Copepods such as this tiny (1.5 mm) egg-bearing female Pseudocalanus spp. are important unseen members of ocean ecosystems. Filled with fat, they provide energy to fishes, whales, and seabirds. This specimen was collected from the Prince William Sound and photographed through a microscope at the Prince William Sound Science Center using an innovative technique called focus stacking. Photo credit Caitlin McKinstry.
If you know many coastal Alaska residents, you might begin to suspect that innovation is in their DNA. My father-in-law, who was born in the 1930s, was the first person in the commercial fishing fleet in Cordova to install hydraulics on his fishing vessel. He ordered the parts from a Montgomery Ward catalogue, and some people thought he was wasting his money. You’d be hard pressed to find a commercial fishing vessel anywhere in Alaska without hydraulics today. It makes you wonder: what innovations are still far off on the horizon, will be broadly adopted that coming down the pike that will allow us to “plug and play” alternative energy technologies over time—some of which may be temporary pilot projects, and some that may be longer term solutions to energy needs. These are just a few of the many ideas that are “on deck.” Cordova is an ideal place to develop, demonstrate, and leverage approaches to building resilience in our changing world. There’s a demand for resilience innovation afoot in Cordova that is best described as “organic collective impact.” Cordovans are compelled to innovate in the face of climate change and a changing economy. An historic spirit of innovation and partnership courses through our community, and the practical outcomes that result can be embraced and repeated in coastal communities anywhere. In our unique “cornor” of the globe, we are connecting with leaders of key organizations and working to prioritize the development and implementation of technological, social, and programmatic approaches to resilience, deploy those efforts with support from funders and partners, evaluate what works, adjust accordingly, share successes, and inspire those successes to be drivers of innovation elsewhere. We welcome additional support and partnerships—innovation is energizing, and there’s lots of room to grow.

KATRINA HOFFMAN
President & CEO
Prince William Sound Science Center

For starters, PWSSC’s new seawater system will be up and running before the year is out. This system will allow the Prince William Sound Science Center to be home to the first running seawater-supported hake hatchery on Prince William Sound—a region with more than a quarter of the pending hake permit requests in the state, but to-date, no local hake hatchery. Through this innovation, we’ll be able to better support a growing industry. We have also applied for grants that, if successful, will allow us to test out help drying facilities using waste heat already generated by other local facilities—another innovation.

Our new campus will be the third location in Alaska to be primarily heated by energy from the ocean with the installation of a seawater heat pump. This has multiple benefits, such as: it allows us to keep money circulating in the community because we’ll be buying power to run the seawater pumps from our local electric cooperative, which keeps folks employed locally; it uses an energy resource (ocean heat) that is locally available and sustainable; and it’s part of a lower carbon emissions operating scenario. Our new campus is poised to accommodate a charging station for electric vehicles, which our community will likely see more of in the not-too-distant future. And we built additional conduit into the building that can allow us to “plug and play” alternative energy technologies over time—some of which may be temporary pilot projects, and some that may be longer term solutions to energy needs. These are just a few of the many ideas that are “on deck.”

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Electric ferries are gaining traction worldwide: Norway operates over 50, Canada recently introduced its first, and the State of Washington has committed, by executive order, to a zero-emission fleet by 2040. Alaska is no exception. A strong maritime industry and culture make ferries a necessary part of our local economies, but their reliance on fossil fuels significantly contributes to pollution. However, recent federal funding initiatives are pushing hybrid vessels as a key component of our state’s future ferry system. For the 35 communities along the Alaska Marine Highway System (AMHS), electric ferries offer lower diesel consumption and carbon emissions, and improved air and water quality.

This January, the US Department of Transportation awarded $285 million to modernize Alaska’s ferry system, including developing hybrid designs and replacing the 58-year-old M/V Tustumena with a hybrid diesel-electric vessel. By adding electric power, captains can use one of their two diesel engines at a time, reducing the current 150 gallons per hour fuel consumption by 1%.

There is a significant future-proofing benefit to investing in these improvements. Introducing battery power to AMHS vessels now will familiarize the state in preparation for future projects, and represents a significant step towards a sustainable, environmentally conscious transportation system.

Residents and visitors alike rely on the Alaska Marine Highway System for business and personal endeavors. The gorgeous scenery is an added bonus. Photo credit AMHS.

Plankton form the base of the marine food web. Tiny single‐celled plant plankton (aka phytoplankton) grow and are consumed by animal plankton (aka 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. Innovative technologies like underwater cameras offer new ways to estimate plankton abundance.

Prince William Sound Science Center researchers have developed an underwater plankton camera and attached it to an autonomous robotic profiler that is deployed from spring to autumn in central Prince William Sound as part of the Gulf Watch Alaska project. In 2022, the profiler completed 538 separate profiles from 60 meters depth to the surface and collected almost a half million individual plankton images. Most of the images show plankton near the surface, particularly during spring months, where productivity is mostly near-surface. Later in the summer, plankton are found in thinner bands further down where there is a balance between sunlight from above and nutrients from below.
Resilience of Subarctic Estuaries

DYLAN Kiene & SEAN POWERS
University of South Alabama
dkiene@disl.org, spowers@disl.org

MARY ANNE BISHOP
Prince William Sound Science Center
mbishop@pwssc.org

The Copper River Delta, Alaska, is the largest contiguous coastal wetland system along the West Coast of North America. Sediments carried by the suspended load of the Copper River form vast expanses of tidal mudflats that are teeming with life. In the rich abundance of benthic invertebrates residing in the sediment, a diverse assemblage of crabs, fishes, birds, and marine mammals occupy the tidal sloughs.

Monthly benthic trawl surveys conducted from April to October of 2002-2006 quantified the demersal species composition and found it to be vital nursery habitat dominated by flatfish. Health and diversity of flatfish communities in the Copper River Delta could serve as a proxy for ecosystem resilience since flatfish species occupying very high or very low latitudes tend to have narrower temperature ranges in which they can thrive making them particularly susceptible to climate change.

A re-evaluation of the benthic community composition is currently underway through an interdisciplinary collaboration between the University of South Alabama and the PWSSC that may shed light on the impacts of significant climate perturbations such as the Northeast Pacific Marine Heatwave and predicted changes in warming of ocean waters on the resilience of subarctic estuaries.

PWSSC staff and engineers from contractor Glosten deploy the PLT Multi, one of the line-throwing devices evaluated in the study and practical trial. Photo credit Alan Sorum/PWSSC.

LINE THROWING

Trials at Sea Lead to New Recommended Device

DANIELLE VERNIA & MAIA DRAPER-REICH
PWSSC Regional Citizens’ Advisory Council
dvernia@pwsrac.org, maia.draper-reich@pwssc.org

To establish a tow between a rescue tug and a vessel in distress, the first step is to pass a light weight “messenger line,” making the critical first connection between the vessels prior to deploying towing gear. Messenger lines may be passed by hand, heaved aboard, projected by mechanical means, or picked out of the water. Establishing this connection can be difficult and dangerous in the rough weather often encountered in Prince William Sound. The Prince William Sound Regional Citizens’ Advisory Council (PWSSC) recently sponsored an innovative project to evaluate commercially available devices for deploying messenger lines.

Surprisingly, given the importance of this equipment to safely arrest a disabled tanker and prevent oil spills, best use practices and device recommendations have been largely overlooked. The devices were evaluated on eight scoring criteria including effectiveness, availability, environmental impacts, and cost. The devices were then tested in practical, real-world conditions on the water. The recommendation of the study is to use a reusable, compressed air device along with a surface float line. A video summarizing the line-throwing trial and complete study results can be found on the PWSSC’s website, www.tinyurl.com/LineThrowingVideo.

THE YELLOW TORPEDO – THAT COULD

ALYSHA CYPERH
Prince William Sound Science Center
acyperh@pwssc.org

The Prince William Sound Science Center tracks fish movement in Prince William Sound (PWS). How do we do it? With acoustic receivers – subsurface pieces of plastic with hydrophones – positioned across Hinchinbrook Entrance, Montague Strait, and the southwest passages. This “Ocean Tracking Network” listens for fish fit with acoustic tags that emit pings every 60-90 seconds. When they pass a receiver, it records when they entered or exited PWS. Because the receivers are at fixed locations, they don’t tell us much about how fish move inside PWS. We partnered with University of Alaska Fairbanks to mount a receiver on a glider, a hydrofoil named Blackcat.

In early 2021, the glider swam throughout Port Gravina and Orca Inlet before journeying through Montague Strait to Seward for pickup. During this time, it detected 30 Pacific herring tags implanted in 2020. We learned that nearly half of these herring expelled their tags, as the glider re-detected them in the same location. We found 12 live herring, most of which were detected by spawning grounds. One herring moved from spawning grounds to Montague Strait, a 65 km distance. The glider detected four herring outside of our receiver arrays in Montague Strait. Turns out gliders are pretty good at finding herring in PWS!
Introducing the GULF WATCH ALASKA LONG-TERM RESEARCH AND MONITORING PROGRAM

Gulf Watch Alaska and the Herring Research and Monitoring programs were established a decade ago to identify factors limiting the recovery of species still listed as injured from the 1989 Exxon Valdez oil spill. In 2022, the two were combined to form the Gulf Watch Alaska Long-Term Research and Monitoring program, and now consist of five components:

1. Environmental Drivers (physical and biological oceanography),
2. Nearshore Ecosystems (subtidal and intertidal systems),
3. Pelagic Ecosystems (prey and upper trophic-level predators),
4. Herring Research and Monitoring, and

Many individual projects remained unchanged so as not to disrupt the critical long-term time series of data and a few projects were replaced by new ones, including studies of herring predators (walleye pollock) and competitors (pink salmon). Science synthesis has most recently focused on understanding how the Prince William Sound and Gulf of Alaska ecosystems responded to extensive marine heatwaves between 2014 and 2019. In the eight years since the onset of the first heatwave, some species have returned to or exceeded pre-heatwave levels, but others have not. The four species that remain injured and not recovered after over 30 years since the oil spill — Pacific herring (a commercially and ecology important forage fish), killer whales (iconic top predators and a highlight of whale watchers), pigeon guillemots and marbled murrelets (ecologically unique marine birds) — are in similar or worse states of recovery after the heatwaves. Luckily, multiple indicators suggest recovery is still possible, despite the setbacks, but expected timelines must be adjusted. Programs like Gulf Watch Alaska demonstrate that it is possible to distinguish natural from human-caused changes in the environment and long-term research and monitoring programs are critical in doing so.

A Herring’s Dilemma: Should I Stay or Should I Go?

MARY ANNE BISHOP
Prince William Sound Science Center
mbishop@pwssc.org

Pacific herring in Prince William Sound are partial migrants, meaning while some herring are year-round residents, others migrate out into the Gulf of Alaska. To determine if there were differences between the “stay” and “go” herring, during four spring-spawning seasons we implanted small acoustic tags into herring. When a tagged herring swims within the detection range of an acoustic receiver, the individual identification code and a time/date stamp is recorded. Using detections obtained from the Ocean Tracking Network, a series of underwater receivers located at the major passageways into the Gulf of Alaska, we were able track herring movements for up to two years. After spawning, most herring moved to the mouths of Hinchinbrook Entrance or Montague Strait. After foraging there, fish that were smaller and lighter tended to remain in Prince William Sound while the longer, heavier (and hence, older) herring tended to migrate into the Gulf of Alaska. Herring remained in the Gulf anywhere from relatively short periods (14 days) to over 300 days before returning. In other words, the Gulf of Alaska is not just a summer foraging area, but also serves as wintering grounds for herring.
PLENTY OF LARVAE IN THE SEA?

SARAH TRAIGER
USGS Alaska Science Center
straiger@usgs.gov

Many intertidal marine invertebrates have a two-part life cycle: a planktonic microscopic stage (larva) that are free-floating within the water column and a benthic stage that lives on the bottom. The benthic stages are generally better studied. Adult populations of animals (e.g., mussels, barnacles, and sea stars) are known to be affected by competition, predation, and physical stressors, such as heatwaves. However, the supply of larvae also may influence local population dynamics; after all, any population needs new animals to replace those that die. The number of larvae that arrive at a particular location can be influenced by water movement, the amount of time larvae are in the plankton phase, and seasonal patterns in species production of larvae.

For three groups of common intertidal animals, numbers of juveniles or adults in the intertidal was not strongly related to numbers of larvae in Prince William Sound since 1973. During aerial surveys, information is recorded on electronic tablets, and photographs are taken to document and quantify the distribution of spawn. This information is critical to monitoring the herring population in Prince William Sound and feeds into a model used to estimate the biomass.

ADF&G is launching an interactive web map that will be updated after each aerial survey so you can follow along throughout the spawning season. The web map will include observed mile-days of milt, survey routes, and observations. Photos from the survey can be viewed by clicking on the individual features in the map. The map contains historic spawn observations for each year since 1973.

CHECK OUT THE PRINCE WILLIAM SOUND HERRING SPAWN INTERACTIVE WEB MAP ON THE ADF&G WEB SITE AT: https://www.adfg.alaska.gov/index.cfm?adfg=commercialbyareapws.herring#maps

Numbers of larvae in Prince William Sound (top row) and juveniles and adults in the rocky intertidal (bottom row) for mussels, barnacles, and sea stars.

In most years, while sea star larvae were rarely observed. Mussels and barnacles in the intertidal may not be limited by supply of larvae and processes that occur in the intertidal after they settle may be more important.
The ocean is becoming more acidic due to the absorption of human-generated carbon dioxide. Globally, ocean acidification (OA) is increasing as human emissions increase. In the Gulf of Alaska, additional factors such as high seasonal productivity, increasing freshwater input, and varying circulation can influence when and where harmful ocean acidification conditions emerge. The impacts are not fully understood, but OA could affect entire ecosystems. To understand impacts to the Gulf of Alaska region, we need a robust set of observational tools to measure carbon dioxide in seawater over space and time. Hydrographic data has been collected by oceanographers along the Seward Line (see page 12) since the 1970s, and ocean acidification measurements have been collected since 2008. New funding from the Exxon Valdez Oil Spill Trustee Council ensures the continuation of these OA measurements every May, July, and September. Moored sensors and a regional biogeochemical model round out this toolset to give a picture of the change occurring in the Gulf of Alaska. Together they allow us to understand the long-term OA trend, as well as the underlying chemical dynamics that control OA conditions. With this knowledge, we can anticipate and respond to future changes.
In 2013, I landed my first job out of high school as a field technician for the Prince William Sound Science Center (PWSSC). I joined a small crew aboard the R/V Cathy G in Prince William Sound for the first sampling season of the Alaska Hatchery Research Program (AHRP). I returned to this job for five summers. Each year we became more regimented in our pursuit of salmon carcasses. In eight seasons, field teams from PWSSC collected samples from over 250,000 pink salmon. The project is in its final years of analysis, and the Alaska Department of Fish and Game has published two papers using samples and data collected by PWSSC.

In July 2022, I joined the Alaska Fisheries Development Foundation as an Alaska Sea Grant Fellow to summarize the AHRP for the Marine Stewardship Council (MSC) and Responsible Fisheries Management (RFM). MSC and RFM are third-party sustainability auditors; MSC is responsible for the blue checkmark on seafood packages. I summarized the results to date in a document available here: afdf.org/sustainability-certification/msc-alaska-salmon. Like all projects, the AHRP has raised more questions than it answered, and the Prince William Sound Science Center is in an ideal position to tackle these questions.

Age Doesn’t Matter… Unless You’re a Fish

Alaska's salmon are getting smaller. Many Alaskans have observed these declines firsthand. For younger generations, knowledge of these declines exists in stories and in the comparisons of salmon caught today with those in old family photos. Family photos show relatives holding the proverbial sea monsters of yesteryear, fish that by today’s standards are the stuff of legends. Such observed declines in fish size over a result of both declines in the average size of fish at age, as well as changes to age at maturity as fish mature and spawn at younger ages. In some species, like Chinook salmon, scientists have documented a decline in both the size of Chinook salmon for their age, as well as a decline in their age at maturity, with more Chinook salmon spending fewer years feeding at sea before returning as adults to spawn. Documenting and tracking these trends in age at maturity and size at age are important tools for fisheries scientists to characterize population health and run sizes over time.

Salmon are aged from seasonal patterns in growth that are visible on bony structures in the fish. Commonly, salmon are aged by counting annual growth zones on their scales, like counting the rings of a tree. The Alaska Department of Fish and Game (ADF&G) has been collecting, storing, and aging salmon scales since the 1960s. These scale age archives represent an impressive record of fish age information and span the entire management history of the department. Advancements in computer processing power coupled with high-speed imaging are allowing scientists to analyze these archives in novel ways. Scientists at the Prince William Sound Science Center and ADF&G are leveraging the existing scale archive in Cordova to investigate the application of neural networks, a form of artificial intelligence to age salmon scales.
Designing the Next 50+ Years for the

EYAK LAKE WEIR

ASHLEY TAYLOR  
Copper River Watershed Project  
ashley@coppermivere.org

In 1972, a weir was installed at the outlet of Eyak Lake in Cordova, Alaska to re-establish the water surface to pre-1964 earthquake levels and keep nearshore sockeye spawning beds submerged. However, the weir is on its last legs, or more accurately, its last sheet piles. It’s currently a barrier to the movement of fish up and downstream, especially smaller juvenile stages of species like coho and sockeye salmon, cutthroat trout, and Dolly Varden. It is also starting to bulge, gradually lowering lake levels as it “tips over.” During the next two years, the Copper River Watershed Project (CRWP) will work with a diverse partnership to install a new outlet structure that improves fish passage.

Engineers and partners will have their work cut out for them. Not only is Eyak Lake a large salmon spawning lake, but it also provides key habitat for eight other fish species, is the City’s secondary drinking water supply, and is a beloved recreational area. While the cultural and recreational aspects are invaluable, it is considered a multi-million-dollar lake when looking at the ex-vessel value of commercial harvest of sockeye and coho salmon returns to Eyak Lake.

It will take creativity and innovation to have one structure tick all the necessary boxes outlined for this project: improve fish passage; maintain water levels to protect important nearshore spawning; maintain property lines and drinking water infrastructure; improve safety around the structure; continue current level of boat passage and fishing access; and expand fisheries monitoring.

CRWP has hired design engineers from DOWL to tackle this challenge and is drawing on the collective expertise of our 14 partners to come up with a solution. We’ve deployed remote monitoring devices, we’re running advanced modeling scenarios, and we are confident that our team will help improve habitat quantity and connectivity to sustain Eyak Lake salmon into the future.

Funding by Exxon Valdez Oil Spill Trustee Council.

An Innovative Way to Identify and Count Passing Salmon

ROB CAMPBELL  
Prince William Sound Science Center  
rcampbell@pwssc.org

The State of Alaska uses fish passage estimates to manage numerous fisheries throughout the state. An important management goal is a certain amount of “escapement” — fish that have left the ocean into spawning streams and have “escaped” the fishermen. For many fisheries, escapement is estimated by setting up a barricade in the stream (called a weir) and counting fish as they pass through.

Weirs require several technicians to run safely and effectively, and cost tens of thousands of dollars per year to run. Several weirs have been unfunded in recent years due to budget cuts by the State.

In 2021, we began developing an in-water camera system with an onboard computer that we are training to count and identify salmon as they pass, as a potential lower cost alternative to a full weir deployment. The camera was deployed in Eshamy Creek, Prince William Sound, to collect video of salmon passage in 2021 and 2022. We are now using the collected video to train computers to identify the salmon from the videos.

Preliminary results show that the computer is quite good at distinguishing between the sockeye salmon (which are large and tend to be shiny) and pink salmon (which are smaller and darker colored) that are most common in Eshamy Creek. Development of algorithms to count the salmon as they pass in and out of frame is ongoing.
The Seward Line is a series of oceanographic monitoring stations that extend 150 miles from Resurrection Bay into the Gulf of Alaska. This area of the ocean is incredibly productive; the plankton at the base of the food web support many of Alaska’s iconic fish, crabs, seabirds, and marine mammals. Measurements along the Seward Line began in 1974 and represent the longest and most comprehensive monitoring program along the coastal Gulf of Alaska. These data have been fundamental to understanding the region’s physical, chemical, and biological processes and how the ecosystem is responding to climate change.

GAK-1

The GAK-1 mooring is co-located with the first sampling station of the Seward Line. Scientists have been collecting ship-based measurements at GAK-1 since 1970 and year-round moored measurements since 1998. This time series supports fisheries research and management by providing a consistently collected time series that documents the magnitude of environmental changes in the coastal Gulf of Alaska.

In May 2022, researchers recovered the GAK-1 mooring and replaced it with a fresh suite of instruments. The mooring logs temperature and salinity at six locations throughout the water column from the surface to the seafloor (800 feet deep), and measures carbon dioxide, chlorophyll, and light.

GLIDERS: PILOTING INNOVATIVE TECHNOLOGY

AOOS and its partners at the University of Alaska Fairbanks recently expanded their operations of underwater gliders in support of an ecosystem-based approach to fisheries management. Gliders are underwater, unmanned vehicles that transmit data back to shore in near-real-time, saving the expense of conducting the work with large research vessels.

In spring of 2022, the glider named Gretel completed a 60-day mission in the Gulf of Alaska where it helped map ocean conditions and the winter distribution of Pacific salmon as part of the International Year of the Salmon project. It also measured the spring phytoplankton bloom that salmon and their prey feed on. In summer of 2022, the glider named Shackleton was deployed near Kodiak to track 35 acoustically tagged Tanner crabs. A follow-up crab survey is planned for 2023 in the Bering Sea.

The Alaska Ocean Observing System monitors Alaska’s marine and coastal environments, shares information, and provides tools to better understand ecosystem changes, inform decision-making, and support the ocean economy.

SUSTAINING OCEAN OBSERVATIONS

THE SEWARD LINE

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THE OCEAN DATA EXPLORER

AOOS’s Ocean Data Explorer is a public web portal that houses and visualizes the largest collection of ocean information in Alaska showcasing the biological, chemical, and physical characteristics of Alaska waters.

DATA PORTAL HIGHLIGHT: SEABIRD MORTALITY TRENDS

The data portal presents datasets generated through several biological monitoring programs. An established community monitoring program known as the Coastal Observation and Seabird Survey Team documents seabird mortality in Alaska. Researchers look at trends in seabird health as a valuable indicator of marine ecosystem health.

DATA PORTAL HIGHLIGHT: MARINER’S DASHBOARDS

The data portal offers three dashboards of maritime conditions so that users can easily access real-time conditions for Prince William Sound, Cook Inlet, and Kodiak. The data are from multiple sources, such as the National Weather Service and the Marine Exchange of Alaska, and includes tide predictions, temperature, barometric pressure, water levels, wind speed and gusts, and wave height and direction. AOOS plans to add dashboards for additional regions and improve the mobile experience.
Plastics Pollution and Migrating Shorebirds on the Copper River Delta

MARY ANNE BISHOP & ANNE SCHAEFER
Prince William Sound Science Center
mbishop@pwssc.org, aschaefer@pwssc.org

Plastic pollution is a worldwide problem and can negatively impact wildlife through ingestion or entanglement. Shorebirds have a high likelihood to be exposed to and ingest plastics because many migrate long distances and concentrate seasonally around shorelines, coastal areas, and estuaries that have elevated levels of plastic pollution.

From mid-April through May, the Copper River Delta along southcentral Alaska serves as one of the Western Hemisphere’s most important shorebird stopover areas. Numbering in the millions, shorebirds who wintered anywhere from South America to southern Canada will stop to rest and forage on the delta before continuing to their breeding grounds in western Alaska.

Thanks to funding from the Huttigruten Foundation, in spring 2023 the Prince William Sound Science Center will investigate if shorebirds stopping on the Copper River Delta have ingested microplastics. An easy, non-lethal way to determine if shorebirds have consumed plastics is to sample their fecal droppings. We will mistnet the shorebirds, briefly place them in a cardboard box to collect their droppings, then will measure, weigh, hand, and release the birds to continue their migration. Our project is part of a larger, Pacific Coast sampling effort that includes sites in Mexico, Canada, and USA.

Investigating the Suspected Decline of a Rare Seabird

ANNE SCHAEFER
Prince William Sound Science Center
aschaefer@pwssc.org

Suspected Decline of a Rare Seabird

ALEUTIAN TERN

U.S. Forest Service, Tongass National Forest
susan.oehlers@usda.gov

Aleutian terns are small seabirds that nest in dispersed colonies along the coastline in Alaska and eastern Russia. Alaskan populations at known breeding colonies have decreased dramatically in recent decades.

To further assess the population status of the species, a group of agencies, non-governmental organizations, and university researchers has been developing a plan to estimate Aleutian tern abundance in Alaska. The surveys will use planes to cover the large swaths of potential nesting habitat along Alaska’s coastlines. Aleutian terns frequently nest with Arctic terns, and differentiating between the two species from a plane is difficult. As such, biologists will conduct ground-based surveys at potential colonies detected from the air.

This summer (2023), the group plans to survey the eastern Gulf of Alaska coastline, extending from Prince William Sound to Glacier Bay National Park. The successful completion of a statewide survey will be an important first step for assessing the conservation status of this species. We need your help! If you see an Aleutian tern colony, please submit your observations to susan.oehlers@usda.gov. Include location of colony (preferably GPS coordinates), estimated number of terns, whether Arctic terns are present, and a photo.

Examining Interactions between Marine Birds and Mariculture Development

ANNE SCHAEFER
Prince William Sound Science Center
aschaefer@pwssc.org

As kelp and oyster farming (mariculture) expands along coastal Alaska, researchers at the Prince William Sound Science Center are working with the Mariculture Research and Restoration Consortium to understand if and how farming development and operation affect marine bird distribution and community composition. Mariculture farms tend to be in protected bays, which are also the preferred foraging habitat during winter for over 30 species of marine birds in this region.

Mariculture development could have positive, negative, or neutral impacts to marine bird populations. Marine birds may be attracted to farms by the creation of novel habitat. For example, above-water farm infrastructure (e.g., buoys, platforms) can provide protected roosting habitat and act as elevated perches to search for prey below the surface. Additionally, the below-water infrastructure and farmed crops (e.g., oysters) may create novel habitats for forage fish and invertebrates on which marine birds prey. Conversely, mariculture operations could repel birds through disturbance.

Understanding how mariculture farms impact marine bird habitat use is needed for both the mariculture industry and state/federal managers to inform sustainable expansion of mariculture development along coastal Alaska, and to evaluate the restoration potential of mariculture.

Photo credit Anne Schaefer.

During summer 2023, researchers in southcentral Alaska will survey the coastline looking for breeding colonies of Aleutian terns, a rare and potentially declining seabird. Photo credit Nate Catterson/USFS.

A least sandpiper is gently extracted from a mistnet by PWSSC researchers. Photo credit Anne Schaefer.

Growing kelp may create novel underwater habitat for forage fish that could attract birds. Photo credit Caitlin McKinstry.
**ALYSHA CYPHER**
Prince William Sound Science Center
acypher@pwssc.org

Did you know that 26% of the permitted and pending Alaskan kelp farms are in Prince William Sound? We have the interest, but can we stay on top of this budding industry? The PWSSC is pitching in to keep Prince William Sound on the map for mariculture by providing workshops and starting a research and commercial kelp nursery.

On March 4, 2023, we held our first “Kelp the Sound” workshop where participants learned how to start and operate a kelp farm. The workshop featured 14 speakers including PWS- and Kodiak-based farmers and stakeholders, including ADF&G and Cordova District Fishermen United. This workshop will be held annually in March and is free for residents of Prince William Sound.

The PWSSC kelp nursery will open this summer and address farmer-inspired questions about when and where to obtain seed stock. We can also provide farmers with commercial kelp. For the season. Each season, kelp farmers obtain 50 adult plants with fertile tissue and send it to a nursery. To date, the most accessible nursery was Alutiiq Pride Marine Institute in Seward. While they are very adept at growing kelp, shipping costs are prohibitive for PWS farmers. By providing local capacity, we strive to keep PWS farmers at the forefront of this budding industry.

**The CORaL Network**

CRISTINA REO
Prince William Sound Science Center
creo@pwssc.org

Established in 2022, the Community Organized Restoration and Learning (CORaL) Network aims to create and maintain a framework that builds the capacity of existing resources within the Exxon Valdez oil spill-impacted region. The CORaL Network is comprised of the following partners: Alaska Sealife Center, Alaska Sea Grant, Alutiiq Museum and Archaeological Repository, Center for Alaskan Coastal Studies, Chugach Regional Resources Commission, and Prince William Sound Science Center.

The CORaL Network will ensure that science outreach is relevant, co-created, and culturally responsive to our regional communities. Goals with the CORaL Network are to increase public knowledge related to the Exxon Valdez oil spill; increase participation of youth in community-based science; integrate the EVOSTC-funded long-term research and monitoring, mariculture, and restoration projects with community identified needs; and increase understanding of Alaska Native knowledge related to development, cultural competency, and collaborative community.

**Meet the Mar ReCon!**

ANNE SCHAEFER
Alysha Cypher

The Mariculture Research and Restoration Consortium (Mar ReCon) is a new project funded by the Exxon Valdez Oil Spill Trustee Council that will support habitat restoration and economic development in Alaska, focusing on Prince William Sound, Cordova Island, and Kodiak Bay. Researchers with ADF&G and Cordova District Fishermen United. This workshop will be held annually in March and is free for residents of Prince William Sound.

The PWSSC kelp nursery will open this summer and address farmer-inspired questions about when and where to obtain seed stock. We can also provide farmers with commercial kelp. For the season. Each season, kelp farmers obtain 50 adult plants with fertile tissue and send it to a nursery. To date, the most accessible nursery was Alutiiq Pride Marine Institute in Seward. While they are very adept at growing kelp, shipping costs are prohibitive for PWS farmers. By providing local capacity, we strive to keep PWS farmers at the forefront of this budding industry.

**Product Development**

Economic Feasibility

**Water biochemistry**

Nutrients

Fish Interactions

Mar ReCon will evaluate the impact of mariculture (seaweed and oysters) on the physical environment (water biochemistry and nutrients) and marine communities (plankton, benthic species, pelagic fish, marine birds, marine mammals). This project will also support farm production, evaluate economic feasibility of producing oyster seed in Alaska, and develop new test products.
Innovative Programs Merge
SCIENCE AND FUN for Adult Learning

CRISTINA REO
Prince William Sound Science Center
creo@pwssc.org

The Prince William Sound Science Center is proud to offer fun, new adult programming. We now offer nature yoga, biweekly on Sundays from 7-8pm. We dive into learning about the surrounding ecosystems and how we can reflect on nature’s lessons to lead richer lives. We host a monthly trivia night, from 7-8pm. You don’t have to be an expert to put your knowledge to the test about birds, plankton, fish, and more. We also created Science Charcuterie Game Night where folks come to the Science Center with their most creative charcuterie boards and compete against friends in science-themed games.

After a three-year hiatus, due to the pandemic, Tuesday Night Talks are back! These talks are a series of lectures organized for experts from the state of Alaska and the world to share their research and findings with the community of Cordova and beyond. They occur every Tuesday from 7-8pm and can be live-streamed using GoToMeeting or viewed afterwards on our YouTube channel.

LASTLY, WE HAVE THE NEW ASK A SCIENTIST COLUMN ON OUR WEBSITE. Do you have a question about why salmon jump or if jellyfish have regenerative capabilities? Email your questions to creo@pwssc.org to have it answered!

The “Sknow Birds,” were the winning team at the first ever Science Charcuterie Game Night on March 16. Photo credit Cristina Reo.

Rethinking
FOOD SYSTEMS in the Classroom and Beyond

LAUREN BIEN
Prince William Sound Science Center
lbien@pwssc.org

When you live in a cold, wet place with sandy soil and little natural light, it is difficult to grow vegetables... the traditional way, that is. So, the Prince William Sound Science Center (PWSSC) has turned to an innovative solution. Since 2019, the education team has been incorporating hydroponics into their classroom and community education programs. The local second graders host deep water culture systems in their classrooms and learn how plants in a hydroponic system photosynthesize with artificial light and get the nutrients they need to survive through liquid nutrients added to the circulating water. Students plant the seeds, monitor the pH of the water, and observe the growth of their lettuce to help them understand more about plants, nutrition, and where we get our food. It is a great way to demonstrate the life cycle of plants while presenting an innovative, local solution to a global issue. It’s tasty, too! Second graders said the lettuce they grew was “the best thing they’ve ever eaten!”

The PWSSC atrium also hosts a hydroponic tower, where we are currently growing herbs and lettuce. The tower decreases the footprint of the system while maximizing vertical growing space. Though not small, it is a mini version of PWSSC’s recently acquired hydroponics farm, formerly run locally as Kale N’ Thyme. This farm, when operating, supplies our community with fresh greens and herbs – grown right here. We are excited to get this farm up and running, both as a teaching tool and as a producer of delicious, healthy foods.
At first glance, glaciers may appear as a barren wasteland, untouched by humans since the last ice age. However, recent discoveries tell a different story. In 2022, a roll of 16mm film was discovered on the surface of a glacier high in the Chugach Mountains. Sixteen-millimeter film was first produced in 1923 and quickly became the industry standard for filming motion pictures. The film sustained significant damage due to impacts from glacial movement and exposure to the extreme environment. The owner of the film and the story behind this 100-year-old production remains a mystery. Archaeological investigations may provide a detailed future narrative. Who were these early explorers or film crews? What struggles did the crews endure to reach such an environment and why did they choose to film on these glaciers? The goal of U.S. Forest Service archaeologists is to understand the dynamic relationship between humans and the environment over past centuries. This discovery is an example of how Chugach National Forest archaeological research is investigating human and environmental systems in Southcentral Alaska. This research assesses the critical factors that affect cultural resource vulnerability and resilience to environmental change in the Chugach Mountains and Prince William Sound.

While the film artifact has been preserved in the cryosphere for 100 years, studying glacier mass balance records (change in the mass of a glacier over time) will help interpret the glacier’s long-term behavior and the probability of discovering additional fragile cultural resources. The 16mm film is located at the bottom center of the photo. Photo credit USFS.
SUPPLIES
• #2 (HDPE) and #4 (LDPE) plastic bags (excluding thin bags, such as produce bags, and bags made with compostable materials)
• Iron and ironing board
• Parchment paper
• Scissors, ruler, cutting board

OPTIONAL
• Duct tape
• Hole punch
• Yarn, embroidery floss
• Needle and thimble
• Sewing machine
• Scrap paper (8.5x11, blank on one side)
• Binder clips
• Buttons

DIRECTIONS
• This activity requires adult supervision
• Cut larger bags into single layer rectangular sheets; trim off handles
• Colorful bags and bags with designs can be cut into smaller bits for decorative purposes
• Heat iron to medium, no steam
• Layer 4-7 large plastic sheets, depending on the thickness of the plastic and your preference for the thickness of the final product.
• Sandwich these layers between two sheets of parchment paper on the ironing board. Make sure the paper extends beyond all edges of the plastic.
• Keep the iron moving at all times over the surface of the parchment paper. Depending on the size and number of layers, it may take up to one minute to fuse. Flip everything over and repeat on the back side.
• Lay a cutting board or large book on top while the plastic cools slightly. This ensures it won’t curl around the edges.
• Check the layers. If there are air bubbles or sections that aren’t fused, repeat steps 6 and 7.
• Once fused and cool, cut your new fabric into desired sizes and shapes; sew, tape, make your creation! Some ideas are listed below.

RECYCLED NOTEBOOK:
• Cut scrap paper in half, then fold each piece in half again (used side facing inwards.) Stack the folded paper, which should measure 4.25” x 5.5”.
• Cut a plastic cover approximately 8 1/2” x 5 1/2”. Fold in half. Insert stack of paper, folded edges facing away from the center of the cover. Secure with clips. Stitch or sew along the spine to hold it all together.

POUCH:
• For a smaller version, search online for “how to fold a zine”. This will produce an 8-page booklet, measuring 2 1/4” x 4 1/4”.

LAMINATED BOOKMARK:
• With clear plastic, you can laminate your favorite pictures and turn them into bookmarks. No stitching required. Tip: laminate the front and back pieces separately before sandwiching the paper in between. Be sure to press the edges together around the outside of the paper to create a good seal. Trim with about 1/8” edge.

YOUR CREATIONS CAN BE USED TO EXPLORE OUTSIDE.

A notebook is perfect for nature journaling.
PWSSC HAS LOTS OF RESOURCES HERE:
pwssc.org/education/nature-journaling

WHAT ELSE CAN YOU CREATE?
We’d love to see your ideas. Email photos to sbaumann@pwssc.org so we can share on our social media channels and newsletter.
One easy way to refuse a plastic bag at the store is to be sure you have a reusable bag with you. Not only does this save on plastic, but you can make your own bag using items you already have at home!

**SUPLIES**
- Old t-shirts
- Scissors

**OPTIONAL**
- Needle + thread
- Sewing machine
- Fusible bonding web, iron, and ironing board

**HOW TO**
- Cut off the sleeves and collar of the t-shirt

**FOR THE FRINGE METHOD:**
- Cut the bottom hem of the t-shirt in ¾” intervals, about 3” long.
- Knot the fringe together, a front piece of fringe to a back piece of fringe.

**FOR SEWING BY HAND OR WITH A SEWING MACHINE:**
- Turn the t-shirt inside out.
- Sew the bottom edges together with a ¼” hem
- Fusible bonding web is for the no-sew/no-fringe method folks. Found at craft and fabric stores, following directions on the package to fuse the bottom hem.

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**WORD SEARCH**
Find the words listed below, inspired by the content of this publication.

1. Ferry
2. Glacier
3. Herring
4. Innovation
5. Kelp
6. Plankton
7. Salmon
8. Science
9. Shorebird
10. Weir
11. Whale
The Prince William Sound Science Center has successfully launched its next

ERA OF IMPACT

Our new 5-acre waterfront campus (with advanced laboratories, a forthcoming running seawater system, and plans for a science residence and dormitory) is a once-in-a-generation opportunity that is relevant to all of Alaska and beyond. The 20,000 sq. ft. facility will make the Science Center and Alaska more competitive for national-level research funding, support high-wage jobs, generate new STE(A)M education opportunities, and advance industries such as mariculture, aquaculture, and commercial fishing.

This is a time of great change in the world that is driving unpredictable outcomes for the things that matter to all of us. With our new facilities, we can grow capacity, programs, and partnerships that will help ensure our region is a stronghold of resilience for the decades to come. We’re taking the long view, because we’re deeply invested in this place—it’s one of the last, best places on earth. Let’s keep it that way. Let’s make it better. We are so grateful to have you all with us.

The 2023-2024 Delta Sound Connections is proudly SPONSORED BY these generous organizations and businesses

PRINCE WILLIAM SOUND SCIENCE CENTER

DONATE NOW VISIT PWSSC.ORG/SUPPORT/WAYS-TO-GIVE/DONATE

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A crowd gathers at the Prince William Sound Science Center’s ribbon-cutting ceremony, June 4, 2022. Photo credit: Hamish Laird.