PRINCE WILLIAM SOUND SCIENCE CENTER

DELTA SOUND CONNECTIONS

NATURAL HISTORY AND SCIENCE NEWS FROM PRINCE WILLIAM SOUND AND THE COPPER RIVER BIOREGION

2016-2017

Biodiversity Serves Us All

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We dedicate this edition of Delta Sound Connections to biodiversity—something that few people think about in their day-to-day lives. Why should you care about biodiversity? Because when the number and variety of living things decrease in an ecosystem, it affects our own well-being and economies.

It may seem odd to think of ecosystems as providing you with services, but they do just that. Thanks to biodiversity, ecosystems provision us with the abundant fish and game meat that so many Alaskans rely on to get them through a winter's worth of dinners. The water that fills our town's reservoir, the oil that gets refined and fuels our cars, the wood with which we build our homes, some of the medicines we use—these are examples of the provisioning services of ecosystems.

Ecosystems regulate the world in a way that makes life better for humans—a fallen tree and a dead salmon get decomposed by bacteria and fungi, converting their tissues into useful nutrients and removing what would otherwise amount to piles of organic waste in places we like to fish and recreate. The act of pollination makes it possible to have fruit in our pies and honey in our tea. The fact that there's a stand of trees alongside a creek stabilizes the soil, helps control flooding, and pulls carbon dioxide out of the atmosphere.

Whether you live in Alaska or are on a once-in-a-lifetime trip here, it is obvious that our ecosystems support Alaskan culture, too. Be it through the use of fur, feathers, bark, grasses, and wood that comprise traditional dress and crafts; the berry gathering trips that fill our summer and fall days; or the trails we love to hike and waters our ferries and fishing boats ply, the natural world influences and guides us.

Lastly, ecosystems provide supporting services that make life as we know it feasible on Earth. Thanks to photosynthesis, plants in the world's oceans—most of which are microscopic in size—generate about 70 percent of the oxygen in our atmosphere. As you read about the diverse ecosystems of our "home turf" in this eighth edition of Delta Sound Connections, I hope you discover something new to appreciate about biodiversity.

What Does Biodiversity Mean to You?

Charlotte Westing | Wildlife Biologist
Prince William Sound Area
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Valuing biodiversity means recognizing that food webs are so tangled and complex that our understanding of them is miniscule in comparison to what is left to be learned. It means considering the importance of all organisms, not just those that fill the freezer. In the face of global climate change, it's important to realize that there are species that will be winners (such as deer in mild winters) but there are those that will be losers (shellfish, black bears).

Mike Mahoney | Board Chair
Prince William Sound Science Center
Area E Drift Gillnetter

Biodiversity matters a lot to me because it is a sign of an ecosystem's health and stability. As a fisherman and resident of a coastal community, I depend on the health and abundance of our ocean and entire watershed. Biodiversity is critical for resilient ecosystems, communities and economies.

Milo Burcham | Wildlife Biologist
U.S. Forect Service
Chugach National Forest

Biodiversity makes this planet interesting. I am fascinated by the range of creatures that inhabit our planet and their diversity of appearances, adaptations, and interrelationships: that we have mammals living near us that range in size from shrews to moose; that a multitude of life forms, from frogs to salmon, are dependent on the work of beavers; and that tropical wetlands are connected to Alaska's Arctic tundra by the multitudes of shorebirds that migrate between them.

Also, biodiversity means resiliency. The greater the diversity of life forms in an ecosystem, the greater the chances of that ecosystem surviving adversity. And that is good for us, as we depend on these ecosystems to survive.

Kristen Gorman, PhD
Research Ecologist
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The evolution of life on Earth, which has been ongoing for approximately the past 3.5 billion years, has resulted in fantastic natural wonders—deep-sea chemosynthetic invertebrate communities, mass migrations of large vertebrates across African savannas and the Arctic tundra, the incredible mating system and plumage variations among tropical birds, as well as the life histories of Pacific salmon.

Life's diversity as we know it does not exist elsewhere in the universe.

For these rather profound reasons, all species deserve to be carefully studied and conserved, if not for their own intrinsic value then at least for their role in shaping the myriad of services they provide, such as food and medicine. As humans, we are fortunate to share our planet with so many other different and interesting species, and we stand to benefit a great deal from a careful understanding of the factors that generate and maintain our planet's biodiversity because it is ultimately our life support system.

INSIDE THIS ISSUE

Page one photos credit: PWSSC.

The Cordova Center—Heart of the Community

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A multi-use community facility, the Cordova Center stands as a testament to perseverance in the middle of this secluded Prince William Sound community. Thirteen years in the making, the 34,000-square-foot building resides in the heart of the business district yet is connected to the lifeblood of Cordova, its port and harbor.

Designed by MRV Architects with much community input, the Center houses the Public Library, the Historical Museum, the North Star Theatre and auditorium, administrative offices, and meeting spaces. A large center atrium welcomes visitors and residents into the warm living room-like space with its million-dollar view of the Cordova harbor.

Special touches of copper adorn the exterior and interior, reflecting the town's past history and connection with the Kennecott Copper Mine in McCarthy. Local rock has been sculpted into the base of the exterior; Yellow Cedar columns and regional art made of old fishing line add a touch of local color.

The spacious library has room for everyone from infants to adults and areas for reading by the magnificent windows. On rainy days, you can tuck yourself into a cozy chair by the crackling copper- and brass-trimmed fireplace.

The historical museum houses a unique collection of artifacts and photos that tell the story of the development of Cordova, Prince William Sound and Copper River regions. Exhibits are being created by the museum staff and Cordova High School volunteers to fill the gallery spaces.

The performance space in the North Star Theatre has been designed to fill many slots on the community's wish list. The 200-seat theater has been designed to show movies and the stage can be set for drama and dance performances, lectures, and musical concerts. It also features a Nancy Stonington Taylor floor-to-ceiling art piece. Meeting rooms within the facility provide ample space for a variety of conferences, meetings, and workshops. Overall, the Cordova Center supports wide-ranging development opportunities in a community still rebounding from impacts caused by the *Exxon Valdez* oil spill.

Photo (top right): The atrium offers views from every angle.
Photo (middle): The Cordova Center with Mt. Eccles in the background.
Photo (bottom right): The North Star Theatre is named after an original movie house in Cordova.
Photos: Zane Jones of MRV Architects.

The Culture Club

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The Culture Club is alive and well, in this case without singer Boy George, at the Cordova Museum inside the new Cordova Community Center.

That's not all.

- The North Star Theatre features a state-of-the-art sound system for movies, musical performances, plays and lectures. A current schedule of upcoming events can be found at *www.thecordovacenter.org*.
- The Copper River Gallery is a temporary exhibits gallery that showcases relevant art and exhibits from local, Alaskan, national and international artists.
- The Museum's permanent art collection features paintings by Alaska's "painter of light", Sydney Laurence, Barbara Hoover, Jules Dahlager, and Cordova's Eustace Ziegler. With assistance from the Rasmuson Art Acquisition Fund the museum is building its collection by adding works from David Rosenthal, Susan Ogle, Karl Becker, Paula Payne, and others.
- The Cordova Historical Society holds a lecture series featuring vintage photographs, local lore, lively discussion and home-cooked snacks.
- The Museum also sponsors elementary school visits and a teen art class. The library sponsors After-School Art activities and a pop-culture Pokemon Club.

Please visit and enjoy the world-class ocean and harbor views from the Cordova Museum, located on First Street in downtown Cordova.

Photo (bottom left): Pokemon Club members fill up the tables in the "teen" room of the library. **Photo (bottom middle):** Plenty of windows provide a good view—rain or shine. **Photo (bottom right):** Local artist R.J. Kopchak turned the fireplace nook into a wonderful space. *Photos: Miriam Dunbar.*

Stormwater Runoff

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In communities large and small, impervious surfaces (such as parking lots or other places where rainwater cannot penetrate) dominate the cityscape. At these sites, it is common to see a rainbow-like sheen from leaking vehicle fluids. According to the U.S. Environmental Protection Agency, these signs of stormwater runoff are indicative of the largest threat to water quality in the United States today.

Stormwater runoff is any pollution in the streets that is swept into storm drains when it rains. Pollution sources include fuel from home heating tanks, oil and other fluids from leaky vehicles, trash, dog poop, sand, gravel and salt. This polluted runoff harms fish and wildlife populations, degrades fish habitat and contaminates drinking water resources.

Reducing impervious surfaces and creating vegetative (planted) buffers are great ways to help reduce stormwater pollution. In Cordova, we tackled the issue of stormwater pollution flowing into Odiak Pond by creating what is known as a bioswale. Runoff from a nearby parking lot drains into the bioswale, where it is slowed and filtered by native plants. The plants filter the water with their roots, extracting and breaking down pollutants. The end results in cleaner water. Because Odiak pond is a spawning and rearing habitat for coho salmon, filtering stormwater before it enters the pond is very important.

If you have a rain gutter, directing the flow of water onto vegetation instead of letting it run down the driveway is an easy way to reduce stormwater runoff. Preventing leaks from cars and home heating tanks also reduces pollution in stormwater runoff—and it saves you money.

Next time it's raining, can you find and stop the source of one of those toxic rainbows? Sometimes identifying a single source is obvious, but sometimes it may be a conglomerate of several sources that are contributing to the toxic gushes. Please do what you can to help prevent stormwater pollution and, in the words of our public education campaign, "Don't Run off Salmon!"

Photo (bottom left): Bioswale before planting in the fall of 2013.
Photo (bottom right): Kate Morse and Waylon next to the bioswale in the spring of 2015. *Photos: CRWP*

Understanding Our Home

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"Understanding our home", the theme of education programs at the Prince William Sound Science Center, has all Cordova fourth through eighth graders participating in hands-on explorations of our local ecosystems.

As part of a comparative ecosystem assessment, seventh- and eighth-grade students from Cordova Jr./Sr. High School visit the city dock each month to monitor water quality, survey invertebrates in the harbor and collect plankton samples. These long-term data sets, along with data collected by the students' peers at freshwater and brackish locations, allow students to compare local ecosystems while improving their understanding of scientific research and data-driven decision making.

Mt. Eccles Elementary School students get their hands (and feet) wet while exploring marine ecosystems during monthly Discovery Room programs. Fourth and fifth graders spend the year learning about Cordova's connection with salmon and marine ecosystems. Students play games to learn about salmon and herring life cycles and food web dynamics. They dissect adult Coho Salmon and Pacific Herring, as well as collect and identify plankton, investigate ocean acidification and visit critical spawning habitats. The sixth grade class investigates ocean circulation, marine debris, and oil spill response, recovery and prevention. The year comes to a close with a Remotely Operated Vehicle (ROV) challenge, during which students design, build and put their ROVs to the test in a mock oil spill cleanup. The sixth graders will end their year with a two-night camping trip on the Copper River Delta, giving them more opportunities to explore and gain a better understanding of our home.

These programs are made possible by a variety of supporters, including the Oil Spill Recovery Institute and Prince William Sound Regional Citizens' Advisory Council.

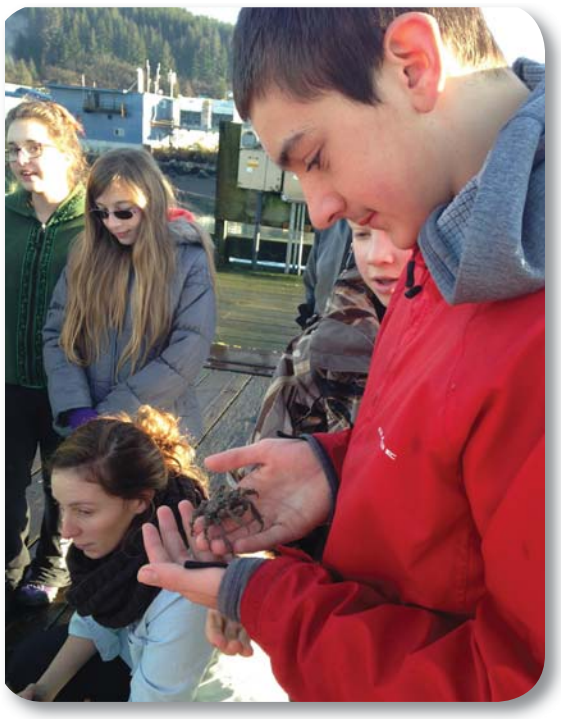

Photo (right): Seventh- and eighth-grade students investigate marine invertebrates during a comparative ecosystem assessment field-trip. *Photo: PWSSC.*

Japanese Tsunami Marine Debris

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In 2015, Gulf of Alaska Keeper (GoAK) crews cleaned Japanese tsunami marine debris from Gulf of Alaska shorelines at Montague Island and Kayak Island, and around Gore Point (on the tip of the Kenai Peninsula) for the Alaska Department of Environmental Conservation (ADEC). Extensive cleanup work also occurred on Montague Island for the *Exxon Valdez* Oil Spill Trustee Council. GoAK contractor Blue Fox Bay Lodge continued ADEC cleanup work on Afognak and Shuyak Islands (north of Kodiak Island). The National Park Service conducted Japanese tsunami marine debris cleanup projects in Katmai, Kenai Fjords and Wrangell-St. Elias National Parks. Together, these 2015 projects removed over 1,400 Super Sacks and many tons of other large debris, adding this mass to the debris collected during 22 previous cleanup projects conducted over several years. That debris has been cached in 11 sites along the Gulf of Alaska.

In late July 2015, during a Japan-funded ADEC project, 3,400 Super Sacks and hundreds of bundles of large debris were long-lined offshore by Alpine Air helicopters and brought to a massive Boyer Towing barge. It was shipped to Seattle and then sent to Waste Management's Astoria, Oregon landfill for disposal. During its passage south, the barge stopped off western Vancouver Island to take on additional debris from the tsunami, collected in Barkley Sound.

Photo (top left): A loader on nearly-covered football-field-sized barge deck works off Kayak Island to make space for more debris from Wrangell Saint Elias National Park shoreline and Barkley Sound, Vancouver Island. *Photo: Ryan Pallister.*
Photo (bottom left): At the Waste Management Duwamish River yard in Seattle, a small portion of the mountain of buoys and other large debris removed from Gulf of Alaska beaches waits on the barge deck for unloading. *Photo: Chris Pallister.*

SNAP TO WIN!

Snap a quick photo showing us where you are reading your copy of *Delta Sound Connections*.
Post your photo on our Facebook wall and tell us your favorite article in this issue for a chance to win a prize! Winners selected 10/1/2016 and 3/1/2017.

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Trends in Wilderness Character of the Sound

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"Wilderness" is a word that is casually applied to Prince William Sound. However, for the U.S. Forest Service (USFS), this term carries explicit meaning, especially for the Wilderness Study Area in the western Sound. Presently, the USFS is analyzing data to describe how wilderness conditions are faring.

Through the Alaska National Interest Lands Conservation Act, Congress designated the Wilderness Study Area in 1980. Its vast territory of 2 million acres includes Columbia Bay, Knight Island, Harriman Fjord, Port Bainbridge and other areas. USFS policy is to preserve its "wilderness character"—a term that comes from the 1964 Wilderness Act. Nationally, the USFS and other agencies use five qualities, including natural and undeveloped lands and opportunities for solitude, to define wilderness character.

Workers with the Chugach National Forest began gathering data on such conditions four years ago. They used an interdisciplinary process that follows national protocols for wilderness management. The data will be analyzed for significant trends later this year.

Some early trends are already apparent. Unauthorized structures such as trespass cabins or abandoned installations have decreased substantially in recent years. Invasive species have increased in number and acreage, but affect a small percentage of lands. Solitude has diminished.

A report with information on additional trends, such as air quality, human manipulation of ecological processes and other features that may ultimately inform management of the Wilderness Study Area will soon be released.

Photo (above): Hiking in the Wilderness Study Area. **Photo (below):** A painter finds inspiration in the Wilderness Study Area of western Prince William Sound.
Photos: U.S. Forest Service

State of the Sound: Very Warm

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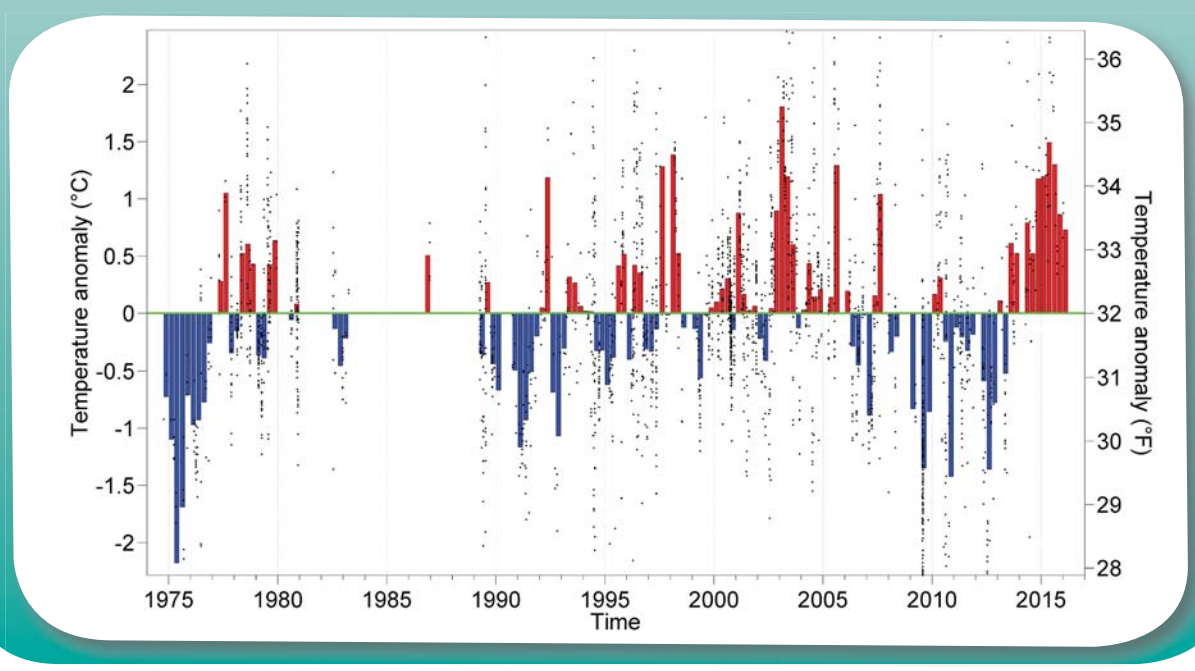
Winter in the Gulf of Alaska and Prince William Sound is usually a pretty wild time. A large low-pressure system called the Aleutian Low brings huge storms across the North Pacific. Those storms mix the surface of the ocean down to a depth of several hundred feet. This mixing plays an important part in local weather by cooling the ocean's surface.

In the winter of 2013 and again in 2014, something changed. Instead of the Aleutian Low, an atmospheric feature that meteorologists have dubbed the Ridiculously Resilient Ridge formed, leading to unusually high pressure over the North Pacific and altering storm tracks away from the North Pacific. This resulted in much less winter mixing than usual and lead to a warm temperature anomaly that oceanographers nicknamed The Blob.

The Blob anomaly has persisted in Prince William Sound through 2015 and into 2016, with temperatures as much as 1-1.5 degrees C (3-4 degrees F) above average. The year 2015 also featured a large El Niño in the equatorial Pacific Ocean. This phenomenon often causes warmer-than-average temperatures, and may be interacting with The Blob signal. Although the warmth due to The Blob is not record-breaking, it is unusual for it to be so warm for so long.

Scientists are watching the region closely, because it appears that The Blob has caused large changes in the marine ecosystem. Reports of dead and dying seabirds, smaller-than-average-sized fish, lower-than-average nutrient concentrations, and changes in plankton blooms may all be related to The Blob.

Graph (below): Near-surface temperature anomalies in central Prince William Sound from 1975 to 2012. The anomaly may be thought of as the departure from "average" conditions. The bars represent quarterly averages and roughly correspond to seasons (winter, spring, summer and autumn); the black dots are actual observations. Red bars are positive ("warmer-than-average") anomalies and blue bars are negative ("cooler-than-average") ones.



Through the Microscope

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On land, elements of the food web can easily be seen everywhere. Trees, shrubs, and grass convert sunlight into food for deer, moose and other herbivores. Many of these herbivores are then eaten by predators and people.

In the open ocean, a similar dynamic exists but on a much smaller physical scale, requiring us to pull out our microscopes to see what's going on. Just like vegetation on land, microscopic single-celled algae (collectively known as phytoplankton) kick off the base of the food web and are consumed by tiny animals (zooplankton). In turn, the zooplankton are eaten by just about everything in the ocean—from the smallest herring to the largest whales.

The zooplankton community is comprised of many different kinds of animals. Tiny shrimp-like crustaceans called copepods are found in abundance throughout Prince William Sound and the Gulf of Alaska. Swarms of these animals can include trillions of individuals. Some animals, including crabs, barnacles, and certain fishes, begin their lives as free-swimming larvae in the zooplankton community. As these transient members grow and metamorphose into adults, they join different ocean communities and contribute to the overall health of the ecosystem. For these reasons, researchers at the Science Center monitor zooplankton during this time of changing oceans and climate.

Photo (left), clockwise from top right: Clam shrimp, male copepod, larval sea star, female copepod with eggs. White scale bar represents 0.5 mm.

Eavesdropping Electronically on Pacific Cod

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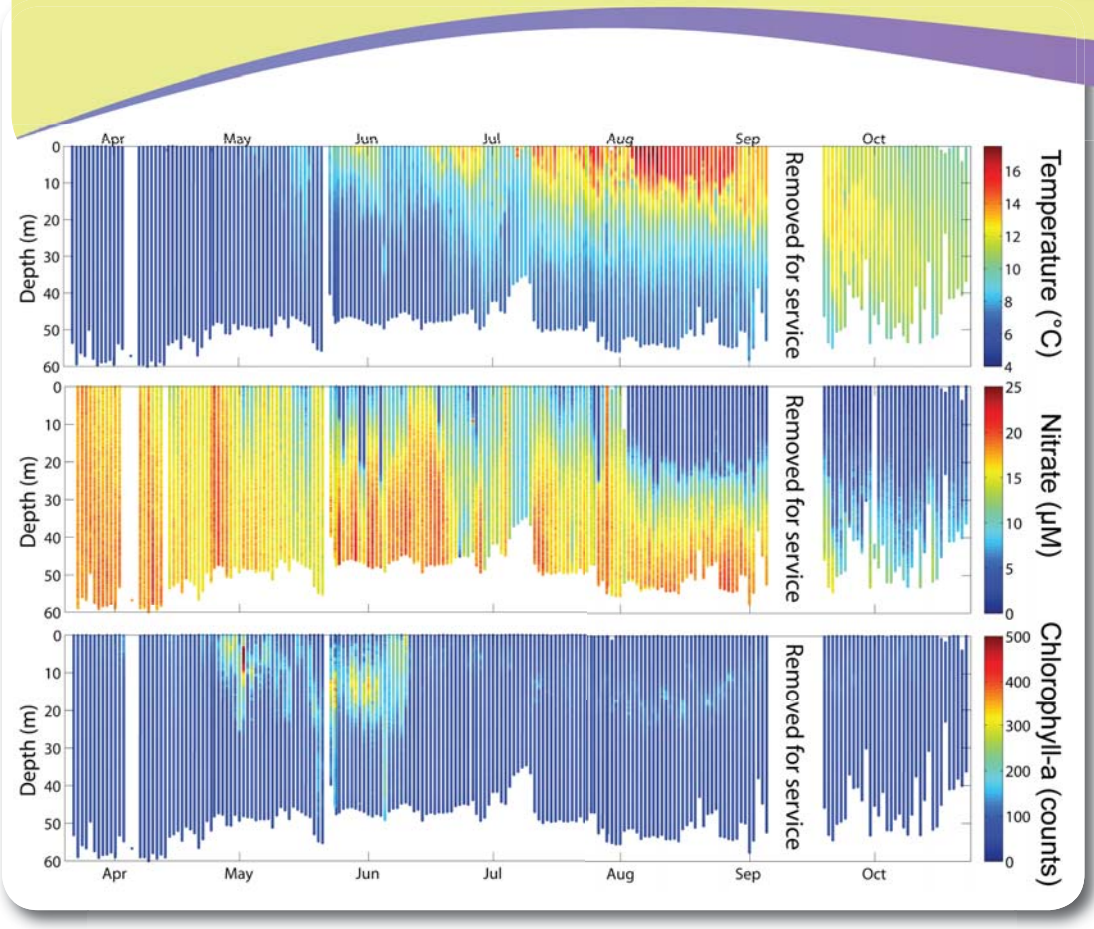
Have you ever wondered where the fish you caught came from or where it was headed? Did the fish spend its whole life in Prince William Sound near the bay where you captured it? Or did it make a purposeful migration into the Gulf of Alaska to feed? At the Prince William Sound Science Center, we are using sound waves through a process called acoustic telemetry to investigate these questions.

Acoustic telemetry requires two essential pieces of equipment: small devices called pingers, which are surgically implanted into fish, and larger acoustic listening stations to hear the unique acoustic signals emitted by the pingers. With funding from the North Pacific Research Board, we implanted pingers in 123 Pacific Cod (*Gadus macrocephalus*) and deployed acoustic listening stations in two Prince William Sound fjords during the winter of 2013. In collaboration with the Ocean Tracking Network, we also deployed acoustic listening stations across the major entrances and passages connecting Prince William Sound to the Gulf of Alaska.

To date, these acoustic listening stations have gathered over four million records of our tagged Pacific Cod. We will download data from acoustic listening stations for the final time in the spring of 2016. Spanning two and one-half years, these records will provide a remarkable look at the movements and ecology of Pacific cod populations inhabiting Prince William Sound.

Photo (top): Suturing a Pacific Cod held in a tagging gurney containing oxygenated sea water.
Photo: Montague Marine Research, LLC.



Graph (above): The evolution of the surface ocean in Prince William Sound in 2015. Temperatures (top panel) began to increase near the surface in May and, by mid-July, had formed a layer of warm water at the surface. Nitrate (middle panel) was high in winter and was completely exhausted near the surface by August. Phytoplankton biomass was highest in May-June, when there were abundant nutrients at the surface and the longer days provided plenty of light.

Robot Collects Daily Data in Sound

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The ocean tends to form into horizontal layers, with warmer, fresher water layering over colder, saltier water. When on cruises, oceanographers aboard ships generally lower instruments into the water to collect information about those layers. The oceans are very dynamic places, and sampling from ships is very expensive. Nowadays, it is possible to use devices called autonomous samplers that can stay out and collect information much more often and for longer periods than is practical with ships.

In March 2015, oceanographers from the Prince William Sound Science Center deployed an autonomous profiling sampler in central Prince William Sound. The Autonomous Moored Profiler (AMP) is a tethered robotic float with several instruments aboard that is able to raise and lower itself from a depth of about 60 meters (180 feet) to the surface every day, using a small onboard winch.

During the 2015 deployment, which lasted until October, the AMP took measurements almost every day and observed the setup of the annual thermocline—the layer of warm water that forms at the surface every year. It also followed the breakup of the thermocline in autumn. By measuring chlorophyll, an index of the abundance of phytoplankton (the single-celled plants that grow near the surface of the ocean), the AMP showed a phytoplankton bloom in the spring (May-June) as the thermocline formed. The AMP also observed a corresponding reduction in the amount of nitrate, the limiting nutrient for phytoplankton growth.

With this information, scientists can watch the annual development of open water productivity in Prince William Sound in near real time. Observations of productivity and nutrient use will give a better idea of how biological production changes from year to year and how the ecosystem is changing over time.

Smitty's Cove Dive Program

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Located in the town of Whittier, Smitty's Cove provides convenient access to Prince William Sound for a variety of commercial and recreational users. Scuba divers are especially attracted to the Cove, which contains the underwater wreckage of a World War II shipping facility and an artificial reef system installed by NOAA.

Project Baseline: Smitty's Cove began in May 2015 and uses a dedicated group of scuba divers to document the underwater environment of this popular site. Volunteer divers have been busy setting up data-gathering stations, refining data collection processes, shooting photos and videos and enjoying their journeys into citizen science. Nearing the project's one-year anniversary, a comprehensive baseline site profile has been established and the team is committed to long-term continued monitoring.

Data collected by divers includes measurements of pH, salinity, depth, temperature and visibility. An additional six survey locations use transects, photo quadrats and population counts to determine the vitality of marine life in the area. These additional surveys focus on key marker species of algae, rockfish, sea pens and sea whips.

Complementing the hard data, a visual library contains imagery of more than 120 species that make their homes in Smitty's Cove. By sharing this information with a network of collaborators, Project Baseline: Smitty's Cove hopes to raise awareness about the marine environment and advocate for additional conservation efforts to protect these vital resources.

Photo (below): Diver conducting a transect survey to measure population density of sea whips (*Halipteris willemoesi*) in Smitty's Cove. *Photo: Brandon Hunter.*

Photo (left): Aerial imagery from 2009 showing Columbia Bay and Heather Island (denoted by red dot). In 2015, Columbia Bay was nearly ice free to the head of the glacier, as noted by the red boundary line. The 2015 survey sites are circled in yellow. **Photo (right):** The exceptionally rare Apetalous Campion growing near Heather Island in 2009. *Photo: Sean Meade.*

Rare Plants of Columbia Bay

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Located to the west of Valdez, Columbia Bay is unique within the region, but also globally as well. It contains a large tidewater glacier that, until 1980, extended almost to the mouth of the bay. This enormous block of ice has since retreated over 12 miles—a movement that has rapidly exposed large areas of underlying rock and substrate. Much of these recently exposed, well drained areas provide suitable and unique habitat for several rare plants.

Concerned about the increased recreational use of the area and the potential for trampling the rare plants, the U.S. Forest Service conducted preliminary plant surveys in 2015. Rare plants were found at two of the five sites surveyed—a high incidence of occurrence compared to the rest of Prince William Sound. A single Pale Poppy (*Papaver alboroseum*) was found in what appeared to be a desolate moonscape. A sizable population of the Alaska Mistmaiden (*Romanzoffia unalaschcensis*) was found thriving in a wet seam. Additional populations of this species were also discovered on Hitchinbrook Island last summer.

Another plant rarely seen in Prince William Sound is the stunning Apetalous Campion (*Melandrium apetalum*), first documented near Heather Island in 2009. Alas, the Heather Island population was not found by surveyors during a visit to this site last summer. More surveys are scheduled for 2016.

INVASIVES

Slug Crossing

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It's well known that Cordova has an infestation of non-native European Black Slugs (*Arion ator*). The large (up to seven-inch) intruders have defoliated gardens and marred sidewalks here for decades. Now, though, they have also appeared in western Prince William Sound.

In the Chugach National Forest, researchers have documented a population in Eshamy Bay, and in 2015, Chenega Bay residents found them in their gardens for a fourth consecutive year. Sightings have occurred at Cannery Creek in Unakwik Inlet, while reports of the slugs in Whittier have increased. A 2006 risk assessment for the Copper River Delta rated the slugs' spread and establishment potential as high, driving concerns about new sightings.

Recently, U.S. Forest Service biologists and Alaska Geographic youth performed population studies at Eshamy, the largest known European Black Slug population outside the Cordova area. Partly funded by the Prince William Sound Resource Advisory Committee, this study indicated the population may be constrained by geographic features, raising hopes for its eradication. This summer, the U.S. Forest Service and Alaska Geographic will experiment with removal strategies. Boaters and others should clean their gear, especially in areas with slugs, before traveling throughout the Sound. Do not intentionally step on slugs, as eggs can still be spread or fertilized. Collecting and burning the slugs is a better response. Report any European Black Slug sightings to U.S. Forest Service biologist Melissa Gabrielson at (907) 424 4757.

Photo: A European Black Slug found along Eshamy Bay. *Photo: U.S. Forest Service.*

Keeping Tabs on Invasive Species

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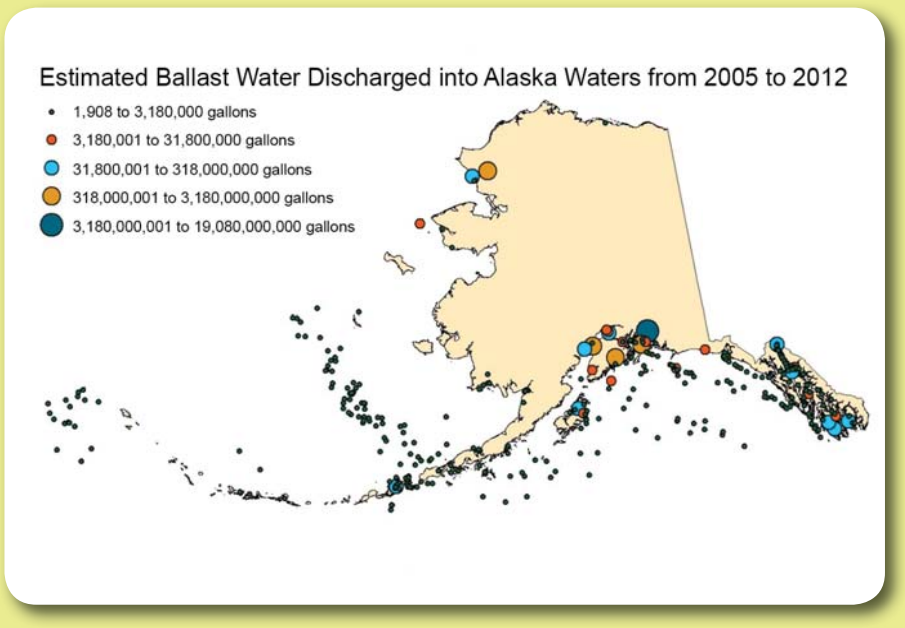
Each year, large volumes of ballast water are discharged into Alaska's waters from tankers and other vessels. This ballast water can contain microscopic species, such as baby European Green Crabs, or other tiny creatures that may not be native to our environment. These non-natives can compete with our native species for food and habitat, posing a threat to the aquatic environment.

In response to this threat, the Prince William Sound Regional Citizens' Advisory Council has partnered with the Smithsonian Institution since 2000 to monitor for the aquatic invasive species that may be transported in ballast water from oil tankers.

As part of this work, we support citizen monitors in communities around the Sound. These volunteers watch their local waters for invasive species, using traps to catch invasive crabs and special collection plates to catch invasive tunicates (or sea squirts)—sponge-like invertebrates, such as the "sea vomit" that covers rocks and other hard surfaces, smothering any life that was there beforehand.

The Council applies various strategies to support local monitoring needs. In Valdez, Council staff members work with a high-school class to combine monitoring and education. A teacher helps us monitor the Whittier area and youth interns in Cordova are trained to monitor their local waters. With support from the Council, a local biologist also monitors Chenega Bay.

Fortunately, our monitors in the Sound have yet to discover any of the most damaging aquatic invasives. However, these citizens help the council remain vigilant against potential threats from these animals and plants. In the future, oil tankers will use onboard ballast water treatment systems that should help reduce the need for this sort of monitoring.



Elodea and Our Outdoor Lifestyle

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> *The more Elodea spreads, the less control we will have over the outcome and cost to Alaskans.*
> - Alaska Department of Natural Resources

Commonly known as pond weed or water weed, *Elodea* is the first invasive aquatic plant recorded for Alaska. It has overgrown lakes and sloughs, changing the aquatic ecosystem and affecting fish habitat. *Elodea* is present throughout the Copper River Delta, including the Alaganik and Eyak systems, as well as Martin and Bering lakes. Because broken segments of *Elodea* will form new plants, this invasive plant can easily spread to new waterbodies. *Elodea* is also resilient, able to survive out of water for more than a day. It can even withstand being frozen in ice.

To prevent the further spread of this invader, clean, drain and dry everything that comes in contact with *Elodea*:

CLEAN Remove all visible mud and plant debris from rods, nets, waders, anchors, boats, and other gear. Once home, pressure wash your watercraft and trailer, including all of the boat equipment that came into contact with the water.

DRAIN Drain and rinse water from areas such as coolers and live wells.

DRY If possible, allow equipment and gear to dry completely before entering new waters. *Elodea* plant segments can easily survive out of water, if allowed to remain wet.

Photo (left): A mat of *Elodea* washed up on the shore of Eyak Lake, Cordova, Alaska, January 2016. *Photo: T. Tanner* **Photo (above):** Individual *Elodea* plants may vary in appearance, depending on species and growing conditions.

For more information, *visit http://copperriver.org/programs/invasive-plant-management/elodea*

ROV Challenge 2016

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Spending a long weekend of 12-hour days with a crew of high school students, sounded intimidating. Thankfully, I was in for a pleasant surprise.

In February 2016 I attended my first-ever Tsunami Bowl—Alaska's regional competition of the National Ocean Sciences Bowl. Over a very intense three days, teams of high school students, who had spent months preparing, got to present their research and participate in a fast-paced quiz competition. I was expecting a viciously competitive atmosphere; instead, what I found was a bunch of friendly, fun and supportive kids who also happened to be wickedly smart.

My role at the 2016 Tsunami Bowl was to put on the very popular ROV Challenge. For this event, teams design, build and test an underwater Remotely Operated Vehicle (ROV) for use in an oil spill response and cleanup scenario. In the midst of the largely academic weekend, the ROV Challenge taps into more tactile learning modalities and offers an opportunity for kids from all around Alaska to experience a bit of marine engineering.

The ROV Challenge is also a venue for drawing participants' attention to oil spill prevention and response. After an introduction covering the devastating effect of the *Exxon Valdez* oil spill and highlighting the need for state-of-the-art oil spill technologies, the day's scenario was introduced: teams were asked to design an ROV for theoretical use at the Valdez Marine Terminal of the Alyeska Pipeline. The ROV would need to be capable of performing an array of tasks. These included inspecting berth infrastructure, securing an underwater anchor and responding to a simulated small "oil spill" represented by 10 black ping pong balls.

Teams had one hour to design and build their ROVs, using a variety of PVC pipes and joints. Watching young minds churn through the spatial possibilities is always gratifying, but at this event, sparks of inspiration seemed to be literally flying through the highly charged air. I didn't catch a single whiff of mean-spirited competition anywhere. Instead, I saw a bunch of awesome kids having a blast and using their brains in an entirely new way.

Congratulations to everyone who competed in the ROV Challenge.

Photo (above): The Contagious Cyclopteruses from Homer High School show off their First Prize ROV. *Photo: Wolfgang Kurtz.*

Mock Oil Spill at Mt. Eccles School

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On February 4, Mt. Eccles' sixth grade class got messy.

The afternoon began innocently enough, with a discussion surrounding oil—from how it forms to the myriad of petroleum-based products made out of it. From there the conversation launched into oil spills, a subject near to Cordova's heart.

When students were asked if they thought that Prince William Sound had recovered from the *Exxon Valdez* Oil Spill, not a single "yes" hand went up. Although the 1989 spill happened long before these kids were born, the effects are still felt and understood throughout our community.

After taking time to consider the somber realities we moved to our hands-on project. Each group of students was given a tub of water and a small vial of "crude oil" (a mixture of vegetable oil and cocoa powder) to create a mock oil spill. Groups were given a variety of materials to attempt to clean up the oil such as sponges, soap, and sorbent pads.

The inherent challenge of removing oil from water led students to a tactile realization about oil spills, and the afternoon ended by highlighting response and prevention strategies currently in place for Prince William Sound.

All in all, it was a great day. We explored, got messy, and asked questions—we even found a few answers.

Thanks to the Prince William Sound Regional Citizens' Advisory Council and the Oil Spill Recovery Institute for supporting the Oil Spill Unit of our Discovery Room Program.

Photo (left): Students examine their mock oil spill and contemplate how best to clean it up. *Photo: PWSSC.*

Exxon Valdez Oil Spill

On March 23, 1989, the oil tanker *Exxon Valdez* left the Valdez Marine Terminal at 9:12 p.m., 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.

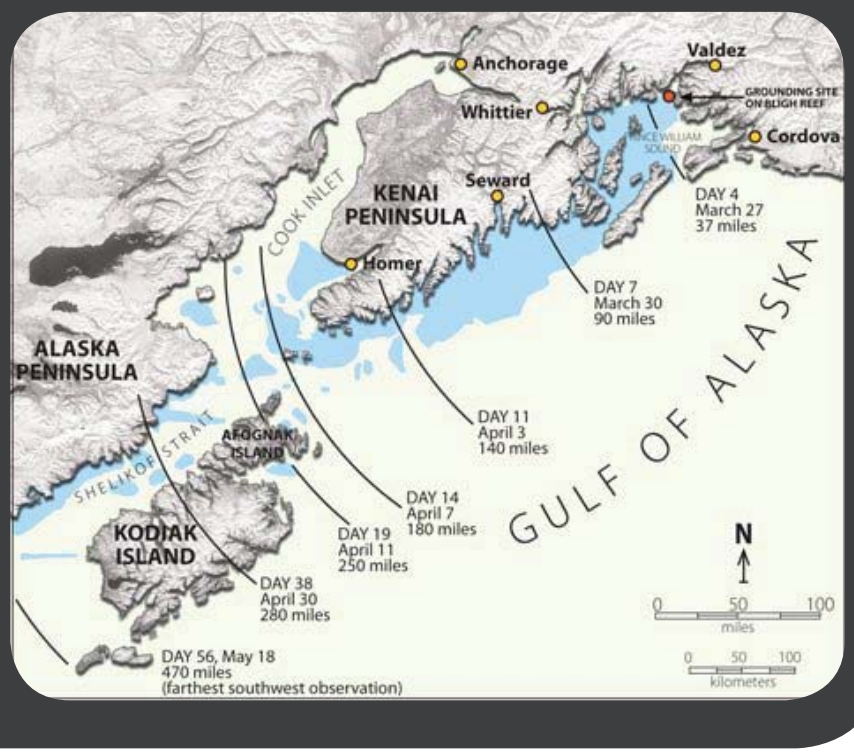
Just after midnight on March 24, the *Exxon Valdez* oil tanker grounded on Bligh Reef, spilling at least 11 million gallons of crude oil into Prince William Sound, the largest oil spill in U.S. waters.

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 (see figure, right).

More information on the immediate and long-term impacts of the spill, as well as links to other oil spill resources can be obtained from the legacy organizations established after the spill, including:

- The *Exxon Valdez* Oil Spill Trustee Council oversees the 1991 $900 million civil settlement for restoration of injured resources and services. The restoration plan includes habitat protection, research and monitoring, and direct restoration.
  www.evostc.state.ak.us
- The Oil Spill Recovery Institute was established by Congress in 1990 to focus on improved technologies and ecological research related to oil pollution in the marine environment of Arctic and Subarctic regions.
  www.pws-osri.org
- The Prince William Sound Regional Citizens' Advisory Council is an independent nonprofit organization whose mission is to promote environmentally safe operation of Alyeska Pipeline's Valdez Marine Terminal and associated oil tankers.
  www.pwsrcac.org



Weather, Weather, Everywhere

The most populated region in Alaska is along the northern Gulf of Alaska, which includes Prince William Sound. The people who live, work and play here make many of their daily decisions based on the weather conditions. Of course, the weather in this region can be highly variable. As the saying goes, "If you don't like the weather, just wait 15 minutes."

Whether you're a commercial or recreational fisher, the captain of an oil tanker, a kayaker out for an afternoon jaunt, or a tourist visiting for the first time, you'll need to know what the winds and precipitation are like now, as well as in the immediate future. You may also want to know what that means for waves, currents and other ocean conditions. Emergency teams need that information, too, to better prepare themselves for any unforeseen search and rescue operations or oil spill response.

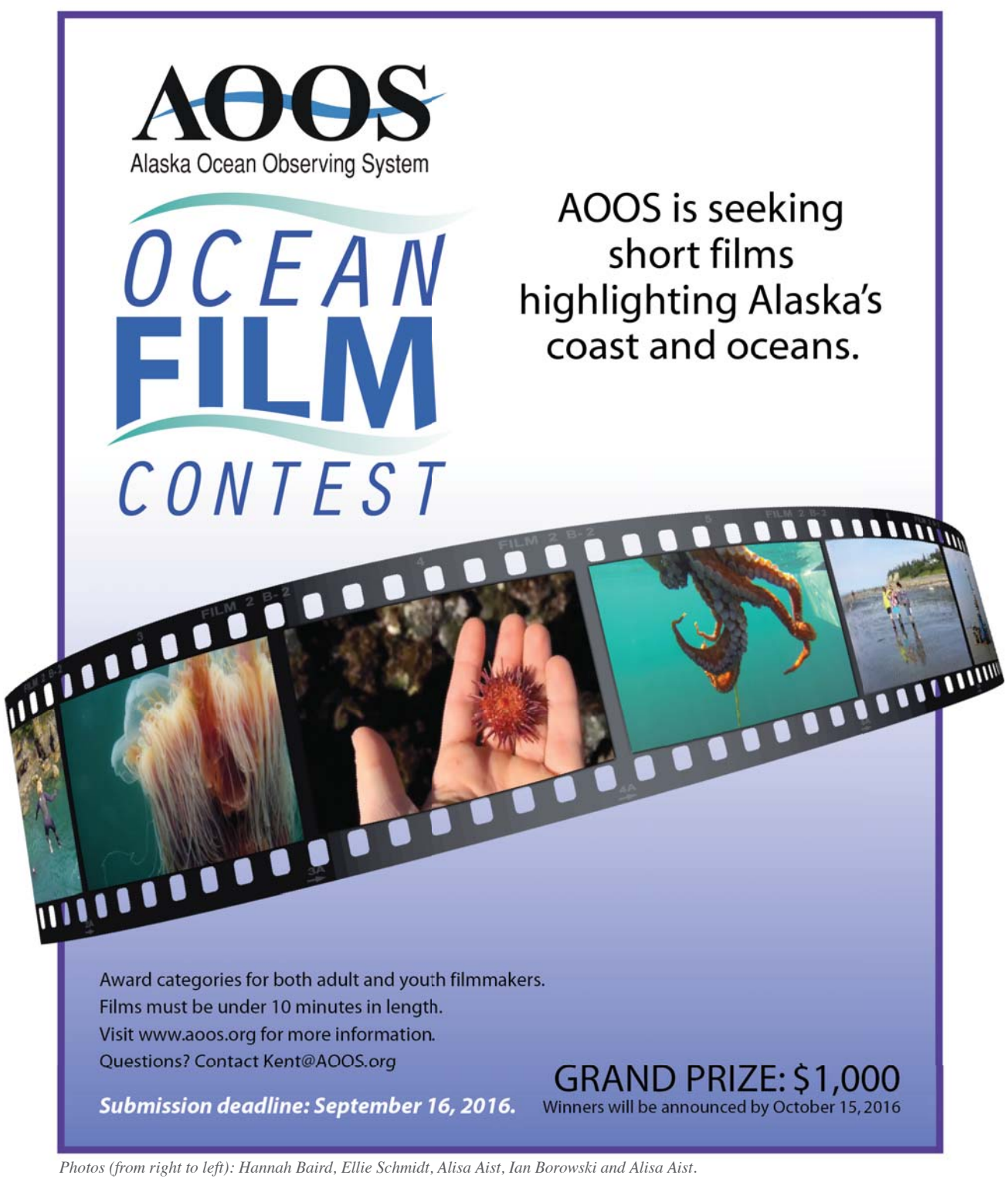
The Gulf region has more weather and observation platforms than other areas of Alaska. However, these are still relatively sparse compared to the platforms in other ocean regions of the U.S. For that reason, the Alaska Ocean Observing System (AOOS) has partnered with the Prince William Sound Science Center, the Oil Spill Recovery Institute, the Prince William Sound Regional Citizens Advisory Council, the U.S. Department of Agriculture's Natural Resource Conservation Service, and the Marine Exchange of Alaska to increase the number of weather stations in Prince William Sound. These include:

SNOTEL (Snow Telemetry) weather stations are operated and maintained by the NRCS with AOOS funds. The stations are located at both sea-level and high-elevation sites to provide valuable weather information and water data for forecasting weather and ocean currents in the sound.

National Data Buoy Center (NDBC) moored buoys are the weather sentinels of the sea, measuring winds, waves and air and sea temperatures. They're part of a national program that is serviced by the U.S. Coast Guard.

Webcams provide real-time observations of weather conditions on the ground. Pilots and mariners use these when planning trips across or around the Sound.

Marine Exchange of Alaska AtoNs co-locate weather sensors with automatic identification system (AIS) transmitters to disseminate real-time weather and other environmental information directly to vessels that are part of the AIS vessel tracking program. With AOOS funding, AtoNs have been installed on Middleton Island immediately outside the Sound and in Valdez.



Photos (from right to left): Hannah Baird, Ellie Schmidt, Alisa Aist, Ian Borowski and Alisa Aist.

Introducing Alaska's Blob Tracker

Since 2013, there has been a lot of talk about this thing called The Blob. On the West Coast, this refers to a large pool of unusually warm water that developed in the North Pacific Ocean, reaching as far north as the Gulf of Alaska. It describes an area of the ocean where sea surface temperatures are higher than normal—what scientists call "anomalous"—and, in the Gulf of Alaska, these temperatures can climb as high as 5 degrees F (3 degrees C) above average during the peak.

The Alaska Ocean Observing System's *Alaska Blob Tracker* blog offers a one-stop status report on The Blob (and El Niño). The blog entries not only cover the story for Alaskan waters but also for waters south to Baja California. Found on the Alaska Ocean Observing System website (www.aoos.org), the blog is updated approximately every two weeks. It provides links to science publications and workshops, as well as to the latest news stories on The Blob and its interactions with the more well-known climate event known as El Niño. Local scientific experts also contribute to the blog, adding their findings on how these oceanic conditions are affecting the surrounding region's weather, marine life and overall environmental conditions.

For the latest news about The Blob and its effects on Alaska, visit the Alaska Blob Tracker at: *https://alaskapacificblob.wordpress.com*

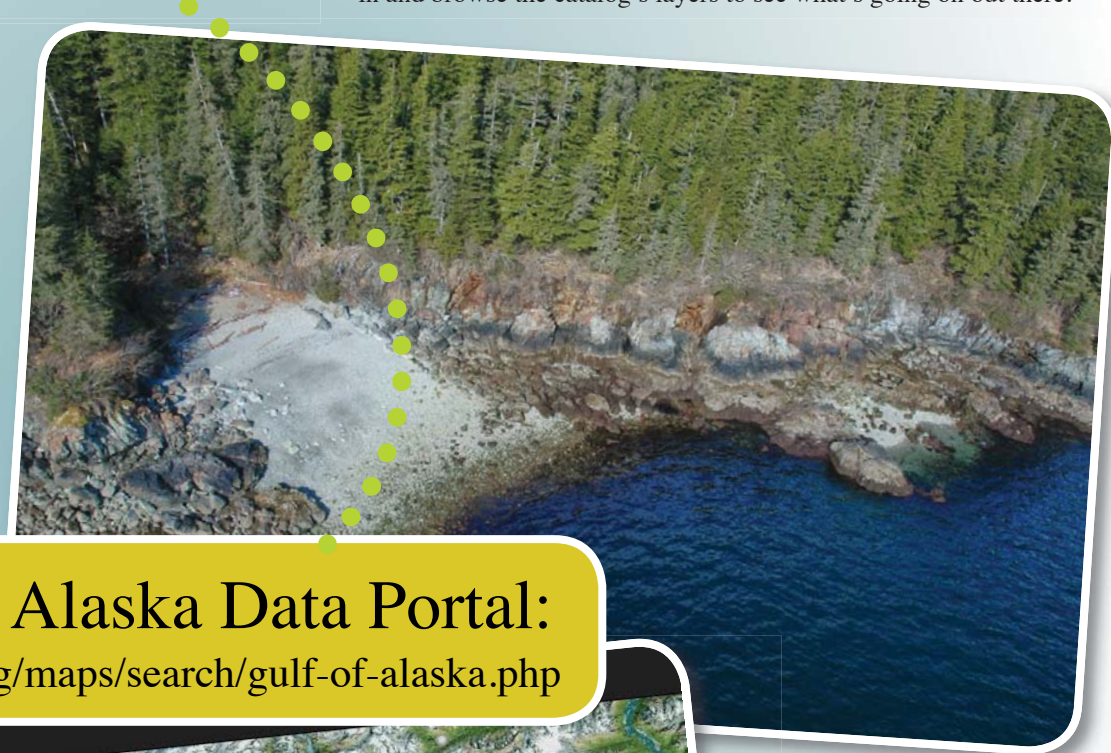
OBSERVING SYSTEM

Happy "Virtual Cruising" with New Data Portal

See what the shore looks like, find out what the weather is or will be next week, and learn where whales have recently been spotted. You can discover all this and more, not only for Prince William Sound or the Gulf of Alaska but for the entire coastline of Alaska, through the AOOS Data Portal.

The portal lets users look at multiple layers of information layered on top of a base map or view individual layers one at a time. They can find models for forecasting weather and wave conditions, along with information gathered from research projects, data on marine mammal movements, and much more.

It's easy—just pull up a map, zoom in to the area you are interested in and browse the catalog's layers to see what's going on out there.



Gulf of Alaska Data Portal:
data.aoos.org/maps/search/gulf-of-alaska.php

Real-Time Data at your Fingertips!

Photos: The AOOS portal now includes ShoreZone video and images for the entire coastline of Alaska, courtesy of the ShoreZone Alaska Project. With it, you can "fly the coastline" on your computer screen.

Screenshots: Within the portal, you can zoom into areas on the map to find real-time information, webcams, habitat information, forecast models and more, including real-time screenshots from sensor stations and a wind forecast model for the region.

AOOS is the regional ocean observing system for Alaska. It provides observations, data, and information products to meet user needs.

AOOS
Alaska Ocean Observing System

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Anchorage, AK 99501
907-644-6703
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63°N
62°N
61°N
60°N
150°W
148°W
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Paxson
Chist
Talkeetna Mountains
Gakona
Gulkana
Glennallen
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Kenny
Lake
Chitin
Wasilla
Chugach
M
Valdez
Anchorage
Portage
Whittier
Tatitlek
Bligh Reef
Prince William Sound
Simpson Bay
Cordova
Eshamy Bay
Knight Is.
Egg Is.
Hinchinbrook Is.
Copper River
Hinchinbrook Entrance
Chenega
Montague Is.
Seward
Montague Strait
Middleton Is.
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PRINCE WILLIAM SOUND
SCIENCE
CENTER
Highways
Trans Alaska Pipeline
USA-Canada Border
Map and design by Kristin Link
estasta
Lake
Slana
ochina
Wrangell Mountains
Mt. Wrangell
14,163 ft
Kennecott Copper
Mine
McCarthy
Chitina River
Copper River
Bagley Icefield
Mt. St. Elias
18,008 ft
Bering Glacier
Bering River
Icy Bay
Flats
Yakutat Bay
Kayak Is.
Yakutat
Gulf of Alaska
144°W
142°W

GULF WATCH ALASKA

Gulf Watch Alaska is the long-term ecosystem monitoring program of the *Exxon Valdez* Oil Spill Trustee Council. More than 40 scientists from 12 different organizations work collaboratively to monitor the ecosystems affected by the 1989 oil spill within the northern Gulf of Alaska. Program scientists monitor a broad range of ecological conditions that, when viewed collectively, can help us understand the factors behind some of the events that we observe in our coastal ecosystems.

In 2015, we observed the effects of one of the strongest El Niño events since 1950. At the same time, other persistent weather patterns served to trap heat in some areas of the Pacific Ocean, causing much warmer ocean temperatures when compared to long-term averages. We increased our understanding about a broad array of unusual biological events related to this widespread oceanographic pattern. The composition of plankton communities changed, which affected the availability and quality of food for grazing and predatory fish and other organisms. Toxic algae increased in abundance, leading to closures for shellfish harvesting and possibly affecting predators and their ability to feed. The warm water—either alone or combined with the changes in the quantity or quality of food and the increase in toxic algae—may have led to an increase in illness and death for whales, sea otters, seabirds and sea stars across the Gulf of Alaska.

The Gulf Watch Alaska program is currently in the fifth year of a 20-year program that builds upon more than 30 years of observations. Many years of data collection and observations provide us a broad perspective on the unusual (or anomalous) conditions such as the ones documented during 2014-2015.

Seabird Mortality Mystery

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Beginning in March 2015, seabirds began dying throughout the entire northern Gulf of Alaska in unprecedented numbers. Following storms in early January 2016, biologists found at least 25,000 dead murres in Prince William Sound. Dead birds began washing up on beaches in the hundreds and dying birds wandered as far inland as Denali National Park. Nearly all of the dead seabirds were Common Murres. When the dead birds were examined, it was determined that nearly all had starved to death. Coupled with additional reports of dead whales in the same area, a toxic algal bloom was initially suspected. However, only a very small number—two out of 106 tested by the National Wildlife Health Center—had any traces of a toxin.

Gulf Watch Alaska scientists believe it's likely that this widespread "unusual mortality event" is related to the anomaly of unusually warm waters in the region. The warm waters could have affected the distribution and abundance of the small fish sought by murres as prey. During the previous summer, scientists monitoring seabird breeding colonies observed murres abandoning their attempts to breed or failing to successfully rear their chicks. Although it was clear the murres were starving, scientists remain puzzled about the mechanism that that led to the birds' death. Whether the birds' prey were scarce or inaccessible or if there are other reasons that the birds couldn't find enough food has yet to be determined.

Gulf Watch Alaska scientists plan to continue to survey beaches to estimate the extent of this die-off and to determine its effects on remaining murre populations.

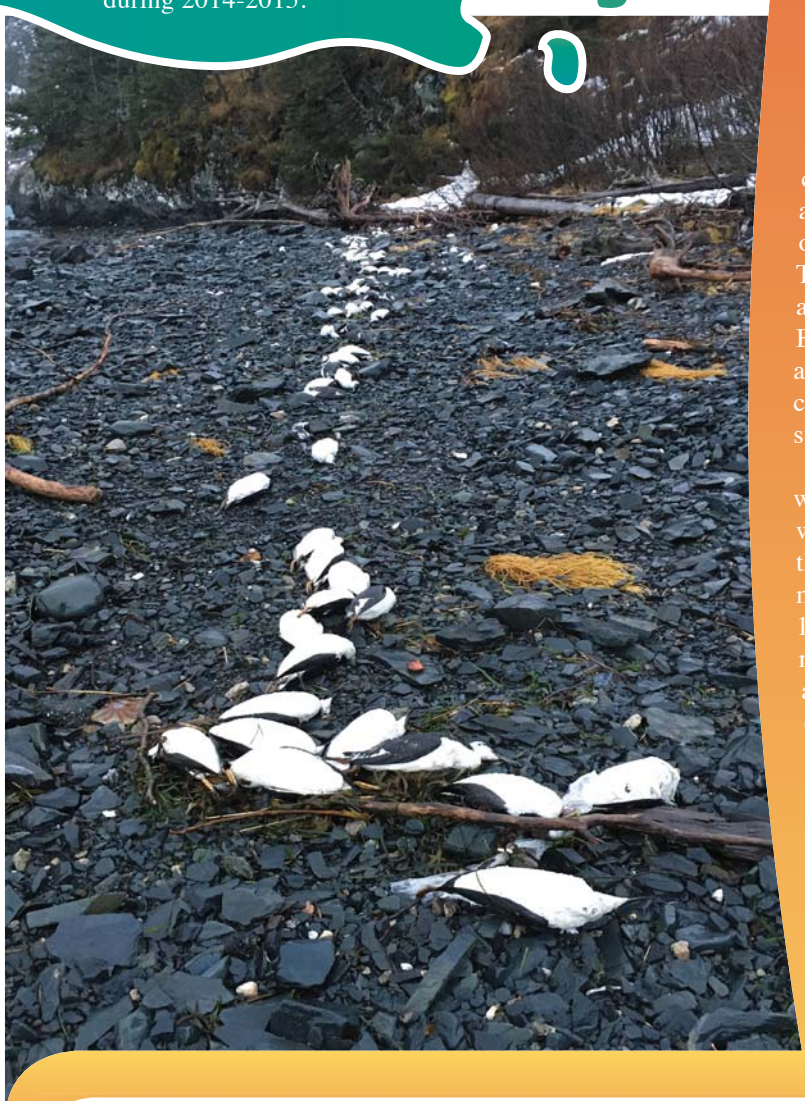

Photo (top right): Dead Common Murres washed up on a beach near Whittier, Prince William Sound, on January 1, 2016. *Photo: D. Irons.*

Hot Times in the Gulf of Alaska

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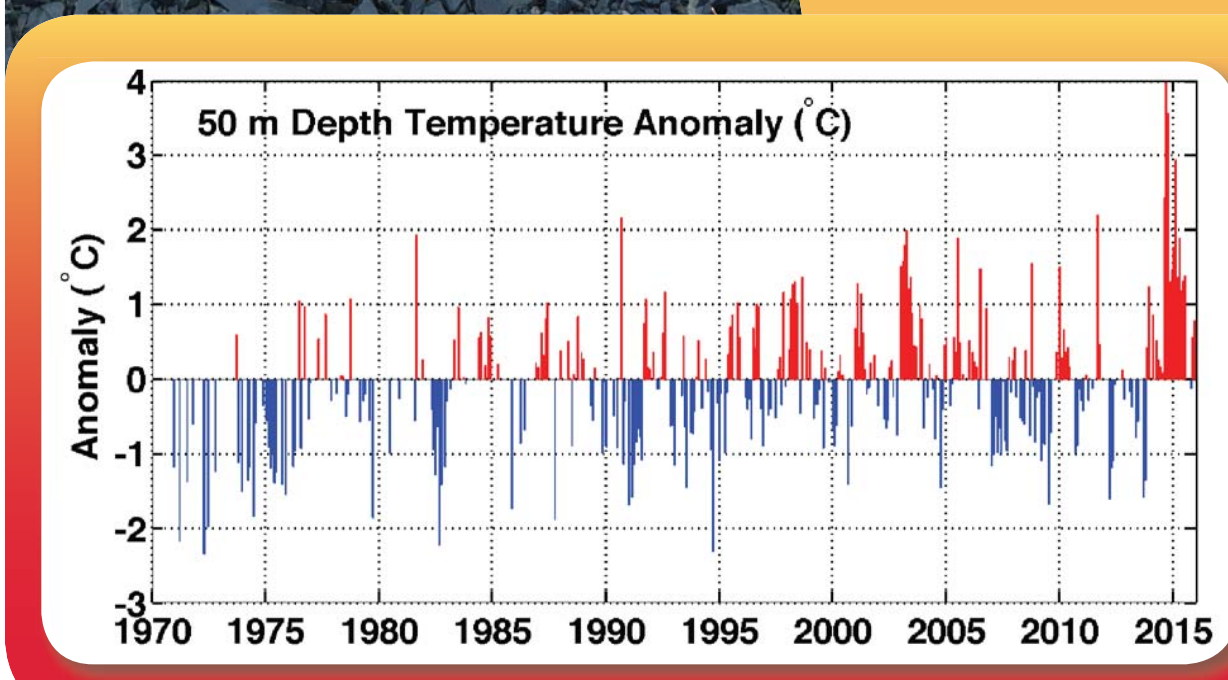
By the end of 2015, ocean temperatures in the northern Gulf of Alaska had been unusually warm for more than a year. In late 2014, the temperature peaked at more than 7 degrees F (4 degrees C) higher than normal at a depth of 50 meters (164 feet) at oceanographic monitoring station GAK-1, located at the mouth of Resurrection Bay near Seward. This was the warmest recorded temperature in more than 40 years of monthly measurements, and it followed a series of seven years when ocean temperatures were relatively cool.

Warm ocean waters were not limited to the area measured at GAK-1. Four other areas of unusually warm water were distributed in deeper waters offshore around the North Pacific Ocean. In the central Gulf of Alaska, a large area formed and became such a persistent feature on oceanographic maps that it was nicknamed The Blob. Other warmer-than-usual areas persisted in the Bering Sea, near Baja California, and along the equator in association with an El Niño event that is considered one of the "top three" of the strongest El Niños since 1950.

As a result of warmer-than-normal ocean waters, by summer's end in 2015, ocean waters were more strongly stratified over the Gulf's continental shelf than has been measured at any other time during the past 10 years. The relatively calm, warm waters near the surface reduced the upwelling and mixing of nutrients from denser, colder waters below. This likely resulted in corresponding changes to food webs, making them more like those during fall and winter months in the Gulf of Alaska.

Figure (below): Monthly ocean temperature anomalies at 50 meters depth recorded at GAK1. Anomalies are computed as deviations from the average annual cycle.



Sea Star Wasting Disease

Benjamin Pister and Heather Coletti,
National Park Service
Brenda Ballachey, U.S. Geological Survey
Thomas A. Dean, Coastal Resources Inc.
Katrin Iken and Brenda Konar,
University of Alaska, Fairbanks
Mandy Lindeberg, NOAA

We monitor sea stars in the intertidal zone because, as top-level predators, they play a vital ecological role in shaping nearshore ecosystems. In the absence of these animals, the sea stars' prey—mussels and urchins, for instance—can multiply and drive out other nearshore inhabitants. Warmer waters are suspected as one of the factors contributing to the extent and rate of infection of what is now commonly called sea star wasting disease. Since 2013, this disease has infected at least 20 different sea star species and decimated populations along the west coast of North America. In 2014, we began conducting surveys for the disease at monitoring sites in the northern Gulf of Alaska through the Gulf Watch Alaska Program.

So far, the incidence of the disease has been low in the areas surveyed. In 2014, only nine sea stars out of 1,588 counted across 30 sites (less than 1 percent) were diseased. In 2015, there was a slight increase in the percentage of diseased sea stars counted—69 out of 2,016 stars observed (3.4 percent) and nearly all of the disease specimens were counted in one area, Kachemak Bay.

Because we are able to survey only a small fraction of available sea star habitat, observations of diseased sea stars by beach walkers and citizen scientists are valuable in this situation. The identification of the species of sea stars that have been infected is particularly valuable and identification guides are available at *www.seastarwasting.org*.

Help us detect sea star wasting disease in Alaska!

If you observe a sea star that seems to exhibit signs of sea star wasting disease, please take a picture, note the location and date, then send to one of the following:

Mandy Lindeberg–mandy.lindeberg@noaa.gov
Katrin Iken–kbiken@alaska.edu
Brenda Konar–bhkonar@alaska.edu
Melissa Miner–cmminer@ucsc.edu
Benjamin Pister–Benjamin_Pister@nps.gov

Photo (top right): Mottled Sea Star (*Evasterias troschelii*) displays white lesions typical of sea star wasting disease.
Photo (bottom right): Infected stars often exhibit a deflated appearance and unnatural twisting. *Photos: Katrin Iken.*

The Faint Shadow of Lingering Oil

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Mandy Lindeberg and Mark Carls
Alaska Fisheries Science Center's Auke Bay Laboratories
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Gulf Watch Alaska scientists continue to monitor the extent of oil from the 1989 *Exxon Valdez* oil spill that is lingering in the environment. When the tanker ran aground, the damage was inescapable. In the path of the spill, surface sheens, coated beaches and dead marine life were unmistakable signs of the disaster and its consequences. Over the next few years, the vast majority of oil was removed, degraded or evaporated, and effects on plants and animals became less obvious. However, long-term studies after the spill demonstrated that oil remained within the sediments of some beaches. The remaining oil was only lightly weathered, and wildlife continued to be exposed to and affected by it—in some instances, for more than two decades.

The data collected during 2015 indicate that some beaches still continue to hold *Exxon Valdez* oil. The extent of this lingering oil is very small relative to the large geographic footprint of the spill. In addition, the oil is in places where it is unlikely to be disturbed. Another study indicates that the oil is no longer being taken up by Sea Otters and Harlequin Ducks. These species are now considered "recovered" from the spill, because the long-term effects of any lingering oil have ceased. Our continued monitoring will provide a perspective on natural variation and effects of human activities within this ecosystem as it recovers from the impacts of the spill.

Photo (right): Sampling in 2015 revealed lingering oil remained on some beaches. *Photo: Corey Fugate.*

HERRING

The Need for Herring Research and Monitoring

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In the decades prior to 1990, there was a large and healthy Pacific Herring (*Clupea pallasii*) population in Prince William Sound. Not only are these forage fish a key link in the complex food web of the sound, they once supported a lucrative commercial fishery that brought the region to life each spring. By 1993, that fishery had closed. The current stock of nineteen thousand tons is well below the historical peak of 130 thousand tons.

The cause of this dramatic stock decline is still being debated. Was it the *Exxon Valdez* oil spill, or could the decline be attributed to disease, climate change, predation, natural cycles or a combination of these factors? While the reason for the decline is still undetermined, it is more important to understand what is preventing the herring population from recovering.

Today, researchers from multiple institutions are working to determine why stocks of herring in the Sound remain depressed. With funds from the *Exxon Valdez* Oil Spill Trustee Council (which oversees settlement funds between Exxon and state and federal agencies), a group of research and monitoring projects were designed to improve predictive modeling of herring stocks. This work is complementary to the Gulf Watch Alaska program, which examines the nearshore and pelagic ecosystems, as well as lingering oil and environmental drivers. Together, these programs give us a better idea of what is going on in our waters.

Herring Genetics

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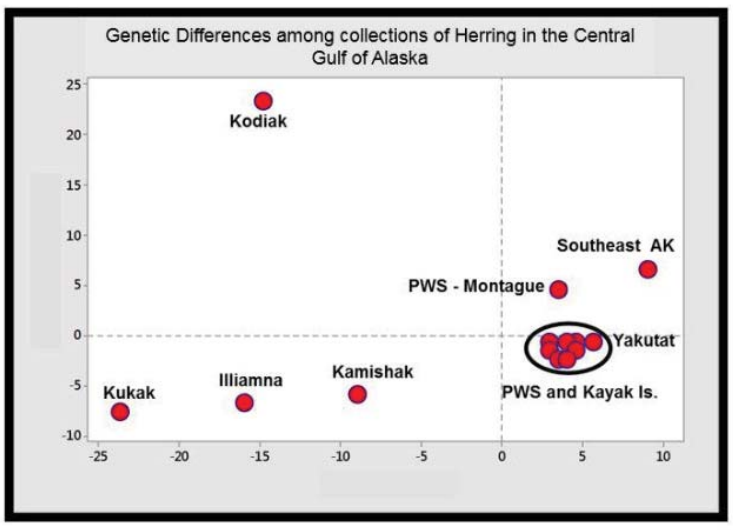
A fish stock is a group of fish of the same species that mix and breed at maturity. Are Prince William Sound herring one or more discrete 'stocks' of fish? Are they spawning with herring from outside the Sound, or are they trying to recover from stocks only within the Sound? A recent genetic study sought to answer these questions, in an attempt to understand the lack of recovery of herring in Prince William Sound.

Results of the study indicate that herring in eastern Prince William Sound are not likely mixing with fish to the west of the Sound—in Cook Inlet and near Kodiak—as previously thought. However, they are genetically similar to herring east of the Sound—near Kayak Island and Yakutat. It is unknown if fish from these eastern areas are mixing with Prince William Sound fish today, or if the genetic similarities are from a past mingling of stocks. This is one piece of the puzzle that may help scientists understand the herring's lack of rebound.

Figure (below): The genetic differences of 14 collections of herring. Results indicate eastern Prince William Sound, Kayak Island and Yakutat are genetically similar and are collectively distinct from Montague Island, Southeast Alaska and locations east of Prince William Sound.



Energetics of Juvenile Herring in the Sound

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Ecologists at the Prince William Sound Science Center and the Alaska Fisheries Science Center's Auke Bay Laboratories have studied over-winter energy management strategies of Prince William Sound juvenile Pacific Herring. The level of energy stores of these young fish can be an important predictor of a young herring's ability to survive its first winter and is also a key factor in determining the strength of each year class.

Recent North Pacific warming trends underscore the need to better understand the connection between oceanographic variability and the ecology of Pacific Herring. Earlier research on stable carbon isotope ratios established that sources of carbon differ between zooplankton from the Gulf of Alaska and Prince William Sound. Carbon (C) has two stable forms (or isotopes) known as C^{12} and C^{13}. Zooplankton from the Gulf of Alaska are relatively depleted in their stable carbon isotope ratio in comparison with zooplankton from the Sound. In other words, Gulf of Alaska zooplankton have a lower amount of C13 and a higher amount of C12, reducing the ratio between the two isotopes. Interestingly, recent data suggest that as young herring depend on carbon derived from the Gulf of Alaska, they tend to be more energy-dense and therefore, more likely to survive their first winter.

This carbon-energy relationship occurs along a spatial gradient across the Sound. Juvenile Pacific Herring caught in western nursery bays reflect a Gulf of Alaska carbon source and are more energy dense than fish captured among eastern bays. Based on location, the pattern of carbon-energy relates to the Sound's patterns of water circulation. Water from the Gulf flows in through Hinchinbrook Entrance, following deep canyons along the west side of the Sound. Thus, climate-driven changes to this circulation pattern may have implications for herring energy stores and recruitment to spawning.

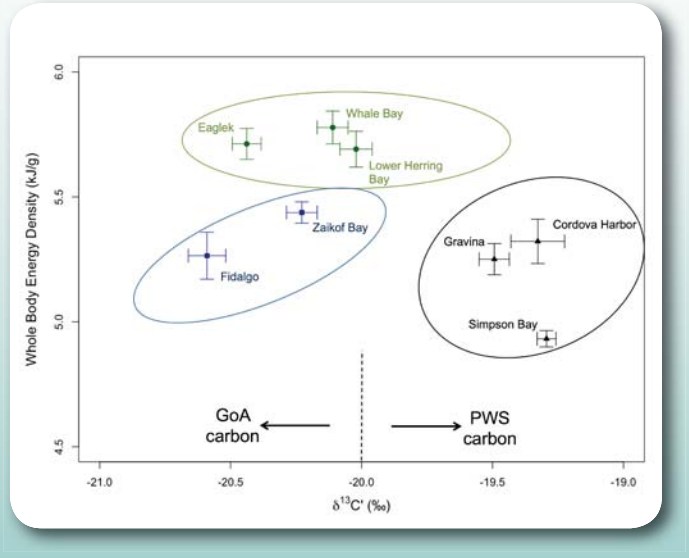

Figure (top right): Spatial variability in Prince William Sound (PWS) juvenile Pacific Herring stable carbon isotope ratio and energy density. Dashed line delineates Gulf of Alaska and PWS carbon sources.
Map (bottom right): Location of nursery bays sampled for juvenile Pacific Herring. Color and symbol of each sampling location reflects that shown in the figure above.

Herring in Nearshore Habitat: Using New Technology in Shallow Water

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Kevin Boswell, Florida International University
Pete Rand, Prince William Sound Science Center

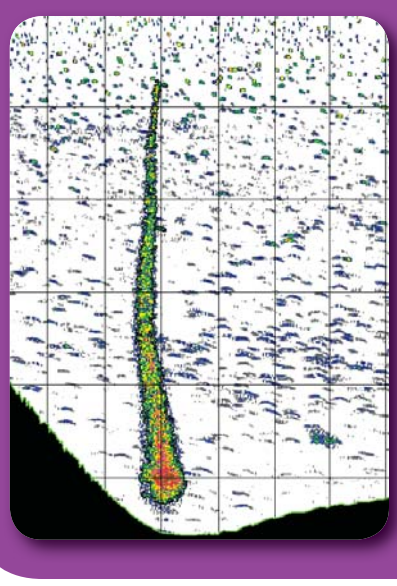
Traditional techniques to study fish generally require the capture of these animals. This can result in high death rates for study organisms, which is not a good thing when the fish are already low in number due to disturbance.

Such is the case with herring in Prince William Sound, making alternative study methods necessary. These methods can include the use of non-invasive remote sensing techniques, including hydroacoustics—essentially, a very advanced shipboard fish-finder. Acoustic surveys of herring in the Sound have taken place since 1993, to describe patterns in abundance and distribution of the herring stock after the *Exxon Valdez* oil spill.

Traditional surveys combine hydroacoustics with trawling from a research vessel. However, these surveys are limited in their coverage, as vessel grounding becomes a threat in the comparatively shallow nearshore bay areas. Recent observations have reported that juvenile herring use these shallow waters in numbers large enough to influence estimates of herring biomass in the Sound.

To begin to understand the numbers of herring not counted in central bay surveys, the Prince William Sound Science Center and Florida International University have deployed a new autonomous surface vessel (ASV) in bays targeted by past trawling efforts. The ASV has a draft of less than two feet, and can access nearshore habitat previously unavailable to acoustic equipment and trawls. The unique vessel is fully automated, and researchers can either pre-program the ASV and monitor its progress remotely or use a Playstation 2 home video game controller to manually direct the vessel.

Initial results show that higher densities of herring are aggregating in nearshore environments than was previously thought. Further work is underway to understand these previously undescribed herring. By collecting this information, we can increase our confidence in the models we use to estimate herring stocks in the Sound. This in turn will allow for better management of the herring fishery in the future.



From Analysis to Synthesis: Better Understanding the Sound's Herring Stocks

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wspegau@pwssc.org

The Herring Research and Monitoring program has collected data on various aspects of the life of Pacific Herring. The researchers have written up what they have learned from their parts of the program, but now, after analyzing the data, another level of effort is needed. This involves a synthesis—that is, connecting the knowledge gained by the various projects that can help us to improve our understanding of these fish. Over the past two years, the researchers have produced two such synthesis reports.

The first synthesis report examined our understanding of factors that determine the likelihood of survival in the herring's first year of life. The second synthesis report focused on connecting the projects to improve our understanding of factors influencing growth and fitness, movement and habitat, disease, and population modeling for the herring. By combining all aspects of the program into these reports, one gets a fuller outlook on what could be limiting this species' recovery in Prince William Sound.

Both of these syntheses are available at: *http://pwssc.org/research/fish/pacific-herring/*

Image (left): A "spike" of herring detected in 20 meters of water. **Photo (middle)**: Surveys were conducted in nearshore bays not accessible to larger research vessels. Lines represent survey tracks. **Photo (right)**: Florida International University's autonomous surface vessel (ASV) deployed in shallow habitat in Prince William Sound.

Twenty-Three Years of Pinging Herring

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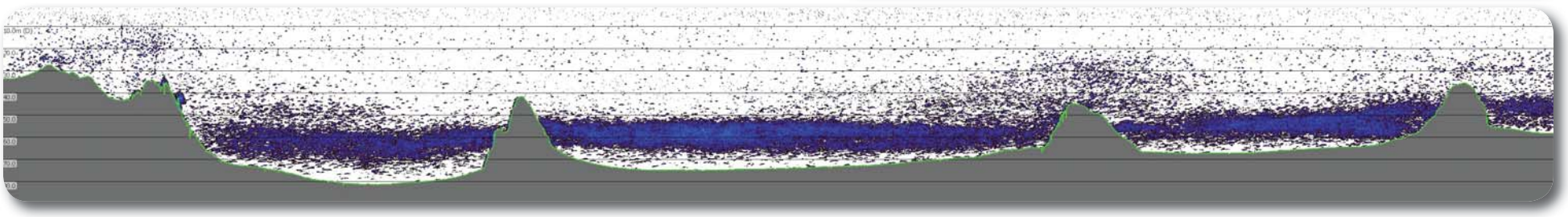
Since 1993, the Prince William Sound Science Center has been listening to returning echos from Pacific Herring. This research has helped us describe the population dynamics of this species. The technology of monitoring fish with echosounders has come a long way since 1993, but the principles remains the same. High frequency "pings" are transmitted into the water. The sound wave echoes off of "targets" in the water column (most fish have an air-filled swim bladder, producing a strong returning echo), and the time and strength of these returns are recorded.

The results provide information on the size and depth of the fish. We use specially-designed echosounders that measure these quantities precisely, but rely on the same principles as common depthfinders on fishing vessels. In recent years, we have been monitoring juvenile herring in the fall in eight bays, and conducting spring surveys in important spawning areas. A number of clues help us direct some of our sampling effort, including watching foraging seabirds and marine mammals. Tips from fishermen and aerial surveys also help us focus our sampling.

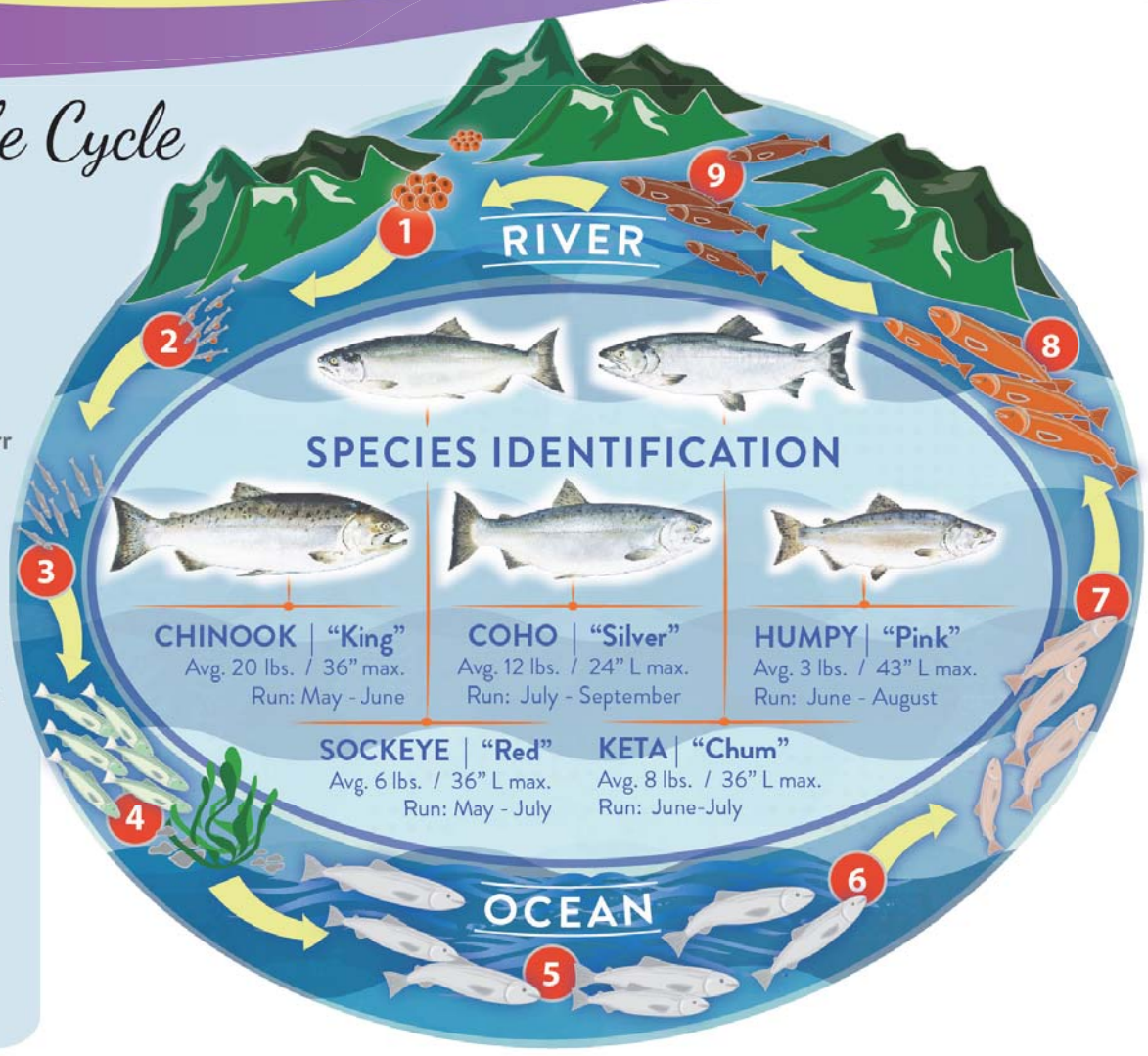
Photo (below): Juvenile Pacific Herring captured during a cruise in Fall 2015. **Figure (bottom):** An echogram showing echos from herring in Simpson Bay, Fall 2015 (in blue). The bottom contour is shown in grey. Each horizontal line represents 10 meters of depth (~33 feet), and the distance traveled by the vessel is four kilometers (~2.2 nautical miles).



FISH & WILDLIFE

PACIFIC SALMON *Life Cycle*

1. **Eggs** incubate
2. **Alevins** emerge
3. **Fry** migrate to rearing areas and grow into **parr**
4. **Smolt** leave rivers and adapt in estuaries
5. **Adults** eat and grow
6. **Mature adults** migrate to spawning areas
7. **Salmon** spawn
8. **Salmon** die after they reproduce
9. **Carcasses** recycle nutrients



Pacific salmon are anadromous, which means they are born in fresh water, migrate to the ocean (salt water) and return to fresh water river systems to reproduce, also known as spawning.

Salmon change color throughout their lifetimes, particularly as they transition from fresh water to salt water and back again.

Hatchery or Wild? Learning from Migrating and Spawning Pink and Chum Salmon in the Sound

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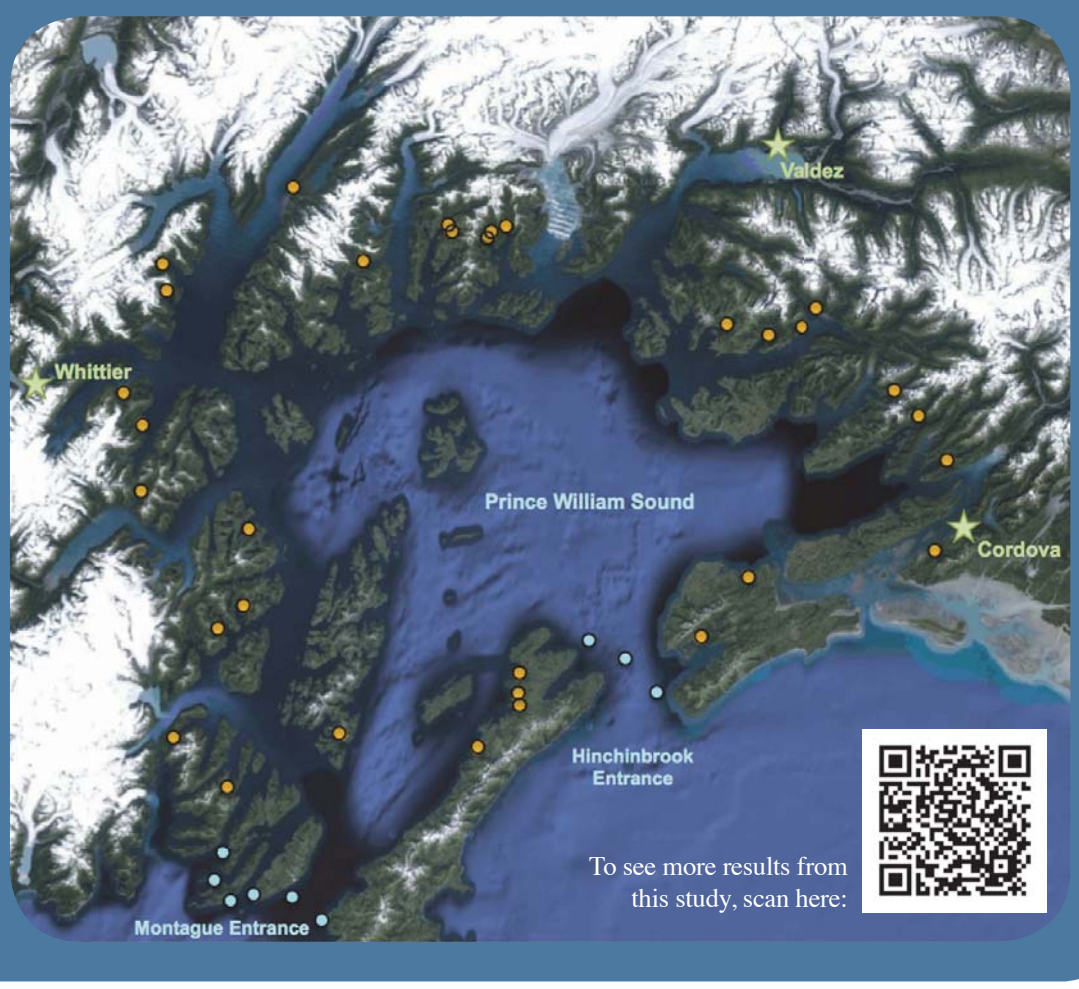
In Prince William Sound, commercial Pink Salmon (*Oncorhynchus gorbuscha*) and Chum Salmon (*Oncorhynchus keta*) fisheries are enhanced with hatchery-produced fish, which results in more fish for commercial capture. However, not all hatchery fish are caught in the fishery. Escapement or straying of hatchery fish into wild spawning streams is an important ecological repercussion of hatchery-based management.

Since 2013, the Prince William Sound Science Center has been assisting the Alaska Department of Fish & Game in their studies of interactions among hatchery and wild Pink and Chum salmon in the Sound. Results from this study will help managers make informed decisions about hatchery and wild salmon management. The goal of the project is to determine the percentage of hatchery fish found at the Hinchinbrook and Montague Entrances during spawning migration, as well as the percentage of hatchery fish spawning in 32 different streams in Prince William Sound (Figure). We do this by examining otoliths (ear bones). During the embryonic stage, hatchery fish are exposed to a slight water temperature increase, which imprints their otoliths with thermal markings that appear much like a barcode when viewed under a microscope.

During 2013 and 2014, the Science Center carried out a test fishery at nine stations in Hinchinbrook and Montague Entrances. Ocean stations were visited approximately twice a week, from the end of May to the end of August. Salmon were captured with a 200-fathom experimental gill net. Each net set lasted about one hour; though some sets were limited in time or space to avoid interactions with marine mammals and sport fishers. We found that the majority of the Pink and Chum Salmon run entering Prince William Sound through Montague Entrance was composed of hatchery fish, while the run entering through Hinchinbrook Entrance was composed of a greater percentage of wild fish. In 2013, a lower percentage of hatchery Pink Salmon was present, which is not surprising since the returns of wild Pink Salmon are greater in odd years.

Prince William Sound stream sampling occurred between mid-July and mid-September. Field crews collected otoliths from spawned-out Pink Salmon carcasses at 28 streams and Chum Salmon at seventeen streams (Figure). In 2013, the percentage of hatchery Pink Salmon found at those streams ranged from 0 to 87 percent; in 2014 it ranged from 0 to 90 percent. Chum Salmon ranged from 0.1 to 97 percent in 2013 and 0 to 80 percent in 2014. For Pink Salmon, 89 percent of study streams in 2013 had less than 20 percent hatchery fish. In 2014, only 61 percent of Pink Salmon study streams had percentages below 20 percent. These numbers are consistent with the larger run sizes of wild Pink Salmon in odd years. With Chum Salmon, there appears to be less annual variability in the percentage of hatchery fish. Eighty-two percent of Chum Salmon study streams had below 20 percent hatchery fish in 2013, while 94 percent of streams were below 20 percent in 2014. Quantifying the percentages of hatchery fish throughout Prince William Sound will enable scientists to further study aspects of survival by both wild and hatchery fish.

Figure (below): Map of Prince William Sound study area. Ocean fishing stations identified by light blue dots and study streams identified by gold dots.



To see more results from this study, scan here:

Warmer Water Temperatures Projected at Salmon Spawning Sites

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Pacific salmon egg incubation rates are highly temperature dependent. Even small increases in water temperature (1-3 degrees C) accelerate development and hatching, affecting juvenile survivorship. The U.S. Forest Service is monitoring water temperature at 30 salmon spawning sites on the Copper River Delta and throughout Prince William Sound.

Winter 2014-2015 was unusually mild and snowfall was low. Water temperatures were generally 1-2 degrees C (2-4 degrees F) warmer than the five-year averages; however, considerable variation was observed across the landscape (See Figure). This variation is due to landscape features such as upwelling groundwater and shallow lakes. Upwelling groundwater reduces temperature changes while shallow lakes accentuate the influence of the atmosphere. We observed surprisingly large increases in temperatures (7 degrees C or 12.6 degrees F) at sites downstream from shallow lakes during the spring months. We attribute these increases to reduced snow and ice melt.

The warm temperatures and low snowfall observed during winter 2014-2015 may become the norm in the 2020s and 2030s. Even warmer conditions are anticipated in the 2040s and beyond. Our findings indicate that shallow lakes and ponds may warm beyond the optimal range (≥ 22 degrees C or 72 degrees F) for salmon development. Warming winter water temperatures are also likely to shorten the duration of egg incubation in some streams, and we are investigating the net impact of this change on local salmon populations.

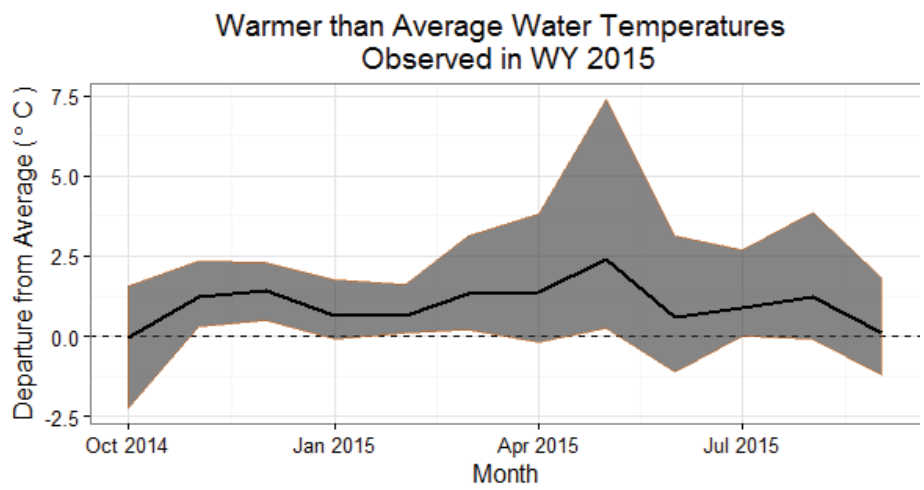

Figure (above): This plot shows the departures from long-term average temperatures that were observed in 2015. The black line shows the average departure and the gray ribbon shows the range observed at all sites.

Photo (far left): Research Fishwheel #1 at Baird Canyon, Copper River.
Photo (left): NVE biologist releasing tagged Copper River Chinook Salmon.
Photos: Brian Malloure

Collaborative Fisheries Management: A Shared Effort

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As the snow melts on Mt. Eccles and the hum of engines in the harbor grows, we look to the Copper River with excitement and anticipation for the 2016 field season and the opportunity to forge new partnerships while strengthening existing ones through effective research collaboration.

Managing Chinook Salmon on the Copper River has been a collaborative effort between the Native Village of Eyak (NVE) and state and federal fishery managers since 2003. In 2002, an annual Sustainable Escapement Goal (SEG) was established for Copper River Chinook Salmon at 24,000 or more spawners. This SEG represents the minimum amount of adult Chinook Salmon required to reach spawning grounds to maintain a sustainable yield/harvest over a five to 10-year period.

For fishery managers to determine if the annual SEG has been met for Copper River Chinook Salmon, NVE biologists estimate in-river abundance through a mark and recapture tagging study using research fishwheels. From this abundance data, fishery managers can estimate Chinook Salmon escapement (i.e., number of adults reaching spawning grounds) by subtracting federal subsistence, state subsistence, personal use, and sport harvest estimates from NVE's in-river abundance estimate. Additionally, the Chinook Salmon run size (i.e., total number returning to the Copper River) is estimated by adding commercial harvest to NVE's in-river abundance estimate. This critical Chinook Salmon data are part of a long-term monitoring project funded through U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resource Monitoring Program.

NVE's research fishwheels have been platforms for a multitude of collaborative scientific studies, such as stock-specific data on Sockeye Salmon, Chinook Salmon, and Steelhead, while providing educational opportunities for tribal members, local schools, non-profit organizations, and universities. During a time of limited funding, an emphasis on partnerships, collaboration and utilization of existing resources as a means of maximizing knowledge is a necessity.

Understanding Hummingbirds in Alaska

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The Alaska Hummingbird Project, Inc. is a 501(c)3 nonprofit, the northernmost hummingbird banding organization in the world. It conducts research, promotes conservation and provides educational outreach on hummingbirds in Alaska.

The project's research focuses on the Rufous Hummingbird (*Selasphorus rufus*), which commonly breeds in southcentral Alaska and winters in Mexico. A species of international concern, the Rufous Hummingbird is a key indicator of environmental health. Anna's Hummingbirds (*Calypte anna*) are listed as rare in southcentral Alaska. Fall sightings of female and immature Anna's have been photo-documented in Prince William Sound and on the Kenai Peninsula for the past decade. An adult male Anna's was photographed in May 2015 in Seward. These sightings suggest that a breeding population of Anna's exists in southcentral Alaska, an occurrence that researchers from the Alaska Hummingbird Project hopes to document. Having banded over 2,000 hummingbirds since 2007, project workers are just now beginning to understand where these tiny avian migrants are going, how they get there and how they survive such extremes in weather and geographic locale. Alaska Hummingbird Project publications, data and project history can be accessed online. You can also follow the Alaska Hummingbird Project on Facebook: facebook.com/alaskahummingbird

Photo (above): This male Rufous Hummingbird has a dot of orange paint on his head to mark him as caught and banded before being released. *Photo: Kate McLaughlin.*

Photo (above): Red Knots in flight. **Photo (bottom):** Radio-tagged Red Knot. Photos*: Milo Burcham.*

The Hunt for Boreal Toads

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Where did all the toads go? Although anecdotal evidence suggests that populations of the Boreal Toad (*Anaxyrus boreas*) are declining in the Copper River Delta, there is a lack of baseline data and long-term monitoring efforts to inform management about this puzzle.

Scientists at Oregon State University partnered with U.S. Forest Service staff at the Pacific Northwest Research Station and Chugach National Forest to investigate this issue. Surveys for Boreal Toads were conducted throughout the Copper River Delta during the summer of 2015. Repeat visual surveys of 10 historically occupied sites determined that there was evidence of toad occupancy at four of these sites during July 2015. However, for species such as the Boreal Toad, which has small, patchy populations, traditional visual surveys may not suffice.

It has been suggested that by extracting DNA from a filtered water sample, the DNA of a target species can be detected up to two weeks following the species' physical presence. The DNA analysis of water samples collected from the 10 historically occupied sites is currently underway. This novel technique will provide information about the distribution of Boreal Toads and provide a framework for future management of this species.

Photo (top): Carmen Harjoe swabs a Boreal Toad for amphibian chytrid fungus (*Batrachochytrium dendrobatidis*), which, if detected, could explain one reason for local species declines. *Photo: Jules Cooch.*

Caspian Terns on the Delta

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An elegant seabird with pointed wings and a forked tail, the Caspian Tern (*Hydroprogne caspia*) has been expanding its range northward along the Pacific coast since the 1960s. These terns prefer to nest on islands so, not surprisingly, their first breeding colony in Alaska was documented on one of the sandy, barrier islands at the mouth of the Copper River Delta.

Breeding on barrier islands has its perils, including flooding associated with storm surges. During the breeding season, a flood can ruin eggs and drown chicks. Flooding may explain the dramatic swings observed in the Delta's Caspian Tern colony. Although the colony grew from approximately 110 pairs to more than 400 pairs between 2005 and 2013, there have been years in which the colony was half the size of the previous year.

Researchers have also observed a shift in Caspien Tern nest location. Instead of nesting out in the open as they used to do, some terns are now nesting under tall grasses on small, elevated dunes. This might be because severe storms are altering the topography of the island, making these elevated sites the best places to nest.

Photo (above): Caspian Tern feeding its chick. *Photo: Oregon State University.*

Why Not Study Red Knots?

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A robin-red breasted, medium-sized shorebird, the Red Knot (*Calidris canuttus*) is one of the prettiest shorebirds stopping on the Copper River Delta each spring. There are six subspecies of Red Knots in the world and the one that stops here, *Calidris canutus roselaari*, is among the least studied shorebird populations in North America.

We wanted to determine how important the Delta has been to these Red Knots in spring. With funding from the Oil Spill Recovery Institute, we flew aerial surveys during two spring migrations to relocate Red Knots previously captured and tagged with radio-transmitters in Grays Harbor, Washington. During the first year of our study, we tagged Red Knots "late" in migration (mid-May). We relocated these Red Knots almost exclusively at Controller Bay, east of the Delta.

During our aerial surveys, we detected over 90 percent of the 50 tagged Red Knots at Controller Bay, the Delta or, in some instances, both areas. Our data suggested that Red Knots arriving early in migration use the Delta and that while Red Knots use Controller Bay throughout migration, it is where they are almost exclusively found later in migration. Most importantly, our work showed that the Copper River Delta and Controller Bay are critical spring stopovers for this little-known subspecies.

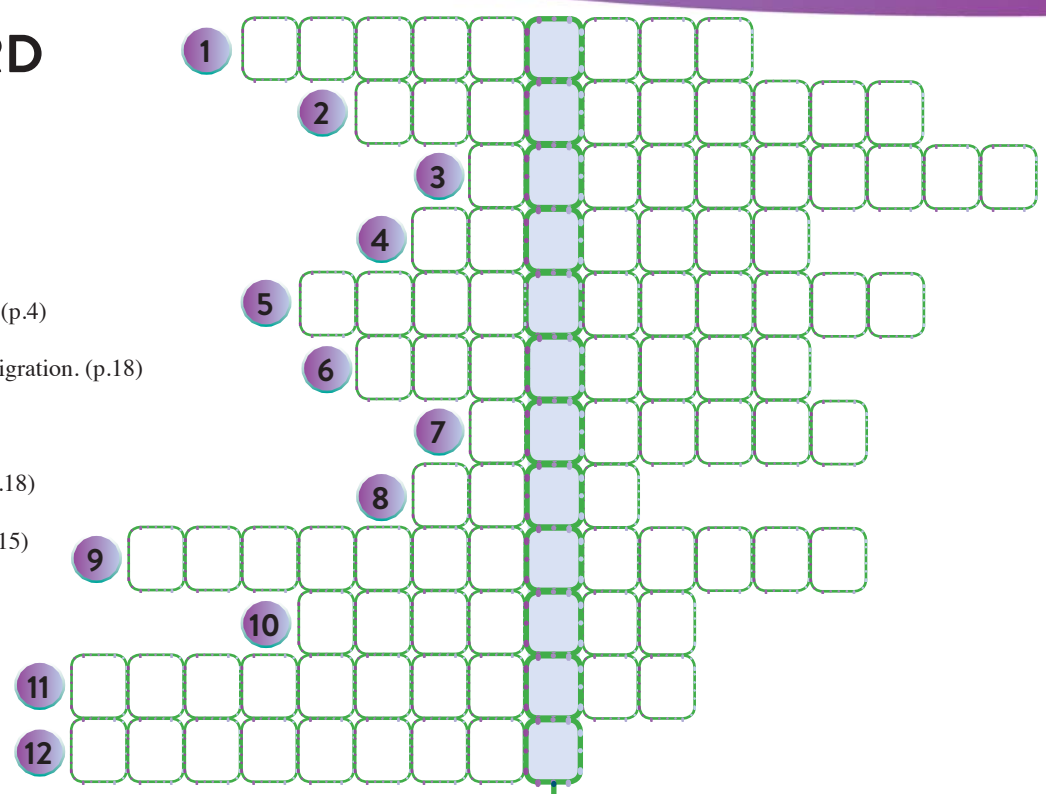
KIDS' CORNER

REVEAL THE MYSTERY WORD

Find answers to the clues throughout the publication.
Write your answers horizontally in the grid.
Reveal the mystery word in the vertical blue squares.

CLUES

1. Large carnivore checking out a weather station. (p.8)
2. These fish were implanted with pingers to track their movements. (p.4)
3. Amphibian of the Copper River Delta. (p.18)
4. Shorebird that stops at the Copper River Delta during its spring migration. (p.18)
5. Little bird that winters in Mexico. (p.18)
6. Gross nickname for an invasive aquatic species. (p.6)
7. Top-level predator of the intertidal zone. (p.13)
8. Found nesting on the barrier islands of the Copper River Delta. (p.18)
9. Fish wheels are used to study this important fish. (p.17)
10. An autonomous surface vessel is used to study these little fish. (p.15)
11. Tiny animals in the ocean. (p.4)
12. Rare plant found in Prince William Sound. (p.5)



ANSWER:

..... is the variety of all living things, including plants, animals, and microorganisms, and their interrelationships.

COLOR THE LINGERING OIL INTERTIDAL ZONE

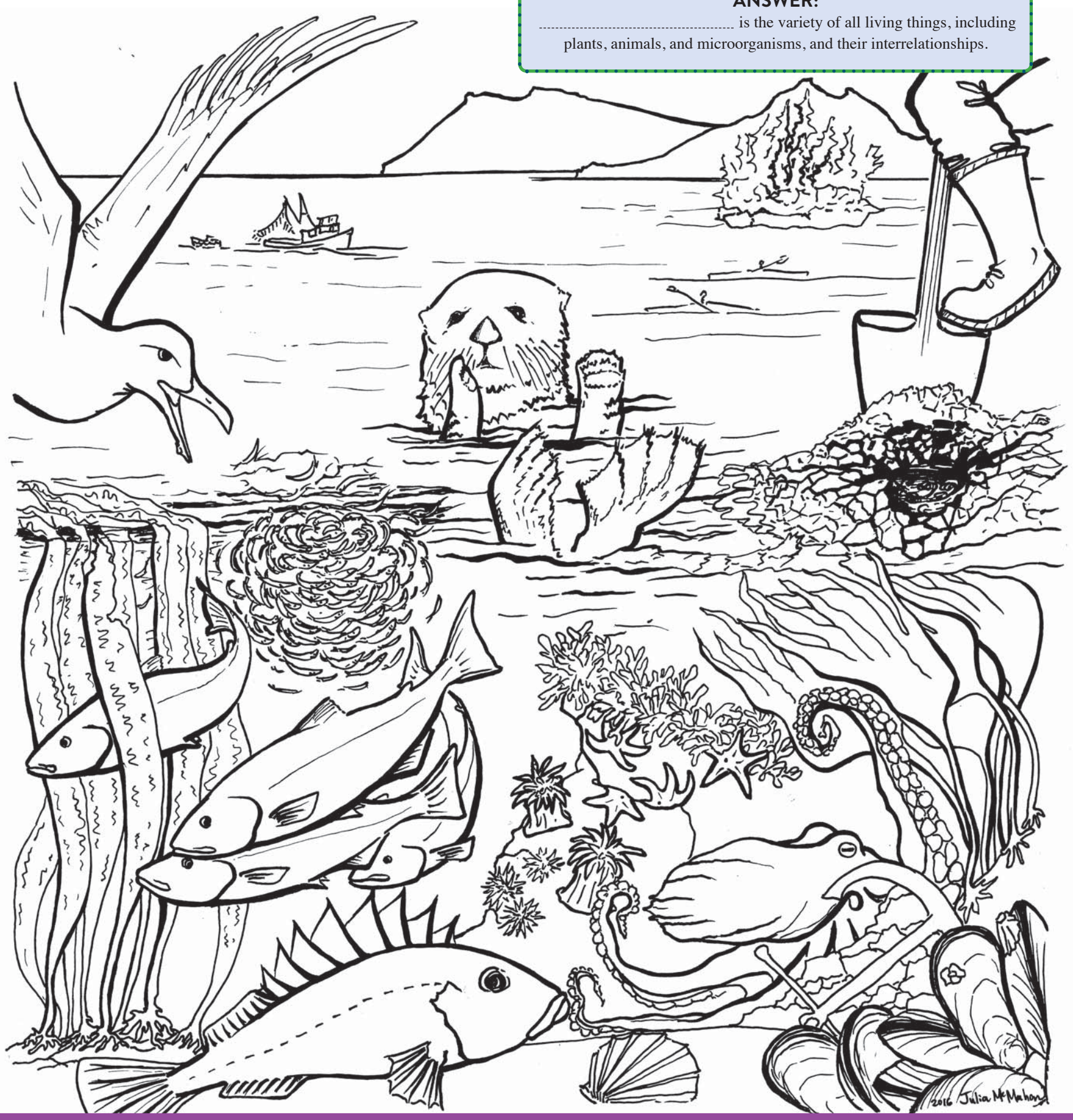


Photo: Anne L. Schaefer

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