

WASHINGTON SEA GRANT

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UNDER HIGH WATER

Washington Sea Grant helps citizens and coastal planners understand what sea-level rise means for their communities

sisit Seattle's Golden Gardens park on a sunny summer day, and you're likely to find a crowd of happy-go-lucky locals playing on the beach and enjoying the spectacular views of Puget Sound and the Olympic Mountains beyond. Thanks to climate change, such idyllic days are under threat. As the Earth continues to warm, the ice sheets will continue to melt and the water that makes up the ocean will continue to expand—and the seas will continue to rise. Which means that Golden Gardens, along with many other culturally and economically important areas in Washington, could one day be under water. As part of the Washington Coastal Resilience Project (WCRP)—a three-year effort funded by the National Oceanic and Atmospheric Administration in 2016—Washington Sea Grant and the University of Washington's Climate Impacts Group led an effort to provide the most detailed picture yet of what sea-level rise could mean for Washington State. Released last summer, the report includes projections for 171 coastal sites from now through 2050. The report provides estimates of the possible ranges of future water levels for each site, with the goal of helping planners and decision makers weigh the risks of sea-level rise under different climate scenarios.

If we manage to limit future greenhouse gas emissions, the report's best estimate for sea-level rise by 2100 is about 1.5 feet. However, due to uncertainty about the various processes that contribute to sea-level change, even under this optimistic emissions scenario seas could rise

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lan Miller, coastal hazards specialist at Washington Sea Grant

by more than seven feet. These projections threaten much more than Washingtonian's leisure time at the beach: the state has more than 3,000 miles of coastline, and more than 400 square miles of land at an elevation within three feet of the high tide line. These areas are already susceptible to flooding and wave damage from winter storms, and will only become more so as the high-tide line rises. Important infrastructure and about 9,000 homes worth more than \$5.25 billion in total have been built in these vulnerable areas.

However, not all of these areas will be impacted equally. Understanding these site-to-site differences is the first step in enabling communities to adapt to their changing shorelines. At the same time the sea is changing elevation, so is the land—but the nature of this land movement varies. In some areas, such as Neah Bay, the local geology results in the land rising, while in other areas, such as south Puget Sound, the land is sinking. These variations in land motion influence how sea-level change affects a community—a community on land that is uplifting will experience slower rates of sea-level rise than a community on land that is subsiding.

Incorporating land movement—and being able to say how much sea-level rise will be felt at a specific location—makes the report's findings especially useful to coastal planners. The localized projections are publicly available on the WCRP website and can be easily accessed using an embedded Google map through which anyone can download estimates for a particular location.

"One of the things we've heard from the planners we have shown it to so far is 'Hey, for the first time we have something that we feel is actionable," says Ian Miller, a coastal hazards specialist at Washington Sea Grant and lead author on the report. "I hope we're going to hear that more, and that these projections will find their way into planning processes at the community scale." The projections could help communities make decisions such as prioritizing the infrastructure that could find itself under high water. "There are two factors that determine what steps a community might take to adapt, and both really need to be decided at the local level," explains co-author Guillaume Mauger, a research scientist at the Climate Impacts Group. "First, what is the context: is it a hospital or other piece of critical infrastructure or is it a park? That's your risk tolerance. And second, what is your value judgment of the amount of risk that's acceptable?"

WCRP is working with pilot communities to help local governments meet these local needs. For example, MetroParks Tacoma used the projections to help design a waterfront park, including where to position important infrastructure that could be vulnerable to flooding. The Washington Department of Transportation has already used the projections, for example, to help design portions of State Route 167.

Preparing for sea-level rise will undoubtedly continue to be a difficult process—but the more information that can be used to help guide these decisions, the better. Washington Sea Grant has remained a leader in this conversation: for example, Nicole Faghin, coastal management specialist, held workshops in November and February to help coastal planners understand the projections detailed in the report. The workshops were filled to capacity, attended by coastal planners, resource managers, public works staff, parks department staff, tribal representatives, conservation district staff, and private consultants working with all of these agencies' staff on projects and plans related to our shorelines.

"People want to learn about the latest science and how to apply it in their daily work," Faghin says. In spite of the many challenges ahead, the response from local communities gives us hope that we will make progress toward addressing them.



ACRES OF COLLABORATION AT THE 26TH ANNUAL SHELLFISH GROWERS CONFERENCE

Bringing together growers and researchers to sustain and further aquaculture in Washington

By Andrew Chin, WSG Science Communications Fellow

ended acres of clams, oysters and geoduck sustain a multimillion-dollar industry in coastal Washington. Given the impending and dramatic changes to Washington's waters on the horizon, shellfish growers and managers are eager to stay ahead of the curve and listen to the science. By the same token, scientists seek feedback from growers on what research is most useful to them.

This spirit of collaboration was thriving at the 26th annual Conference for Shellfish Growers, held at the Alderbrook Resort in Union, Washington on March 11-12, 2019. Organized by Teri King, an aquaculture specialist at Washington Sea Grant (WSG), the conference brought together shellfish producers, managers and researchers to discuss pressing issues and current research related to shellfish biology and aquaculture.

Examples of joint-effort research between scientists and growers at the conference was evident from a variety of sources. "The growers understand the scientific process. Many of them do their own experiments," King said. Parker MacCready, a physical oceanographer at the University of Washington, presented the LiveOcean model, which is essentially an underwater weather forecast for Puget Sound that integrates atmospheric, oceanographic and river flow data to give predictions of water quality and currents up to three days in advance. The maps that MacCready has developed model hypoxia and oil spills in Puget Sound and ocean acidification in Willapa Bay. MacCready was eager to expand his offerings in ways that clearly focus on the growers' needs. "I'd love to hear from everyone about what would be most relevant to you," he said at the conference. "If you want different timescales, parameters or area-I can make any map with this model, you just need to tell me what to do."

"One great suggestion [received from a grower in the conference audience] was to make maps showing areas that are 'good or bad' to set out oyster seed, based on things known to affect oyster growth like temperature, aragonite saturation state, and salinity," he later said. Other suggestions from the conference audience included the expansion of harmful algal bloom and bottom oxygen modeling to detect hypoxia for Dungeness crab fisheries along the coast. In addition, there was great interest in collaborating on burrowing shrimp control research. Increasing abundances of shrimp, which disrupt the sediment and choke shellfish plantings, have been observed in Washington—and as chemical control is banned, growers and managers are interested in finding alternative methods. Presentations from the Washington Department of Natural Resources and student researchers from the UW Toxicology Lab highlighted mechanical harrowing and applying salt as possible solutions.

Presentations from growers on sources of mortality led to open-ended questions: "I'm curious to know if anyone else has observations [of mortality]," said biologist Nick Wenzel from Seattle Shellfish. Different suggestions were floated around, including buildup of rotting Ulva sea lettuce that may cause toxic fumes. Sharing these personal observations help growers improve operations and scientists develop and rigorously answer questions.

Learning didn't only occur between growers and scientists: the conference was a great opportunity for growers to exchange observations with one another, as well. Many participants swapped notes about their farming practices throughout the conference. "We come away every time with something to try and do," said Dawn Smart, co-owner of HC Snail in Union.

In the end, everyone at the conference cared about one thing: shellfish. And the recognition that managers, scientists and growers are all working towards a common goal was a welcome break from the sometimes adversarial narrative found between resource users and managers.

"The conference is invaluable for bringing researchers, shellfish growers and managers together to understand various sides of an issue and move forward with valuable research that answers pressing questions," King said.



Teri King, aquaculture specialist at Washington Sea Grant

GREEN CRABS HAVE ARRIVE ARE THEY HERE TO STAY?



Washington Sea Grant's monitoring program works to prevent invasive green crabs from establishing populations in Puget Sound By Jasmine Prat, WSG Science Communications Fellow

uget Sound shorelines are teeming with life, from birds soaring overhead, to schools of salmon smolts darting through the shallows, to crabs scuttling along the beach. But what if one species could shift the balance of this entire coastal ecosystem?

The Washington Sea Grant Crab Team thinks the invasive European green crab has the potential to do just this. Green crab is considered one of the world's 100 most invasive species and has proven to be highly mobile and incredibly adaptable, as well as an aggressive predator. For decades, researchers have watched green crabs disperse around the world, damaging coastal habitats in the process. In 2016, the first green crab was documented on Washington's inland shorelines. If their numbers increase and spread, instead of the wealth of diversity we see today, beaches could contain mounds of green crabs, which have the capacity to outcompete several local species for

food and shelter. With a meticulous monitoring program, Crab Team works to stop the green crab invasion before these detrimental impacts take place on Washington's shores. Currently, Crab Team works with over 250 volunteers, tribal biologists and state agency personnel to monitor for green crab at 54 sites in Washington. In 2018, Crab Team volunteers alone spent over 4,000 hours conducting monthly surveys from April through September, when the crabs are most active. To date, there have been almost 200 crabs found across seven monitoring sites in Puget Sound. Most of these crabs were found at Dungeness Spit, near Sequim.

The threat of green crabs establishing in Puget Sound and their potential effect on native species has not been taken lightly. "The biggest risk we face from the green crab is the fact that it prefers to be a predator," says Emily Grason, program manager of Crab Team. "It can survive and thrive eating almost anything, and because of its tendency to become extremely abundant, just through eating things it can have really dramatic impacts on the native habitats that it invades." A green crab's diet can include many species cultivated by the shellfish

Good news! WSG received funding for Crab Team in the Washington State biennial budget, which was passed in April. Thank you to the staff, partners and supporters who worked hard to make this happen.

Green crab photo: Greg Jensen

Mr. Gas

ED IN PUGET SOUND:

industry, including clams, oysters and mussels. Green crabs can also devour the eelgrass used as nursery grounds for Dungeness crab and salmon, and in other regions they have turned formerly lush habitats into stretches of mudflats.

Researchers have long feared the spread of green crabs into inland Washington. Green crabs are highly mobile, traveling on ocean currents for months at a time in their larval stage, and they are adept at hitching a ride in shipments of shellfish or on marine gear as adults. They first appeared on the West Coast in San Francisco Bay in the late 1980s, and spread in fits and spurts over the following two decades. Green crabs were discovered on Washington's outer coast in 1998, where they remained largely contained for nearly two decades. However, in 2012 green crabs were documented on the Canadian side of the inland sea shared by British Columbia and Washington. Called the Salish Sea, this body of water includes Puget Sound, the Strait of Juan de Fuca and the Strait of Georgia.

In response, Washington Sea Grant and Washington Department of Fish and Wildlife formed Crab Team, which began preemptive monitoring for green crabs in 2015.

HOW TO IDENTIFY EUROPEAN GREEN CRABS

- Wider at front than back of the carapace
- 5 spines (or marginal teeth) to the outside of each eye

 Up to 4" across the carapace (or back shell)

• Although referred to as "green crab," color is not its distinguishing feature. The actual color can vary from dark mottled green to orange or red









n early March, Russell Callender and Julie Fisk, WSG director and special assistant to the director, traveled to the other Washington for the Sea Grant Association Spring Meeting. Along with Sang Han from the UW Office of Federal Relations, they also visited key NOAA personnel and members of the Senate Appropriations Subcommittees on Commerce, Justice and Science, as well as our state's congressional delegation. These visits solidified relationships that are essential to WSG's future-and just in time. On March 11, the presidential administration released an overview of its Fiscal Year (FY) 2020 budget request, which included a proposal to eliminate the Sea Grant program. just as it did for FY 2018 and 2019. Fortunately, Congress rejected the FY 18 and FY 19 proposals and ultimately provided historic levels of funding for the program. "I am delighted to report that the staff I met on my recent trip indicated continued support for Sea Grant," Callender says. "While this is encouraging, the funding process for FY 20 is far from complete."



Ed Melvin

d Melvin, WSG marine fisheries scientist had a paper published in the journal Conservation Biology that details the extraordinary efficacy of streamer lines in reducing seabird bycatch in Alaska's longline fisheries. Since streamer lines were adopted in 2002, seabird bycatch has been reduced by 77 to 90 percent, saving thousands of seabirds per year, including hundreds of endangered albatrosses. Melvin's paper has received extensive media coverage from respected national publications such as Nature's Research Highlights, TreeHugger and Forbes.

FM in Port Townsend, WSG launched Coastal Café, a sciencebased radio program focusing on regional marine science news. Aaron Barnett, boating program specialist, and MaryAnn Wagner, assistant director for communications, host the show, interviewing researchers, policy experts and people who live and work on the coast about issues impacting Washington State coastal communities and the natural environment. Recent quests have included lan Miller. WSG coastal hazards specialist, and artist Ray Troll. The show airs twice-monthly and is also available on the KPTZ website as a podcast

n partnership with KPTZ 91.9







Brent Vadopalas



Jackson Blalock

WSG welcomes Brent Vadopalas as an

aquaculture specialist. Julie Fisk as special assistant to the director and Jackson Blalock as an outreach specialist. Vadopalas' research focuses on the interface between aquaculture and the environment. He received his doctoral degree from the UW in 2003, and has continued to work at the university ever since. Fisk earned her master's degree from the UW School of Marine and Environmental Affairs and has worked with many groups within the UW, including EarthLab, the Climate Impacts Group and UW Sustainability. Blalock earned his master's degree in landscape architecture at the UW and was a 2017-2018 WSG State Policy Fellow. In his current role, he works toward ecosystembased management and coastal hazards resilience in southwest Washington's estuaries.

Andrew Chin became AWSG's first Undergraduate Science Communications Fellow in January. Read his story about the Shellfish Growers Conference on page 3. Applications for the next Undergraduate Science Communication Fellowship will open in November.



2019 Orca Bowl winners, Garfield High School

In February, 20 teams of high school students from Seattle to Soap Lake descended upon the UW for the 22nd annual Orca Bowl, a high-spirited event organized by Maile Sullivan, WSG education specialist. The teams tested their knowledge of marine science against one another, hoping to earn a spot to go to the National Ocean Sciences Bowl (NOSB) Finals, which were held on April 11-14 in Washington, D.C. The team from Garfield High School took first place at the regional competition, with Newport High School and Ocean Research College Academy taking second and third, respectively. Tacoma Science and Math Institute took home the Megan Vogel Sportsmanship Award for their upbeat attitude and integrity. Because the team from Garfield couldn't go to the finals, Newport High School went and earned seventh place.



Kate Litle and Maile Sullivan

Bridget Trosin, WSG coastal policy specialist led king tide viewing parties in both Oak Harbor and Raymond in January. King tides are the most extreme tides of the year. These events can help planners and decision makers visualize how sea-level rise will affect communities. "We use king tides to communicate the effects of sea-level rise and what it will look like in the future," Trosin explained. "We invited the public down to talk about what a king tide is, Washington State's King Tide program, and sea-level projections." With predicted sealevel rise, today's king tides are likely to become the everyday tides across our region.

WSG staff in red.

he work of several WSG staff was officially recognized through awards. Education specialist Maile Sullivan earned the 2018 Outstanding Informal Educator of the Year award from the Northwest Aquatic and Marine Educators. Boating specialist Aaron Barnett was recognized for his outstanding environmental leadership in the January issue of Northwest Yachting. Kate Litle, assistant director for programs, was nominated for the 2019 UW Distinguished Staff Award for all that she does for WSG. Last but not least, the Washington Coastal Resilience Project team, including WSG's lan Miller. Nicole Faghin. MaryAnn Wagner and Paul Dye, was awarded the UW College of the Environment Award for Community Impact for their work on sea-level rise. Congratulations!

Washington Sea Grant

Sea Star

KEEPING WASHINGTON'S RECREATIONAL BOATING DATA IN SHIP SHAPE

or Bob Goodwin, every Saturday morning starts the same way. Cup of coffee in hand, he fires up his computer and logs on to the Washington Department of Licensing's (DOL) secure server. Then he downloads the dataset that records every powerboat that was bought, sold or transferred within the state—data that he has been collecting on a weekly basis for the past 17 years. When viewed as a whole, each piece of information he collects is part of a much bigger story: Many people who live in Washington keep close ties to the water.

Goodwin worked at Washington Sea Grant (WSG) as the coastal resources specialist for 33 years before he retired in 2004. But even after his retirement, he has remained a part of the WSG family. Working in collaboration with the Northwest Marine Trade Association, he sorts through the weekly boat sales data, making these statistical summaries easily accessible on a quarterly and yearly basis through the WSG website. This information bolsters an economically important sector by helping boat dealers make informed business decisions, and even helps keep the water we play on clean. While Goodwin describes the boat sales project as an "asterisk" to the overall work he did before he retired, it has been an important one.

Goodwin first joined WSG for a summer job in 1972, when he was fresh out of his master's degree program in urban geography at the University of Washington. The WSG framework appealed to him: "I was not happy in a purely academic setting. I was not the kind of person who could sit in an office and write papers without having a foot in the outside world," he says. "Sea Grant really brought two worlds together—the external world of business and government and the academic world—in a more applied fashion than I had been pursuing in my studies."

In 1975, Stanley R. Murphy—WSG's first director, who was pivotal in founding the program—appointed Goodwin to the position that he held for nearly three decades. As the coastal resources specialist, Goodwin worked on a wide spread of issues. Early on, he helped develop the coastal resources component for the Institute of Marine Studies (which later became the School of Marine and Environmental Affairs) and then organized repositories of information and technical expertise for coastal managers. In 1977, he coordinated a multidisciplinary WSG research project on the economics of marine recreation in Washington State that would eventually lead him to his ongoing pursuit of data on boat sales. Through the project, he discovered that no one really knew how many boats there were in Washington!

In the early 1980s, waterfront revitalization became a central part of his career: for example, he and Marc Hershman organized the Seattle Waterfront Symposium, in which a panel of experts presented their vision for Seattle's downtown waterfront. He and Jim Good wrote a guidebook, *Waterfront Revitalization for Small Cities*, applying its principles to efforts in Raymond, Washington, and Warrenton, Oregon, to bring new economic activity to their dilapidated wharves and adjacent waterfront lands.

Goodwin started collecting data from the DOL on the sales of new and used boats in 2002, when the State began to require that boaters register their vessels. He saw it as an opportunity to fill the information void on the size of the Washington boat fleet and the types of new vessels that were entering it.

In the time since he began collecting these datasets, Goodwin has heard numerous reports about how they have helped guide business decisions. A marina consultant used it to understand where there is demand for more moorage. A boat dealer changed his business strategy when he saw that new boat sales were decreasing while used boat sales were increasing. It has also been used to help protect Puget Sound, by informing decisions on where to install new pumpout stations for boat waste and where to target oil spill prevention outreach.

"One of WSG's critical roles is to provide universally accessible, trusted sets of data that everyone can use and rely on," says Goodwin—a role that Goodwin has helped WSG live up to for nearly two decades. Now 81, he says he'll continue to collect boat sales data through this year, but he's getting ready to pass on his duties to a successor. We salute you, Bob! After retiring from his threedecade career with Washington Sea Grant, Bob Goodwin has continued to lead the charge on monitoring local boat sales



Bob Goodwin



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Report sightings to: crabteam@uw.edu.

Green Crabs • continued from page 5

Over the first year of monitoring, no green crabs were found. However, in August of 2016, one was hauled in from a muddy crab trap in Westcott Bay on San Juan Island. "On the one hand, I was really disappointed that the green crab was captured," says Jeff Adams, project lead of Crab Team. "While on the other, I was very happy for the validation of the Crab Team approach and that early detection now gave us a chance to control any concentrations of green crabs." To carry out their monitoring efforts, Crab Team recruits volunteers to set up crab traps at sites around Washington where green crabs are most likely to establish. Volunteers record numbers, sex ratios and sizes of all trapped organisms, providing important baseline information about our local crab and other native species populations, as well as green crab detections.

Increasing temperatures create cause for worry about invasion rates increasing. "During warm winters, survival tends to be better for green crab, so not only do they spread more, we expect their survival to be higher," explains Sean McDonald, Crab Team's co-principal investigator. This past winter started out unusually warm and, by late January, shellfish growers had already reported three green crabs in Samish Bay—the first time Nonprofit Organization U.S. Postage Paid Seattle, WA Permit No. 62

green crabs have been sighted in Washington during the winter months. This is especially concerning because one of the crabs was a female with eggs, which was the first evidence of reproduction within the Washington waters of the Salish Sea.

However, the fact that these observations are being made is a testament to the effectiveness of Crab Team education and outreach to diverse partners, and Crab Team remains hopeful that further spread of the crab is still preventable. "Across all these sites, we're really not talking about a lot of crabs . . . yet," says Grason. "We're finding them pop up as one or two or three individuals and we're looking really hard to find them, which gives us some indication that they're still really, really rare."

Crab Team wants to keep it that way. The team hopes their work and local news of green crab migrations will attract additional public awareness and involvement, as well as continued program resources. Crab Team continues to seek new volunteers to join their monitoring efforts and encourages members of the public to report any green crab sightings. They need as many eyes on the beach and boots in the mud as they can get!

For more information: wsg.uw.edu/crabteam