2021-2022

DELTA SOUND CONNECTIONS

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PRINCE WILLIAM SOUND SCIENCE CENTER

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

ADAPTATION

On April 17, 2021, ADF&G fisheries biologist Shane Shepherd witnessed one of the largest Pacific herring spawning events he had ever seen. The entire southwestern and northeastern coastlines of Kayak Island, along with a large section of the eastern reefs, were active with heavy spawn. Pacific herring are a key link in the complex food web of Prince William Sound and once supported a lucrative early-season commercial fishery that brought the communities of the Sound to life each spring. Continued research and monitoring efforts are necessary to improve our ability to predict and understand changes in the herring population. *Photo credit: ADF&G.*

MUSSELS ARE THRIVING
Thank your (un)lucky stars

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A YEAR OF UNPLANNED ADAPTATION

"...THE WORLD IS STILL UNPREDICTABLE AND STILL WE SURVIVE BY THE GRACE OF CHANCE AND THE STRENGTH OF OUR CHOICES." *—Robin Wall Kimmerer, Gathering Moss*

By the time you read this, I hope the majority of the trials of the COVID-19 pandemic are behind us, although for many it will take time to recover from our collective and individual traumas. While the pandemic required many of us to shrink the sphere of people and places to whom we are exposed, it also gave us an opportunity to focus inward; an opportunity to better know ourselves and the places we could call upon as a refuge in trying times. Changing everything about our day-to-day lives was a form of adaptation—albeit adaptation that came as a shock, not allowing for much "easing in". Adaptation in nature occurs at difference paces, too—sometimes allowing for gradual changes within a system; at other times requiring rapid reorganization after a shock.

KATRINA HOFFMAN
President & CEO
Prince William Sound Science Center

For years, the concept of resilience has been at the heart of the Prince William Sound Science Center's mission; we think of it as the ability to predict shocks to systems (when possible), avoid them or adapt when they happen, and continue to thrive. With no way to avoid the COVID-19 shock around the globe, it seems the theme of the past year -- here and everywhere -- has been adaptation. And the driver of all that adaptation serves as a reminder of an old truth: nature always has the final say, and as humans, we must adjust accordingly.

Despite the challenges of the past year, history has shown it to be possible to emerge stronger from extreme challenges. In interview commentary about her book Gathering Moss, Robin Wall Kimmerer reflected that through the eons, humans have survived catastrophes by "being small… giving more than you take… working with natural law, sticking together."* Here at the Science Center, we try to do our part to help keep ecosystems, communities, and cultures intact, sharing critical knowledge along the way. Resilience—which requires the ability to adapt—is why we consider science, the economy, climate, education, local knowledge, and people with nearly everything we do. As more shocks will surely come our way, we are reminded that our mission remains more relevant than ever. Inside these pages, we invite you to read about what we and our colleagues have been working on. Thanks for your interest in our work to advance community resilience and the understanding and sustainable use of ecosystems.

*Robin Wall Kimmerer, **"People can't understand the world as a gift unless someone shows them how,"** interviewed by James Yeh. *The Guardian*, May 23, 2020.

BIRD AND WILDLIFE CHECKLIST

RECOMMENDED BIRD/MAMMAL GUIDE: *Sibley's Field Guide to Birds of Western North America* by David Allen Sibley and the *Guide to Marine Mammals of Alaska* by Kate Wynne.
List compiled by the Prince William Sound chapter of the Audubon Society.
U = UNCOMMON • **S** = SEASONAL

LOONS AND GREBES
- ❑ Common Loon
- ❑ Red-throated Loon
- ❑ Pacific loon (s)
- ❑ Yellow-billed Loon (s,u)
- ❑ Horned Grebe
- ❑ Red-necked Grebe

SHEARWATERS AND PETRELS
- ❑ Fork-tailed Storm-Petrel
- ❑ Sooty Shearwater (u)

CORMORANTS
- ❑ Pelagic Cormorant
- ❑ Double-crested Cormorant

HERONS
- ❑ Great Blue Heron

WATERFOWL
- ❑ Surf Scoter
- ❑ White-winged Scoter
- ❑ Long-tailed Duck
- ❑ Barrow's Goldeneye
- ❑ Common Goldeneye
- ❑ Bufflehead
- ❑ Harlequin Duck
- ❑ Mallard
- ❑ Dusky Canada Goose
- ❑ Common Merganser
- ❑ Red-breasted Merganser

SHOREBIRDS
- ❑ Black Oystercatcher
- ❑ Semipalmated Plover
- ❑ Least Sandpiper
- ❑ Yellowlegs (Lesser and Greater)
- ❑ Red-necked Phalarope (s)
- ❑ Surfbird (s)
- ❑ Black Turnstone (s)
- ❑ Dunlin (s)
- ❑ Western Sandpiper (s)

GULLS/TERNS
- ❑ Glaucous-winged Gull
- ❑ Herring Gull
- ❑ Mew Gull
- ❑ Bonaparte's Gull (s)
- ❑ Black-legged Kittiwake
- ❑ Parasitic Jaeger
- ❑ Pomarine Jaeger
- ❑ Arctic Tern (s)
- ❑ Aleutian Tern (s,u)

SEABIRDS
- ❑ Tufted Puffin (s)
- ❑ Horned Puffin (s)
- ❑ Marbled Murrelet
- ❑ Kittlitz's Murrelet (u)
- ❑ Parakeet Auklet (u)
- ❑ Pigeon Guillemot
- ❑ Common Murre

RAPTORS
- ❑ Bald Eagle
- ❑ Peregrine Falcon

HUMMINGBIRDS
- ❑ Rufous Hummingbird (s)

KINGFISHERS
- ❑ Belted Kingfisher

PASSERINES
- ❑ Tree Swallow
- ❑ Violet Green Swallow
- ❑ Bank Swallow
- ❑ Chestnut-backed Chickadee
- ❑ Winter Wren
- ❑ Common Raven
- ❑ Northwestern Crow
- ❑ Black-billed Magpie
- ❑ Steller's Jay
- ❑ Hermit Thrush
- ❑ Varied Thrush
- ❑ American Robin
- ❑ Wilson's Warbler
- ❑ Orange-crowned Warbler
- ❑ Song Sparrow
- ❑ Fox Sparrow
- ❑ Savannah Sparrow

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

O HERRING, WHERE ART THOU?

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Seasonal movements are common in many species of fish, including the Pacific herring in Prince William Sound. These herring spawn in the spring, then either migrate out into the Gulf of Alaska or remain in the Sound. Based on detections of acoustic-tagged fish, we know that by November some herring are back around their spawning grounds. But where are they spending their winters?

Using an autonomous underwater glider (pictured above), we hope to find the wintering grounds. With funding from the Alaska Ocean Observing System, in January 2021 a collaborative team from the University of Alaska Fairbanks, PWS Science Center, and NOAA deployed the six-foot long glider in eastern Prince William Sound near Port Gravina.

Shaped like a torpedo with wings, the bright yellow glider travels around 1 km/hour, diving slowly towards the bottom, and once there, climbing back up to the surface where it uploads data to scientists via a satellite link. Our particular glider, named Shackleton, is equipped with a receiver that can detect the acoustic tags. With more than 300 tags implanted in Pacific herring in the Sound, we believe the mystery of where herring overwinter will finally be revealed.

HERRING RESEARCH IN THE TIME OF COVID-19

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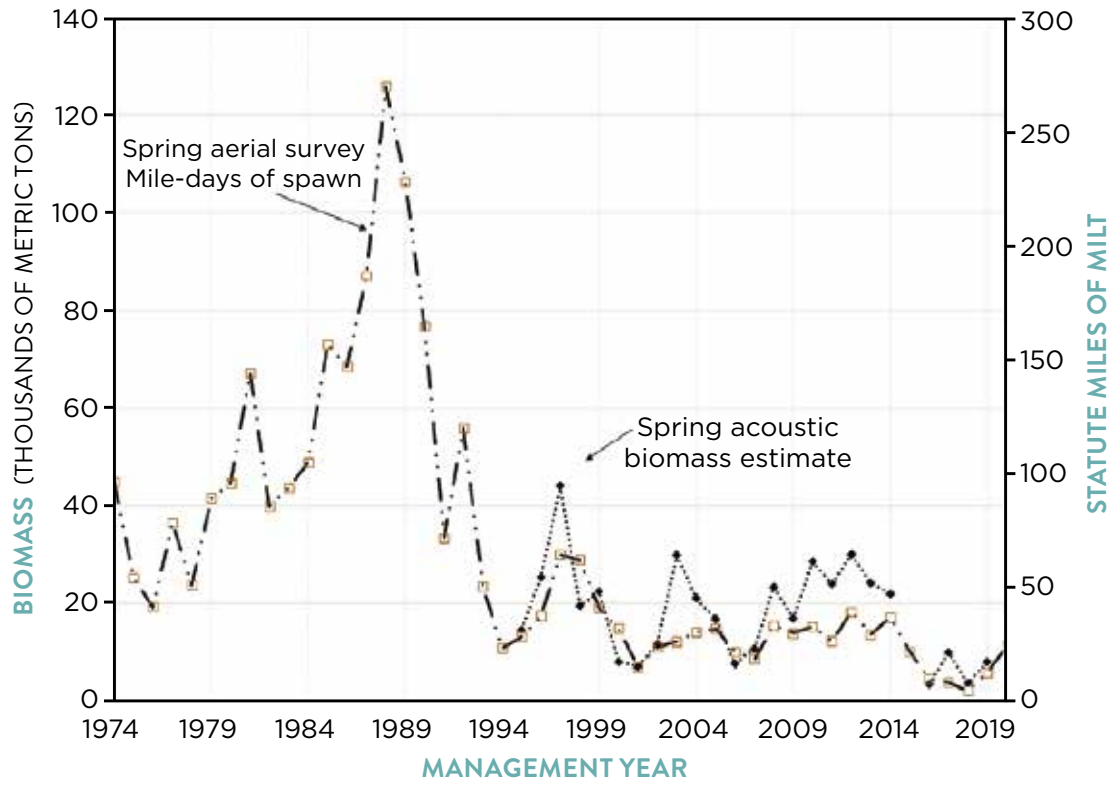
2020 became the year of adaptability. The Covid-19 outbreak had the State of Alaska start work and travel restrictions at the beginning of April at the same time as the herring spawn, our busiest time of sampling. We had one vessel at sea and another being loaded when the work restrictions were put in place and as a team we had to scramble to adjust our efforts to align with those restrictions.

With the help and flexibility of many people, we were able to conduct all of our work. Researchers did double duty to fill in for those not able to get to sea and local fishermen assisted in collecting samples when we weren't able to get one vessel to sea. A physical oceanographer even learned to collect blood for disease analysis. With the adaptability and willingness to assist others, we were able to achieve all of our objectives in 2020. ■



Mile-days of milt in Prince William Sound based on aerial surveys and biomass estimates from acoustic surveys. Includes preliminary results of the 2020 survey from Alaska Department of Fish and Game.

SNAPSHOT OF PWS HERRING

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Prince William Sound (PWS) herring population estimates are generated annually by the Herring Research and Monitoring (HRM) team with a Bayesian age-structure-assessment (BASA) model. The model takes inputs from aerial surveys of mile-days of spawn (total number of miles of spawn observed each spring), acoustic surveys of spawning biomass, age-sex-size, historical egg deposition, and disease prevalence data. This information is collected each spring during research surveys conducted in the sound. The survey area covers traditional spawning regions within Prince William Sound and occasional surveys in the Kayak Island area.

The current status of PWS herring is looking a little brighter these days in some respects. Aerial surveys observed a record low level of mile-days of milt in 2018 (figure above) with a 5-fold increase by 2020. The weight and length at age values in age-5 and -6 fish have been decreasing since 2015 meaning the population is composed of smaller than normal fish with very few older fish being observed in the population as well.

While these two observations are concerning, antibody data compiled by the disease team show very low levels in recent years implying that the newly recruited fish haven't been previously exposed to noteworthy pathogens. This decrease in pathogen exposure may be a contributing factor to the rapid biomass increase that was first observed in 2019 in the BASA model. This increase appears to be driven by a large recruitment of fish from the 2016-year class seen throughout the Gulf of Alaska with recruit to spawner metrics across the region being nearly four times greater than the next most successful year class since 1980.

The herring population is beginning to increase but will need additional large year classes to join the spawning biomass to continue this trend. ■

PWSSC.ORG/HERRING

ZIGGING AND ZAGGING FOR HERRING

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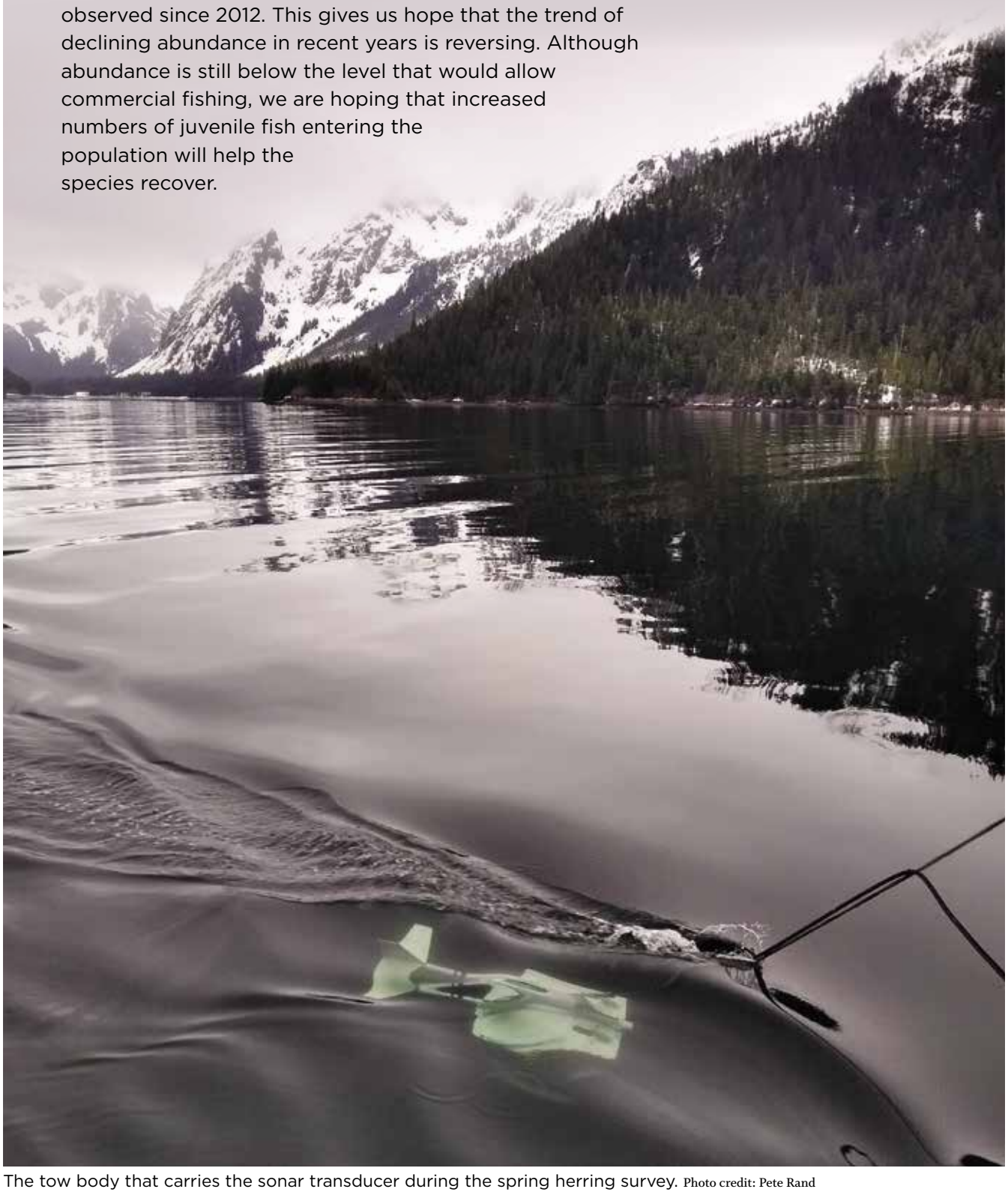
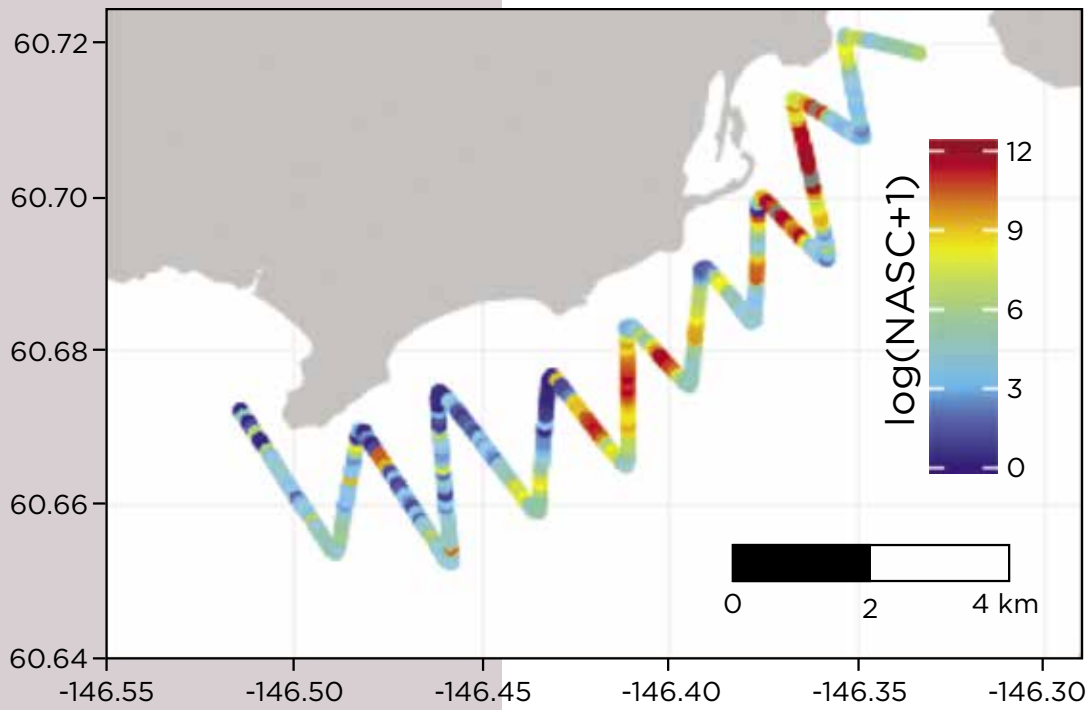
The year 2020 was the twenty-eighth consecutive year that the Prince William Sound Science Center conducted a spring survey for Pacific herring. The survey is scheduled each year in the spring when adult herring aggregate in large schools nearshore to spawn. Our survey relies on sonar and is conducted during nighttime hours when the fish are easier to count. The transducer (a metal and ceramic disk) is attached to a tow body (below) and dragged just below the surface following sunset. Based on what is seen from aerial surveys and predator distributions (sea birds and marine mammals) during the day, the crew lays out a "saw tooth" cruise track, consisting of zigs and zags that follow certain depth contours where herring tend to congregate just before spawning.

This past year we saw a large number of herring in Port Gravina (upper right figure); the largest aggregation observed since 2012. This gives us hope that the trend of declining abundance in recent years is reversing. Although abundance is still below the level that would allow commercial fishing, we are hoping that increased numbers of juvenile fish entering the population will help the species recover.



The tow body that carries the sonar transducer during the spring herring survey. Photo credit: Pete Rand

The zig-zag cruise track from one evening survey in Port Gravina during spring 2020. The red colors along the transect indicate very dense herring schools encountered along the transect.



ACOUSTIC-TAGGED HERRING: MODELING THE UNKNOWN

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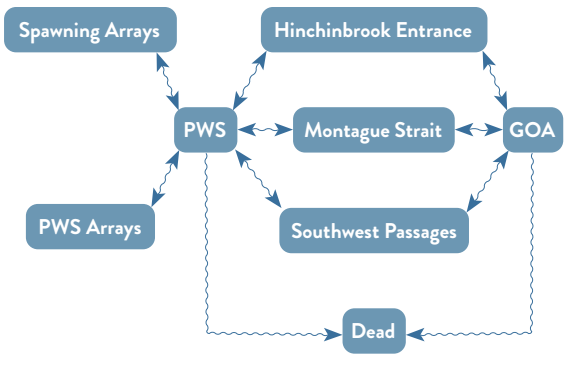
Implanting Pacific herring with acoustic tags has opened a new realm of possibilities for determining herring movements. Beginning in 2013, the Prince William Sound Science Center in collaboration with Canada's Ocean Tracking Network and the *Exxon Valdez* Oil Spill Trustee Council, installed a series of underwater hydrophones on the spring spawning grounds of herring as well as at strategic locations where Prince William Sound (PWS) flows into the Gulf of Alaska (GOA) (see infographic below). Since then, we have added hydrophones at various locations around the Sound. When a herring swims within the detection range of the receivers, the receiver records the individual identification code and a time/date stamp for that fish.



But what happens when a tagged herring is in an area of Prince William Sound that does not have acoustic receivers, or is in the Gulf of Alaska where we have no receivers, or worse yet—if the fish has died? How can we determine which of the eight possible locations, known as "states," the fish is at?

Welcome to the world of mathematical models and probabilities! Computational models can now be quickly run on small personal computers; scientists write equations that relate the data from the acoustic tags detected at the hydrophones to the probability of where the fish is (referred to as the "state").

Because there are two consecutive arrays at the entrances between Prince William Sound and the Gulf of Alaska, we can determine what direction the tagged fish are swimming. Using a model known as a Bayesian model, the directional information is incorporated and a probability that a fish migrated can be determined. It is complicated, but importantly these equations can help us to estimate herring survival as well as distinguish seasonal migration between Prince William Sound and the Gulf of Alaska from short-term back and forth movements. ■

ABOUT TIME

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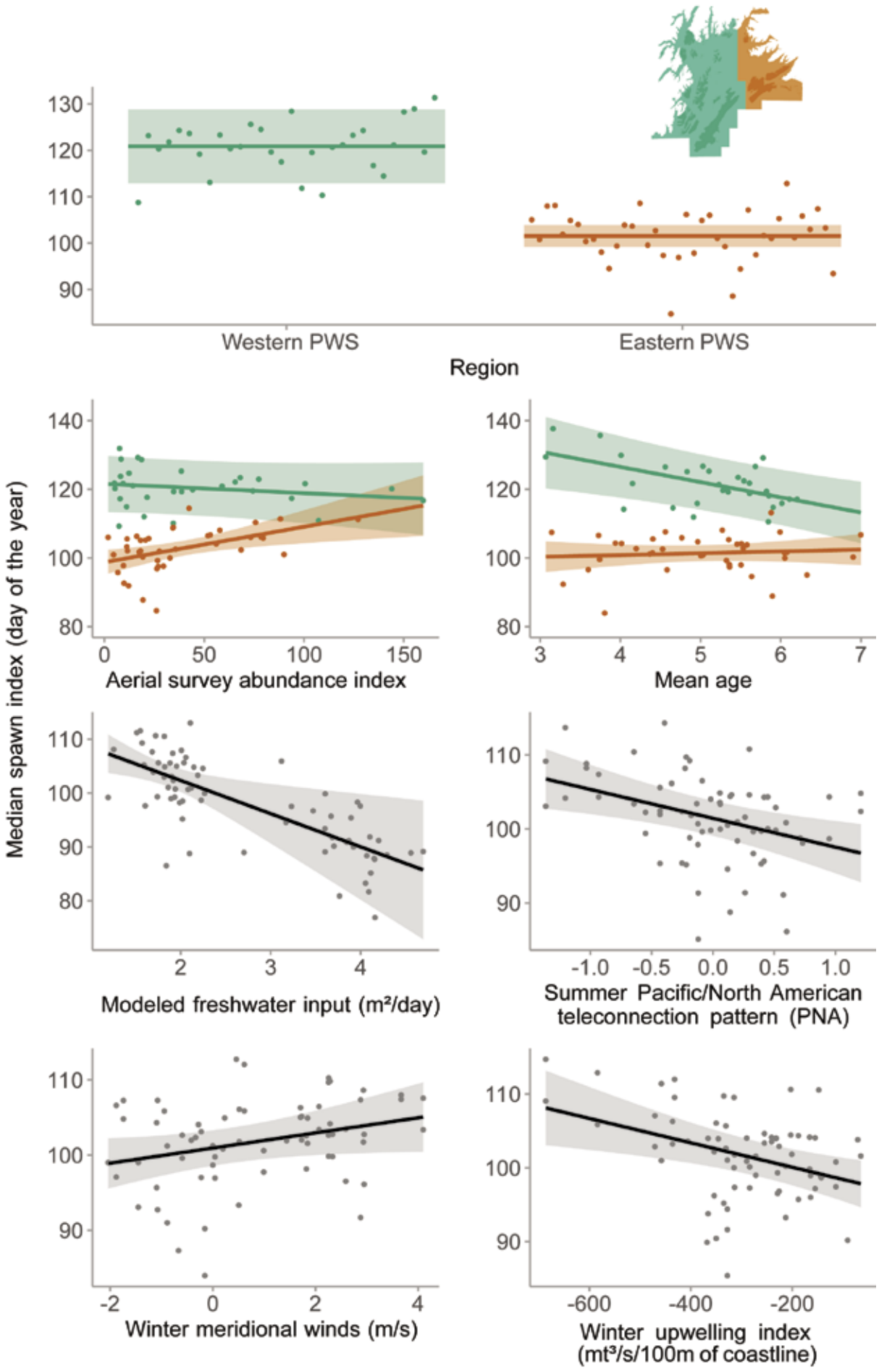
In nature, timing is everything. Spatial and temporal distributions of pelagic fish are closely related to their environment. For this reason, spawn timing ideally coincides with phytoplankton blooms that can provide beneficial conditions for the newly hatched fish. The blooms ensure they have plenty of food to grow and a greater chance of surviving the long, cold, food-scarce winter.

Alaska Department of Fish & Game aerial surveys have found pronounced changes in the location and timing of herring spawning in Prince William Sound since the 1970s. By examining the aerial survey data in conjunction with environmental factors, we identified what some of the leading causes of these changes might be. Once widely distributed across the Sound, spawning has gradually contracted to waters primarily near Port Gravina and Port Fidalgo in the east and along the northern tip of Montague Island. Spawn timing is highly variable from year to year but appears to be trending earlier in the year since the early 1980s. This earlier spawning correlates with several large-scale climatological factors such as weaker winds in the fall and winter and warmer water temperatures (mainly driven by the positive phase of the Pacific-North American Teleconnection Pattern).

Although the specific factors that influence spawn timing appear to be different in western and eastern Prince William Sound, changing ocean conditions can bring additional complications for fish life history across the board. Thus, a complex suite of factors, partly geographic, and partly environmental, appear to have driven shifts in spawn location and timing, which is likely to impact the survival of herring in their first year of life. ■



Observed trends in aerial survey data and population, environmental, and climatological conditions.

REPRESENTATION MATTERS IN SCIENCE

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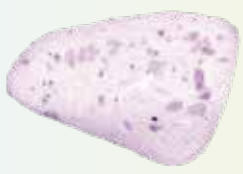

This picture shows a cross section of a herring heart tissue sample. The dark purple spots indicate *Ichthyophonus* infection.

Science is fascinating but can be intimidating to students trying to choose their careers. I felt this way as I worked to get an environmental science degree. As a first-generation college student, I didn't have much guidance for navigating higher education and, growing up, I rarely saw representation of my Indigenous, Peruvian, and Mexican background in science. Navigating college and a science degree was challenging, but along the way I was presented with new opportunities, career options, and met scientists with the same ethnic background as myself.

I was given my first research opportunity with scientists at the USGS Western Fisheries Research Center and PWSSC. We worked on understanding how a pathogen called *Ichthyophonus* affects herring populations. Initially I was intimidated by having little knowledge in pathology and research, but within three months I was presenting our research at a conference hosted by the *Society for the Advancement of Chicanos and Native Americans in Science*.

The knowledge I've gained while working with herring has inspired and empowered me to think about graduate school, a research career, and mentoring and encouraging youth to get into science. I see this research as a means of reciprocity to respect and give back to an animal and an ecosystem that provides for people. We research the pathogen in herring to learn about it, with the larger goal of conserving herring populations. In the future, I hope to share my knowledge and continue the reciprocal work with the environment and with students. ■

Eliana Bravo in her element at the USGS Western Fisheries Research Center.

GULF WATCH ALASKA PROGRAM LEADS TO UNDERSTANDING OF SPECIES ADAPTATION

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All organisms must adapt to their environments or they will cease to exist, but how do scientists learn about adaptation? The Gulf Watch Alaska program is studying organisms from plankton and seaweeds to forage fish and whales in the northern Gulf of Alaska through long-term monitoring, taking the same set of measurements year after year. The studies allow scientists to identify changes over time relative to environmental conditions such as temperature and salinity, access to food, and the abundance of predators. The articles on this page provide three examples.

An oceanography project in Prince William Sound includes a high-tech camera that captures beautiful images of plankton in the water column along with measurements of temperature and salinity. Over time the scientists will record whether plankton species change or shift their seasonal timing and abundance relative to climate change.

A nearshore project with study areas from Prince William Sound to the Alaska Peninsula includes annual sampling of Pacific mussel beds and their sea star predators. The recently documented sea star wasting disease has resulted in mussels expanding their range lower in the intertidal zone where they typically are preyed upon by sea stars.

A killer whale project in Prince William Sound and Resurrection Bay includes non-invasive techniques to determine the diet of resident (fish eating) populations of killer whales. The study is documenting seasonal shifts in diet based on prey availability. In addition, new study techniques show prey species that were not previously detectible, demonstrating that scientists, too, adapt to tools available.

The Gulf Watch Alaska program is funded by the *Exxon Valdez* Oil Spill Trustee Council, which determined that an ecosystem approach was needed to understand why some species injured by the 1989 oil spill were not recovering more than two decades after the spill and clean up efforts. To learn more about the Gulf Watch Alaska program and our findings, visit our webpage at gulfwatchalaska.org. ■

A *Metridia* copepod image taken by the camera in Prince William Sound. Copepods are a crustacean zooplankton, about the size of a grain of rice. The dark patch in the middle of its transparent body is its gut, full of phytoplankton it has eaten.

SMILE, YOU'RE ON PLANKTON CAM!

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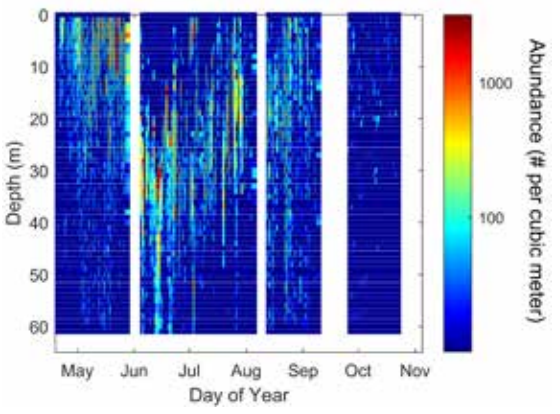
Plankton form the base of the marine food web. Tiny single-celled plant plankton (phytoplankton) grow and are consumed by animal plankton (zooplankton) grazers; zooplankton are food for larger animals like fish, birds, and whales. The amount and type of plankton present changes within and among years and measuring them is not easy. New technologies like underwater cameras offer new ways to estimate plankton abundance.

In 2016, an in-water plankton camera was developed and deployed on an autonomous robotic profiler that is deployed every year in central Prince William Sound from spring to autumn. In 2020, the profiler completed 315 separate profiles from 60 meters depth to the surface and collected more than 700,000 individual plankton images.

Using Deep Learning techniques similar to those used by Google to automatically identify images on the internet, 43 different kinds of plankton have been discriminated, to an accuracy of about 90%. The images, along with other data collected by the profiler, are giving us an unprecedented picture of how the plankton ecosystem of Prince William Sound works, and how it is changing as the climate does. ■



Abundance (number per cubic meter) of *Metridia* copepods in Prince William Sound during April to October 2020. Abundances are averaged by depth and are shown from the surface (top of the figure) to about 60 meters depth (bottom of figure). Hot colors indicate high abundances and cool colors indicate low abundances. We can see that in the spring (April-May), *Metridia* is most abundant near the surface, and moves down into deeper waters into the summer. This is partly to be where their food is, and partly to avoid predators.

MUSSELS ARE THRIVING; THANK YOUR (UN)LUCKY STARS

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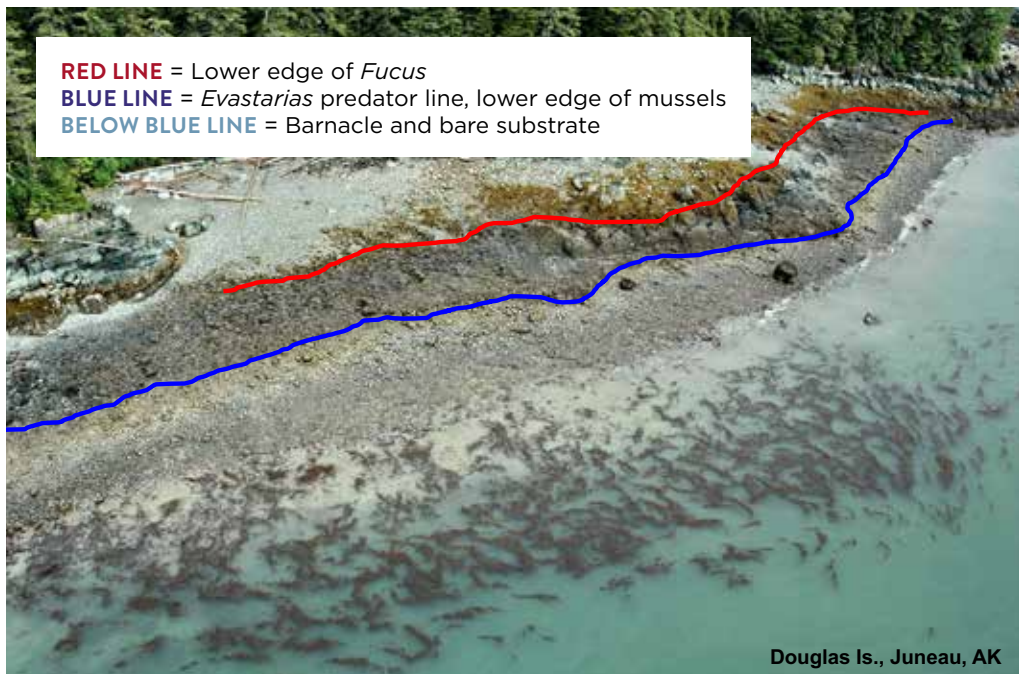
Sea stars are considered keystone species because even in relatively small numbers they have large effects on marine ecosystems. Experiments have shown that when sea stars are removed, intertidal mussels, a main sea star prey, become more abundant and outcompete other species. In the absence of sea stars, large mussel beds can form, resulting in a less diverse community. Sea stars are less tolerant of air exposure than mussels and stay lower in the intertidal (closer to water) to avoid drying out. For this reason, sea stars are often important in setting the lower limit of mussel beds in the intertidal.

What happens to mussels when sea star numbers decline at very large scales? An outbreak of sea star wasting syndrome (SSWS), which causes sea stars to die, began in 2013 and spread across the west coast of North America. The long-term monitoring program, Gulf Watch Alaska, saw dramatic declines in sea stars, particularly those that eat mussels, in the northern Gulf of Alaska between 2014 and 2016. In most locations, sea stars remain rare today and the sunflower star, *Pycnopodia helianthoides*, has recently been listed by the International Union for Conservation of Nature (IUCN) as Critically Endangered.

Numbers of mussels and the size of mussel beds have increased at many locations across the Gulf in the years following the decline of sea stars, presumably because of lower predation. These changes could persist for years until sea star numbers rebound and could benefit other animals that eat mussels, such as sea otters, sea ducks, and Black Oystercatchers. ■



ABOVE: Aerial photo of a rocky intertidal beach at low tide showing typical zones for rockweed (above the red line), mussels (above the blue line), and upper extent of sea star predation on mussels (blue line). *Photo credit Mandy Lindeberg, NMFS.*

RIGHT: Pacific blue mussels filter feeding during a high tide. *Photo credit Sarah Traiger, USGS.*

TOP: Healthy mottled sea stars. *Photo credit Mandy Lindeberg, NMFS.*

BOTTOM: Mottled star with sea star wasting disease. *Photo credit Brenda Konar, UAF.*

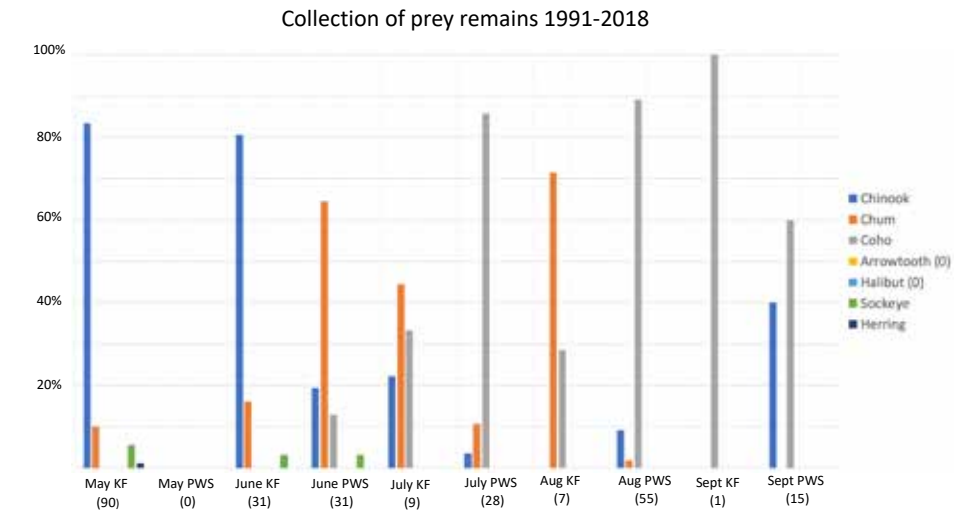
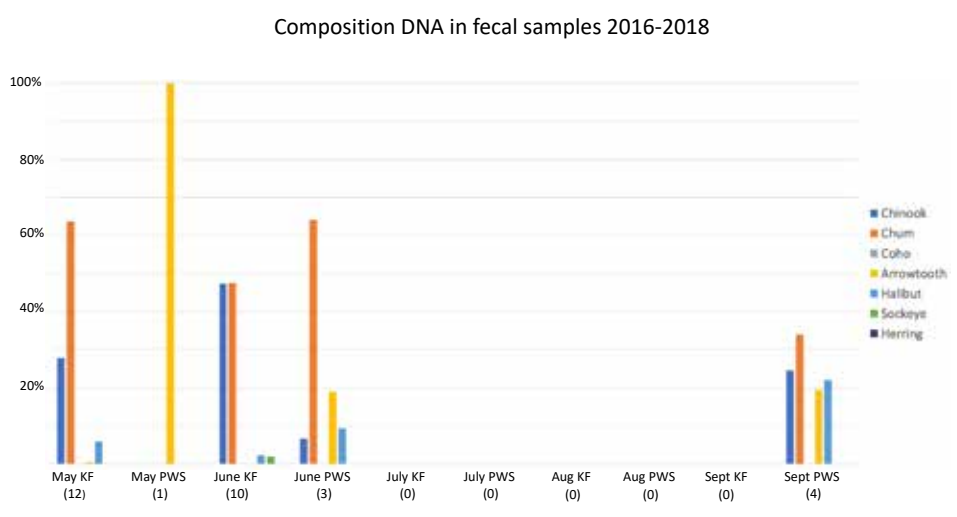


Figure 1: The seasonal diet of a resident killer whale shifts with salmon abundance. Chinook and chum salmon, then later coho salmon dominate the diet, shown here by prey samples collected in Kenai Fjords (KF) and Prince William Sound (PWS) during May to September, 1991-2018. Numbers of samples in parentheses.



Figrure 2: Seasonal diet changes for killer whales are also studied by percentage of prey DNA present in fecal samples collected in Kenai Fjords (KF) and Prince William Sound (PWS) during May, June, September, 2016-2018. The fecal samples confirm Chinook and chum salmon and reveal a small amount of halibut and arrowtooth flounder. Numbers of samples in parentheses.

THE SEASONAL HARVEST FOR ALASKA'S RESIDENT KILLER WHALES

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For thousands of years, Native Alaskans have adapted to the seasons to harvest specific runs of salmon, berries, and caribou, or to watch the monthly ebbs and floods of tides for shellfish. These seasonal traditions remain active for many Alaskans. The 'resident' (salmon specialist) killer whales in Alaska are not so different. Families are led through the seasons by matriarchs with up to 80 years of experience. These matriarchs have a keen awareness of seasonal shifts in salmon runs, locations with abundance of fish, and knowledge of species of fish that provide enough fat energy to pack on blubber and survive through lean times.

Nearly every year in Resurrection Bay, the same pods arrive consistently in mid-May to forage on Chinook salmon that are on their way to Southeast Alaska and British Columbia. During the same time, other pods are targeting passing chum salmon in Hinchinbrook Entrance, Prince William Sound—part of a rich early season abundance. As the season shifts to coho salmon, these pods shift locations to find them. For many years, the North Gulf Oceanic Society has collected salmon scales during feeding events to better understand these seasonal shifts in foraging spots (figure 1). More recently we have also been collecting fecal samples from resident killer whales, which have revealed a small but important amount of foraging on halibut and arrowtooth flounder (figure 2). ■

A long chase to exhaust a fish. Salmon for dinner!

Photo credit Dan Olsen, NGOS.

THE NEXT WAVE

WHO MIGRATES THE MOST?

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Birds are a great example of animals that annually travel huge distances to chase environments with plenty of food. Some birds, like the Arctic Tern, make an annual migration of 30,000 km (18,640 miles) from the Arctic to the Antarctic. This distance is nothing compared to the migrations that happen daily in the open ocean.

Zooplankton, microscopic animals comprising the base of the ocean's food web, travel up and down in the water column to find food and escape predators. The most abundant group, copepods, are tiny (0.2 – 4 mm) shrimp-like animals that feed on microscopic algae called phytoplankton. Some copepods in PWS are a quarter of the size of a rice grain! During the day, copepods remain at depth in the dark, hiding from predators. At night, they migrate upward to where tasty phytoplankton reside near the formerly light-filled surface.

In the deepest parts of PWS, this vertical migration can be about 800 m (875 yards). For a tiny 2 mm copepod, each meter equates to a kilometer translating to a round trip migration of 1600 km (1000 miles) each day. In one month, copepods travel almost twice as far as Arctic Terns making "diel vertical migration" one of the biggest migrations on the planet. ■

KELP FARMING IN PRINCE WILLIAM SOUND

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A new industry is coming to Prince William Sound, one that is poised to provide economic opportunity in our maritime sector and has the potential to help with mitigating the acidification of our marine waters.

Kelp farming is fast becoming an attractive business opportunity in response to global demand: The Island Institute of Maine finds that the "global seaweed market is large, diverse and growing" (Edible Seaweed Market Analysis, 2020), with worldwide markets for seaweed exceeding $4 billion USD in 2017, and a projection for that to double by 2024 (Alaska Oceans Cluster).

Growing kelp takes clean, cold water, and about six months of grow time. It doesn't require fertilizer, fresh water, or land, which means it has a pretty light resource footprint. On the other side of the ledger, kelp blades absorb CO_2 in the water, helping to mitigate local effects of ocean acidification (kelp cultivated in the water column with oysters has been shown to have a "halo effect" by reducing acidification and enabling oysters to grow stronger shells faster).

NOAA research has found that "seaweeds also gobble up nitrogen and phosphorus," which are the excess nutrients that drive harmful algal blooms. Unchecked algae growth depletes the ocean of oxygen when it decomposes (NOAA Fisheries, Seaweed Aquaculture).

What does the world do with the 40 million tons of kelp cultivated annually? Kelp is turning up in hundreds of food and "nutraceutical" products, in hand sanitizer and toothpaste, and is being explored for use in biodegradable plastic packaging.

Kelp farming is a great fit, and economic development adaptation, for our region's coastal communities – its winter growing season can balance the summer fishing season; area residents have lots of experience on PWS waters; and our maritime infrastructure of boats, harbors, and seafood processors can all be taken advantage of for kelp harvesting and processing. ■

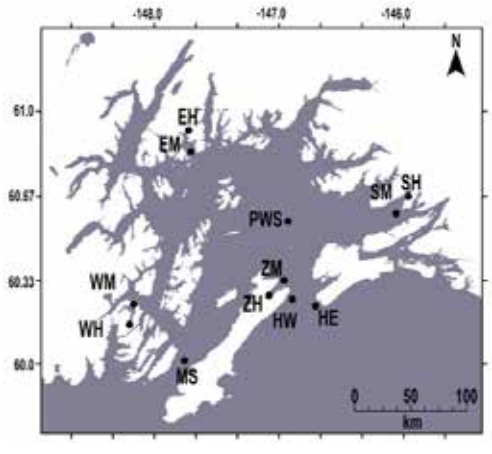
PWSEDD.ORG

A plate of ribbon kelp *(Alaria marginata)* fresh, blanched, and dried. *Photo credit Tamsen Peeples.*

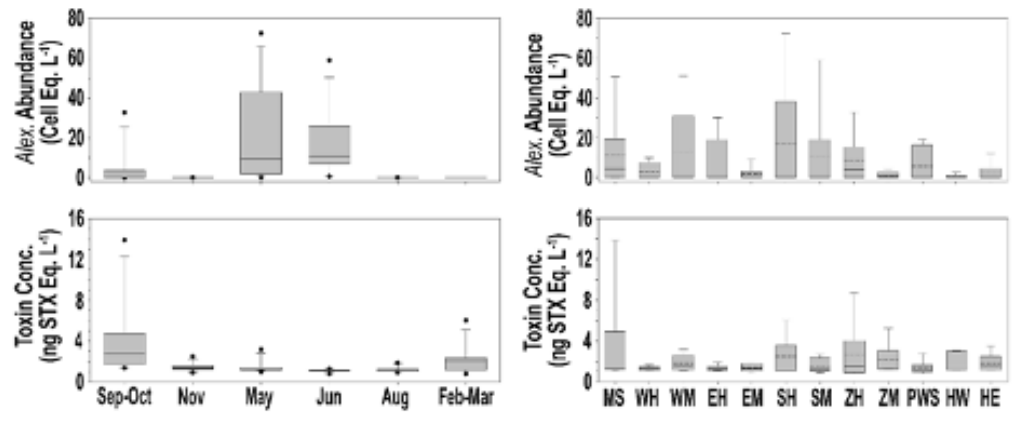
A longline growing sugar kelp *(Saccharina latissima)* being hauled up.

PREVALENCE OF PARALYTIC SHELLFISH TOXINS IN PRINCE WILLIAM SOUND PLANKTON

Zooplankton vary in size and shape but most are very tiny and require a microscope to view properly. This collage of zooplankton illustrates their size compared to a grain of rice (middle). Clockwise from top: *Limacina helicina, Corycaeus anglicus, Tricornia borealis, Pseudocalanus, Ostracod, Bipinnaria* (seastar larvae), *Acartia longiremis,* and *Neocalanus plumchrus.*



Primary collection sites in Prince William Sound (PWS) for *Alexandrium* abundance and PSP toxins in plankton.



Alexandrium abundance (Cell Equivalents per liter) and STX toxin concentrations (nanograms per liter) in the phytoplankton fraction (20 micrometer net) in PWS. Left panels are concentrations binned by collection month, right panels are concentrations binned by sampling site.

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Saxitoxins (STXs) produced by the phytoplankton dinoflagellate *Alexandrium catenella* are potent neurotoxins that accumulate in shellfish during blooms each spring and summer. These toxins cause Paralytic Shellfish Poisoning (PSP).

PSP toxins may be transferred through the marine food web, reaching seabirds, marine mammals, and other high-level consumers. Because these compounds are likely transferred through middle trophic level organisms such as zooplankton, forage fish, and benthic invertebrates, there is concern that STXs may also accumulate in salmon and other commercially important predatory fish species, although the trophic transfer pathways for PSP toxins in Alaska are unclear.

To examine *Alexandrium* prevalence in PWS, a plankton sampling program began in 2018, looking both at *Alexandrium* abundance and Saxitoxin concentrations. We found that *Alexandrium* blooms occur seasonally in PWS, with maximum cell abundances in May-June. Overall, PSP toxins are at low levels in PWS, but planktonic toxin levels were variable and often not coupled with *Alexandrium* abundances. ■

MAXIMIZING SALMONS' ABILITY TO ADAPT

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Smaller body sizes. More parasites. Softer flesh. These are some of the observations shared by Copper River salmon harvesters in recent years. While there is no single answer to explain these observations, many agree that the water conditions are changing. Recent summers have been warmer and drier, while winter snowpack is changing. Glaciers are retreating, storms are increasing in duration and intensity, and the ocean is more acidic. The best way to help salmon adapt to these changing conditions is to maximize the habitat available to salmon and sustain the genetic diversity within salmon species.

This is where the Copper River Watershed Project has focused our resources—to help provide an intact and barrier free watershed to allow salmon unimpeded access to a diversity of habitats. For over a decade, CRWP has been working with our partners to prioritize and replace failing and undersized culverts with crossings that mimic natural systems.

The undersized culvert in the foreground was replaced with the larger culvert to allow the stream and aquatic organisms like salmon to pass under the Copper River Highway unimpeded. *Photo credit USFS.*

Juvenile salmon live multiple years in freshwater before migrating out to the ocean. During this time, they need to be able to escape unsuitable conditions, such as warm water and low flow conditions, and find more favorable habitats. To maximize the number of fish migrating out of the watershed, we need to maximize their access to quality habitat.

As for the return migration, people eagerly await the return of Copper River sockeye. Did you know there are an estimated 156 spawning sites for sockeye in this watershed, representing an estimated eight genetically distinct populations? This genetic diversity within the species is crucial to support the adaptations of salmon to the changing habitat conditions they are facing.

Working towards reinstating a barrier free watershed by replacing undersized culverts, CRWP is hopeful we can help salmon effectively mitigate the changes they face, maintain genetic diversity, and support the future of salmon.

More information on our fish passage and other programs available at copperriver.org. ■

PWSSC field crew dipnetting for sockeye salmon with Childs Glacier as a backdrop during 2020. Captured fish are transferred to a recirculating trough for measurements and insertion of the radio tag. Fish are quickly released back to the river to resume their migration. *Photo credit PWSSC.*

COPPER RIVER SOCKEYE SALMON ENJOY A MORE 'NORMAL' MIGRATORY YEAR

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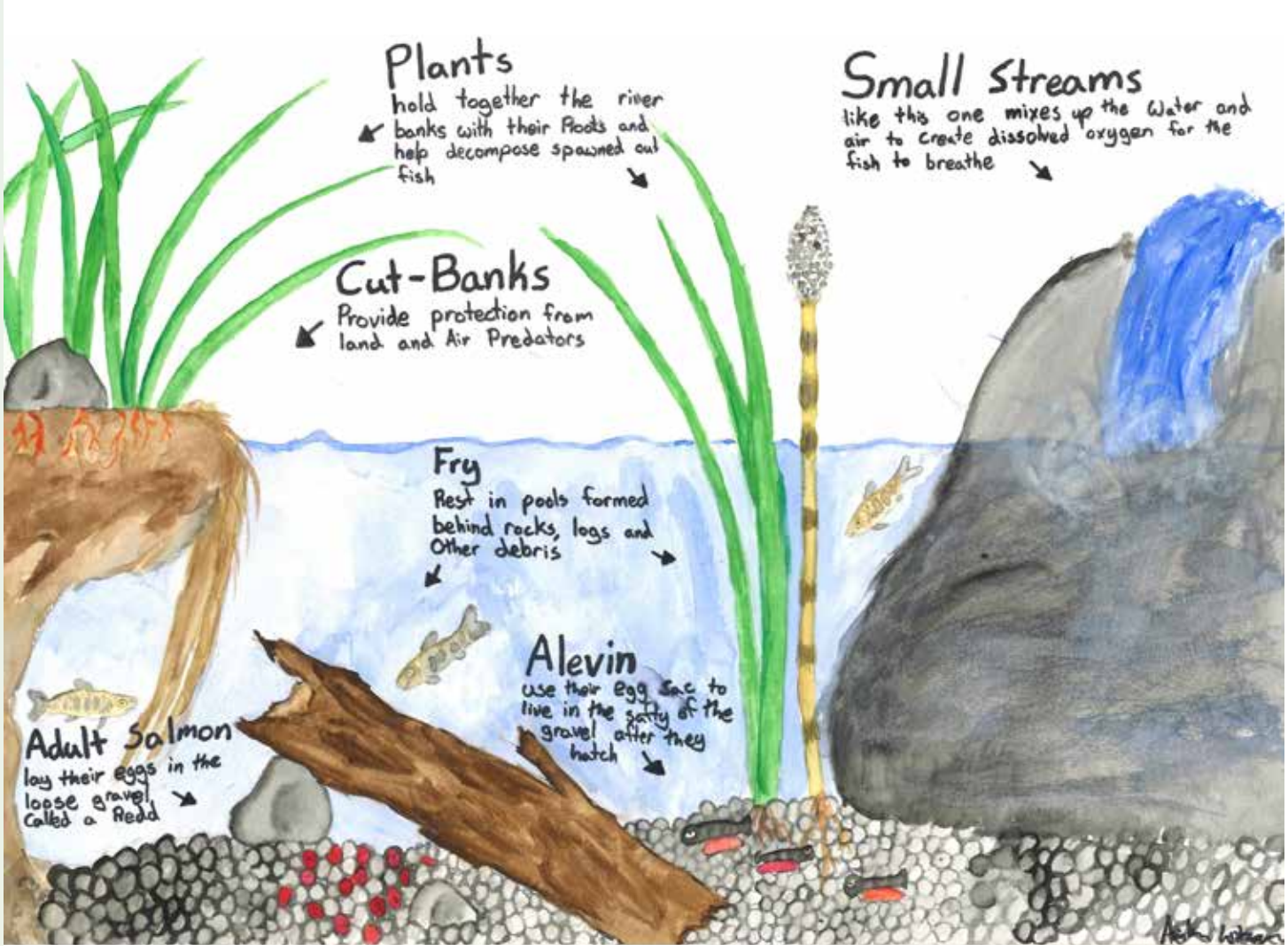
Sockeye salmon in the Copper River struggled under record high river flow during 2019, a year of unprecedented heat in Alaska leading to increased glacial melting and flooding conditions in the lower river. Fortunately, air temperatures during summer 2020 in Alaska were cooler, leading to river conditions that made it easier for adult sockeye salmon to reach the spawning grounds. "It is a great natural experiment to compare how these fish cope with changes in river flow from year to year" says the lead scientist, Dr. Pete Rand, on a new multi-year study. Rand and his colleague, Dr. Kristen Gorman, have been studying energetics and health of these fish as they meet challenging migratory conditions.

Climate projections indicate salmon are going to be challenged with high flows from increased glacial meltwater during their annual spawning migration. "The year 2019 gave us our first glimpse on how these fish are going to be challenged with changing river conditions in the future" comments Rand. Many more of the fish that Rand and Gorman radio-tagged in the lower river in 2020 successfully passed waypoints upriver, based on detections from aerial surveys and antennas on the riverbank.

The study is ambitious and complex and is only possible through collaboration with several organizations throughout the watershed, including members of Native Alaskan communities. "These fish are so iconic, and they are important in so many ways, including food security and recreation" adds Rand. This project hopes to increase our understanding of the resilience of salmon populations throughout the watershed. The project is made possible from funding from the North Pacific Research Board and the Idea Network of Biomedical Research Excellence.

Native Village of Eyak field crew member, Cole Weaver, releasing a radio-tagged sockeye salmon on a research fishwheel in the lower Copper River during spring 2020. *Photo credit NVE.*



Juvenile Salmon Habitat, a watercolor created by 2017 Copper River Stewardship Program participant, Anika Witsoe.

63°N
62°N
61°N
60°N
Paxson
Talkeetna Mountains
Talkeetna
Gakona
Gulkana
Glennallen
Mendeltna
Tazlina
Copperville
Copper Center
Kenny Lake
Chitin
Wasilla
Chugach
Valdez
Anchorage
Unakwik Inlet
Tatitlek
Portage
Whittier
Eaglek Bay
Bligh Reef
Port Gravina
Simpson Bay
Cordova
Alaganik
Blackstone Bay
Prince William Sound
Eshamy Bay
Knight Is.
Egg Is.
Hinchinbrook Is.
Copper River
Hinchinbrook Entrance
Chenega
Montague Is.
Seward
Resurrection Bay
Montague Strait
Middleton Is.
N
25
50
Miles
150°W
148°W
146°W

PRINCE WILLIAM SOUND SCIENCE CENTER

Map and design by Kristin Link

Highways

Trans Alaska Pipeline

USA-Canada Border

entasta Lake

Slana

ochina

Wrangell Mountains

Mt. Wrangell
14,163 ft

Kennecott Copper Mine

McCarthy

na

Chitina River

ountains

Copper River

Bering River

Bering Glacier

Bagley Icefield

Mt. St. Elias
18,008 ft

Icy Bay

Yakutat Bay

Yakutat

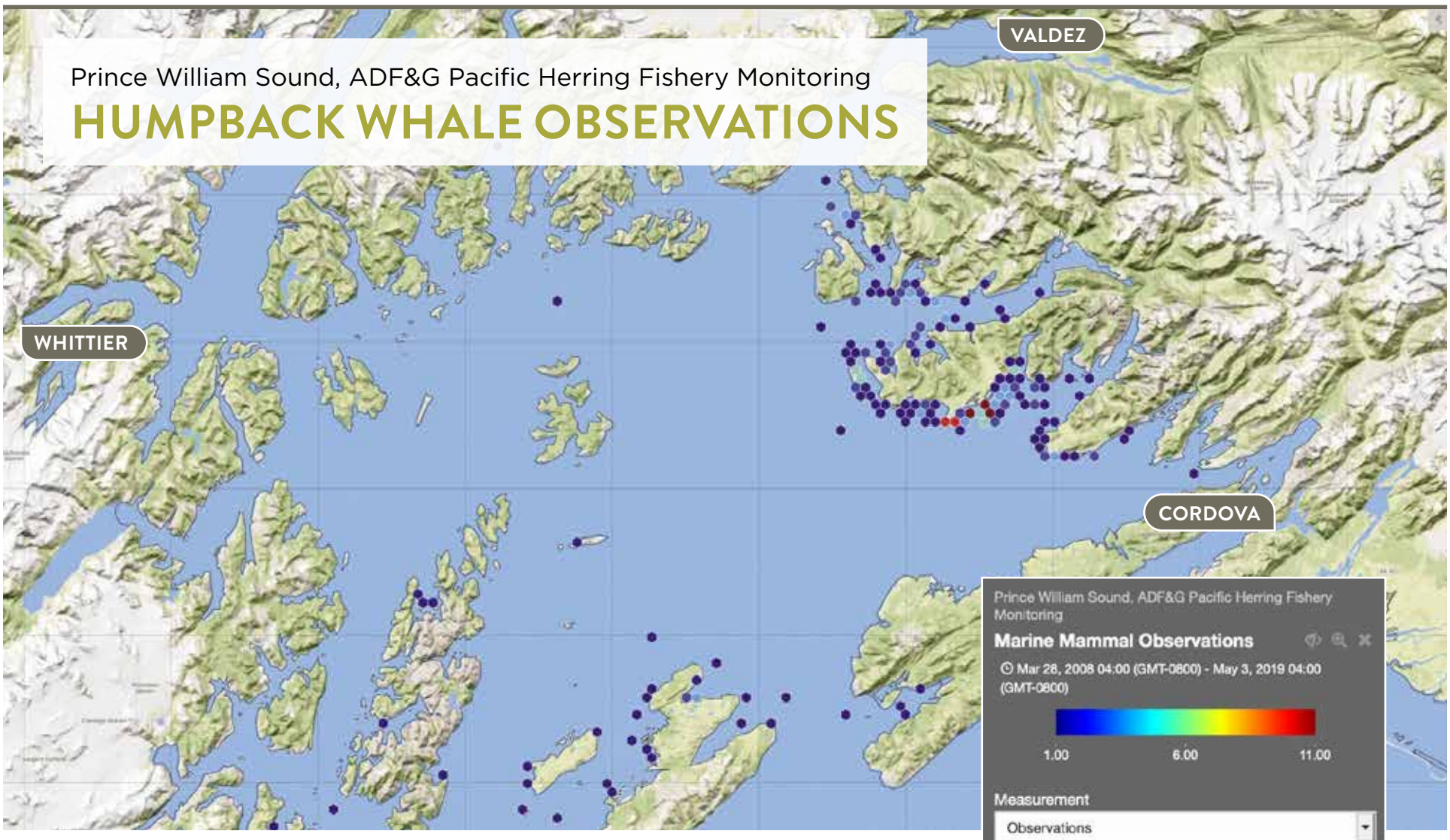
Flats

Kayak Is.

Gulf of Alaska

144°W

142°W



OCEAN DATA EXPLORER

The Ocean Data Explorer (ODE), the Alaska Ocean Observing System's (AOOS) data portal, uses cutting-edge technology to deliver data and information about the oceans and coasts of Alaska to the general public, mariners, resource managers, researchers, and other interested parties.

Anyone with an internet connection can search the portal for current and historical information from the greater Alaska region and immediately display this information on a map or graph. The information can also be downloaded as a data file. The AOOS ODE provides a way for users to find information they need to help make a variety of decisions.

Humpback Whale Observations

The ODE is used as a source of information on humpback whale observations in the example above. This screen shot of the ODE map displays counts of humpback whales observed as part of the Prince William Sound, Alaska Department of Fish & Game Pacific Herring Fishery Monitoring Program. These aerial surveys are conducted annually between late March and mid-May to observe the majority of spring Pacific herring spawning events. This screenshot displays all humpback whale sightings that occurred over the ten year period of surveys between 2008 and 2018. This information is one of thousands of data layers available for display and/or download. Go to https://portal.aoos.org/?ls=271fe275-77f9-6594-273e-9975c9df9c8f#map to view this information. ■

ALASKA HARMFUL ALGAL BLOOM NETWORK

Coordinating a statewide approach to HAB awareness, research, monitoring, and response in Alaska.

PARTNER HIGHLIGHT:
Alutiiq Pride Marine Institute (APMI)

The Alutiiq Pride Marine Institute (APMI), formerly the Alutiiq Pride Shellfish Hatchery, is a division of the Chugach Regional Resources Commission (CRRC), a Tribal consortium representing seven Tribes from the coastal Prince William Sound and Lower Cook Inlet regions. APMI started as the only shellfish hatchery in Alaska, with the mission of supporting the aquatic farm industry by providing seed stock, developing seed for new species, and conducting research to enhance shellfish in the state. It quickly became clear that supporting shellfish aquaculture required a better understanding of the environmental stressors to shellfish, including ocean acidification and harmful algal blooms. APMI is developing laboratory capabilities to monitor how these conditions change over time through their Chugach Regional Ocean Monitoring (CROM) Program. These capacities include a Burke-o-Lator for examining ocean acidification, qPCR equipment for molecular species identification, and ELISA capabilities for detection of biotoxins that cause conditions like paralytic shellfish poisoning. APMI is partnering with each of its Tribal communities across the region to process seawater samples collected on a weekly basis by community samplers. Results from this testing are shared back to these communities, as well as statewide using the Alaska Harmful Algal Bloom and Alaska Ocean Acidification networks. Through the development and implementation of Tribal natural resource management programs, APMI assures the conservation, sustainable economic development, and stewardship of the natural resources in the traditional use areas of the Chugach Region. ■

Patrick Norman and Jeff Hetrick walking to the dock in Port Graham, Alaska to conduct sampling.

Deployment of a yellow autonomous underwater glider with *R/V Sikuliaq* in the background. *Photo credit NPRB/Brendan Smith.*

R/V Nanuq approaching the silty Copper River discharge plume.

Photo credit Seth Danielson.

LONG TERM ECOSYSTEM RESEARCH IN THE GULF OF ALASKA

The impacts of COVID-19 were far-reaching and included effects on research during the summer of 2020. Despite challenges and restrictions due to COVID-19, scientists working on the Northern Gulf of Alaska Long Term Ecosystem Research (NGA-LTER) were able to complete their 2020 field operations. This was incredibly important to maintain the long-term collection of data that began in 1970.

The Northern Gulf of Alaska region including Prince William Sound is known for its biological productivity and diversity. From the lowest levels of the food chain (plankton) to its iconic salmon, halibut, crabs, seabirds, and marine mammals, this region supports many commercial, sport fish, and subsistence fisheries. Scientists at the University of Alaska and their many partners recently joined the National Science Foundation's Long Term Ecological Research (LTER) network that was created to test and develop ecological theories across a spectrum of ecosystems.

The US LTER network consists of 28 sites with a rich history of ecological inquiry, collaboration across a wide range of research topics, and engagement with students, educators, and community members. It brings together diverse groups of researchers with multi-decadal data collection and ecosystem experiments extending beyond the typical 2-4 year research grant. These sites allow each new generation of scientists to apply new tools and explore new questions in systems where the historical context is well understood, shared, and thoroughly documented.

Multidisciplinary research at well-established locations has been an important component of marine studies in Alaska. Many of these observations have been made offshore of Resurrection Bay, the fjord that connects Seward, Alaska, to the North Pacific Ocean. The Seward Line observations stretch 150 nautical miles from the inner continental shelf into miles-deep oceanic waters well past the shelf break. These observations have been critical in defining the ocean conditions that characterize the Northern Gulf of Alaska habitats and their associated biological communities.

Research data are collected year-round from instruments attached to stationary buoys, such as the Gulf Ecosystem Observatory, that measure a wide variety of parameters including water temperature, salinity, nutrients, currents, and ocean acidification, as well as underwater sounds including marine mammals and ship noise. Data are also collected from oceanographic cruises on the *R/V Sikuliaq* (261 ft. length) and *R/V Nanuq* (40 ft. length), two modern and state-of-the-art scientific research vessels operated out of the University of Alaska Fairbanks Seward Marine Center in Resurrection Bay. The newest addition to data collection methods for this project will include underwater autonomous gliders that can be launched from research vessels and then operate robotically, moving through the water for months at a time collecting important scientific data in places that lack shipboard observations.

Studies in the Northern Gulf of Alaska by the LTER project are currently focused on the growth of microscopic marine algae called phytoplankton. Like terrestrial plants, phytoplankton contain the green pigment chlorophyll and require sunlight and nutrients in order to live and grow. Phytoplankton form the base of the food chain in the ocean. Most are beneficial sources of food to animal plankton (zooplankton) and fishes, but some can generate toxins such as those that lead to paralytic shellfish poisoning. The growth of phytoplankton depends on a complex interaction of ecosystem factors such as temperature, water column stratification, light and nutrient availability. Knowing how this happens is vitally important to understanding how the ecosystem works.

Growth incubation experiments of phytoplankton from the Copper River plume water are showing how balances of fresh water, light, and nutrient availability impact phytoplankton growth. Water quality measurements and zooplankton collected using nets show how differing plankton communities thrive in fresh, brackish, and salty shelf waters that extend along the salinity gradient that extends from the Copper River outflow to the open ocean. Satellite-tracked drifters transmit hourly reports of GPS position and sea surface temperature and show how wind and tides modify the local currents.

Now you know what some of those buoys that you see on the ocean and some of the science vessels moving through the Sound and the Gulf of Alaska are doing. It's all in the name of science!

These ongoing observations are supported by Alaska Ocean Observing System, the M.J. Murdock Charitable Trust, the North Pacific Research Board, the *Exxon Valdez* Oil Spill Trustee Council, and the National Science Foundation.

OCEAN ACIDIFICATION UPDATE

AOOS established the Alaska Ocean Acidification Network in 2016 to engage with scientists and stakeholders to expand the understanding of ocean acidification (OA) processes and consequences in Alaska.

WHAT IS OCEAN ACIDIFICATION?

Scientists estimate that the ocean is thirty percent more acidic today than it was 300 years ago, traceable to increasing levels of atmospheric carbon dioxide (CO_2) generated by humans. As CO_2 is released into the atmosphere by human activities, about half of it stays there and much of the rest is absorbed by the ocean. This lowers the pH and increases the acidity of seawater, changing the environment for the organisms that live there.

WHY IS OCEAN ACIDIFICATION A CONCERN FOR ALASKA?

Some of the species most susceptible to OA often include the basis of the food chain, so researchers expect the effects of OA to be felt throughout the marine ecosystem. This could dramatically affect the lives and livelihoods of Alaskans, including many who rely on wild foods and the $5.8 billion Alaska seafood industry. OA in Alaska is expected to happen faster than in other regions due to its cold water, which can absorb more CO_2. Since Alaska waters have already become more acidic due to natural factors, an increase in ocean acidification could have major impacts.

HOW DO WE MONITOR OCEAN ACIDIFICATION?

When people think of acidity, they often think of the pH scale, but tracking ocean acidification requires more than that. A suite of variables needs to be collected simultaneously, and a long time series is needed to tease out trends from natural variability. Strategies for monitoring ocean acidification in Alaska's coastal and ocean ecosystems include ship-based monitoring, open ocean buoys, instruments attached to docks or moorings, shore-based systems in labs or hatcheries, and community-based water sampling.

TRIBES ARE INVOLVED

Native Alaskans depend on wild food for nutrition and culture and are becoming key players in OA monitoring efforts. Tribes in Lower Cook Inlet, Prince William Sound, Southeast Alaska, Kodiak, and the Arctic are taking water samples near their communities. These samples will help build an understanding of baseline conditions and local influences that can help Tribes plan and respond. Do you know how community water samples are collected? In beer bottles! (Clean ones, of course.)

Learn more about Ocean Acidification in Alaska by visiting the Alaska Ocean acidification network website.

LEGACY.AOOS.ORG/ALASKA-OCEAN-ACIDIFICATION-NETWORK

Community sampler Jamie Hubbard collecting the first OA sample from Larsen Bay, Alaska.

LIGHT-LEVEL GEOLOCATION TRACKS NON-BREEDING MOVEMENTS OF TUFTED PUFFINS

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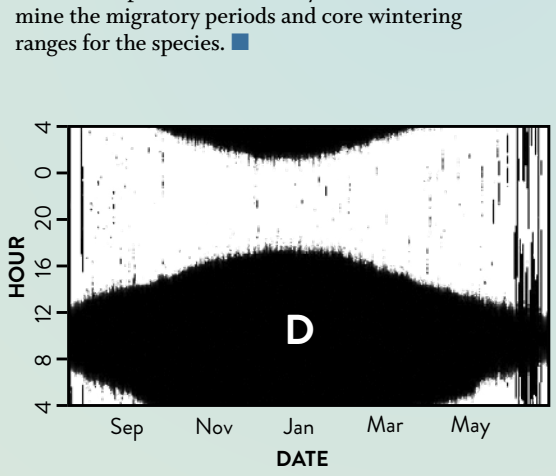
Tufted Puffins (*Fratercula cirrhata*, Figure 1a) are one of over 20 species that comprise the Alcidae – a family of unique northern seabirds known for their ability to "fly" underwater by using their wings as flippers to propel themselves to capture prey. Unlike their southern hemisphere counterparts, penguins, alcids also use their "flippers" for aerial flight. Due to their bulky bodies and relatively short wings, these birds have comparatively weak flying skills.

Many questions remain as to where Tufted Puffins reside at sea during the non-breeding season, particularly given their somewhat limited flying abilities. While much is known about Tufted Puffin breeding ecology and where they forage to feed their chicks, the species' migratory routes and wintering areas are not well understood but are important to determine for management purposes. Thus, researchers at Prince William Sound Science Center and the University of Alaska Fairbanks have been tracking adult Tufted Puffins since 2018 after they leave their breeding colony at Middleton Island in the Gulf of Alaska (Figure 1b) until they return the next season.

Using light-level geolocators (Figure 1c), the research team has successfully tracked 40 adult puffins for periods of 10 months to nearly two years. These tags are well suited for attaching to seabirds for extended periods of time as they weigh only one gram and have enough battery life to last nearly two years! The geolocator tags measure light levels two times each day throughout the year (Figure 1d). Using astronomical algorithms, light-level data can be processed and analyzed to determine the migratory periods and core wintering ranges for the species. ■



Adult Tufted Puffins (A) were captured in nesting burrows at Middleton Island (B, Gulf of Alaska) and outfitted with light-level geolocator tags (C) during the breeding season in 2018 and 2019. Geolocator tags were retrieved in 2019 and 2020 to obtain light-level data (D).

INFLUENZA TRANSMISSION:

WHICH COMES FIRST — THE CHICK OR THE EGG?

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The COVID-19 pandemic has meant that the study of zoonotics — diseases that are transmissible from animals to humans — has become front and center. Abundant throughout most of the world, gulls are reservoirs for influenza, making them an important group to track for spillover. Sponsored by the National Institute of Health, the PWSSC and Tufts University have been monitoring avian influenza in Glaucous-winged Gulls that nest on the Copper River Delta's barrier islands since 2009. These gull colonies can number in the thousands and provide the opportunity to study long-term trends in influenza transmission in response to global change.

We wanted to know if the dense gull colonies make prime hotspots for influenza. To test that, over three years we chased down more than 750 chicks and collected blood and swab samples. We found very few chicks were infected. However, over 50% of the young chicks had antibodies to protect against influenza. In other words, maternal antibodies were present in the embryos while they were still in the egg. Answering the proverbial question: the egg came first — and in this case mitigated influenza transmission. Our study suggests that colonies are havens of protection and outbreaks occur after chicks fledge. ■

One hatched chick, one on its way out, and two eggs in the nest of the Glaucous-winged Gull on Egg Island. *Photo credit Anne Schaefer*

A Marbled Murrelet *(Brachyramphus marmoratus)* in breeding plumage displaying its fishing prowess. *Photo credit Anne Schaefer*

MARINE BIRD PREDATORS WORK SMARTER, NOT HARDER

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How food resources are dispersed in the environment plays a big role in determining the density and distribution of predators on the landscape. In the marine environment, piscivorous (fish-eating) marine birds distribute themselves in relation to prey availability (forage fish). But, if you've seen one forage fish school, have you seen them all?

Researchers at the PWSSC wanted to understand what qualities set more tempting fish schools apart from others for marine bird predators in Prince William Sound during winter. They found that marine birds tend to follow the mantra "work smarter, not harder" and targeted schools that were easier to access. Fish schools with birds nearby were 8 meters (26 ft) closer to the surface and in areas with bottom depths 9 meters (29.5 ft) shallower than schools without birds. Selecting schools that are easier to access maximizes the energy return from the prey item by minimizing the amount of energy expended by the fish-eating birds, which is especially important during winter when metabolic demands are higher, but reduced daylight and extreme climate limit foraging opportunities. ■

GOING VIRTUAL WITH THE COPPER RIVER DELTA SHOREBIRD FESTIVAL

Melissa Gabrielson participates in world migratory bird day with a virtual field trip from Hartney Bay.

Content from Facebook was continually updated.

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In early 2020, the Copper River Delta Shorebird Festival was preparing for their 30th anniversary with invited guests, special events, and an anticipated record attendance. Then, the world changed, and in-person events weren't an option. The results of the virtual effort surprised the committee in their magnitude and relevance. Events included live field trips, videos, online classes, and presentations through the festival Facebook page.

This event recorded over 25,000 participants, reached primarily due to the dynamic content and live events. While the festival made the commitment to go virtual, this effort had some challenges. A host of new skills including video collection, live event hosting, and connecting with remote sites had to be learned all within weeks of the event and sometimes as the event was ongoing. This virtual event also identified challenges for communities relying on ecotourism for economic input.

Many of the lessons learned will be folded into future events increasing the wonder and spectacle of migration and the Copper River Delta to a worldwide audience. ■

FACEBOOK.COM/COPPERRIVERDELTASHOREBIRDFESTIVAL

Yellow-cedar foliage and fruit. *Photo credit Sean Meade.*

ALASKA YELLOW-CEDAR IN A CHANGING ENVIRONMENT

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Prince William Sound (PWS) is home to the northernmost populations of Alaska yellow-cedar *(Callitropsis nootkatensis)*. Alaska yellow-cedar is a long-lived coniferous tree that grows along the Pacific coast regions of Alaska and British Columbia with cultural significance in indigenous cultures, a unique ecological role, and special value as a forest product. Through the heart of its range, it has experienced rapid mortality due to a warming climate and subsequent decrease in winter snowfall. Snow is important for this species as it insulates fine roots during the cold winter and reduces browse by Sitka black-tailed deer, which preferentially eat young yellow-cedar.

Large yellow-cedar tree in Prince William Sound, Alaska. *Photo credit Sean Meade.*

Although it is experiencing decline in much of its range, yellow-cedar populations in PWS appear to be healthy and showcase good regeneration. Yellow-cedar occurs in small, isolated populations near shoreline in eastern PWS and is most abundant in northwest PWS near Cedar Bay. Scientists are interested in these populations at the northern limit of its range to reveal clues to the species' future and survival in a changing climate. A coordinated effort between many research institutions is currently underway to help determine the major factors influencing yellow-cedar survival and adaptability. ■

NATIVE BEE MONITORING IN ALASKA

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Many Alaskan flowering plants rely on flies, butterflies, and more than 100 species of native bees for pollination. Insect pollinators are essential for reproduction of many plant species, which provide benefits such as erosion control, carbon sequestration, and wildlife habitat. Since most Alaskan berries species significantly benefit from insect pollination, pollinators are important for farming and subsistence as well. As a prey species, pollinators are an important component of the food web.

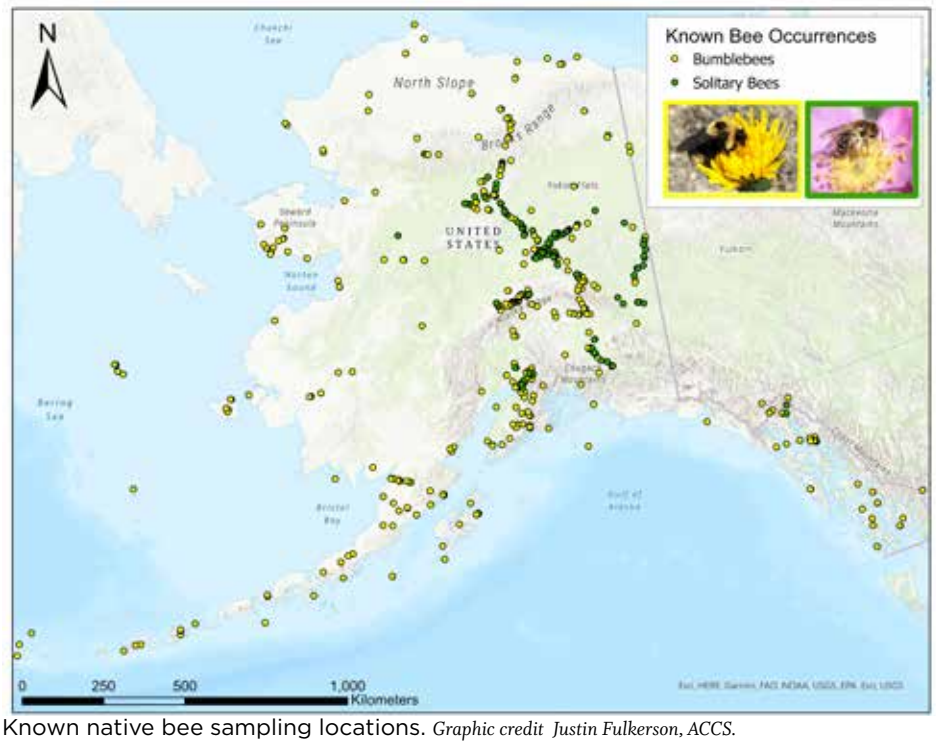
Despite their critical role in functioning ecosystems, very little is known about bees in Alaska. It is unclear if our bee populations are stable or in decline like many in the contiguous United States. When intensive surveys do take place, we often find bee species that have never been seen before in Alaska!

Bumblebee (likely yellow head bumble, *Bombus flavifrons*), flying toward woolly geranium (*Geranium erianthum*). *Photo credit Kim Mincer, BLM.*

To address that knowledge gap, the Bureau of Land Management and UAA-Alaska Center for Conservation Science are implementing the Alaska Bee Atlas to better understand the distribution, status, and trends of Alaska's native bees. This effort will build statewide partnerships and collect important baseline data to conserve these species and their habitats efficiently and proactively.

We are seeking dedicated citizen science project leaders to coordinate bee monitoring projects throughout Alaska. Please contact Justin Fulkerson at jrfulkerson@alaska.edu with questions. ■

ACCS.UAA.ALASKA.EDU/WILDLIFE/POLLINATOR-DIVERSITY



Known native bee sampling locations. *Graphic credit Justin Fulkerson, ACCS.*

The BLM Alaska Wildlife Program uses a landscape approach in conserving wildlife habitat to help ensure self-sustaining populations and a natural abundance, distribution, and diversity of all wildlife.

BLM.GOV/ALASKA

ADAPTATION

IN PWSSC EDUCATION PROGRAMS

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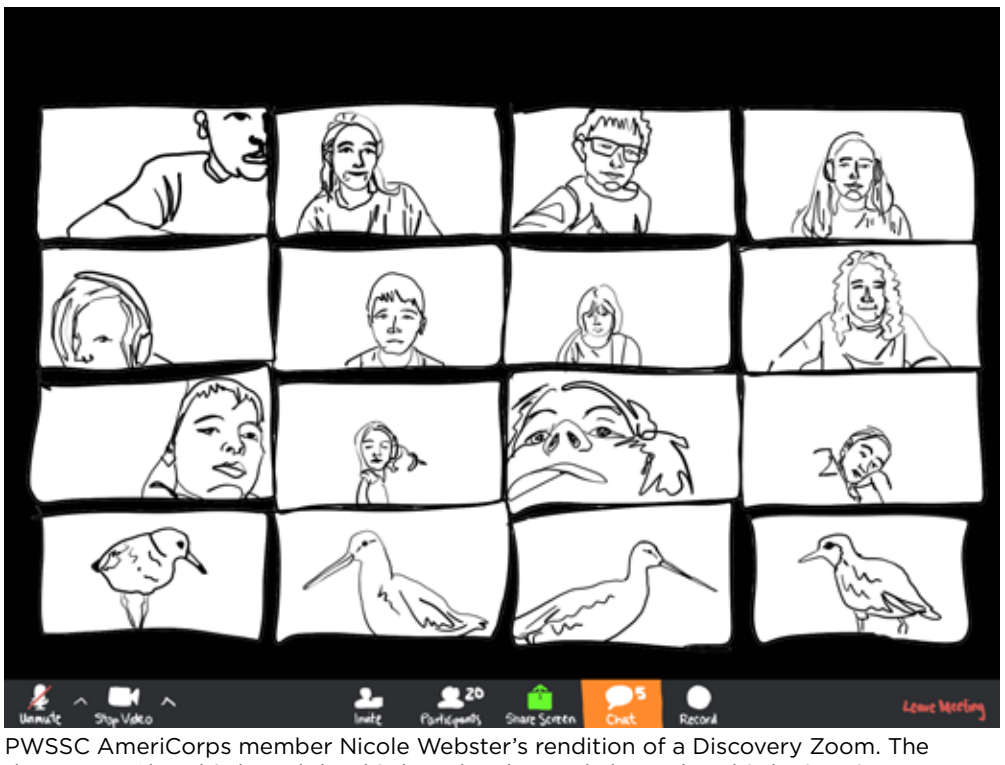
Adapt. A longstanding internal motto of the Science Center education team. Despite meticulous planning, there will always be an unknown, uncontrollable variable popping up to make programs "more exciting." The weather predicted sun, but it is raining sideways: Adapt. It is Shorebird Festival, but the shorebirds have flown on by: Adapt. That's just how it is in our line of work. Truthfully, it is part of what makes our jobs so fun. However, in March of 2020 we were met with a challenge we had not faced before: a global pandemic caused by Covid-19. Well, what else could we do but adapt?

So, with some creative problem-solving, technology, good partners, and willing participants, the Science Center education team has been able to continue sharing our enthusiasm for the world around us with a wide audience. In the spring, we moved our 'Discovery Room' sessions with local elementary classes online. These 'Discovery Zoom' programs focused on local animals, like shorebirds, and habitats, like the intertidal zone, so that students would feel empowered to go out and explore with family and friends. We ran the Copper River Stewardship Program during the summer, with limited numbers, no travel, and activities that connected stewards virtually through shared experiences. Already heavily focused on the outdoors, most of our other programs are continuing to run as usual and we've even added a new class at the High School (see next page).

While nothing could have prepared us for COVID-19 specifically, we were prepared, as always, to adapt. ■



PWSSC AmeriCorps member Nicole Webster's rendition of a Discovery Zoom. The theme was Shorebirds and the third graders learned about shorebird migration patterns, feeding habits, and species seen in Cordova.

The Copper River Stewardship Program stewards set minnow traps along a stream in search of coastal cutthroat trout. *Photo credit PWSSC.*

PRINCE WILLIAM SOUND NATURAL HISTORY SYMPOSIUM HEADS INTO FOURTH YEAR

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The Prince William Sound Stewardship Foundation and its partners will host the 4th annual PWS Natural History Symposium on May 24, 2021. The event is free to the public and provides the latest science, research, and heritage news from across the Sound. It will occur online due to the Covid-19 pandemic.

This year's 18 speakers will discuss a range of topics, including Alaska Native culture, regional land management, fish, wildlife, geology, and various topics related to climate change. Among last year's highlights were Dan Olsen's (North Gulf Oceanic Society) presentation on local orcas and John Morton's (FWS biologist, retired) talk on rapid ecological change on the Kenai Peninsula.

The symposium is a high-quality learning opportunity for guides, tour operators, and other educators, who support over 50 tourism-related businesses in the Sound. It also provides the public with updates on regional issues such as climate change and ocean health.

"We see the symposium as an investment in the Prince William Sound community and economy," says Heather Thamm, board chair for the Stewardship Foundation.

The symposium is co-hosted by the Prince William Sound Regional Citizens' Advisory Council, City of Whittier, and the Chugach School District, with help from the Chugach National Forest. Its speakers represent the PWS Science Center, Alaska State Parks, Chugach Regional Resources Council, and many others. Visit princewilliamsound.org for more details and to see last year's symposium.

PRINCE WILLIAM SOUND SPRING GREENS: REACHING OUT TO CITIZEN SCIENCE BOTANISTS ON INATURALIST

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Due to COVID-19, 2020 provided an opportunity to ramp up outreach and engagement using the increasingly popular and virtual iNaturalist application. iNaturalist allows users to upload photos of any taxa (plant, animal, insect, fungi, etc.) to help users identify their finds while also contributing to science.

A month into the pandemic found Alaskans itching to get outside and connect with others safely. The Prince William Sound Spring Greens project kicked off in April and logged all vascular plant observations taken from Whittier to Cordova and north through the Copper River Basin throughout the flowering season. This project encouraged participants to observe plants as they were just starting to emerge in the spring and continued through the summer to capture the various stages in the plant life cycle called phenophases.

Data on changes in plant phenophases is being tracked globally through a variety of platforms and helps researchers understand effects of climate on plants and other species. The iNaturalist application is also useful for tracking rare plant distributions and expanding ranges of species. A total of 83 observers contributed over 1,130 observations that documented 427 species of vascular plants and lichen over just four months in 2020! ■

Link to website: https://www.inaturalist.org/projects/prince-william-sound-spring-greens

Screenshot from the Prince William Sound Spring Greens project on iNaturalist.

Parnassia fimbriata, or Fringed Grass of Parnassus is uncommon in the lowlands of Prince William Sound. *Photo credit Kate Mohatt.*

A sampling of nature journal pages from local Cordova students. *Photo credit Nicole Webster.*

Nature journaling can be done inside, too! Students observe plankton under a microscope. *Photo credit Nicole Webster.*

THE NURTURE OF NATURE JOURNALING

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Despite having to rework most of our education programs, PWSSC managed to launch a whole new curriculum during last year's chaos. A partnership between PWSSC and Cordova High School, Introduction to Nature Journaling and Scientific Art is a year-long, once-weekly class offered to local teens. Highly adaptable and well-suited to the pandemic's changing nature, it has been a rousing success and a balm to these educators' hearts.

The course, broadly, is designed to inspire curiosity and connection to nature and to encourage practices of mindfulness. It introduces concepts of nature journaling, scientific illustration, and alternative natural art processes, using drawing and painting as a methodology to learn about nature and science. To connect with their sense of place, students engage in field trips to native habitats and local organizations. They also listen as community members, some scientists; some artists; some both, give presentations and share their creative energy. Class topics range from Mushrooms in Colored Pencil to Hard Parts in Pen & Ink; from Cyanotypes to Wildlife Photography; and from Plankton Photomicrography to Preserving Botanicals.

Sketching in the rainforest during class. *Photo credit Nicole Webster.*

Nature journaling is not a new idea, nor is PWSSC the first to implement this type of program. The curriculum we use is largely guided by the teachings of John Muir Laws and Clare Walker Leslie and inspired by Alaskan field artists like Kim McNett and Kristin Link. Our course was specifically structured to address Place Based Education discussions PWSSC had been hosting with Cordova School District and community partners over the past few years. Connection to place, involving expert community members, and art were three topics identified as areas for growth during these conversations.

This program is supported by a RurAL CAP Foundation grant. Check out our website for class updates and prompts to work on from home! ■

PWSSC.ORG/EDUCATION/NATURE-JOURNALING

PEER LISTENERS BUILD COMMUNITY RESILIENCE

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The 1989 *Exxon Valdez* oil spill taught Prince William Sound and the downstream region that the social and emotional health of a community takes time to heal.

Mental health professionals today compare the impacts of disasters, such as a major oil spill, to those of COVID-19. When will the crisis end? How long will recovery take? Am I doing the right thing in response? These questions echo from 1989 to 2021.

Prince William Sound Regional Citizens' Advisory Council hosts a Peer Listener Training to empower residents in our region to support each other through intentional listening. In a disaster, mental health services are overwhelmed and costly. A neighbor who shares your culture, lifestyle, and experience may be more approachable than a professional counselor.

Trained peer listeners, unlike therapists or counselors, do not give advice and are not experts. Instead, they actively listen and help their peers vent strong emotions, feel heard, and have their experiences normalized. A peer listener knows when to make referrals to more advanced support systems.

Checking in on neighbors, asking intentional questions about well-being, and listening with empathy build connectedness and healing. Our collective resilience supports us through all disasters that impact our community. ■

BLUBBER GLOVE

Seals, sea lions, and whales have a special adaptation that helps them stay warm in cold Alaska waters. In this activity, we'll learn ***firsthand*** just how good blubber is at keeping marine mammals warm.

DIRECTIONS

- Plastic bags (quart-sized zipper storage bag, produce bags, bread bags)
- Vegetable shortening and other items around the house that might work as "blubber" (bubble wrap, a wool sock, etc.).
- Bowl or bucket of ice water
- Watch with timer
- Paper and pencil

SUPPLIES

1. Fill the zipper storage bag ¼ full of vegetable shortening.
2. Turn a second bag inside out and insert it into the shortening filled bag, then "zip" the edges together (or duct tape).
3. Squish and spread the shortening around evenly in between the bags.
4. Place one hand inside the blubber glove.
5. Put your other hand in an empty zippered storage bag.
6. Have a friend or family member time how long you can keep each hand submerged in the ice water.
7. Next, try other types of blubber gloves. Wrap your hand in bubble wrap and cover it with a bread or produce bag. Or slip a wool or fleece sock over your hand.

Try as many different things as you can think of and keep track of your time. Does one work better than the other? Why or why not?

MOVE THROUGH PAPER

Want to learn a fun way to overcome a seemingly impossible challenge … one that will wow and amaze your friends and family?

DIRECTIONS:

1. Cut out a rectangle by cutting along the brown dotted line. (You can also use a piece of 8.5" x 11" paper or print a PDF here: https://pwssc.org/home-2/delta-sound-connections/)
2. Show someone the piece of paper and ask, "Do you think I can move my entire body through a hole I make in this piece of paper?" Have them study the paper. They are probably thinking, "How in the world can you possibly fit your body through a hole in an 8 ½" x 11" piece of paper?"
3. Fold the paper in half, lengthwise, along the blue dotted line, this side of the paper facing out.
4. Cut along the red lines, then the green lines.
5. Cut along the blue dotted line down the middle but DO NOT cut either of the end segments (purple hash marks).
6. Hold up the paper by one end, let it fall open, and walk through the hole!

With enough ingenuity and creative thinking … you can overcome just about anything!

ADAPTATION

AN ADJUSTMENT THAT LIVING ORGANISMS DEVELOP TO SURVIVE IN A CHANGING OR NEW ENVIRONMENT.

PHYSICAL VS. BEHAVIORAL ADAPTATIONS

Some plant and animal adaptations can be physical, i.e. related to their body or structure. Other adaptations can be behavioral, i.e. how they act or move. Put a star ★ next to the physical adaptations and circle ✎ the behavioral adaptations.

Snowshoe hares have brown-gray fur in the summer and turn white in the winter.

Shorebirds migrate thousands of miles every year between warmer climates in the winter, to northern latitudes in the summer where there is ample daylight and food.

Brown bears hibernate during the winter when food is scarce.

Salmon have gills that work in both freshwater and saltwater.

Mountain goats have a long, shaggy winter coat to keep warm in extreme winter conditions.

Devil's Club is covered in needle-like spines to deter animals from eating it.

Zooplankton migrate vertically (up and down) every day: they feed near the surface during the night and go deeper into the water during the day to avoid getting eaten themselves!

NATURE JOURNALING MISSION: ASTONISHING ANIMAL ADAPTATIONS

- **SUPPLIES**: Pencil and sketchbook or copy of our worksheet.
- **OPTIONAL:** Colored pencils, clipboard, binoculars, camera.

Look at the photos on this page and the previous page to get some inspiration for your nature journal. Then, take a walk around your neighborhood or a drive somewhere away from lots of people. Keep a lookout for an astonishing animal! When you spot one, pull out your supplies and start investigating the animal in your journal. Use words, pictures, and numbers to describe the animal, its habitat, and any of its adaptations that you can identify. If you can't stay for long, or if the weather is ugly, take a few photos instead. Enjoy your time outside; then, when you get home, use your photos to investigate the animal in your nature journal.

DRAW ONE PART OF THE ANIMAL UP CLOSE:

When you saw the animal...

What day was it?

Where were you?

What time was it?

What was the weather like?

Did you see more than one of this type of animal? *How many did you see?*

What do you notice about the animal?

What type of animal is it?

Does it belong to a group of animals?

What color is it?

What do you wonder about the animal?

1.

2.

What do you notice about this part of the animal?

Why do you think it looks the way it does?

How do you think it helps the animal?

Does this part of the animal remind you of anything?

What do you notice about the area you saw t he animal in?

What type of habitat is it? Was it easy to get to?

Was there mud or snow or plants on the ground?

How do you think this habitat affects the way the animal lives and looks?

Is the animal the same color as its habitat?

What parts of the animal's body do you think help it live in its habitat?

DRAW THE ANIMAL'S HABITAT *(the area that you saw it in):*

FUN FACT: Getting outside, moving our bodies, and nature journaling are all practices we can use to help us adapt to the stress in our life. Give them a try when you're feeling "bogged down!"

**Adapted from "Zoom In, Zoom Out" in Laws & Lygren's How to Teach Nature Journaling*

ADAPTATION ANSWER KEY: ★ Physical adaption: snowshoe hares, salmon, mountain goat, devil's club ○ Behavioral adaptation: shorebirds, brown bear, zooplankton

BREAKING GROUND

After 32 years and over $120 million in impact, we've just broken ground on our new research & education campus overlooking Orca Inlet.

This once-in-a-generation project has been years in the making, and we expect to occupy the new location sometime in 2022. In our new waterfront center we'll generate knowledge on important issues, including: climate change, fish, birds, mammals, and a sustainable economy for the region. This work will happen through carefully planned collaborations, and we'll share our hard-earned knowledge with many people, including scientists, managers, and local and regional community leaders.

The Copper River Watershed Project (CRWP), another local nonprofit with whom the Science Center collaborates, recently received title to over 120 acres of adjacent property whose future uses are restricted to conservation and recreation. Together, we are creating a research, education, recreation, and conservation district that will provide community benefits for generations to come.

Good facilities are important to understanding this remarkable region, home to Copper River salmon and the world's richest waters and fundraising for the new campus continues as we work to finish the project debt-free. Will you support the PWSSC's new campus, as well as our important mission to advance ecosystem research and science education?

With your help, our work as a nonprofit in one of the world's last, great natural regions will continue for years to come.

We want to thank all our community members, donors, funders, volunteers, staff, and board members over the last three decades for your support. Your help ensures that the promise of today remains the promise of tomorrow. ■

DONATE NOW

VISIT
PWSSC.ORG/SUPPORT/NEW-BUILDING

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