SEA STAR

WASHINGTON SEA GRANT

Summer 2017

SHINING A LIGHT

Scientists are measuring how sediment impacts light availability in the water column at the mouth of the Elwha

By Niall Dunne

Unshackled from its two, large, century-old hydroelectric dams, the Elwha River, on the north side of the Olympic Peninsula, continues its speedy path towards natural recovery. The watershed has been transforming since the 2011–14 dam removals. New forests are sprouting up on now-exposed reservoir lakebeds, and adult Chinook salmon, sockeye salmon, steelhead and bull trout have all passed upstream through the former dam sites to re-colonize the upper reaches of the river.

Perhaps the most dramatic changes can be seen at the mouth of the river, where the coastal delta has substantially increased in size (by 72 acres by the end of 2014). The Elwha and Glines Canyon dams impounded an estimated 21 million cubic meters of sediment, and in the six years since dam demolition began roughly two-thirds of that sediment has been carried down the river. About 90 percent has made it all the way to the Salish Sea.

Prior to dam removal, the nearshore by the mouth of the Elwha was highly eroded and dominated by cobble. Now, the eroded shore has been replaced by a sandy beach, steadily nourished by a stream of sediment washing down from the mountains.

While a boon for local beachgoers, the initial release of enormous amounts of sediment from behind the dams had negative effects on some marine organisms. Surveys by USGS and WA DNR scientists show that kelp density near the river mouth decreased by 60 to 100 percent in the first two years after the 2011 removal of the Elwha Dam—most likely due to reduced light associated with elevated turbidity (suspended sediment) and the decrease of a rocky substrate for kelp to attach.

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UW researchers prep the tripod system for deployment on a UW boat at Ediz Hook, WA, 2015. Photo by E. Eidam.

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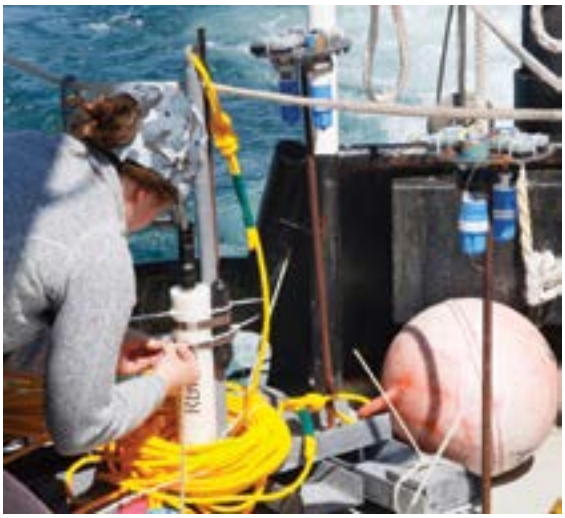

UW researcher Jenny Renee puts the finishing touches on a set of light mounts for deployment, May 2016. Photo by E. Eidam. Bottom right: Graduate student Hannah Glover. Photo by Mark D. Stone

Kelp rebounded in 2014 at some gravel-cobble sites outside the "sediment deposition zone," a relatively small area close to the river mouth where at least 10 centimeters of new sediment has accumulated. "We think turbidity had cleared up enough by then to allow for macroalgae growth," says USGS's Steve Rubin, who leads scuba surveys of the marine biota offshore of the Elwha River delta. "In the past few years, it appears that algae recovery has continued at gravel-cobble sites as turbidity has continued to decrease."

To get a better understanding of the interplay between the suspended sediment and light availability for kelp, Washington Sea Grant-funded scientists are conducting a two-year study at the mouth of the Elwha. Led by UW School of Oceanography's Andrea Ogston, Sea Grant's Ian Miller and USGS's Nancy Elder, the team is collaborating closely with other state and federal researchers.

Ogston's graduate students, Emily Eidam and Hannah Glover, are heavily involved with data collection and analysis. "We're using sensors mounted on small, steel platforms to look at properties of the water column," says Eidam, "primarily at the impacts of suspended fine-grained sediments on the availability of light for marine organisms, especially kelp."

"Fine-grained sediments eroding from the former dam reservoirs are creating a surface plume downstream at the mouth of the river that blocks a lot of the available light," continues Eidam. "The discharge varies a lot depending on the weather and seasons: On dry, sunny, summer days, the plume can look pretty clear; during extreme rainstorms, however … basically, the water looks like chocolate milk."

The team is using seven platforms, each one equipped with 10 sensors that measure light, photosynthetically active radiation, turbidity, temperature, salinity, wave energy, and water pressure. The platforms are deployed at about ten meters in different coastal sites near the mouth of the river, and they record continuous measurements of light reaching the seafloor for about two weeks at a time—at which point they're usually covered in algae and slime and must be retrieved.

The team is deploying the platforms four times per year to capture seasonal variability. They're also using a large tripod platform that stays underwater most of the year and measures everything the small platforms measure plus a few extra metrics, such as current speed.

"The sediment plume is tidally forced, and gets pushed around a lot when it reaches the sea," says Eidam. "The plume is very dynamic and changes location roughly every six hours. We're studying a range of sites on the coast so we can capture that variability."

"It's also important that we capture the light signal throughout the water column," says Glover, "not just at the surface. Only a small portion of the fine-grained sediment coming down the river settles on the sea bed. However, even after this has settled, it can still be active due to turbulence. Sediment can be re-suspended in a cloud near the bed, and this can affect biota."

After just one year of data collection, the researchers are already seeing results. "We now know that sediment is the dominant factor controlling light reaching the bottom of the water column, which is normal in shallow water around the Pacific Northwest and mountainous regions in general," says Glover. "Also, we're seeing definite seasonal patterns in the suspended sediments: Winter storms and spring snowmelt produce more turbidity in the water. And as might be expected, points closer to the river mouth are more impacted by the sediment."

Steve Rubin, Helen Berry (DNR), and Melissa Foley (USGS) have helped the team figure out the best spots to locate their sensors. They are also helping to deploy and recover the sensor platforms. "The collaborative effort will lead to a better understanding of how the system is rebounding from the initial disturbance," says Eidam. "And what the 'new normal' will be as sediment loads decrease over time."

AVOIDING A CLAM CALAMITY

Sea Grant researchers seek paths forward in local conflicts over geoduck farming

By Niall Dunne

With its long history of mining, forestry and fishing, the Pacific Northwest is no stranger to conflicts over natural resources. In recent years, one such conflict in and around the waters of southern Puget Sound is commercial geoduck clam aquaculture. Farming of the giant clam has steadily expanded in the region's privately owned tidelands since the mid-1990s, despite the opposition of some shoreline homeowners and conservationists concerned by its environmental impacts.

From 2007 to 2013, at the request of the State Legislature, Washington Sea Grant coordinated an intensive research program looking at the ecological effects of geoduck aquaculture, and it has continued to support related studies. To date, the results have found no serious ecosystem effects. A 2015 modeling study showed that the food web in the central Sound could support a doubling of current geoduck production levels, with only minor changes in individual species biomass or overall ecosystem resilience.

Recognizing that this research has done little to ease the concerns of some stakeholder groups, WSG has funded a two-year study examining the social and policy dimensions of the geoduck aquaculture conflict. The results, published in the journal "Coastal Management" in January[1], reveal a complex set of issues that include not only concerns about ecological sustainability, but also conflicting values and perceptions about shoreline aesthetics, the regulatory process and industry economics.

Resolving these broader controversies may be important for the long-term viability of the fishery. "Unless you have social understanding and acceptance of your activities, it can be difficult to move forward with them," says Clare Ryan, the study lead and a professor of natural resource policy in the UW School of Environmental and Forest Resources.

The farming process

In Puget Sound, intertidal geoduck aquaculture occurs on roughly 200 acres of mainly private and tribal tidelands. Farm sizes range from about a half-acre to five acres. Several government agencies are involved in the permitting process. Clams reach market size in five to seven years. At the beginning of the process, nursery-raised "seed" clams are placed in the sand and protected from predators such as crabs and birds using an array of PVC tubes draped with netting. The tubes and netting are removed after two years, when the geoducks are safely nestled underground. Harvesters use low-pressure water hoses to liquefy surrounding sediment and allow extraction of mature clams.

It's a profitable business. Geoducks fetch up to $25 per pound at the dock and up to $125 per pound on the Asian market, where about 95 percent of the harvest is exported. The farming gear, harvesting methods and the distribution of large profits are all points of contention in the geoduck conflict.

Interview concerns

For Ryan's study, UW graduate students conducted interviews with individuals representing a variety of viewpoints related to geoduck farming, as well as analyzing the decisions of state land-use hearing boards on challenges to geoduck aquaculture permits.

The students interviewed 23 key players in the conflict, including homeowners, shellfish industry representatives and representatives of environmental organizations and governments. Based on responses to a series of open-ended questions, the research team identified six main categories of concern: aesthetic, recreational, land-use, ecological, political/regulatory and economic.

Clam Calamity • continued on back page

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>
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Geoduck farms use netting to keep their gear in place.

1 Ryan CM, McDonald PS, Feinberg DS, Hall LW, Hamerly JG, Wright CW (2017) Digging deep: managing social and policy dimensions of geoduck aquaculture conflict in Puget Sound, Washington. Coastal Management 45(1): 73–89.

FIELD NOTES

With the WSG Crab Team's widely reported detection of the first invasive European green crab in Puget Sound last summer, the team has had record attendance at volunteer training sessions. WSG marine ecologist **Jeff Adams** says the team is expanding its network of monitoring sites by at least 50 percent. A new population of green crab appeared in April at Dungeness Spit with upwards of 75 crabs captured as part of the WSG Crab Team's early detection program. "As a result, our volunteer ranks have swelled to 100," says WSG Crab Team project coordinator **Emily Grason**. The Skagit Marine Resource Committee and the Swinomish Indian Tribal Community are contributing volunteers, site access and gear to aid the monitoring project.

Several years ago, the Paul G. Allen Family Foundation sponsored a $10,000 contest to inspire innovative approaches to combat ocean acidification (OA)—caused when human-generated carbon dioxide (CO_2) reacts with seawater to form carbonic acid. WSG OA specialist **Meg Chadsey** joined other local researchers to propose using fast-growing kelp to take up CO_2 (through photosynthesis) and keep it out of the water column. They received $1.5 million in funding to test the idea. At the Museum of History and Industry's Edible City Science Fair in Seattle last April, Meg took the message to the public where more than 200 visitors learned about the project and sampled kelp treats.

WSG hosted its 20th annual Orca Bowl at the UW on Feb. 25. Twenty teams representing 15 high schools from around Washington State participated in the daylong ocean-knowledge competition. About 85 volunteers—including UW faculty, staff and students—staffed the event.

Tacoma Science and Math Institute (SAMI) won for the first time and advanced to the National Ocean Sciences Bowl at Oregon State University. WSG education specialist **Maile Sullivan** said, "Students from Ellensburg, Soap Lake and Tacoma SAMI, who had originally come to watch the event, banded together to form a team of their own, which they dubbed 'El Soapy Tacoma' and even won one of the rounds!" Friday Harbor High School placed second and Tacoma School of the Arts finished third. Clallam Bay High won the Megan Vogel Sportsmanship Award.

A BIG SUMMER FOR SMAL

By Amy Brodbeck, WSG Communications Fellow

As the days get longer, more recreational boaters are out on the water—and Aaron Barnett is there to meet them. Barnett is Washington Sea Grant's Boating Program Specialist, and this summer he is kick-starting a campaign to reduce small oil spills in Washington.

In the coming months, he aims to distribute upwards of 2,000 free bilge pillows to recreational boaters. "Boaters are the first line of defense" in preventing spills, says Barnett, and his absorbent pillows are useful tools in the fight to protect water quality.

Bilge pillows strategically placed in the hull of a boat can prevent oily bilge water from reaching surrounding waters. Barnett recently redesigned the pillows for ease in use. To prevent corrosion, they no longer have any metal pieces, and he added a loop on one end so they can be tied off more easily below deck.

Why are small spills a big deal?

Tools like Barnett's pillows are cheap and easy to use but can make an enormous difference in the protection of fragile marine ecosystems. The Washington Department of Ecology reported that from 2011 to 2015, recreational boaters spilled almost 6,000 gallons of diesel and gasoline into Puget Sound and coastal waters. Most of these individual spills were small, amounting to less than one gallon each. These data reflect reported spills, but actual amounts are likely much higher.

Oil spills can have serious effects on marine ecosystems. According to NOAA's Office of Restoration and Response, diesel is one of the most acutely toxic oils—largely due to polycyclic aromatic hydrocarbons (PAHs), which are also present in gasoline. Scientists have found that exposure to PAHs can lead to developmental abnormalities, growth impairments and the suppression of immune system functions in a range of marine organisms.

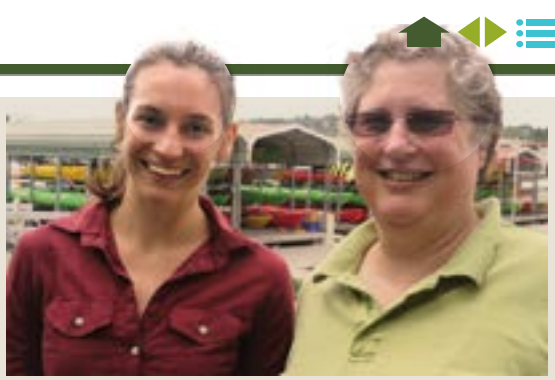
Marine Water Quality specialist **Teri King** organized two large events in early 2017. SoundToxins volunteers gathered in Port Orchard to share research findings from 2016 and plan for the year ahead. Each week, more than 65 volunteers monitor sampling sites in Puget Sound for harmful algae, helping ensure safe shellfish and a healthy fishery.

Teri hosted the 24th Conference for Shellfish Growers at the Alderbrook Resort. More than 150 attended presentations on harmful algal blooms, native bivalve ecology and forage-fish monitoring. Other sessions included: involving shellfish growers in assessment of aquaculture-related ecosystem services; Army Corps of Engineers aquaculture permitting; and juvenile oyster health monitoring.

Lyndsey Guild brings a passion for phytoplankton and marine ecosystems to her new position as WSG's research aide. She will work with Teri King on SoundToxins, which provides early warning of harmful algal blooms

in Puget Sound, and as an assistant to UW oceanographer Cheryl Greengrove. A life-long resident of Pierce County, Lyndsey has bachelor's degrees in environmental science and psychology from UW Tacoma. As a research technician, she has been on numerous research cruises throughout Puget and Clayoquot Sounds. When not in front of a microscope, Lyndsey can be found cooking good food and planning her next outdoor adventure.

Carrie Garrison-Laney is combining her passions — tsunami science, scientific communication and scientific education — in her position as Tsunami and Coastal Resilience Liaison/Environmental Outreach Specialist. Carrie's research as a graduate student included work on identifying and dating paleo-tsunami deposits in California and Washington, numerical modeling of tsunamis, and using intertidal diatom ecology to study past tsunami inundation events and sea level change. She also taught students in middle school through graduate level about tsunami deposits and earthquake hazards in Washington.



Samantha Larson joined WSG in May as the Science Writer, writing and editing technical and general content from federal reports to this newsletter. She also writes about science, the environment and outdoor adventure for local and national publications including *Crosscut*, *Grist*, and *National Geographic*. Samantha has a bachelor's and a master's degree in Earth Systems "oceans track" from Stanford University. Aside from writing, her life centers around things that get her outside. Her biggest claim to fame is she was once the youngest person to have climbed the highest mountain on each continent.

Karen Morrill-McClure joined WSG as the Computer Systems Administrator, providing IT support including client computers, servers and networking services. Previously, she taught information technology topics various colleges and universities and worked for Rockwell International, where she used computer models to analyze loads for the NASA space shuttle. Karen holds a bachelor's degree and master's degree, both in General Engineering from Harvey Mudd College. She enjoys scuba diving and women's soccer, and is an ardent fan of the Seattle Reign FC.

L OIL SPILLS PREVENTION

Where do humans fit into the equation?

Understanding human behavior may be useful to prevent or mitigate these spills. Last year, Barnett and the WSG communications team conducted a survey that assessed boaters' perceptions and practices. The results confirmed that Washington boaters understand the important role they play in preserving water quality, and they want to help.

Survey participants correctly identified oil spills as boating's main threat to the marine environment. Despite this knowledge, however, most boaters did not think that reporting a spill should be a necessary next step, and they admitted feeling fearful of the potential legal and financial repercussions.

This summer, Barnett aims to spread the word that reporting an oil spill is not only environmentally crucial, but also legally required. "It's better to report a spill yourself than for you to be reported by somebody else," Barnett notes. The bilge pillows he will distribute throughout the season will feature a new tag with phone numbers that boaters can use to report spills.

How to get involved

Barnett will bring his boating expertise and free bilge pillows to Puget Sound area marinas throughout the summer, so check your local marina's schedule or contact Barnett directly. He can be reached at *aaronb5@uw.edu* or 206.616.8929. Oil spills can be reported at 800.424.8802.

The Small Oil Spills Prevention Program is a partnership between Washington Sea Grant and the Washington Department of Ecology, with support from Washington's District 13 Coast Guard Auxiliary. It is part of the Clean Marina Program, a 20-year partnership between Puget Soundkeeper Alliance, the Northwest Marine Trade Association and Washington Sea Grant. For more information, visit wsg.washington.edu/community-outreach/boating.

GREEN SHORES FOR HOMES

WSG and its partners lead the way for waterfront dwellers trying to restore their shorelines.

By Niall Dunne

"People really like to get recognition for doing the right thing," says Washington Sea Grant coastal management expert Nicole Faghin. "When we want people to take action on their own, we try to use the carrot, not the stick. It's human nature. People respond better that way."

A Lake Washington residence before converting to a natural shoreline in the Green Shores for Homes project, Kirkland, WA, 2012. Photo by the Watershed Company.

That's the psychology behind green building certification programs like LEED (Leadership in Energy and Environmental Design), which recognizes water conservation, energy efficiency and emissions reductions in buildings. LEED gives homeowners practical benefits like permit concessions, higher sale prices and tax breaks. At the same time, they get to savor the satisfaction and bragging rights that come with being certified Silver, Gold or Platinum. Often that's enough, says Faghin: "People get to put up a nice plaque, and other people say, 'I want that too.'"

Thanks to Faghin and her Canadian colleagues, waterfront dwellers in Washington and British Columbia can enjoy the recognition, together with expert guidance and—in some cases—practical incentives for doing the right thing on their beaches as well as in their homes. In 2011, WSG and its partners started developing Green Shores for Homes (GSH), which awards LEED-style points for sustainable practices such as reducing impervious surfaces, treating water runoff, planting native riparian vegetation and removing or forgoing bulkheads. The last practice bestows a points bonanza.

An international collaboration

The idea of shoreline sustainability ratings originated in Canada with the nonprofit Stewardship Centre for British Columbia. The late 1990s and early 2000s spawned what its executive director D.G. Blair calls "the realization that we need to take care of our shorelines." Meanwhile, "LEED was just starting to gain traction." The Stewardship Centre convened a series of workshops on sustainability guidelines for various waterfront venues. "The story goes that the facilitators were stuck in traffic, talking about their work, when the idea arose—why not create a LEED for shorelines?"

The Stewardship Centre did just that. In 2010, it released its Coastal Development Rating System (CDRS), which awards LEED-style points for shoreline-protection practices. But CDRS focuses on large-scale development—parks, institutions and commercial and multi-family projects—rather than private homes. When the Canadians presented CDRS at the binational Salish Sea Conference, the Seattleites in attendance wondered, "Why not private dwellings?"

In Washington, says Faghin, "We realized that the biggest problem was with single-family homes and that homeowners were who we needed to target." Many government agencies and institutions were working to remove shoreline armoring. But anxious homeowners who lacked expertise and could be swayed by bulkhead-building contractors were still armoring about a mile of additional Puget Sound shoreline each year.

So, Washington Sea Grant, the City of Seattle and San Juan County worked together with Canadian partners, including the Stewardship Centre and the Islands Trust, to devise GSH.

"The funding came from the U.S. Environmental Protection Agency through its Puget Sound Watershed Management Assistance Program," says Faghin. "We hired a team of specialists who used the best available science to create the technical credits and points system for the program."

Homeowners earn points and a final rating in four main categories: shoreline physical processes, shoreline habitat, water quality and shoreline stewardship. The "Green Shores for Homes: Credits and Rating Guide," published on greenshoresforhomes.org, provides a detailed explanation of the rating system and application process.

Pilot properties

GSH is building momentum. Faghin and partners have so far certified four pilot properties in Washington and one in British Columbia. All projects have involved the removal of bulkheads and the restoration of a soft, natural shoreline.

For instance, a homeowner in a residential neighborhood on the east shore of Lake Washington removed 150 feet of bulkhead and a shoreline

gazebo, along with a lawn and ornamental shrubs that extended from the house to the bulkhead. They then re-sloped and revegetated the riparian area with native plantings and re-contoured the shore with a mix of cobble and gravel, adding a layer of spawning gravel to enhance shallow water habitat for salmon. Boulders and large woody debris were also added to the gravel beach to attenuate wave energy and add habitat complexity.

The homeowner earned a "Chinook" or level-1 rating, collecting points in all four rating categories. Paul Broadhurst, the landscape architect on the project, was excited by the opportunity to restore ecological connections between land and water.

"There is now a seamless progression from an ornamental landscape near the house to a much wilder, natural one at the living shoreline," says Broadhurst. "The homeowners value and enjoy this. They now think of their landscape as habitat."

Enthusiasm like Broadhurst's is also being felt north of the border, where a waterfront homeowner on Vancouver Island's Qualicum Bay recently became the first Canadian to complete the certification process, using the documentation developed here. Blair says that even though local codes didn't require the sustainable measures taken, the GSH documentation expedited the permit process. A high-density multifamily project in Victoria is now working on its certification, Blair adds, and local authorities are again proving receptive.

Kirkland: the first pilot community

In spring 2017, the City of Kirkland became the first jurisdiction in Washington to officially embrace the GSH program. Christian Geitz, a planner with Kirkland's Planning and Building Department, was initially drawn to the program when he volunteered as a verifier on one of the GSH's pilot properties.

"I quickly realized how well the goals of the program work with Kirkland's current codes and align with our Shoreline Master Plan for removing bulkheads and restoring natural, dynamic and active shores along Lake Washington," says Geitz. "I also like the idea of how the program will connect natural shorelines all the way from our lakes out to the marine environment."

As GSH's first pilot community, Kirkland will promote the program to homeowners, contractors and designers as a tool that works well with the city's existing code. It also offers private owners the chance for a beautiful shoreline with a beach they can walk on.

"Most shoreline homeowners think they need bulkheads to protect their homes—but in fact, if their homes are set back far enough from the water, they usually don't." says Geitz. "We show them plans, drawings and before-and-after photos of what's possible, and it's really nice to see that recognition take hold—the knowledge that they can have easier access to the water, while also creating a shoreline that's more aesthetically pleasing, beneficial to the environment and secure against erosion and flooding."

"Green Shores for Homes is a tool we can utilize as a talking point at the front counter in our planning office," Geitz adds. We tell folks about the website—plant the seed—and, as with green home projects, we can offer faster review times to designers and contractors who submit plans that incorporate the GSH rating system."

At this point, says Faghin, the GSH partners are still working to get the program tied into a tax-credit system or a low-interest loan program for property improvements. But even without this in place, the program offers plenty of incentives. Already, homeowners greening their shores can enjoy improved access to the beach, impress neighbors with their GSH accolades, benefit from a smoother route at the permit counter and, best of all, track the recovery of their shoreline habitat.

Homeowners earn points and a final rating in four main categories: shoreline physical processes, shoreline habitat, water quality and shoreline stewardship.

The Lake Washington residence after converting to a natural shoreline, 2014.

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Opinions varied widely. Regarding aesthetics, for example, some homeowners complained about garbage spreading from farm sites to public and private beaches and about noise and light pollution from harvesting operations. They also objected to seeing dense rows of upright PVC piping studding beaches. Other respondents, however, felt that the visual impacts of the aquaculture were minimal.

Politically, some respondents felt that the geoduck industry was over-supported by government agencies, while others maintained that the current labyrinth of regulations was not conducive to industry growth.

Ecologically, some respondents claimed that previous scientific research was biased by its funding sources. Others had doubts about the small temporal and spatial scale of the research. Yet other respondents felt the research was quite reliable and properly conducted.

Economically, some commented positively about potential job growth, while others felt that the jobs would be low in quality and number. Some expressed concern about profits going overseas rather than staying in the local economy.

"Many of the drivers underlying the conflict are common to natural resource disputes," says Ryan, "in particular, the uncertainty about information, lack of trust among stakeholders and the clash of values that takes place when people attach different meanings to—and form different bonds with—natural settings."

Hearing board decisions

To understand the policy issues, Ryan and her team analyzed nine state hearing board permitting decisions that took place from 2010 to 2015. The concerns expressed in the hearings reflected those from the interviews: mainly, the ecological, aesthetic and recreational effects of the industry. None of the petitions resulted in the cancellation of a permit.

"In some cases, the issues may be solvable by neighbors just being good neighbors—for instance by farmers giving residents advance notice of upcoming harvesting operations," says Ryan. But she also says that the hearing board system may not be addressing some of the fundamental drivers of the conflict.

Suggested strategies

Ryan and her colleagues and students developed three strategies that could help build trust among stakeholders: practicing and publicizing aquaculture best-management practices; incorporating "best available science" more explicitly into the permitting process; and joint fact-finding, in which stakeholders work together to collect data, analyze facts and come to shared decisions.

"Despite all the challenges revealed by the study, we did the study to see if there was any common ground among the stakeholders," says Ryan. "And I think we did find some. Many folks we interviewed stated that Puget Sound has a beauty and pristine quality that should be preserved regardless of how the shorelines are used—and that seems like something to be hopeful about."