring – a gathering of orcas with a red sunrise, or a new hotspot for feeding seabirds, or just a big snowstorm… it’s all very memorable.

Winter seabird surveys are part of the Prince William Sound Herring program, sponsored by the Exxon Valdez Oil Spill Trustee Council.

Brrrrrrr... surveying seabirds in winter

For more information, please contact Dr. Mary Anne Bishop at mbishop@pwssc.org or Dr. Kathy Kuletz at Kathy_kuletz@fws.gov.

Caspian Tern arriving at the Copper River Delta colony with a Pacific herring. Photo by Adam Peck-Richardson, Oregon State University.
Resident killer whales outnumber transients

A look at the diets of Prince William Sound orcas

Craig Matkin, North Gulf Oceanic Society

Prince William Sound is prime habitat for killer whales, particularly Hinchinbrook Entrance and Montague Strait, although they may be seen anywhere. It’s incorrect to assume that most are chasing harbor seals, Dall porpoise and seal lions. The “transient” type of killer whale does specialize in eating mammals, but they are far less numerous than the fish eating “resident” killer whales. Occasionally resident killer whales are found in large socializing/feeding groups of over 100 whales. So, pipesistently, these two types of killer whales do not associate or interbreed and live very different lives while swimming in the same waters.

What is so attractive about the Sound for these fish eating resident killer whales and why would they occasionally form large socializing/feeding groups? It’s the same thing attracting thousands of visitors..... the Pacific salmon. Large, spread-out groups of whales communicating with their calls may be better able to find schools of fish and alert the other whales.

Resident killer whales can be picky about the salmon they consume. In spring, they target Chinook or king, the biggest salmon with the highest oil content. After Chinook, they favor chum, whose numbers have been enhanced by hatchery production of fry. Finally, the arrival of Coho salmon in mid-summer feed them all through the fall as they prepare for the lean winter months. In winter only a few Chinook salmon are around and the whales may feed on other fish. Resident killer whales are never seen taking the small, low oil content pink salmon, even though there may be millions of them returning to the Sound.

To determine what the whales are eating, researchers use a fine mesh net to collect scales from the water just after a kill. Biopsy samples (small cores of skin and blubber) are taken from the whales where chemistry also indicate their feeding habits. Without a doubt, the society of resident killer whales that use Prince William Sound is dependent on the salmon.

For more information on killer whales, visit www.whalesalaska.org.

Arrays to monitor fish movement

New hydroacoustic arrays will record fish movements in and out of Prince William Sound

Brad Reynolds, PWS Science Center

During 2011, the Prince William Sound Science Center is collaborating with the Pacific Ocean Shelf Tracking Project (POST) and the Ocean Tracking Network (OTN) to install hydroacoustic arrays across the entrances to Prince William Sound. Arrays will be deployed across the mouths of Hinchinbrook Entrance and Montague Strait. Three, smaller arrays will also be installed in the southwest Prince William Sound passages (see map). Each array consists of 2 to 16 acoustic receivers moored on the seafloor. The arrays work by forming a seamless listening line capable of detecting fish tagged with acoustic transmitters. When a tagged fish comes within range of, or crosses a receiver line, a unique fish identification number and time of detection are recorded and stored by the receiver. Depending on the tag, other data including swimming depth and temperature can also be recorded. Detection data are later uploaded to a surface vessel via an underwater modem.

Since 2008, we have recorded nearly five million detections for 68 different species.衬衫ly, our disappointment quickly waned however, as we analyzed the movement data. We didn’t expect much excitement; for my inner fisherman could not help but be disappointed by their small size. Apologetically, I would return to report that most of my lingcod were a measly 18 to 20 inches in length. If you have angled lingcod, then you understand my frustration. A desirable catch is typically larger than 36 inches and up to 52 inches!

Nonetheless, for two years we tracked the movements of these lingcod within the array of acoustic receivers installed in Port Gravina as part of the Pacific Ocean Shelf Tracking project. We didn’t expect much excitement; however, as we analyzed the movement data, our disappointment quickly waned as novel patterns began to emerge. We discovered that three and four year old lingcod disperse within a five week period during either winter or spring. We believe that winter departures may be related to sexually immature lingcod or newly-mature male lingcod being displaced when larger males establish territories prior to spawning. In Alaska, lingcod spawn from January through March, but males establish territories as early as November. Spring departures may be indicative of the onset of migratory behavior where lingcod move out into Prince William Sound and possibly the offshore waters of the Gulf of Alaska. Our study was the first to document a pattern in the migration timing for this life stage in lingcod. While this phenomenon is assumed to occur for many species, confirmation has been difficult without the application of acoustic monitoring.

On subsequent tagging trips I have too excited about catching such a small datapoint! Brad Reynolds is a fish ecologist at the Prince William Sound Science Center. For more information on this project contact Dr. Mary Anne Bishop at mbishop@gwsc.org or Dr. Sean Powers at spowers@usouthal.edu. The full findings of our research can be accessed online at www.plosone.org.
Major research program to study lack of herring recovery

Staff.

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 had been closed and only briefly been reopened for two years. The current approximately 20,000 tonnes biomass 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, change climate, 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 to determine why herring populations remain depressed. 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. Below are brief summaries for 2 of the projects. More information for this effort funded by the Exxon Valdez Oil Spill Trustee Council can be found at http://www.pwssc.org/herringsurvey.

Physical Oceanographic Characteristics of Herring Nursery Habitats

Prince William Sound herring spend most of their first two years of life in small, sheltered ‘nursery’ bays, where physical conditions such as temperature and salinity greatly affect their survival. For example, colder water temperatures in the winter reduce metabolism, which may enhance overwinter survival of juvenile herring by lowering energy demands. In the summer, an influx of fresh water helps to trap nutrients in the surface layer, leading to higher plankton productivity and more food availability. To better understand these and other factors, Shelton Bay of the Prince William Sound Science Center and Texas A&M University is installing moorings at the heads of four nursery bays in Prince William Sound to monitor temperature and salinity. The data will give scientists a better idea of the variation of these properties throughout the year and the role they play in determining herring survival.

Plankton and Oceanographic observations in PWS: Herring survival is dependent on availability of zooplankton, their primary food source. Zooplankton abundance in Prince William Sound can be affected by a variety of environmental conditions such as ocean temperatures, salinity, and availability of nutrients. To monitor these environmental conditions, Dr. Rob Campbell of the Prince William Sound Science Center is conducting monthly surveys at twelve sites in Prince William Sound. By measuring temperature, salinity, chlorophyll, turbidity, and nitrate, as well as collecting zooplankton, Dr. Campbell will be able to estimate the amount of zooplankton food available to juvenile and adult herring throughout the year. When combined with the results from other herring studies, these surveys will help provide a comprehensive picture of the factors affecting herring survival and how they change through space and time.

Through multiple plenary and over 20 breakout sessions, the Conference examined current knowledge of regional climate, natural and managed ecosystems, socioeconomic conditions, and traditional cultural values of Alaska’s coastal forests and surrounding areas. It also created an educational opportunity for students, agencies, and the public. Northern climate scientists and experts shared their research, perspectives and insights. The conference featured a public key-note address, paper and poster sessions, and a youth participation component with an emphasis on 1) biophysical systems, 2) their relevance to economic and cultural values, 3) their importance to advancing knowledge, and 4) utility for education, policy, and adaptation. In addition to cutting edge science centered on northern climates, the conference was kicked off by keynote speaker, Majora Carter, in a public address. Majora is one of the nation’s pioneers in successful urban green collar job training and placement. She addresses public health, poverty alleviation, and climate change. To see highlights of the Conference, review abstracts and poster sessions, and listen to posts from the sessions, visit www.uaa.alaska.edu/classroomsforclimate.
Local citizen’s group hosts Gulf of Mexico visitors

Linda Robinson,  
PWS Regional Citizen’s Advisory Council

The Deepwater Horizon oil rig explosion in the Gulf of Mexico (GOM) on April 20th, 2010 was a grim reminder to Alaskans of the Exxon Valdez oil spill in March, 1989. Residents of the GOM, suddenly faced not only with the deaths of oil workers, but also spreading oil and damage to the environment, were looking for help. While Alaska has a fairly strong oil spill prevention and response system in place – the Gulf does not.

To try to understand how to respond to this disaster, GOM residents wanted to visit Alaskans to see what happened in the aftermath of the Exxon Valdez spill and how they can be better prepared for preventing and responding to an oil spill in the future. Over two dozen visitors came on trips coordinated with the Prince William Sound Regional Citizen’s Advisory Council (PWSRCAC), representing national leaders, fishermen, travel organizations, response centers and local parishes. Several news groups were also on these trips, including WWLTV in New Orleans, the Washington Post, and CNN.com.

Guests visited with PWSRCAC board members and staff. They were able to meet and exchange information with Alyeska Pipeline Service Company, the U.S. Coast Guard, Alaska SeaGrant, Shoreside Petroleum, Copper River Seafoods, Prince William Sound Science Center, the Ilanka Cultural Center in Cordova as well as the Prince William Sound RCAC. They also toured the Solomon Gulch Hatchery in Valdez. Community meetings were held to discuss issues and ask questions. Most visitors left with the intent of organizing citizens’ oversight in the Gulf. This will be challenging due to minimal funds, but after the President’s Deepwater Horizon Report was released, which included recommendations for citizens’ oversight not only in the Gulf but also in Arctic, this may eventually become a reality.

The goal for the Exxon Valdez oil spill affected area, written in the Oil Pollution Act of 1990 is “to promote partnership and cooperation among local citizens, industry, and government, and to provide citizen oversight of environmental compliance by oil terminals and tankers.”

For more information on this topic please contact Linda Robinson, robinson@pwsrcac.org, or visit our website at www.pwsrac.org.
Students catalogue salmon in pond

Thanks to Cordova’s 7th grade science class, Odiak Pond has been added to the State of Alaska’s Catalog of Waters Important for Spawning, Rearing or Migration of Anadromous Fishes. This catalog is maintained by Alaska Department of Fish & Game and establishes extra protection for listed waterways in order to sustain the State’s anadromous fish populations, primarily salmon.

Over the 2009-2010 school year, Cordova 7th graders collected the data necessary to prove that Odiak Pond is important spawning and rearing habitat for coho salmon.

Thanks to the 7th grade class for their hard work, and to our project partners for their help, including Cordova School District, US Forest Service Cordova Ranger District, Native Village of Eyak, Alaska Department of Fish & Game and Prince William Sound Science Center.

Visit www.copperriver.org to view the films created by the students. Follow links to “watershed education.”

Chugach Regional Resources Commission (CRR)’s “Iqsak K-12 Science Curriculum Project” is a 3-year US Department of Education funded project to develop a K-12 science curriculum for the Chugach region that reflects Alaska Native beliefs, values and understandings of the natural world with science education standards. Chugach Regional Resources Commission believes that a culturally-based natural resource science curriculum would enhance Alaska Native Students’ education and motivation to pursue post secondary degrees and careers in the sciences and natural resource management. The goal of the Curriculum is to introduce students to the relationships, diversity, and communities in the ecological and cultural environment of the Chugach Region, exploring Alutiiq and scientific perspectives and the connections between the two. For more information visit us online at www.iqsak.com or chugachk12.blogspot.com.

\[\text{SEAL FACTS}\]

Seals are mammals and they weigh about 24 pounds (10.9 kg) at birth and gain weight rapidly during a month-long suckling period, doubling their weight. Adults may weigh up to 300 pounds and males are somewhat larger than females. They are covered with short, stiff, bristle-like hair. There are three different kinds of seals in Alaska (bearded, ringed and harbor) and only harbor seal (Phoca vitulina) lives in the Prince William Sound. Their coloration varies, but two basic patterns occur: a dark background with light rings, or light colored sides and belly with dark blotches or spots. Harbor seals molt annually, usually in late summer. They eat a variety of fish such as salmon and herring, and crustaceans and squid. You can find them near coastlines, fresh water river systems, on remote intertidal sandbars, rocky shores and ice. (ADFG, 2011) Baby harbor seals sound like “maaa” and adults’ sound is almost like barking.

\[\text{SOUND}\]

- is a mechanical vibration that travels through matter as a waveform.
- consists of longitudinal or compression waves in matter.
- sound wave moves at approximately 1130 feet/sec. or 770 miles per hour at room temperature or 70 degrees Fahrenheit.
- the frequency of sound is the rate at which the waves pass a given point; the relationship between velocity, wavelength and frequency is: velocity = wavelength \times frequency.

\[\text{LEARN SUGGESTED WORDS!}\]

| Arrow | ruq |
| Boat | palag'utaq |
| Fire/campfire | keneq |
| Fish spear | kapsuun, kapsuutaq |
| Fish hook | iqsak |
| Hunt/hunting | pisurluni |
| Kayak, bidarka | apaqaq |
| Loud | kallaghtuluni |
| Oar, paddle | paku'ut |}

Illustration from the publication Chugach Sounds, copyright Chugach-Alaska Corporation

(\text{Vocabulary from Nanwalegmuit Pokawigmiut-llu Napugnerit - Conversational Alutiiq Dictionary, Kenai Peninsula Alutiiq by J. Leer, 1978.})
Marine debris survey

This chart was created by participants in the Prince William Sound Science Center’s Ocean Science and Leadership Expedition, a 10-day field course in ocean sciences. On the 2010 trip, participants completed a marine debris survey and cleanup of 17-Mile Beach in Valdez Arm.

Marine debris refers to any material found on shore or in the ocean that does not occur naturally. This debris comes from many sources: spills from boats, objects forgotten or left on beaches, and even garbage from city storm drains. Most marine debris washes ashore after drifting objects forgotten or left on beaches, and not occur naturally. This debris comes found on shore or in the ocean that does not occur naturally. This debris comes found on shore or in the ocean that does not occur naturally.

Types of marine debris found on 17-Mile Beach Total: 202 pieces of trash

- Misc 18%
- Styrofoam 50%
- Plastics 8%
- Paper 8%
- Rubber 8%
- Glass 8%
- Metal 8%
- Wood 8%
- Other 8%

**Loons and Grebes**
- Common loon
- Red-throated loon
- Pacific loon
- Yellow-billed loon (s)
- Horned grebe
- Red-necked grebe

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

**Guillemots/Terns**
- Glaucous-winged gull
- Herring gull
- Mew gull
- Bonaparte’s gull (s)
- Black-legged kittiwake
- Parasitic jaeger
- Pomerine jaeger
- Arctic tern (s) (meruiskulek)
- Aleutian tern (s, u)

**Seabirds**
- Tufted puffin (s) (ngaqngaq)
- Horned puffin (s) (ngaqngaq)
- Marbled murrelet
- Kittlitz’s murrelet (s)
- Parasitic auklet (s)

**Sea Birds (cont’d)**
- Black guillemot
- Common murre
- Razorbill
- Thick-billed and black-backed (chakkalak)
- Double-crested cormorant
- Great blue heron
- Pelagic cormorant

**Heron**
- Great blue heron

**Waterfowl**
- Surf Scoter (unavirllat saqulet)
- White-winged scoter
- Long-tailed duck
- Barrows goldeneye
- Common goldeneye (qupugnaq)
- Bufflehead
- Harlequin duck
- Mallard (ungusaq)
- Canada goose (tullek)
- Common merganzer (paug)
- Red-breasted merganser

**Cormorants**
- Pelagic cormorant
- Double-crested cormorant

**Misc**
- Insulation
- Glass
- Wood
- Plastic
- Metal
- Rubber

**Plastics**
- Bottle caps
- Plastic rings
- Plastic bags
- Plastic straws
- Plastic bottles

**Paper**
- Newspapers
- Magazines
- Envelopes

**Rubber**
- Gloves
- Bands
- Tires

**Glass**
- Bottles
- Jars

**Metal**
- Cans
- Nails

**Wood**
- Sticks
- Branches

**Other**
- Stuffed animals
- Toys
- Baby bottles

Since 1989, the Prince William Sound Science Center has conducted research and education to promote a sustainable future for the world’s richest waters - the Prince William Sound, Bering Glacier and Northern Gulf of Alaska bioregion. Through research, monitoring, education, demonstration, and scientific support, we provide the knowledge necessary to maintain self-regulating biodiversity, productivity and the sustainable use of renewable resources.

Friends of Prince William Sound & Copper River Delta

Thanks to our generous sponsors for their contributions. Please support these businesses and organizations who support our education efforts.

- **$500+**
  - Exxon Valdez Oil Spill
  - Trustee Council
  - Salmon for Alaska
- **$250**
  - Alaska Good Time Charters
  - Auklet Charter Services
  - Cordova District Fishermen United
  - Ecorest
  - von Wickman Family & Babkin Charters
- **$100+**
  - Leisure Time Charters
  - Pangaea Adventures
  - CR/PWS Marketing Association
  - Whittier Marine Charters
  - Stan Stephens Glacier and Wildlife Cruises

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We need your help to continue planning, developing and delivering our education and research programs. Consider a membership today!

Join online at www.pwssc.org or mail this form to: PO Box 705, Cordova, AK 99574

Name: ____________________________
Address: __________________________
Email: ____________________________

The PWS Science Center is a 501(c)(3) nonprofit research and education organization based in Cordova, Alaska.
From its origin in 1974, the salmon enhancement program of the State of Alaska was intended to protect the fisheries from cyclical weaknesses in the wild salmon returns. The Alaska Department of Fish & Game created the Fisheries, Rehabilitation, Enhancement, and Development (FRED) division and a constitutional amendment provided the basis for passage of the private, non-profit Hatchery Act in 1974. 

Prince William Sound hatcheries use the “ocean ranching” method of aquaculture, where eggs collected each summer and fall from wild brood stock are incubated in the controlled environment of the hatchery during the Sound’s harsh winter months. In the spring, fry emerge from their incubators and are released into the Sound. Salmon return to PWS to spawn after spending between 1-5 years in the Pacific ocean, depending on the specific species of salmon.

There are 6 hatcheries operating in PWS region. Annually, approximately 600 million pink, 133 million chum, 30 million sockeye, and 6 million coho salmon smolt are released. On average, this provides approximately 30 million pink, 4 million chum, 1.2 million sockeye and 600,000 coho adult salmon for the number of Alaska salmon are caught in gillnets.

### HATCHERIES

<table>
<thead>
<tr>
<th>Name</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prince William Sound Hatcher</td>
<td></td>
</tr>
<tr>
<td>Copper River Hatchery</td>
<td></td>
</tr>
<tr>
<td>Seldovia Hatchery</td>
<td></td>
</tr>
<tr>
<td>Kasilof Hatchery</td>
<td></td>
</tr>
<tr>
<td>Haines Hatchery</td>
<td></td>
</tr>
<tr>
<td>Cordova Hatchery</td>
<td></td>
</tr>
</tbody>
</table>

For more information: www.pwsa.com or www.wildsalmon.org/index.cfm/hatchery/whatcheries/whatcheries.sta

### TEST YOUR KNOWLEDGE!

Test your knowledge of fish species by reviewing the Prince William Sound hatchery's list:

- **Scallop**
- **Halibut**
- **Pink Salmon (Humpy)**
- **Coho Salmon (Silver)**
- **Chinook Salmon (King)**
- **Pacific Herring**
- **Rockfish**
- **Pacific Cod**
- **Longline**
- **Spot Prawns**

#### QUESTION:

Which fish is set in a circle and can be drawn closed at the bottom? (Select one)

- Scallop
- Halibut
- Pink Salmon (Humpy)
- Coho Salmon (Silver)
- Chinook Salmon (King)
- Pacific Herring
- Rockfish
- Pacific Cod
- Longline
- Spot Prawns

#### ANSWERS:

- **Scallop**
- **Halibut**
- **Pink Salmon (Humpy)**
- **Coho Salmon (Silver)**
- **Chinook Salmon (King)**
- **Pacific Herring**
- **Rockfish**
- **Pacific Cod**
- **Longline**
- **Spot Prawns**

### Facts about Alaska's commercial fishing industry

- Alaska is the top producer of wild, high-value salmon, producing nearly 80% of the world's supply.
- The seafood industry is Alaska's largest private sector employer. Seafood contributions to the state general fund over the past 6 years have totaled over $1.5 billion. A testament to the long-time importance of the seafood industry in Alaska, the 2013 Fishermen’s Business Tax is the oldest tax in the state.
- Due to high quality initiatives and increased demand Alaska is realizing more value per pound of seafoods.
- Alaska is the #1 ranked state for volume of commercial landings and over 55% of America's commercial seafood is caught in Alaska. Alaska State commercial landings amount to 39% of the total value of seafood landed across the USA, at $1.7 billion.

### Salmon feeds Alaska.

It fills bellies with some of the finest wild protein in the world. It provides jobs and income to thousands of commercial permit holders and crew across the state. It brings commerce and infrastructure to communities and tax revenue to local and state coffers. It supports a spirit and way of life that is as wild and natural as Alaska's coastline is long.

You may not realize all the ways that Alaska's commercial fishing industry benefits the state and its residents. Revenues from commercial fishing not only support individual jobs, but seafood taxes also boost the state’s general fund and help support schools, hospitals and infrastructure in communities throughout Alaska. Inbound freight costs to the state are reduced up to 10c/lb due to seafood that is shipped out reducing the cost of goods and merchandise you purchase in Alaska.

Whether you harvest commercially, for subsistence, sport or personal use, wild Alaska salmon feeds us all and we all benefit from this shared resource. We invite you to join us in celebrating all the ways that Alaska's salmon industry supports our economy, community and culture.

### Learn all the ways that salmon feeds Alaska.

Visit us and share why Alaska’s salmon industry is important to you:

Facebook.com/Salmon4AK

### Decorate your salmon then send us your best design for a chance to win a Salmon for Alaska prize package!

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