



1. *Sarcodiotheca gaudichaudii* 2. *Pyropia columbiensis* 3. *Laminaria yezoensis*
4. *Bossiella hakaiensis* 5. *Fucus distichus* 6. *Sargassum muticum*
7. *Protomonostroma undulatum*



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Summer of Science

Welcome to our second 2025 issue of the Tula Quarterly! Here are some stories for the dog days of summer, documenting discoveries and innovation from the Guatemalan highlands to the British Columbia coast.

In this issue:

- From the Global South to Canada's wild west coast, a global crew of ocean scholars dives into hands-on science with the Hakai Institute—and returns home with fresh skills, new perspectives, and a fire to change the future of ocean research.
- Located at the intersection of shifting currents and climates, Calvert Island is home to one of the richest collections of marine algae on Earth, offering a crucial record of a changing ocean.
- In Guatemala's remote highlands, health leaders are turning to TulaSalud's Kawok smartphone app—a powerful tool for community care—to bring life-saving maternal and child health services closer to home.

This issue's cover art, by illustrator Mercedes Minck, is inspired by the diversity of algae species that collect around British Columbia's Calvert Island, as featured in "Calvert's Kaleidoscopic Seaweed." ■



A photograph of a sunflower sea star on a dark, rocky seabed. The sea star's body is heavily eroded and discolored, showing bright red and white patches where its tissues are being lost. Its arms are fragmented and scattered around it. The surrounding water is dark and murky.

Researchers Discover Cause of Sea Star Wasting Disease

In the journal *Nature Ecology & Evolution*, a group of researchers reveals the culprit behind sea star wasting disease, a marine epidemic that has decimated sea star populations along the west coast of North America. Understanding the cause is essential for the recovery of sea stars and their kelp forest ecosystems.

A sunflower sea star is shown in the late stages of sea star wasting disease (SSWD) just off British Columbia's Calvert Island in 2015.

In *Nature Ecology & Evolution*, a group of researchers revealed the cause of sea star wasting disease (SSWD). This discovery comes more than a decade after the start of the marine epidemic that has killed billions of sea stars—representing over 20 different species from Alaska to Mexico—since 2013.

The challenging four-year investigation eventually

pinpointed the microbial culprit behind SSWD: a strain of the bacterium *Vibrio pectenicida*.

Vibrio is a genus of bacteria that has devastated coral and shellfish as well as humans. (*Vibrio cholerae* is the pathogen that causes cholera.) A strain of *V. pectenicida* has previously been shown to wipe out the larvae of several species of scallops with a “swift and dramatic” course of infection.

In the case of sea stars, infection with the *V. pectenicida* strain FHCF-3 initiates a grim disease that begins with exterior lesions and ultimately kills sea stars by “melting” their tissues, a process that takes about two weeks after exposure. Afflicted individuals often become contorted and lose their arms.

The international research effort was led by scientists from the

Hakai Institute, the University of British Columbia (UBC), and the University of Washington—and was conducted in collaboration with The Nature Conservancy, the Tula Foundation, the US Geological Survey's Western Fisheries Research Center, and the Washington Department of Fish and Wildlife.

Over 90 percent of sunflower sea stars (*Pycnopodia helianthoides*)—which are capable of sprouting 24 arms and growing to the size of a bicycle tire—were wiped out by the disease in the past decade, landing them on the International Union for Conservation of Nature's [Red List of critically endangered species](#). The loss of sunflower sea stars, which support kelp forests by feeding on kelp-eating sea urchins, has had widespread and lasting effects on coastal ecosystems.

“When we lose billions of sea stars, that really shifts the ecological dynamics,” says Melanie Prentice, the first author on the study and an evolutionary ecologist at the

Hakai Institute and UBC. “In the absence of sunflower stars, sea urchin populations increase, which means the loss of kelp forests, and that has broad implications for all the other marine species and humans that rely on them. So losing a sea star goes far beyond the loss of that single species.”

Kelp forests provide habitat for thousands of marine creatures and contribute millions of dollars to local economies through fisheries, recreation, and tourism. They're also culturally important for coastal First Nations and tribal communities, they sequester and store planet-warming carbon dioxide, and they protect coastlines from storms.

“Understanding what led to the loss of the sunflower sea star is a key step in recovering this species and all the benefits that kelp forest ecosystems provide,” says Jono Wilson, director of ocean science for The Nature Conservancy's California chapter.

Identifying the disease in afflicted sea stars was impossible without a known pathogen, as sea stars can respond to other stressors and diseases with similar visual signals of contortion and loss of arms. The long-awaited result showing *V. pectenica* as the causative agent comes after a four-year research process. The team of scientists explored many possible pathogens, including viruses, first looking in sea star tissues before homing in on the high levels of *V. pectenica* in sea star “blood,” or coelomic fluid.

“When we looked at the coelomic fluid between exposed and healthy sea stars, there was basically one thing different: *Vibrio*,” says Alyssa Gehman, senior author of the study and a marine disease ecologist at the Hakai Institute and UBC. “We all had chills. We thought, That's it. We have it. That's what causes wasting.”

Amy M. Chan, a marine microbiologist in the Aquatic Virology and Microbiology Lab at UBC, then created pure cultures of *V. pectenica* from the coelomic fluid of sick sea stars. Researchers injected the cultured pathogen into healthy sea stars, and the ensuing rapid mortality was final proof that *V. pectenica* strain FHCF-3 causes SSWD.

The research was supported by UBC, The Nature Conservancy, the Tula Foundation, and several other institutions, and conducted at the Aquatic Virology and Microbiology Lab at UBC, and at the Marrowstone Marine Field Station in Washington State, run by the US Geological Survey's Western Fisheries Research Center.

Now that scientists have identified the pathogen that causes SSWD,



This cookie sea star found near Calvert Island, British Columbia, shows how SSWD “melts” the animal's flesh.



Sunflower sea stars are predators of kelp-eating grazers like sea urchins, so the decline of this species has meant a proliferation of urchins, as shown here in 2019, and a widespread loss of kelp.

they can look into the drivers of disease and resilience. One avenue in particular is the link between SSWD and rising ocean temperatures, since the disease and other species of *Vibrio* are known to proliferate in warm water, Gehman says.

“Those patterns of *Vibrio* in general suggest that we really should look down that road to see how temperature dependence matters.

“This finding opens up exciting avenues to pursue and expands the network of researchers able to develop solutions for recovery of the species,” says Wilson. “We are now actively pursuing studies looking at genetic associations with disease resistance, captive breeding of the animals, and experimental outplanting to understand the most effective strategies and locations to reintroduce sunflower sea stars into the wild.” ■

Researchers and project partners hope the discovery will help guide management and [recovery efforts for sea stars](#) and the ecosystems affected by their decline.



Hakai Institute research scientist Alyssa Gehman checks on an adult sunflower sea star in the US Geological Survey’s Marrowstone Marine Field Station in Washington State in 2021.



Gone with the Glaciers: Researchers Track Unprecedented Ice Loss

From the Canadian Rockies to the Swiss Alps, the acceleration of glacial melt is “falling off a cliff” due to warm, dry conditions and the phenomenon of glacial darkening.

A bird's-eye view of Mount Robson in the Canadian Rockies in September 2022 shows the stark effects of warming. Loss of snow and thinning ice mean a barren late-summer landscape after years of record melt.

A study published in [*Geophysical Research Letters*](#) reveals that glaciers in western Canada, the United States, and Switzerland lost around 12 percent of their ice between 2021 and 2024. A 2021 study in [*Nature*](#) showed that glacial melt doubled between 2010 and 2019 compared with the first decade of the 21st century. This new paper builds on that research, says lead author Brian Menounos, and shows that in the years since, glacial melt continued at an alarming pace.

“Over the last four years, glaciers lost twice as much ice compared to the previous decade,” says Menounos, a professor at the University of Northern British Columbia and a chief scientist at the Hakai Institute. “Glacial melt is just falling off a cliff.”

Warm, dry conditions were a major cause of loss across the study areas, as were impurities from the environment that led to glacial darkening and accelerated melt. In Switzerland, the main cause of darkening was dust blown north from the Sahara Desert; in North America, it was ash, or black carbon, from wildfires.

The research combined extensive aerial surveys with ground-based observations of three glaciers in western Canada, four glaciers in the US Pacific Northwest, and 20 glaciers in Switzerland, all of which are important for culture, tourism, and cool fresh water—and all of which are melting rapidly.

Snow and ice, when not obscured by dark particles, reflect the sun's energy in a process known as

the albedo effect. To dig deeper into the North American story, Menounos and his collaborators used satellite imagery and reanalysis data to look at declines in albedo. They found that albedo dropped in 2021, 2023, and 2024, but the biggest declines occurred in 2023—the worst wildfire season in Canadian history.

“2023 was the year of record, no question,” Menounos says.

In contrast to reflective white snow, a glacier covered in black carbon will absorb more radiation from the sun. This heats up glaciers and accelerates melting. At Haig Glacier in Canada's Rocky Mountains, glacial darkening was responsible for nearly 40 percent of the melting between 2022 and 2023, the researchers found. Yet

despite such evidence, physical processes like the albedo effect aren't currently incorporated into climate predictions for glacier loss, so these masses of ice could be melting faster than we realize.

"If we're thinking, Well, we have 50 years before the glaciers are gone, it could actually be 30," Menounos says. "So we really need better models going forward."

In the areas covered by this study, the impact of glacier loss on sea level rise is small, but a longer-term decline in glacial runoff could impact human and aquatic ecosystems, especially in times of drought, Menounos adds.

In the shorter term, increased melting raises the risk of geohazards like outburst floods from newly formed glacier lakes. All of this poses questions around how communities should respond as well as plan for a future with less ice.

"Society needs to be asking what are the implications of ice loss going forward," Menounos says. "We need to start preparing for a time when glaciers are gone from western Canada and the United States." ■



Meltwater pools on the surface of Place Glacier near Pemberton, British Columbia, where calving ice and persistent thinning illustrate a shift toward a more ephemeral cryosphere.



Sperry Glacier, in Montana's Glacier National Park, is shown here in fall 2023 coated in a dark layer of impurities, such as wildfire ash.



Peyto Glacier is located in the Canadian Rockies in Alberta's Banff National Park.



Calling on Kawok: Digital Health Solutions in Rural Guatemala

In a rural, mountainous region where maternal and infant health face critical challenges, health officials are looking to TulaSalud's powerful combination of technology and local knowledge to save lives.

The surrounding terrain and remote nature of many of the communities in Guatemala's Alta Verapaz and Izabal departments make healthcare solutions difficult.

Thelma Aguilar is the chief medical officer for the province (known as a department) of Izabal, Guatemala. Before taking on this position—and following her own career as a healthcare professional—she worked in the Guatemalan Ministry of Public Health and Welfare (MSPAS). It was at MSPAS, she says, that she had a troubling and life-changing encounter.

“During a health campaign, a woman brought her baby to be seen at a health center, but the

baby no longer had vital signs,” recalls Aguilar. “This mother had walked a long way so we could help her with the baby, but by the time she got to us, he was already gone. That moment really shook me, and it had such a big impact on my life because it made me realize that our strategy must be to bring health services closer to the people.”

It was also while at MSPAS that Aguilar learned about TulaSalud and the Kawok program that uses smartphone-based

technology to improve infant and maternal health outcomes in rural Guatemala. An assessment of health indicators in the department of Izabal prompted Aguilar to reach out to TulaSalud's executive director, Isabel Lobos.

“Kawok is a strategy that aligns with the ministry's mission and vision—to provide access, coverage, and healthcare services at the community level,” says Aguilar. “In our department we need to strengthen our strategies in maternal and child health. I believe Kawok can help us do that.”



Thelma Aguilar, a chief medical officer in Izabal, is determined to find effective solutions for rural Guatemalans. Photo by Franklin Alexander Guadrón García/TulaSalud

Aguilar's conversations with Lobos led to a meeting in June 2025 at TulaSalud's headquarters, located in the city of Cobán in the department of Alta Verapaz. The visit included a presentation by frontline health worker Juan José Bac Soria.

"The purpose of our visit to Cobán was to learn about best practices and bring them to our communities," says Aguilar. "We know Kawok has been successful in other departments, so why not bring it to Izabal as well?"

A crucial digital health ecosystem for saving lives

TulaSalud has trained and supported thousands of frontline health workers serving remote Guatemalan communities.

Guatemala remains near the bottom of Latin America's development indicators—including those related to poverty, inequality, health, and human rights—and women, Indigenous people, and rural populations often experience these challenges more severely.

A critical part of TulaSalud's support for frontline healthcare workers is a digital ecosystem. Healthcare workers are provided with smartphones—enabling the use of WhatsApp and other messaging platforms for coordination and communication—as well as the Kawok mobile app that can monitor and synchronize health data in real time.

Kawok tracks current data on thousands of children and pregnant women, enabling nurses and doctors to respond to what is happening at the community level.

Health workers have used the digital health ecosystem to make approximately one million calls per year relating to patient follow-up, clinical consultation, and emergency transportation, and the Kawok app has registered more than 500,000 pregnancies and more than 950,000 children for nutrition monitoring.

"I always want to point out that Kawok is not just data, or the form on the smartphone that gets filled in by a frontline nurse," says TulaSalud president Christy Gombay. "It's everything put



Residents of rural Guatemala waiting to see a nurse. Photo by Kristina Blanchflower/Tula Foundation

together. Kawok is the training that is behind the nurses' ability to use the app. It's the ability to make a phone call, and the ability to send and receive messages quickly in these very remote areas. It's all of the embedded tools that have been automated and that have evolved over the last 20 years."

"It's essential to start from scratch"

Digital services and automation are the foundation of Kawok, but at the heart of TulaSalud's success is the direct outreach to communities by frontline health workers. This is one of the strengths that makes Kawok unique, Aguilar says, and it points to the need for person-to-person contact that is sometimes missing from big-picture healthcare strategies.

"We said, 'Izabal needs this strategy because the people—especially the communities—need it,'" recalls Aguilar.

"We tend to focus on large-scale strategies and expanding coverage, but we forget the community. And that's the starting point for any real implementation—getting close to the people, understanding their needs. I think it's essential to start from scratch, and that begins with face-to-face contact."

Aguilar went to Cobán with the hope that Izabal would be able to adopt the Kawok strategy. She was accompanied in Cobán by members of her nutrition and IT teams, and recalls their conversations afterward. "They told me, 'Doctor, we're truly impressed by the strategy. We believe we can do it. We can make it happen.' I saw a lot of hope and excitement in their eyes," she says,

offering gratitude to TulaSalud for opening the doors to her team in Cobán.

Recent signals from colleagues and officials look promising, including a meeting with Guatemala's vice president Karin Herrera.

"We talked about nutrition and, during my presentation, I mentioned that we would rely on Kawok," says Aguilar. "She smiled and gave us a thumbs up."

At that point, Aguilar realized Herrera already knew about Kawok. "Her reaction said it all," says Aguilar. "I thought, We're on the right path."

The response from the vice president encouraged Aguilar to pursue the meeting with TulaSalud in Cobán. Afterward, when she spoke with local authorities in Izabal about adapting the Kawok program, they told her they were "fully on board."

This is excellent news, says Gombay.

"In the past when we have had similar visits, TulaSalud team members have had to sell the benefits of what we are doing

with Kawok. Now we have people coming to us who know its value, know what it can achieve, and want to learn how they can do the same thing. That to me is a really significant shift."

Change will take time, adds Gombay, explaining that it has taken 20 years for TulaSalud to create the Kawok program and build its impact.

"There are no quick and simple solutions, and we are not expecting miracles, particularly if there is no outside funding coming through," he says. "But to see this interest from health authorities outside Alta Verapaz is, for me, inspiring and heartening. It seems that it could be very good news for the people and communities of Izabal."

The future is always uncertain, but for her part, Aguilar is optimistic.

"Like those on our team who were with me, I also believe it can be done. I believe that with support from organizations like TulaSalud, we can bring about change, and, God willing, we will succeed." ■



A nurse checks a baby's weight and health indicators in rural Guatemala. Photo by Franklin Alexander Guadrón García/TulaSalud



Lighting a Fire for Ocean Science

Ocean scholars from around the world waded into Canada's coastal ecosystems for hands-on science that ignites a passion for the future.

Esraa AbouElmaaty (center), a marine biologist and ocean scholar from Egypt, enjoys checking out the intertidal sea life on Quadra Island, British Columbia, as part of a biodiversity survey led by Hakai Institute researcher Alyssa Gehman (left).

When Ratna Suhita zipped her suitcase shut in Bali, Indonesia, in the fall of 2024, her bag bulged with packets of chili pepper spice—fiery little reminders of home. She was heading to Canada for 10 months as one of 10 scholars in the 2025 cohort of the Nippon Foundation–Partnership for Observation of the Global Ocean (POGO) Centre of Excellence. It would be her first time outside the country and her first time experiencing winter. She didn't want to be without heat.

Since 2005, POGO has been quietly transforming the field of ocean science. At its heart, the

collaboration is about people—especially those from the Global South. It's about training ocean-minded thinkers, doers, and future leaders to monitor the sea with the tools of today and the perspective of their home regions. While it focuses on developing nations, the ripple effect is global; the program is training a new generation to listen more closely to the sea, and to bring those observations back to shore in meaningful ways.

For Suhita, a master's student studying remote sensing and GIS, the most rewarding part of the program wasn't the lectures at Memorial University in St. John's,

Newfoundland, or Dalhousie University in Halifax, Nova Scotia—or even the snow, which she enjoyed for the first time in her life. What really lit her fire was the time with the Hakai Institute on Canada's west coast.

"We've been informally calling this segment 'The Field School,'" says Kacie Conrad, one of the project managers from the Hakai Institute overseeing day-to-day life for the scholars. She adds that Hakai's researchers have been enthusiastic and creative about how to invite the scholars into their areas of expertise.

The scholars' time at the Hakai Institute was a whirlwind of salty air, slick kelp, and tech talk. During their two weeks on Quadra Island, they scrambled along the coastline doing intertidal biodiversity surveys that culminated in a mini bioblitz, where they recorded as many species as possible to get a snapshot of the local biodiversity. They also enjoyed workshops on geospatial technology that spun satellites and sensors into storytelling tools.

For Maryjune Cabiguin, a scholar from the Philippines with a biology background, it was the state-of-the-art aquaria called mesocosms that got her mind racing. They're a step up from the experiments on community ecology she ran at home using more manually controlled aquarium heaters to control for water temperature.

"When we are in our respective countries ... I just think, what more could we do if we had these

kinds of resources?" she asks.

Then came Calvert Island, British Columbia: remote, rugged, and dripping with West Coast mystique. There, amid the clouds of blackflies and persistent drizzle, the cohort teamed up with the Hakai Institute's watershed and ocean observation crew—even getting to launch buoys and gliders, autonomous underwater vehicles, into the sea.

Organizers made sure scholars spent time moving across the land and sea, paddling coastal routes by kayak and walking terrain shaped by salt, storms, and time. The goal wasn't just to attain technical skills—it was to gain orientation, a geographic grounding. Participants walked away with a visceral sense of why these field stations are so well placed for watching the ocean breathe.

"It's not educational per se. It's just giving them that full picture of why this is the coolest location

to do what we do," says Naomi Boon, who helps Conrad oversee the program, a job that requires the logistical mind of an air traffic controller and the enthusiasm of a camp counselor—especially on cold rainy days.

Despite the bugs and rain, Ndague Diogoul, an oceanographic researcher from Senegal, found the excursion with the watersheds crew revelatory.

"After our experience at Hakai ... I think when I go back to my home I won't be able to stay in the office," she says. "Doing research in Canada is very different from what we do."

Dennis Otieno, a scholar from Kenya with a career that pinballs from oceanography to banking to entrepreneurship, says the program is helping him reimagine the shape of research itself. "One thing I realize," he says, "is you can't work alone—and you can't know everything."

Growing up near Lake Victoria, the second largest freshwater lake in the world after Lake Superior, Otieno learned early about the power of water to connect and sustain. Now, with an eye on Kenya's blue economy, he's focused on building capacity at home through collaboration.

"Knowledge is something where it doesn't really matter how many papers you publish. What matters is what impact it has, and whether it informs policies," Otieno says.

The Hakai Institute is committed to at least another two years with POGO and to making the program a success in Canada—so next year promises a new set of adventures.



Maryjune Cabiguin, a POGO scholar from the Philippines, examines some of the critters that accumulated in a light trap off the Quathiaski Cove dock near the Hakai Island Ecological Observatory on Quadra Island.



POGO scholars—including José Manuel (front center), Esraa AbouElmaaty (back center), and Punya Puthukulangara (far right)—learn the ins and outs of rocky intertidal surveys with Hakai Institute researchers.

“We all recognize the cost-effectiveness and efficiency of making ocean observations remotely, via autonomous systems, modeling, and artificial intelligence,” says Eric Peterson, cofounder and codirector of the Tula Foundation.

“At the same time, we need to anchor our knowledge in specific locations around the globe that we monitor long term and across the spectrum of science. We welcome our Nippon-POGO scholars, providing them with exposure to field science outside the academy, and perhaps inspiring other centers in the same spirit in other ocean nations,” says Peterson.

For this crew of scholars, scattered across the globe but drawn together by the ocean’s pull, the work is only beginning. And while they’ll soon return home with suitcases emptied of chili pepper packets, they’ll possess a new kind of fire to inspire their research and innovation. ■



A little rain is no deterrent for the Hakai Institute’s oceanography team to deploy an ocean glider off Calvert Island, British Columbia, in front of an audience of POGO scholars.



Hypoxia Emerges as a New Threat on Canada's Pacific Shelf

Low oxygen levels, known as hypoxia, are a growing threat to marine life in the global ocean. Now, say researchers, warning lights are flashing in the deep waters of British Columbia's Queen Charlotte Sound.

Ocean gliders, such as this one deployed off Calvert Island, British Columbia, are some of the instruments used to collect data on oxygen levels in Queen Charlotte Sound—part of new research showing that seasonal hypoxia, once rare in this region, has become increasingly common in recent years and is projected to worsen by mid-century. Photo by Katrina Pyne/Hakai Institute

Oceanographic researchers have released [a new paper](#) showing worrying declines in oxygen levels in Queen Charlotte Sound, a large section of the British Columbia coast between Vancouver Island and Haida Gwaii. Its deep waters were once considered a refuge from low-oxygen conditions, but recent observations show seasonal and widespread occurrences of low oxygen—known as hypoxia—across large swaths of the continental shelf underlying Queen Charlotte Sound.

Researchers project that these harmful conditions will become more persistent in the coming decades—and that the deep waters in Queen Charlotte Sound will be largely hypoxic by 2050, with serious consequences for marine life and fisheries.

“Over the last few decades, we've seen a general decrease in oxygen in waters all over the globe, and the warning lights are flashing for the Central Coast of BC,” says Sam Stevens, an oceanographer and postdoctoral researcher at the Hakai Institute and lead author on the paper. “Now we're seeing a change in the ecosystem there. And if these trends continue, as we expect, hypoxia will continue to worsen in the coming decades.”

The study draws on nearly 20 years of data, along with intensive observations from 2022 and 2023, and was led by scientists from the Hakai Institute, the University of British Columbia, Fisheries and Oceans Canada, and the University of Victoria.

A large portion of the measurements from 2022 and 2023 were collected by the Canadian-Pacific Robotic Ocean Observing Facility (C-PROOF) using ocean gliders—autonomous underwater vehicles that traveled back and forth across Queen Charlotte Sound, diving from the surface to the seafloor to record oxygen levels, temperature, salinity, and other conditions in fine detail.

These declines in oxygen are largely caused by climate change, says Stevens, because as surface waters of the ocean get warmer it becomes harder for atmospheric oxygen to be mixed into the ocean via winds, storms, and tides. The team found a strong correlation between oxygen variability in Queen Charlotte Sound and conditions in subarctic waters



Coastal habitats—including seagrass meadows, mudflats, marshes, mangroves, and forested tidal swamps—collectively store more carbon on an annual basis than the aviation industry emits.

off Japan and Russia, suggesting that changes in ocean conditions thousands of kilometers away are affecting oxygen supply to the Canadian shelf.

“The long-term changes that we’re seeing now on the BC coastline actually seem to originate thousands of kilometers away across the Pacific,” says Stevens.

Warming causes seawater to hold less oxygen, but that explains only a small part of the loss. The bigger driver is that winters in the subarctic North Pacific are producing less cold, dense, oxygen-rich water, meaning less oxygen is delivered into the ocean’s interior—and eventually to BC’s coastal waters.

“These changes on the other side of the Pacific slowly make

their way over to us here in BC, about eight to 10 years later,” says Stevens. “For most people, it would be quite surprising to learn that changes in the ocean near Japan are affecting the straits, inlets, and fjords of British Columbia.”

The authors estimate that by 2050, more than half of the Queen Charlotte Sound seafloor could be seasonally hypoxic. This shift has broad ecological implications.

“Over the last few decades, there have been mass die-offs of seafloor organisms in Oregon and Washington related to hypoxia, and it’s possible we’ll begin to see similar events occurring here in BC,” Stevens says.

Hypoxia on the continental shelf has been linked to stress, displacement, and mortality in

marine species such as crabs and rockfish, and could affect deep inlets and fjords that rely on Queen Charlotte Sound for oxygen-rich water—including Bute Inlet, Knight Inlet, and Rivers Inlet.

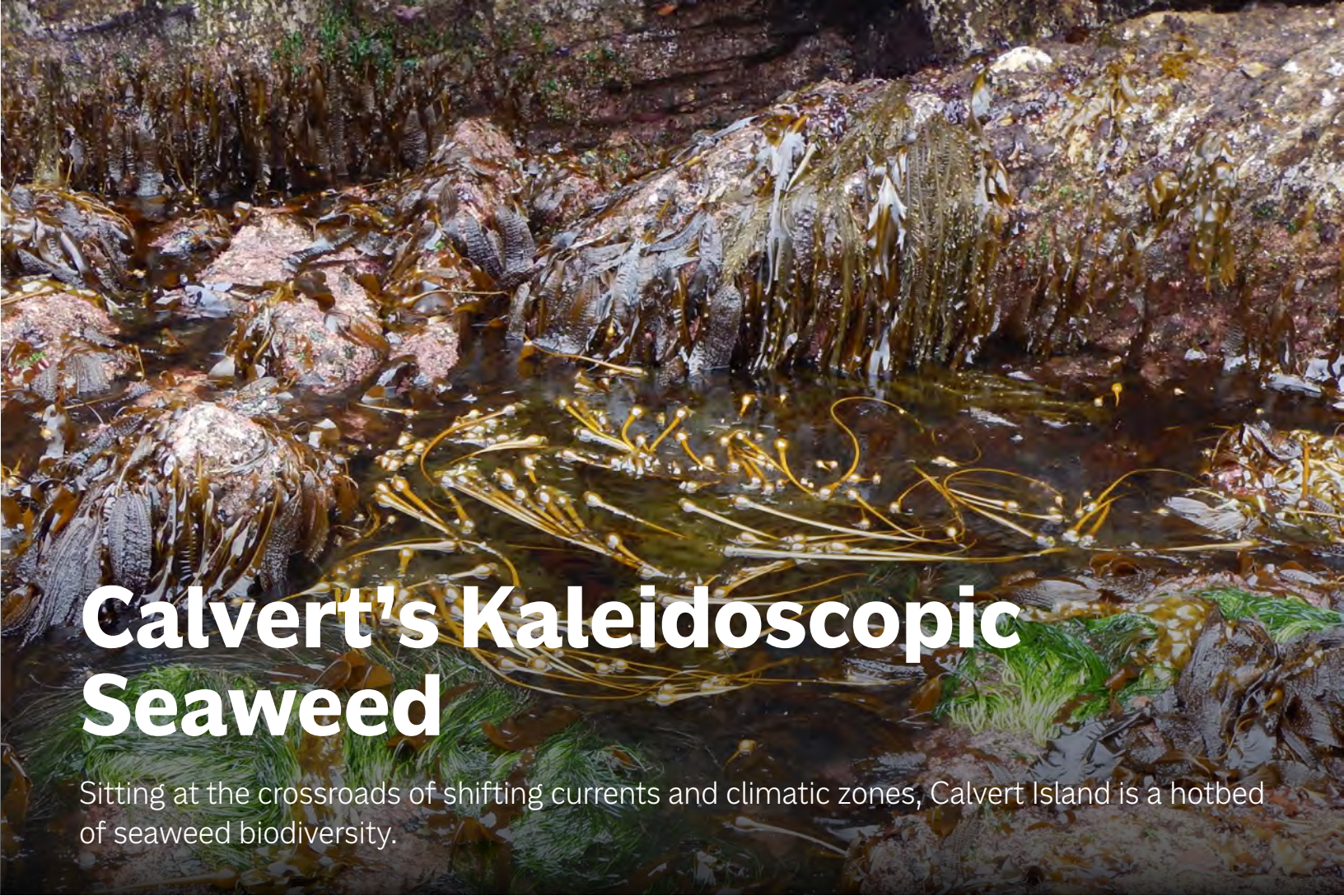
With the region entering this new regime, the researchers call for enhanced monitoring and modeling efforts to better anticipate and manage future changes.

“Queen Charlotte Sound supports valuable fisheries, biodiversity hotspots, and protected areas,” says Stevens, noting that the paper’s findings underscore the urgency of tracking both long-term oxygen trends and short-term variations, as well as the regional and global forces that drive them.

Enhanced monitoring would entail continued observation by ocean gliders, as well as developing “detailed physical and biogeochemical models and careful ecosystem monitoring for fish and seafloor invertebrates,” says Stevens. “The warning signs are there, and we need to keep a close eye on these troubling developments using all the tools at our disposal.” ■



A vibrant seafloor community near Calvert Island, British Columbia. Photo by Hakai Institute



Calvert's Kaleidoscopic Seaweed

Sitting at the crossroads of shifting currents and climatic zones, Calvert Island is a hotbed of seaweed biodiversity.

Researchers have cataloged nearly 370 species of seaweed around Calvert Island, including *Nereocystis luetkeana* (bull kelp), center, and *Costaria costata* (five-ribbed kelp), bottom right.

Calvert Island is unique among the islands of British Columbia's Central Coast for its white-sand beaches, sheltered lagoons, and wave-battered tidepools. It also features tremendous biodiversity, including one of the largest collections of seaweed in Canada—maybe on the planet.

Since researchers began surveying seaweed here, nearly 370 species of marine algae have been cataloged around this single island. Of those, 42 are green algae, 67 are brown, and the rest—a whopping 258 and counting—are red algae. A team of Hakai Institute scientists and collaborators, led by seaweed experts Sandra Lindstrom and Patrick Martone, has been rolling out peer-reviewed studies to

document these species, from tasty *Pyropia nereocystis* to *Codium fragile*, aka dead-man's fingers, whose stubby branches are each made of a single cell. The next paper that Lindstrom, Martone, and their team will publish, in the journal *Botany*, chronicles brown algae, including kelps.

Lindstrom is an algae aficionado and adjunct professor at the University of British Columbia (UBC) who's been studying seaweed diversity on the BC coast for over 50 years. While researchers have conducted seaweed surveys around Vancouver Island, Prince Rupert, and Haida Gwaii, says Lindstrom, Calvert Island and the surrounding Central Coast were long overlooked.

"There are some unique features around Calvert Island that make it an especially rich area for species," Lindstrom says. "There's such a diversity of habitats." This diversity arises from a convergence of cold currents, tectonic plates, variable microclimates, and glacier-carved fjords.

In 2011, Lindstrom partnered with Martone—a recently dubbed "[king of kelp](#)" who runs the Martone Lab at UBC—to embark on a book journey to produce *The Marine Flora of Calvert Island*. But the pair soon got overwhelmed by the sheer abundance of algae. They decided to break the algae into their three color classes, and then got to work hand-pressing seaweeds onto special paper,



Calvert Island offers a diversity of habitats, making it a rich environment for seaweed research. Photo courtesy of Patrick Martone

One of the 42 green algae documented on Calvert, *Codium fragile*—aka dead-man's fingers—features stubby branches, each made from a single cell. Photo by Patrick Martone

similar to the way plants are pressed for preservation.

Once a seaweed is pressed and given a best-guess name, a clipping is sent to the Hakai Institute genomics lab for DNA analysis. “We identify every single species,” says Martone, “from the large seaweeds down to the fuzz on your finger.”

This comprehensive approach to surveying biodiversity is how the team has discovered several new species—including some of the “fuzz” varieties. Other microscopic

traces of seaweeds have yielded DNA matches but have yet to be seen by the naked eye.

For these reasons, DNA analysis has made the book project balloon into a much larger undertaking, says Martone. With red algae alone representing over 250 species in this region, identification makes for a significant workload. “It’s just a daunting task,” he says.

Yet, adds Martone, it’s rewarding to create a database of all the algae in a single location, because it will provide a critical baseline

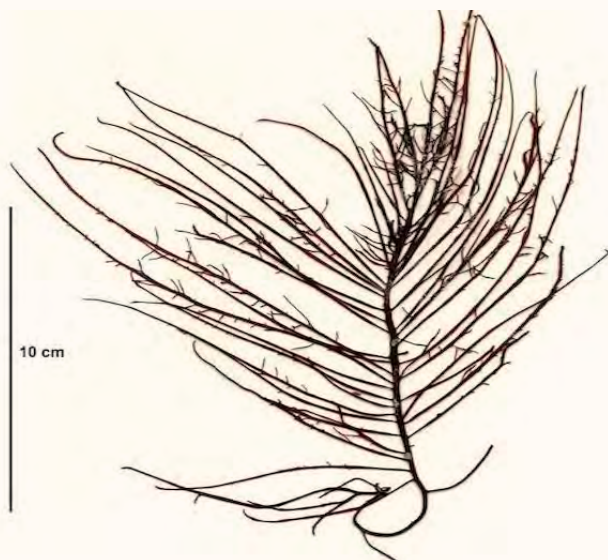
for tracking future changes to the ecosystem.

“So if there’s some big event, some heatwave or some man-made disaster, we can point back to our data set and say, Hey, these species used to live here.”

Martone and Lindstrom have already witnessed many changes in the 14 years that they’ve been cataloging Calvert Island seaweed. Martone remembers the excitement of first discovering *Laminaria yezoensis*, a brown alga also known as suction-cup kelp,



Seaweeds—like these *Ulva* (first photo) and *Pyropia* species (second and third photo)—are pressed for preservation and then sent to the Hakai Institute genomics lab for DNA analysis.



The red algae *Sarcodiotheca gaudichaudii* has diverged into genetically distinct populations around Hakai Passage.



Other unique Calvert Island discoveries include a species of *Bangia* that seaweed expert Sandra Lindstrom has never encountered anywhere else.

in the early years. Lindstrom was already familiar with it from her work in Alaska, but Martone—who did his PhD at Stanford and was thus more familiar with California seaweeds—had never encountered it.

“I took a lot of photos when we first started this survey, because I was so excited to see this big new kelp I’d never seen before,” Martone recalls. However, possibly as a result of the northeast Pacific heatwave of 2014 to 2016, the species has all but disappeared from the intertidal zone.

“I set aside time to go look for it, to take more pictures, and it’s totally gone,” Martone says. “I haven’t seen it on Calvert Island in many years.”

A [2023 study](#) that Martone and Lindstrom coauthored with Matt Whalen—a former Hakai Institute postdoctoral scholar who is now an assistant professor at Virginia State University—documented such shifting ranges, as well as ecosystem reorganization following that same marine

heatwave. For example, the range of *Fucus distichus*, once a common rockweed on Calvert Island, has contracted significantly, leaving intertidal rocks in some areas bare. Since seaweeds form habitat, such disappearances have knock-on effects for invertebrates and fish communities, Martone says.

While some species may be in decline, new ones are showing up. In 2014, former Hakai scholar Jen Burt picked up a *Postelsia palmaeformis* (sea palm) that washed up on Calvert’s West Beach. These wave-loving “palm trees of the sea” were first described in California, but they may be pushing northward with changing ocean conditions. This was the northernmost specimen ever found.

The survey team’s [2021 paper](#) on green algae summarizes additional northern records for Calvert Island, including translucent, lime-hued *Ulva expansa* and *Ulva stenophylla*. In contrast, the hairy *Acrosiphonia sonderi* and crinkly *Protomonostroma undulatum* have reached their southern limits

around Calvert.

Perhaps most interesting are the seaweeds that diverge into genetically distinct populations along the deep passages and fault lines around this storied island, Lindstrom says. For example, Calvert has two populations of *Sarcodiotheca gaudichaudii*, a red alga shaped like branched spaghetti, that’s mysteriously differentiated, possibly into separate species, around the marine trough known as Hakai Passage. Such abrupt changes hint at deeper processes, from shifting currents to impacts from glaciation.

“They are related species,” Lindstrom says, “but at some point they diverge sufficiently that they’re genetically isolated, and yet they overlap here geographically. So, there are little interesting stories like this that we pick up all the time.”

There are seaweeds that have shown up on Calvert Island and maybe nowhere else on Earth, Lindstrom adds. On two winter

trips to Hakai's Calvert Island Ecological Observatory, she stumbled upon *Bangia*, a stringy species related to *Pyropia*, that had coated some intertidal rocks in fine filaments. In all her years studying seaweed, she had never seen it anywhere else, underscoring what's special about this stunning island set between ecological worlds.

"It may occur in other places, but maybe not. Maybe Hakai is its last stand," Lindstrom says. "We don't know, but it's nice to have data to show that there are some distinct things here that we're not aware of elsewhere."

In a time of rapid global change, Calvert Island has a vital record of the seaweed biodiversity that's here now. ■



Seaweeds collect on white-sand beaches and wave-battered intertidal zones, like this one, on Calvert Island.



Researchers Find Crab and Clam Resilience Etched into Shells

In the Broken Group Islands off western British Columbia, shellfish populations have evaded large-scale commercialization and remained stable for the past 3,000 years.

Scientists conducted research on clamshells at archaeological sites in Tseshaht First Nation territory in the Broken Group Islands off the west coast of Vancouver Island, British Columbia.

A new study reveals a bright spot for shellfish populations in the northeast Pacific Ocean. Combining paleontological tools and archaeological data with conservation research, [the paper](#) finds that, for the past 3,000 years, crab and clam species have remained stable in the Broken Group Islands off the west coast of Vancouver Island, British Columbia.

The results, published in the [July 2025 issue](#) of *Biological Conservation*, suggest that the area has been largely sheltered from large-scale commercialization during the past century—while also demonstrating the sustainable relationship between local Indigenous peoples and shellfish over millennia.

“We always think of ourselves as separate from nature, but we are a part of our ecosystems,”

says Kristina Barclay, a research scientist at the Hakai Institute who was the lead author on the study. “Indigenous peoples understand this inherently, and the archaeological record can also demonstrate that.”

Dungeness crab is one species of cultural importance to coastal First Nations, and the study—which Barclay conducted as part of a Banting Postdoctoral Fellowship at the University of Victoria (UVic), in collaboration with UVic researchers Julia Baum and Iain McKechnie as well as a Tseshaht First Nation representative, Denis St. Claire—finds that crab populations in the Broken Group have remained stable over thousands of years of harvesting. Crabs such as Dungeness have been largely overlooked in the archaeological record, despite concerns from First Nations on the Central Coast and other parts

of British Columbia about species declines.

The paper takes a novel approach to studying the abundance of crabs and clams: it looks at evidence of crab predation efforts by Dungeness, red rock, and graceful rock crabs on littleneck and butter clams. When a crab attacks but fails to kill, it leaves a claw-shaped “repair scar” on the clam shell, “just like if you’ve healed from a broken bone,” Barclay says.

Repair scars have been used to assess the relative abundance of crab populations in modern contexts, but this is one of the first studies to consider scars as archaeological evidence of historical crab populations. For coastal First Nations and fisheries managers, this approach offers “one more tool in the tool box,” Barclay says, which could be applied more broadly on the

BC coast, especially given the large number of archaeological sites.

“The approach was originally developed to study predator-prey interactions in the fossil record and predator-prey evolution through time,” Barclay adds. “It’s really cool to apply it to other fields.”

The fact that the Broken Group Islands are a stronghold for shellfish populations may not come as a surprise; the archipelago is located within Tseshaht First Nation territories and Pacific Rim National Park Reserve and is only accessible by boat, thereby sheltering the region from the kind of commercial harvesting that’s devastated populations elsewhere. But Barclay says she was surprised that ocean acidification and warming ocean temperatures due to climate change haven’t yet made a bigger dent in the Broken Group.

“I was expecting more of a sad story and was very happy to see that these populations are resilient,” Barclay says.

But just because it’s a good news story now doesn’t mean things aren’t tenuous, she adds.

“These ecosystems are still vulnerable to climate change, so we still really need conservation and to cut carbon emissions.” ■



Littleneck clams (left) and butter clams are both eaten by crabs in the northeast Pacific Ocean. The butter clam shows a distinctive repair scar—a record of a crab’s crushing claw that the clam survived.



University of Victoria anthropology students excavate an Indigenous shell midden in the Broken Group Islands. Fragments of clamshells—an abundance of which can be seen near the surface of this site—offer clues about shellfish resilience and Indigenous harvesting that stretch back thousands of years. Photo by Iain McKechnie



Short Takes

Under Pressure

A meltwater pool on the surface of Place Glacier is another indicator of the continuing and rapid loss of ice there and throughout the global cryosphere.

In late July 2024, more than one million cubic meters of water suddenly drained from a lake on top of Place Glacier in western British Columbia, triggering downstream flooding. Researchers say the event was a hint of what's to come.

Long monitored by the Geological Survey of Canada (GSC), Place Glacier is now at the center of a growing effort to understand our changing cryosphere—the parts of the earth where water is primarily frozen, including alpine glaciers, ice sheets, and areas of permafrost and snow. Scientists from the Hakai Institute, the University of Northern British Columbia, GSC, and the province are working to understand and anticipate these types of floods known as glacier outburst floods, which often occur during late spring and summer.

New instruments, including “smart” ablation stakes—autonomous devices that take high-precision readings of snow and ice melt—were installed in June to deliver real-time data on melt rates and water depth in glacier lakes. The

team also installed new instruments to record water temperature and depth, both important measurements for predicting how much water can be released during these types of floods and when that might happen. The Hakai Institute's Airborne Coastal Observatory is also supplying data on the glacier's surface topography to help researchers assess how these types of lake basins grow and deepen through time.

Combining on-the-ground field work with satellite data from above, the Hakai Institute cryosphere team is improving predictions of when and how these outburst events occur. ■

Short Takes

A Secret History Beneath the Surface

Hakai Institute hydrographer Nick Viner pilots a remotely operated underwater vehicle to get footage of the lakebed, looking for further clues of past landslides.

On a summer day, Comox Lake is busy with recreational boaters and zooming jetskis, and little suggests that the area has a history of violent landslide events. But beneath the surface, buried in the mud of the lake, lies a surprising geological record.

Thanks to high-resolution lakebed surveys, researchers are uncovering a hidden history of underwater landslides, preserved in layers of sediment.

Hakai Institute hydrographer Nick Viner operates multibeam sonar for the survey, and also pilots a remotely operated underwater vehicle that takes footage of the lake bottom. “Once you see a big tree and it’s got that root ball still intact but broken, that lets us know this tree was ripped out and put here by something like a landslide,” says Viner.

Led by the Geological Survey of Canada under its Natural Hazards and Climate Change Geoscience Program, the project combines underwater mapping with seismic profiling to trace the scars of past disasters on both Comox Lake and Horne Lake on Vancouver Island.

Employing multibeam sonar, the Hakai Institute’s bathymetric surveys provided the first step, revealing a surprising number of underwater landslide features. These collapsed slopes, which may have been triggered by earthquakes, offer possible evidence of both recent and prehistoric events.

Some evidence is well known—like the Magnitude 7.3 earthquake in 1946 that triggered a landslide and wave on Comox Lake. But researchers suspect that much older events are preserved in deep layers of the lakebed.

The next step for researchers is to use sub-bottom acoustic profilers to look beneath the surface for buried landslide deposits, which could offer further signs of past seismic activity. Together, these technologies are painting a fuller picture of Vancouver Island’s geological past, and offering clues for preparing for its seismic future. ■

Short Takes

Dungeness Detection: Where Are All the Megalopae From?

No bigger than a pinky fingernail, Dungeness crab megalopae are larvae in the final swimming stage, just before they settle down to feed on the ocean floor—where they can grow to a shell width of over 20 centimeters.

Tiny Dungeness crab larvae drifting along British Columbia's coastline could hold clues to a bigger mystery surrounding their origins. The Sentinels of Change program, managed by Hakai Institute scientists along with local experts and community volunteers, uses light traps—plastic jugs equipped with LED lights—to attract and then count the tiny crabs, known as megalopae. Trap locations mainly span the Salish Sea from Seattle, Washington, to British Columbia's Quadra Island, with some outliers farther south and north.

Despite the broad geography of sampling, scientists still don't know whether the Dungeness megalopae turning up in their traps originate from distinct local crab populations or one superpopulation that spans the Salish Sea.

Are early-season larvae coming from different populations than those that show up later? And how far can these baby crabs travel? To answer these questions, researchers at the Hakai Institute will sequence the genomes of larvae collected from 10 locations across British Columbia—providing the first-ever genomic snapshot of Dungeness crab

population structure in the province.

While similar work in Washington State concluded that all crabs came from one giant population, the results from British Columbia's dynamic and diverse coastline might tell a different story. This work could have implications for how Fisheries and Oceans Canada and First Nations manage their crab fisheries, since conservation measures depend on understanding whether there's one stock—or many—to protect. ■

Short Takes

Snow Counts

Bill Floyd, a research hydrologist with the BC Ministry of Forests and an adjunct professor at Vancouver Island University, measures snowpack with a snow corer near the summit of Vancouver Island's Mount Arrowsmith in April 2021.

How much water is stored in snow? Bill Floyd, a research hydrologist with the BC Ministry of Forests and an adjunct professor at Vancouver Island University, is helping to answer that question with snow surveys across southern British Columbia. Working with the Hakai Institute's Airborne Coastal Observatory, University of Northern British Columbia, and local partners, Floyd's team at the Coastal Hydrology Research Lab translates raw measurements of snowpack into snow-water equivalent maps—a valuable addition to the watershed management toolbox.

The team has been collaborating with the Metro Vancouver, Nanaimo, and Comox Valley regional districts since 2020, expanding to additional watersheds as interest grows. Their approach combines on-the-ground data collection—for example, digging snow pits to measure depth and density—with aerial LiDAR surveys of the same areas. Together, these methods generate reliable estimates of how much water is stored in seasonal snowpack.

The data is especially important for water managers in this region where snowpack is highly variable due to warm winter temperatures that turn snow into rain. Peak snow volume can nearly double or halve from one year to the next, with watersheds becoming free of snow at entirely different times, depending on how warm the spring is. While Floyd notes that four or five years is too short to detect trends, the regional variability is striking.

As the climate shifts, turning snow data into clear, usable information about water supply is no longer a luxury—it's a necessity. ■

Short Takes

New Condos Set Up in Owen Bay—For Invertebrates

Autonomous Reef Monitoring Structures (ARMS) are a way to monitor the presence and development of invertebrates—such as coral, nudibranchs, barnacles, snails, and worms—using seafloor "condominiums" that are retrieved annually to see who moved in.

Autonomous Reef Monitoring Structures (ARMS) are stacks of PVC plates that mimic natural habitat. These artificial structures sit on the ocean floor and are designed to allow colonization by sessile organisms such as seaweeds and bryozoans, but also capture small mobile invertebrates such as crabs, snails, and limpets.

ARMS are used around the world for monitoring the biodiversity of seafloor and reef communities. They have more typically been deployed in tropical zones, but this project provides researchers in the Sentinels Alliance—a Hakai Institute initiative—a new way to study kelp forests and assess species composition in the temperate waters of the Salish Sea.

As part of a pilot study, 10 ARMS were placed in Owen Bay on Sonora Island, British Columbia. Five units were installed in kelp forests and five in adjacent urchin barrens, helping researchers to determine if this number of ARMS will be enough to capture the biodiversity of organisms when the project scales up. As the project expands, researchers will gain a more holistic understanding of kelp forest biodiversity in the region. ■



Short Takes

ELVIZ

MAKING BIG GEOSPATIAL DATA ACCESSIBLE

A Natural Resources Canada, GeoBC, and Hakai Institute Initiative

Featuring an array of high-precision data, including imagery, hillshade, slope, and elevation, ELVIZ goes beyond simply displaying the landscape—it unveils its transformations.

After a year of collaboration and hard work, the Hakai Institute’s geospatial team, in collaboration with Natural Resources Canada (NRCan) and GeoBC, is excited to introduce [ELVIZ.ca](https://elviz.ca). This new tool delivers complex geospatial information from LiDAR data and images from the Hakai Institute’s Airborne Coastal Observatory, helping users see change in Earth’s dynamic landscapes.

ELVIZ isn’t just a map—it’s a dynamic tool for exploring how landscapes change. High-res LiDAR data lets ELVIZ users track terrain shifts over time, compare past and present, and dive deep into the details—all from their browsers. ELVIZ is a prime example of the Hakai Institute’s data mobilization efforts in action. ■

Short Takes

Behind the Lens on an Island Bioblitz

Margot Hessing-Lewis and Isaak Haberman work on either side of Sandra Lindstrom, an adjunct professor at the University of British Columbia, to press unique seaweeds for long-term preservation and to allow detailed examination of their morphology and structure.

A [new photo essay by Hakai photographer Bennett Whitnell](#) takes readers to a marathon, three-week biodiversity survey on Quadra Island, British Columbia. Scientists and budding naturalists sift through mosses on the forest floor, clamber over seaweed-covered rocks, and dive into underwater worlds, unearthing the island's hidden marvels—from a glow-in-the-dark moss to a parasitic barnacle to a basket star straying far from its usual home in the deep sea. Bennett's visual journey captures the curiosity and camaraderie of a team united by the thrill of discovery, inviting readers to see the island's life in a whole new light. ■

Tula in the News



Scientists Discover the Cause of Sea Star Wasting Disease

After a challenging four-year investigation, researchers from the Hakai Institute, the University of British Columbia, the University of Washington, and the US Geological Survey's Western Fisheries Research Center have revealed the cause of sea star wasting disease (SSWD): a strain of the bacterium *Vibrio pectenicida*. This breakthrough finding has been covered by the [Associated Press](#), [bioGraphic](#), [Canadian Press](#), [Canada's National Observer](#), [CBC](#), [The Guardian](#), [the New York Times](#), [Science](#), [the Washington Post](#), and many more outlets around the world, including radio programs and TV stations. Congratulations to the Hakai Institute researchers involved with this groundbreaking work: Alyssa Gehman, Melanie Prentice, Carolyn Prentice, Colleen Kellogg, and Rute Clemente Carvalho!

Researchers Aim to Fill Data Gaps about Dungeness Crabs Amid Concerns of Declining Populations

The [CBC](#) highlights the Hakai Institute's 10-year Sentinels of Change research project that's investigating Dungeness crab populations from Prince Rupert, British Columbia, to Puget Sound, Washington.

Pacific Coast Tidal Wetlands Store Vast Amounts of Carbon, New Study Confirms

A collaborative cross-border study. Recent findings from Hakai Institute researchers Margot Hessing-Lewis and Carolyn Prentice that showcase the carbon-storing potential of tidal swamps in the Pacific Northwest were featured in a piece from the [Pew Charitable Trusts](#).

BC Glaciers are Disappearing at a Record Pace

Hakai Institute scientist and University of Northern British Columbia professor Brian Menounos recently led a global study revealing that glaciers in the western United States and Canada have lost nearly one-quarter of their volume since 2000—and 12 percent in just the past four years. This story was picked up by [The Tyee](#), [Canadian Press](#), and [Canada's National Observer](#), among others.

BC Sunflower Sea Stars are Now Endangered, but a Ray of Hope Remains

The Committee on the Status of Endangered Wildlife in Canada has assessed sunflower sea stars (*Pycnopodia helianthoides*) as endangered. An article by [Canada's National Observer](#) shows some rays of hope for sunflower sea stars if they're similarly assessed under Canada's Species at Risk Act, which could help with funding and recovery planning.

Can Kelp Forests Help Tackle Climate Change?

The first national assessment of Canada's kelp forests and their role as blue carbon sinks is based on a collaborative study involving Hakai Institute researchers. Read about the study in [The Conversation](#).

Clams on Canada's Broken Group Islands are Thriving

[Technology Networks](#) recently covered a new study led by Hakai Institute researcher Kristina Barclay. It examines how crab scars on clamshells in the Broken Group Islands of British Columbia demonstrate shellfish resilience and the sustainable relationship between Indigenous peoples and shellfish over millennia.

The BC Coast is a Story of Extremes

Our partners at Pacific DataStream—an open-access platform for sharing water quality data in the British Columbia and Yukon regions—recently wrote a [spotlight](#) on the Hakai Institute's groundbreaking work monitoring freshwater runoff along the BC coast. The piece demonstrates how this watershed data is helping to illuminate the region's complex land-sea connections.

The Tombolo in Bloom

Hakai Institute cofounders Christina Munck and Eric Peterson are profiled in the [Watershed Sentinel](#) for the institute's sustainable facilities, including greenhouses of fresh fruits, vegetables, and herbs.

Recent Publications

High sensitivity to ocean acidification in wild out-migrating juvenile Pacific salmon is not impacted by feeding success

Abstract excerpt:

Salmon populations are declining worldwide, with high mortality rates during juvenile marine migration presenting a bottleneck to recruitment. We investigated the combined effects of ocean acidification and food limitation on the survival, condition, and gene expression profiles of juvenile chum salmon (*Oncorhynchus keta*) to develop predictive biomarkers for CO₂ exposure and food deprivation.

Frommel, A.Y., Akbarzadeh, A., Chalifoux, V., Ming, T. J., Collicutt, B., Rolheiser, K., Opie, R., Miller, K. M., Brauner, C. J., & Hunt, B. P. V. (2025). High sensitivity to ocean acidification in wild out-migrating juvenile Pacific salmon is not impacted by feeding success. *Ecological Applications*, 35(5): e70058.

<https://doi.org/10.1002/eap.70058>

Merging coastal archaeology and conservation paleobiology to evaluate shellfish resilience to Indigenous harvest over the past 3000 years

Abstract excerpt:

Globally, shellfisheries are increasingly important for food, nutrition, and livelihoods. However, sustainable management of these fisheries is threatened by human activities, including climate change, overexploitation, and disruptions to natural ecosystems. Indigenous archaeological records of shellfish are ubiquitous but underutilized data sources that could expand and inform current management practices. Here, we merge paleobiological and archaeological methodologies to evaluate relative abundances of crabs and their clam prey over the past 3000 years on western Vancouver Island in the northeast Pacific.

Barclay, K. M., Baum, J. K., St. Claire, D., & McKechnie, I. (2025). Merging coastal archaeology and conservation paleobiology to evaluate shellfish resilience to Indigenous harvest over the past 3000 years. *Biological Conservation*, v.307.

<https://doi.org/10.1016/j.biocon.2025.111186>

Impact of CO₂-induced aquatic acidification on environmental DNA and RNA shedding and persistence

Abstract excerpt:

Anticipated future increases in CO₂ levels are predicted to have a diverse array of lethal and non-lethal effects on the marine ecosystem. While there has been extensive research on the physiological impacts of ocean acidification on marine species, our understanding of how increasing levels of carbon dioxide affect the shedding and decay of environmental DNA and RNA (eDNA and eRNA) in marine habitats is limited. In the present study, we conducted mesocosm experiments to determine the shedding and decay rate constants of eDNA and eRNA in *M. gigas* (*Magallana* [*Crassostrea*] *gigas*). To our knowledge, this is the first study manipulating seawater pH using CO₂.

Lopez, M. L. D., Rolheiser, K. C., Etzkorn J., Imbery, J. J., Lemay, M. A., Giménez, I., & Helbing, C. C. (2025). Impact of CO₂-induced aquatic acidification on environmental DNA and RNA shedding and persistence. *Environmental DNA*, 7(4), e70158.

<https://doi.org/10.1002/edn3.70158>

A blueprint for national assessments of the blue carbon capacity of kelp forests applied to Canada's coastline

Abstract excerpt:

Kelp forests offer substantial carbon fixation, with the potential to contribute to natural climate solutions (NCS). However, to be included in national NCS inventories, governments must first quantify the kelp-derived carbon stocks and fluxes leading to carbon sequestration. Here, we present a blueprint for assessing the national blue carbon capacity of kelp forests in which data synthesis and Bayesian hierarchical modeling enable estimates of kelp carbon production, storage, and export capacity from limited data.

McHenry, J., Okamoto, D. K., Filbee-Dexter, K., Krumhansl, K. A., MacGregor, K. A., Hessing-Lewis, M., Timmer, B., Archambault, P., Attridge, C. M., Cottier, D., Costa, M., Csordas, M., Johnson, L. E., Lessard, J., Mora-Soto, A., Metaxas, A., Neufeld, C. K., Pontier, O., Reshitnyk, L., Starko, S., Yakimishyn, J., & Baum, J. K. (2025). A blueprint for national assessments of the blue carbon capacity of kelp forests applied to Canada's coastline. *npj Ocean Sustainability* 4, 30.

<https://doi.org/10.1038/s44183-025-00125-6>

The Tsalwadi Site: late Pleistocene and early Holocene stone tool industries on the lower Woss River, Vancouver Island, Canada

Abstract excerpt:

The Tsalwadi Archaeology Site (EbSp-9) has components that date to the terminal Pleistocene and early Holocene. It is situated on relict terraces and scroll bars of the Woss River on north-central Vancouver Island, a productive salmon stream. Two discrete archaeological components have been identified at EbSp-9. Overall, stone tool detritus from both components is primarily early reduction stage materials. Expedient tools are also common. Evidence of salmon in the river dates to at least 14,000 years ago. Site usage may have been related to fishing, processing fish, creating fish camp infrastructure, and rendering stone tools from river rock.

McLaren, D., Dyck, A., Letham, B., Alfred, H., Fedje, D., Hebda, C. F. G., Abbott, C., Law, V., & Stafford, J. (2025). The Tsalwadi site: Late Pleistocene and early Holocene stone tool industries on the lower Woss River, Vancouver Island, Canada. *PaleoAmerica*, 1–21.

<https://doi.org/10.1080/20555563.2025.2510718>

Glaciers in western Canada-conterminous US and Switzerland experience unprecedented mass loss over the last four years (2021–2024)

Abstract excerpt:

Over the period 2021–2024, glaciers in Western Canada and the conterminous US (WCAN-US), and Switzerland respectively lost mass at rates of 22.2 ± 9.0 and 1.5 ± 0.3 Gt yr⁻¹ representing a twofold increase in mass loss compared to the period 2010–2020. High transient snow lines, and impurity loading due to wildfires (WCAN-US) or Saharan dust (Switzerland) darkened glaciers and thereby increased mass loss via greater absorbed shortwave radiation available for melt. This ice-albedo feedback will lead to continued high rates of thinning unless recently exposed dark ice and firn at high elevations is buried by seasonal snowfall.

Menounos, B., Huss, M., Marshall, S., Ednie, M., Florentine, C., & Hartl, L. (2025). Glaciers in western Canada-conterminous US and Switzerland experience unprecedented mass loss over the last four years (2021–2024). *Geophysical Research Letters*, 52(12),

<https://doi.org/10.1029/2025GL115235>

Beyond presence and absence: using eDNA and microsatellite genotyping to estimate densities of microscopic life forms in wild populations

Abstract excerpt:

Many challenges arise when monitoring organisms with cryptic life histories. For example, some cryptic life stages are hard to identify or sample due to their microscopic nature, which creates unknowns surrounding an organism's population dynamics. Environmental DNA (eDNA) is a non-invasive sampling technique used to monitor cryptic species when traditional survey methods are challenging. In this study, we present two complementary R packages that can be used to estimate the number of individuals in an eDNA sample.

Liggin, L. M., Rolheiser, K. C., Pontier, O., Ramírez-Ibaceta, B., Giménez, I. & Alberto, F. (2025). Beyond presence and absence: Using eDNA and microsatellite genotyping to estimate densities of microscopic life forms in wild populations. *Molecular Ecology Resources*, e14116.

<https://doi.org/10.1111/1755-0998.14116>

Sedimentary DNA metabarcoding and Indigenous knowledge reconstruct natural and anthropogenic disturbances to a freshwater lake in the oil sands region of Alberta, Canada

Abstract excerpt:

Sedimentary DNA (sedDNA) is crucial for reconstructing historical community compositions in aquatic ecosystems. In Cowpar Lake (Doghostú), Alberta, a significant landslide event in the early 1940s impacted the lake's geochemistry and fish populations, as documented by Indigenous knowledge from the Chipewyan Prairie First Nation and corroborated by targeted fish sedDNA analyses. The present study used genes for DNA metabarcoding of a sediment core from Cowpar Lake to assess the effect of the documented landslide and to reconstruct the historical community composition of eukaryotic functional trophic groups.

Lopez, M. L. D., Dersch, A., Drevnick, P., Clemente-Carvalho, R., Morien, E., Hebda, C. F. G., Ussery, E., McMaster, M. E., Lemay, M. A. & Helbing, C. C. (2025). Sedimentary DNA metabarcoding and Indigenous knowledge reconstruct natural and anthropogenic disturbances to a freshwater lake in the oil sands region of Alberta, Canada. *Environmental DNA*, 7(4), e70169.

<https://doi.org/10.1002/edn3.70169>

Vibrio pectenica strain FHCF-3 is a causative agent of sea star wasting disease

Abstract excerpt:

More than 10 years following the onset of the sea star wasting disease (SSWD) epidemic, affecting over 20 asteroid species from Mexico to Alaska, the causative agent has been elusive. SSWD killed billions of the most susceptible species, sunflower sea stars (*Pycnopodia helianthoides*), initiating a trophic cascade involving unchecked urchin population growth and the widespread loss of kelp forests. Identifying the causative agent underpins the development of recovery strategies. Sequencing of diseased sea star coelomic fluid samples from experiments and field outbreaks revealed a dominant proportion of reads assigned to the bacterium *Vibrio pectenica*.

Prentice, M. B., Crandall, G. A., Chan, A. M., Davis, K. M., Hershberger, P. K., Finke, J. F., Hodin, J., McCracken, A., Kellogg, C. T. E., Clemente-Carvalho, R. B. G., Prentice, C., Zhong, K. X., Harvell, C. D., Suttle, C. A. & Gehman, A. M. (2025). *Vibrio pectenica* strain FHCF-3 is a causative agent of sea star wasting disease. *Nature Ecology & Evolution*.

<https://doi.org/10.1038/s41559-025-02797-2>