SEA STAR

WASHINGTON SEA GRANT

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IDEAS BLOOM IN THE SQUAXIN ISLAND TRIBAL GARDEN

How WSG social science research helped catalyze a budding community space

Aleta Poste stands at the center of the medicinal garden, a small circular patch laden with symbolism. Seven plant beds ring around her, one each for the bands of the Squaxin Island Tribe. Two paths cut the plot into four equal sections, in keeping with the g^{w}*ədᶻadad* teachings of Poste's ancestors, which honor the four directions, four seasons and four stages of life. The paths are laid with oyster shells: "This represents the connection between the land and the sea," explains Poste, a Squaxin Island member and manager of the Squaxin Island Tribal Garden.

This deep land-sea connection initially led Melissa Poe, lead social scientist at WSG and liaison with NOAA's Northwest Fisheries Science Center, to work with the Squaxin Island Tribe. The research began by exploring the cultural importance of the tribe's shellfish harvesting. Later, Poe and her Squaxin Island tribal collaborators looked at how such practices could be affected by environmental changes, including ocean acidification. Some of the marine-themed questions about well-being that Poe's projects raised, however, helped tribal members hone in on a land-based vision: the Squaxin Island community garden.

The Squaxin Island Tribe comprises Coast Salish indigenous clans that have lived in the seven southernmost watersheds of Puget Sound for thousands of years, in an area surrounding the modern-day cities of Olympia and Shelton. From salmon spawning grounds to geoduck beds, their ancestral territory was abundant in marine resources. Rights to the land and resources located in their traditional harvesting grounds are reserved for the tribe through the Medicine Creek Treaty of 1854. These resources are essential to their nourishment and to their culture. As Poste says, "We are the people of the water."

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Above: Squaxin Island Tribal Garden manager Aleta Poste shows off a tomato.

Below: Traditional shellfish harvesting grounds of the Squaxin Island Tribe.

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In 2013, Poe and Jamie Donatuto, an environmental health analyst with the Swinomish Indian Tribal Community, began to research the importance of the shellfish resources to the Squaxin Island tribal community's sense of place and identity. Many Squaxin Island members expressed how formative it had been to grow up harvesting shellfish along the shore, knowing that they were doing the same activity and eating the same food that their ancestors had for generations. "The research confirmed an understanding of the intricate connection between marine resources and multiple dimensions of well-being," Poe says. "It became clear that shellfish and traditional foods are fundamental to community expression, relationships and identity — to who they are as a people. At the same time, we know that shellfish are highly vulnerable to ocean acidification."

The research raised another important question: What could environmental change mean for the future well-being of the tribe? Seeking answers, Poe, Donatuto and WSG's newest social scientist, Melissa Watkinson, teamed up with Squaxin colleagues Charlene Krise, Aleta Poste, Casey Brown and Candace Penn to conduct community-based research within the Squaxin Island Tribe. Funding was provided by WSG, the NIH National Library of Medicine and NOAA's Integrated Ecosystem Assessment Program.

First, the researchers defined health and well-being from the community's perspective. Then, they assessed how this well-being could be diminished in the future by ocean change.

Using social science techniques, including ethnographic interviews, grounded theory-based analysis and community verification, the researchers arrived at seven indicators to describe health and well-being within the Squaxin Island tribal community: physical health, community connections, natural resource security, cultural use and practice, education, self-determination and resilience.

In subsequent workshop-format surveys on how these indicators could be affected by future ocean change, they found physical health, cultural use and practice, and community connections to be most vulnerable — particularly owing to the expected changes to the tribe's food practices, such as gathering shellfish.

The research sparked conversations within the tribe on how to buffer impacts to some of the cultural practices and well-being benefits that are associated with their traditional foods. The idea that came up repeatedly was to establish a community garden. Such a garden could reinforce physical health by providing fresh, organic fruits and vegetables. It could provide refuge for cultural practices by being a place to grow and learn about traditional medicines and traditional ways of preparing foods. It could strengthen social connections by being a gathering space to share stories, give gifts and hold celebrations.

"We wanted to take care of the community's idea of having a community food space again," Poste says. That vision is now a reality. The Squaxin Island Tribal Garden was built, planted and harvested in 2016 and has continued to grow fruits, vegetables and medicinal plants. Community members can pick up produce at the weekly farm stand, and the remaining harvest goes to the tribe's elder center. The garden also hosts classes on topics like cooking, jam-making and medicinal practices. "We are educating and reaffirming the knowledge that exists here in the tribe — and giving people the space to share in it again," Poste says.

The garden is also a space where the community can gather and be together. "In our daily lives, we're governed by the clock. You're forced into a timeframe," Poste says. "But when we're out harvesting, it feels like time is infinite. You're able to have those conversations you might not otherwise have, to make time for those stories that take a little longer. I always think of that phrase, 'time immemorial' — that's huge," she continues. "I like to think of this garden as my medicine."

Melissa Poe and Aleta Poste in the Squaxin Island Tribal Garden.

RESEARCHERS DOCUMENT SALMON DIVERSITY USING ANCIENT DNA

WSU scientists invent novel techniques to tackle a challenging question of genetic history

By Max Showalter, WSG Science Communications Fellow

Northwestern rivers like the Columbia and Snake were once brimming with salmon, but decades of overfishing and environmental change have dramatically reduced or wiped out populations. Today, the only remnants of these populations are scattered patches of ancient bones. Ancient bones that could share secrets of the past — if only someone could make them talk.

Bobbi Johnson, who recently completed her doctorate at Washington State University, is just the person to get these bones talking. With her advisor Gary Thorgaard and colleague Brian Kemp, Johnson has used genetic sequencing to investigate the question, has the dramatic loss of Chinook salmon also led to reduced genetic diversity?

"We know that salmon in the Columbia River have experienced massive losses in population size," Johnson explains. "We assumed this meant there were also losses in genetic diversity. However, we had never been able to test or quantify it. This project did that."

By using novel techniques, Johnson and colleagues compared genetic sequences of modern salmon with DNA taken from 7,000-year-old samples. Their results show that genetic diversity among Chinook salmon in Northwestern river basins has dramatically decreased. The study, now published in the journal *PLOS ONE*, reveals the impact that centuries of environmental change has had — with real consequences for modern fish stocks.

Genetic diversity is a measure of the characteristics in a population's genetic makeup. Like tools on a tool belt, genetic characteristics may serve specialized functions that work best in certain contexts. Many traits in a population allow the fish to succeed in changing environments. "All environments change, so diversity is a way to hedge your bets against the inevitable," Johnson says. When a population declines, the genetic diversity decreases and the ability of the population to adapt to change decreases also.

Comparing the genetic diversity from before and after the population decline requires DNA from both periods. While finding DNA from modern salmon is easy, it's not so straightforward for bygone fish. To find the ancient DNA, or aDNA for short, Johnson and her colleagues dug through an ancient trash dump, known as a midden, looking for salmon bones that had been discarded by indigenous people. The team worked with government, academic and tribal researchers to acquire 346 fish vertebrae for DNA analysis to compare with 366 modern samples.

The scientific challenges didn't end there given that DNA can degrade a lot over 7,000 years. "Things like moisture, heat and the sun are really hard on genetic material," Johnson explains. To get around this, the group developed a novel method called rescue PCR (short for polymerase chain reaction). In traditional genetic sequencing, PCR increases DNA concentrations by taking short snippets and then growing them. But with degraded DNA, there might not be enough genetic material to do this through conventional means. Rescue PCR increases the concentrations of the reagents needed to grow the DNA, enhancing the chances of success.

As it turned out, the rescue PCR technique worked — and yielded surprising results. The group found that nearly two-thirds of the genetic diversity from the ancient samples was lost in today's Columbia River Basin stocks. This is more than the losses found in other river basins in Washington, Oregon and Idaho. Given that the rivers are very similar environments, Johnson says this result was unexpected.

The team also asked whether patterns of diversity loss might leave clues about historical climate events or more contemporary dam placements, but no strong correlations were found. This was in part due to lack of available samples from relevant time periods.

In the future, the team hopes to conduct similar experiments in other regions. "Right now, one area we're looking at is California. Looking at salmon in a different area with a different history can help us understand this study better," Johnson says.

While the team's work highlights the genetic differences between ancient and modern salmon stocks, Johnson and colleagues emphasize their results don't indicate the fish's genetic suitability to its current environment, as previous research suggests today's salmon populations are highly adapted to their home rivers. So make no bones about it — in the Pacific Northwest today, the Chinook salmon is still king.

Researcher Bobbi Johnson. Photo by Washington State University.

Johnson prepares DNA samples for analysis. Photo by Lindsay Hilldorfer.

The tooth of a Chinook salmon. Photo by Bobbi Johnson.

A SMALL OYSTER POISE

Above spread: Researchers look at Olympia oysters in Puget Sound. Photo courtesy of Bonnie Becker.

Above: Olympia oyster (*Ostrea lurida*), actual size.

By Max Showalter, WSG Science Communications Fellow

The Olympia oyster — or "Oly" — may be small, but it has played a big role in Washington's history and culture. As the only oyster native to the region, the Oly once covered vast swaths of the state's shorelines, and was nutritionally, economically and culturally crucial to indigenous populations for thousands of years. But after Europeans arrived, overfishing and industrial pollution caused the Oly to rapidly decline.

"The story of the Olympia oyster has been almost forgotten," says Bonnie Becker, associate professor of marine ecology at the University of Washington (UW) Tacoma. "When people ask, 'why should we restore Olympia oysters?' there are some strong ecological reasons, but also historical, social and cultural reasons why [restoration] is so important."

Efforts to restore the iconic species are underway, but the task remains daunting. Modern populations are scattered throughout the Sound and number only five percent of historical levels. Both Becker and UW researcher Steven Roberts are leading separate WSG-funded projects to help overcome the challenges associated with low, disconnected oyster populations. They hope to inform restoration efforts by tracking where oysters move and how they might adapt to various conditions.

Restoration from populations

Oyster restoration can be either passive or active. In passive restoration, ecosystem managers encourage larval oysters to settle in new locations by making the seafloor more desirable. In active restoration, oysters are reared indoors and then transplanted to new parts of the Sound.

To ensure successful active restoration, managers must know which oysters do best under a given set of conditions. For the Oly, that means finding out whether certain populations of oysters are particularly adapted to where they live in the Sound.

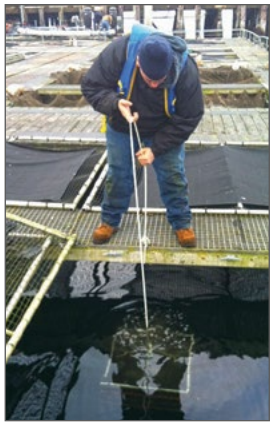
Roberts hopes to answer this question by moving oyster populations from one natural bed and rearing them under the conditions of another. The team is looking for *adaptive differentiation* among Olympias — changes in the oysters' tolerance to environmental conditions.

"The populations in one embayment might be adapted to warmer temps," explains Brent Vadopalas, a UW research scientist with the Roberts

D FOR A BIG COMEBACK

Washington Sea Grant research advances Olympia oyster restoration efforts

Left: Olys are deployed for a reciprocal transplant experiment. Photo courtesy of Steven Roberts.



Above top: A basket of Olys is prepared in the lab. Photo courtesy of Bonnie Becker.

Above: A basket of Olys is repositioned in the water. Photo courtesy of Steven Roberts.

team. "If you put another population, from a colder environment, in the same embayment, it might not reproduce as well."

The team sought location-specific differences in oysters from Fidalgo Bay, Hood Canal and South Sound. They saw unexpected results. Although Puget Sound is a small and fairly well-connected place, oysters showed local adaptation, suggesting that populations might not be interacting as much as expected.

"The rate of maturation and the spawn time took us by surprise," Roberts says. "Irrespective of where they were put, the South Sound oysters spawned earlier by about two weeks." But the team has some theories about what causes such differences.

Larvae on the move

Why might the Olympia oyster demonstrate local adaptation over such a small spatial scale? One possible answer is limited population connectivity.

Population connectivity measures how often geographically distinct populations interact. For oysters, that means learning how larvae are dispersed and where they settle. "Usually oysters like to settle on other oysters," says Becker, who investigates patterns of larval movement and settling that drive passive restoration. Understanding such patterns can help resource managers determine where to initiate passive restoration.

Becker, along with graduate student Megan Hintz and collaborators, use the chemical makeup of Olympia shells to learn where a particular larva has been over its lifetime. This process is simplified by the Oly's unique reproduction method. While most marine bivalves release their eggs to be fertilized within the water column, Oly parents retain their eggs through early larval stages until they reach a certain maturation milestone. This trait, known as brooding, means it's easier to pinpoint a location where the larva grew up.

"While the early larva is being brooded inside its mom, its shell is forming. That shell has elements incorporated into it in some proportion to what's in the environment," Becker says. This proportion of elements, measured by a technique called elemental fingerprinting, reflects the conditions under which the shell is formed, giving hints to its location. "It's like a little flight recorder of where that larva has been."

Olympia oysters • continued on last page

FIELD NOTES

WSG Coastal Hazards Specialist Ian Miller co-authored a new paper on how sediment from the Elwha dam removal projects affected nearshore marine ecosystems near the mouth of the Elwha River. The study, published in the journal *PLOS ONE*, sifted through eight years of data collected before, during and after the dam removals. The researchers found that while there were no significant overall changes in the invertebrate fish communities, kelp abundances markedly decreased. However, more recent surveys suggest that kelp has already begun to rebound.

In early March, members of the Washington shellfish community gathered in Union, Washington, for the 25th annual Conference for Shellfish Growers. Organized by WSG's Marine Water Quality Specialist Teri King, the event drew record attendance and provided an effective opportunity for information sharing between community and industry partners. Discussions ranged from shellfish disease and environmental stressors to farming technology and drones. Following on the heels of the conference was the 110th annual meeting of the National Shellfisheries Association, held in downtown Seattle in late March, with over 300 presentations and attendees from around the United States. King made a presentation and WSG staff shared a table with the California and Oregon Sea Grant programs. One highlight was the Chinese Dinner hosted by researcher Ken Chew in the International District.

WSG welcomes Melissa Watkinson as a new social scientist. Watkinson is a Pacific Northwest native and a citizen of the Chickasaw Nation. She has a master's degree from UW Bothell, where she worked with the Quinault Nation to understand how historical land policies impact the capacity of coastal tribes to adapt to climate change. As a graduate student, Watkinson worked with WSG on developing social indicators for the Washington Marine Spatial Plan and on a study on the socio-cultural dimensions of ocean acidification. In 2016, she completed a Washington Sea Grant (Hershman) State Fellowship at The Nature Conservancy.

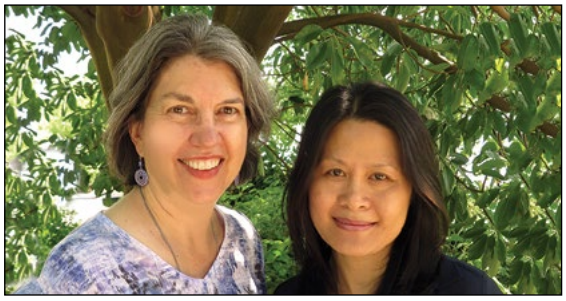
Melissa Poe, social scientist at WSG, recently co-authored a paper with the Social Well-being Indicators for Marine Management (SWIMM) working group. SWIMM was launched in winter 2014 with support from WSG and the NOAA Northwest Fisheries Science Center (NWFSC) to better understand and improve human well-being as a goal of ecosystem-based management. The international group includes 16 scientists with expertise in relevant fields such as anthropology, political science and ecology. The paper, published in the journal *Ecosystem Health and Sustainability*, presents a new framework to help decision-makers consider how people are affected by changes in the natural environment and by different management strategies.

WSG Director Penny Dalton Retires

This spring we bid farewell to Penny Dalton, our director of 13 years. Dalton is retiring to Portland, Oregon, joining her family.

Dalton came to WSG in 2005, leading with a deft hand, expanding the program into emerging areas of marine research and outreach — from ocean acidification and aquaculture to coastal resilience and workforce development. During her tenure, she nurtured new partnerships and developed new sources of funding for WSG. A former Knauss Fellow, she understood the value of fellowships. She oversaw six fellowship programs and helped pave the way for a new generation of marine policy experts, much like herself.

Dalton fostered WSG's ability to provide researchers, government managers and planners, coastal residents and businesses with the programs and tools needed to make decisions that protect and conserve the marine environment and its resources. We wish her well!



Eileen Herman and Trinh Vo

WSG Administrative Assistant Eileen Herman and Grant and Fiscal Officer Trinh Vo were honored at the UW College of the Environment Spring Celebration for their work on the new HR system. They each received the Distinguished Staff Member Award. Congratulations!

Left to right: Melissa Watkinson, Meg Chadsey and Melissa Poe

WSG staff Melissa Poe, Melissa Watkinson and Meg Chadsey, along with researchers from UW Applied Physics Laboratory and JISAO, were awarded a $700,000 grant from the NOAA Ocean Acidification Program to study of the ecological and cultural impacts of ocean acidification on Pacific Northwest coastal communities. Trends in biological and chemical data collected from the Olympic Coast National Marine Sanctuary will be used to project how tribal communities will be affected by ocean acidification.

The spread of native burrowing shrimp threatens use of some prime oyster-growing land: the shrimp soften the ground, making it impossible for oysters to grow, a particular problem in Washington's Willapa Bay area. Now WSG, with Assistant Director for Outreach Paul Dye as project lead, has received $200,000 from state funders to conduct a three-year study to identify best management practices that optimize the value of shellfish farms and preserve their availability as habitat for other species. WSG will work with the Washington Department of Natural Resources (DNR), local oyster growers and many other partners.

Orca Bowl

More than 100 aspiring marine scientists descended upon the UW Fishery Sciences Building to participate in the 21st annual Orca Bowl competition on February 24. Thanks to WSG Education Specialist Maile Sullivan and UW staff, student and faculty volunteers, 20 teams from Washington high schools competed for a chance to move on to the National Ocean Sciences Bowl (NOSB) competition. Newport High School from Bellevue came out on top and moved on to the NOSB Finals in Boulder, Colo. in April. They did exceptionally well, placing fifth overall and receiving the prestigious James D. Watkins Sportsmanship Award. Team Captain Peyton Lee also won the Best in Competition Award for his oral testimony in the Science Expert Briefing.

THE FACES OF WASHINGTON SEA GRANT'S WORKSHOPS

Meet the instructors behind the First Aid at Sea, Marine Wiring and Corrosion, and Diesel Engine Troubleshooting and Maintenance courses

By Max Showalter, WSG Science Communications Fellow

Training is a core mission of Washington Sea Grant. Spearheaded by Marine Operations Specialist Sarah Fisken, the organization offers nearly 20 classes and workshops a year for commercial fishermen and recreational boaters alike. These courses span a wide range of boating basics — and their instructors come from diverse personal backgrounds and experience. WSG instructors Art Cole, Kevin Ritz and Walt Trisdale share stories of what brought them into the classroom and how their individual expertise helps shape their teaching.

Art Cole, First Aid at Sea

Art Cole has spent nearly a decade saving lives in Washington's boating communities. As an instructor for the First Aid at Sea workshops, Cole teaches the basics of how to quickly and effectively assess and act on trauma and injuries shipboard. "The goal is to teach people how to stabilize the patient as best as they can with the tools and training they have," Cole says.

Cole, who is a fire chief and paramedic, focuses on teaching his students to take control of the first 20 minutes after an accident or injury occurs on board a vessel, which increases the chances of survival until help can arrive. In his time teaching for WSG, Cole has given this lesson to thousands of fisherman and recreational boaters.

Complacency, Cole says, is the biggest challenge he faces as a teacher. He suggests regular coursework in first aid, even if you've taken a class before. After all, one day of instruction could save a life.

Kevin Ritz, Marine Wiring and Corrosion

For Kevin Ritz, teaching marine electricity and wiring has a personal motivation. Ritz lost his son, Lucas, eighteen years ago to electrocution.

"He was electrocuted by a boat in the water, even though he was touching absolutely nothing. I decided I needed to do my best to prevent this from happening again," Ritz says.

Ritz educated himself on every aspect of marine electricity, eventually starting his own marine wiring company. Today, he teaches Marine Electrical Wiring workshops for WSG. "The most rewarding part of teaching is seeing the light bulb coming on, so to speak, when somebody suddenly starts getting some basic understanding of electricity," Ritz says.

Ritz focuses the one-day workshops on the basics, as well as projects that class participants want to tackle on their own boats. But if there's any one thing to learn about marine wiring, Ritz says, it's knowing when to call in an expert.

"The biggest takeaway for students of the class is how to do this safely, and knowing when they should be doing it or bringing in a professional." Electricity can be dangerous, but through his classes Ritz hopes to turn fear into mastery and respect.

Walt Trisdale, Diesel Engine

While many of his high school friends went on to work as car mechanics, Walt Trisdale wanted to do something a little different. Trisdale landed in Port Townsend as a marine diesel mechanic in 1994, where a love for boats grew into a full-time position at the Northwest School of Wooden Boatbuilding (NWSWB). Now, he's also an instructor for WSG's diesel engine troubleshooting and maintenance workshops.

To help with the challenge of teaching to both commercial and recreational boaters, Trisdale always incorporates a show-and-tell element. Regardless of the type of ship, he says, the principles of diesel engines are the same and boil down to two key points: "Understanding your fuel systems is absolutely the number one thing to remember. A close second would be maintenance. Neglected items could kill your engine."

Trisdale is also a welder machinist; he says that to be a diesel mechanic is to possess many diverse skills. Fortunately for his students, one of those skills is a penchant for teaching.

> "It's really beneficial for people in the diesel engine class to see the different systems and how they connect."
>
> Instructor Walt Trisdale

Walt Trisdale (far right) instructs a diesel engine class.

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Becker explains that so far, the elemental fingerprinting approach has been a success in Puget Sound on a regional level. "Determining if oysters are from North Sound, Central Sound or the Strait of Juan de Fuca using the shell chemistry appears to be working," Becker says. "Having an empirically proven understanding of how far oysters are dispersing will be a great success."

A bright future for Oly?

What will success look like for this team of scientists studying the Olympia oyster? The best outcome for their work is to provide resource managers and organizations focused on bringing back the small oyster with a better restoration toolset.

"We wanted to inform managers regarding what meaningful stock structure exists in Puget Sound, and we wanted to inform restoration practitioners about which populations they should use," Vadopalas says. "These important restoration decisions are ultimately up to resource managers."

A success for the Oly is a success for the region, Becker adds. "Having healthy oyster populations is important to how the Sound is functioning."

As the Olympia oyster shows, good things do come in small packages.

Oysters are muddy business. Photo courtesy of Steven Roberts.