SEA STAR

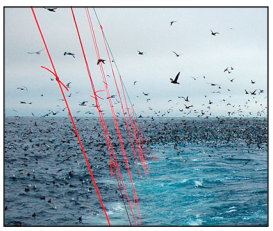
Washington Sea Grant

University of Washington

Autumn 2015

The power of one: how Meg Chadsey made Washington State respond to ocean acidification. Page 4

Saving seabirds and watchdogging the waters: awards season for two Sea Grant staffers. Page 7



HANGING BY A THREAD

Biologist Emily Carrington probes the secrets of the humble mussel's powerful attachment, and how mussels will fare as sea chemistry changes.

By Elizabeth Cooney, WSG Communications Fellow

Hundreds of invertebrates along Washington's shores have evolved ways of clinging, sticking, and anchoring themselves against crashing waves. One of the most successful is the humble mussel, which dominates turbulent rocky intertidal zones in temperate seas worldwide. But will the remarkable structure that enables mussels to stay put continue to work as the seas become warmer and more acidic? That's one question University of Washington biology professor Emily Carrington is trying to answer. The answers she's finding aren't simple, but they're sometimes surprising.

The unassuming but commercially valuable mussel encrusts rocks, docks, and pilings by producing a cluster of thread-like anchors called the *byssus*. The unique protein matrix that makes up byssal threads gives each strand surprising strength and stretch,

Carrington • continued on page 2

Musseling in: Emily Carrington (in hat) explains byssal effects to Govenor Jay Inslee.

Carrington • continued from page 1

For a mussel, the implications of byssal thread quality are simple: hold fast or die.

even in salt water. Carrington ventured into the world of mussel attachment during her postdoctoral days when she discovered that the byssus was incredibly understudied. Since then, she has remained at the leading edge of efforts to characterize it, seeking to discover how byssal production and strength might differ between species or depend on a mussel's environment. Her current research, supported by Washington Sea Grant, investigates several questions regarding mussel attachment: Do lower pH and higher temperatures affect the byssus? Does low food supply or spawning drain resources from byssal production? Will different mussel species respond differently to changing environmental conditions? To answer these questions, Carrington has embarked on a data-collecting journey in the lab and in the field.

Laura Newcomb, a graduate student working with Carrington, has conducted laboratory experiments and field assessments of the effects of seawater conditions on mussels since 2013. In the lab, Newcomb and previous student researchers observed that when seawater's pH (a standard measure of relative acidity) drops below about 7.6, the strength and elasticity of byssal threads decline. Since pH can range from just above 7.0 to well above 8.0 in the bays where mussels grow, they do encounter this threshold in the field. Likewise, 19°C is the "magic" temperature above which byssal strength drops off, and rising temperature seems to have a more dramatic impact on mussels than falling pH. It is common in research comparing environmental factors to see synergistic effects when more than one condition changes. But in this case, "one really seems to dominate over the other," says Newcomb.

The results reveal themselves to a simple tug test: When conditions are less than ideal, mussels can be pulled loose more easily. The Carrington lab uses quantitative approaches to measure attachment strength, like yanking mussels from the rocks with a force gauge and stretching individual threads in a tensometer to measure extension and breaking point. But the implications of byssal thread quality are simple for a mussel: hold fast or die. "It's a binary thing," explains Newcomb. Sometimes she revels in the simplicity of looking at "just one thing that really determines survival."

While the possible outcomes from environmental trends are relatively straightforward, impacts vary depending on scenario and species. When temperatures rise, the native bay or Pacific blue mussel (*Mytilus trossulus*) grows fewer threads but the naturalized Mediterranean mussel (*M. galloprovincialis*) grows more. Another native species, the California mussel (*M. californianus),* shows no change as waters warm but is more sensitive to low pH and less resilient in low salinity. These results suggest that as the climate warms and water temperatures rise, Mediterranean mussels may outcompete the native species. As it happens, the less-adaptable *M. trossulus* is also called "the foolish mussel."

Carrington and Laura Newcomb, heading for the water.

Another factor that Carrington suspects plays a role in byssus production is changing energy demand over the course of the reproductive cycle. *M. trossulus* spawns in spring, *M. galloprovincialis* in winter, and *M. californianus* year-round. Laura Newcomb's lab experiments found that the negative effects of reduced pH and high temperature were less obvious during spawning. Carrington suspects this is because there is little additional damage pH and temperature can do to the already-weakened byssal threads produced by mussels allocating their energy to eggs and sperm. In addition to observing these trends in the lab, Carrington and Newcomb are conducting field studies to see if the same responses occur in the mussel-encrusted bays and coves of Whidbey Island.

The mussel byssus has long been a subject of fascination for Carrington. In recent years, however, she has discovered that as climate and ocean conditions change, her research could also provide valuable insights to the aquaculture industry. She began examining the ways environmental conditions affect mussel attachment in the bays and inlets where mussel farmers cultivate their stock. Along the way, she has developed an unexpectedly close working relationship with a resident team of mussel farmers, whose input and collaboration have become an integral part of her lab's research.

Early on, Carrington tapped Ian Jefferds, the general manager of Whidbey Island's Penn Cove Shellfish, as her go-to field contact. Penn Cove, founded in 1975, is the oldest and largest mussel farm in the United States. Its operation depends on wild mussels to seed each year's harvest, making it a natural laboratory for studying mussel attachment, both in the wild and in aquaculture operations.

The collaboration started small but grew when Penn Cove helped Carrington install monitoring equipment on one of its mussel rafts. Carrington's sensors supplemented a system already in place at the farm and set the stage for joint data collection. During setup, Jim Nagel, Penn Cove's resident engineer, worked closely with Newcomb to make sure the telemetry equipment would serve her needs as well as those of the company. Over time, and as the research began to entail regular trips into the field, Jefferds and his team's input became even more deeply implanted in the research effort. "They are taking these skiffs out to the harvesting barge," Carrington explains, "and sometimes they might notice the water's a little greener or the mussels look a little different. A really important part of our research is communication with the people who are actually on the water every day."

For Newcomb, the anecdotal information Penn Cove's employees provide is extremely useful for interpreting data. Carrington and Newcomb are also quick to point out that the farmers were the first to observe changes in mussel attachment. "This research is really a way to quantify what they've been observing all along!" says Newcomb.

For their part, mussel farmers appreciate having access to data from Carrington's monitoring systems. With some skillful maneuvering by Nagel and help from the UW Applied Physics Lab's Emilio Mayorga, information collected at the perimeter of the mussel rafts is sent remotely to a computer in the company warehouse, then uploaded to the visualization system on the Northwest Association of Networked Ocean Observing Systems (NANOOS) website. Here, data can be viewed by Penn Cove employees, members of the Carrington lab, and the public at large. "It's interesting for our employees, because they have questions too," says Jefferds. "It's one thing to read about a study that happened in a lab, but allowing our crew to assist and watch Laura and Emily has provided opportunities to ask more questions and learn what's going on."

Jefferds sees other reasons to be involved. Although his operation remains healthy and seems sustainable, he doesn't take things for granted. "We don't want a situation. Why wait for one to happen?"

This proactive spirit makes the mussel attachment project unusual. Much aquaculture-related research, such as recent work on oyster settlement and fish farming, has mobilized in response to challenges that the industry already faced. But, as Newcomb has learned while working with Carrington and the Penn Cove team, talking about farming in the face of climate change does not have to mean doom and gloom. "I've changed the way I talk about it," she says, emphasizing the preventive rather than reparative role her research could play. "As a student, I am learning the perspective of the farmers who have to ask, 'At what point do you start switching your practices'?"

Carrington • continued on page 8

"A really important part of our research is communication with the people who are actually on the water every day."

Sorting the bounty at Penn Cove.

THE MOUNTAIN-MOVING "MOSQ

Washington Sea Grant's Meg Chadsey proves

Three-year-old Meg discovers the sea. Courtesy Shepherd family.

The Journal of Irreproducible Results once published a paper calculating how quickly the Pacific and Atlantic coasts would sink into the sea from the weight of all the old magazines stored in their basements and attics. Mock science it might have been, but magazine hoarding has had real impact on ocean policy in this state and beyond — via Washington Sea Grant's ocean acidification specialist, Meg Chadsey.

In 2010 Chadsey was a disenchanted fortysomething ex-microbiologist looking for an outlet for her real passion, the marine environment. After visiting her parents on Vashon Island, she left to catch a flight to Minneapolis. "Luckily, my parents never throw out magazines," she says. She grabbed a 2006 issue of *The New Yorker* to read on the plane.

That issue happened to contain a seminal article by Elizabeth Kolbert, "The Darkening Sea," on what was still a relatively esoteric phenomenon, ocean acidification. Chadsey was amazed and appalled to learn that carbon dioxide emitted by human activities and devices (including the plane she was on) was changing the basic chemistry of the world's oceans and the prospects for the creatures in it. Unlike most people who get alarmed by something they read, she resolved to do something about it. "By the time the plane landed, I knew that this was what I wanted to do when I grew up."

"The beach was my world. Like half the biologists in the world, I started out wanting to be a marine biologist."

But then she got distracted.

It had taken Chadsey a decade to find her calling, though it marked a return to her salt-sprayed roots. Growing up on Vashon, she'd spent every minute she could along Puget Sound: "The beach was my world. Like half the biologists in the world, I started out wanting to be a marine biologist."

But like so many childhood dreamers, she detoured. "In college I got distracted by recombinant DNA, which was just becoming mainstream then." She became a molecular biologist — "a postdoc in this very nice lab [at UW] with very nice people. But it wasn't my calling."

Chadsey found herself sneaking down the block to attend seminars at the School of Fisheries and Aquatic Sciences (SAFS) and casting about for ways to combine two of her main interests: marine policy and sustainable foods. She collaborated with Tom Leschine, then director of UW's School of Marine and Environmental Affairs, and NOAA algal bloom researcher Vera Trainer on a paper about how institutions responded when toxic algae started forcing razor clam closures on the coast. "I dabbled in marine issues, worked for the Marine Stewardship Council." She assisted F.O.R.K.S. (previously Seattle Chefs Collaborative), a nonprofit promoting local, sustainable food sources. Caroline Gibson, who helped run a rockfish conservation group, worked with Chadsey during those days and marveled at her energy and perseverance: "She's amazing — balls to the wall when she gets going on a project."

And then Chadsey read that four-year-old article on ocean acidification (OA). She'd come late to the acidification issue, but she was a quick study. "With her chemistry background she understood this vast, complex issue long before I did," says Gibson.

That winter, SAFS devoted its entire 2011 Bevan Series on Sustainable Fisheries to acidification. Chadsey attended every session; two speakers stood out. One was Richard Feely, a senior scientist at NOAA's Pacific Marine Environmental Laboratory (PMEL), whose pioneering measurements of the carbon signal in upwelled deep-ocean waters revealed that the Northwest littoral is a frontline in acidification's onset. The other was former Congressman Brian Baird, who had (with then-Congressman Jay Inslee) sponsored the only ocean acidification bill — funding research and monitoring — to make it through Congress. "The hard cold facts Dick Feely had were pretty devastating," says Chadsey. "Fortunately they scheduled Brian Baird the next week. He didn't bring good news, but if anybody can make you laugh about ocean acidification, it's Brian. One thing he talks about is how people can digest really dispiriting information, what turns them off, and how they can engage on an issue."

Baird threw out one little idea: to make message buttons ("square because people think round buttons look like political campaigns") saying, "Ask me about pteropods" — the tiny swimming snails, a.k.a. "sea butterflies," that are essential to the North Pacific food web, acutely vulnerable to acidifying water, and charismatic in a micro-species sort of way.

"I thought, 'That's easy,'" Chadsey recalls, and she had the buttons made. Baird says he still wears his and it still starts conversations.

That was just the start of the inspiration Chadsey drew from the Bevan talks. Feely and Baird — grim science plus irrepressible ac-

"Sea butterflies" become poster children for acidification.

UITO" OF OCEAN ACIDIFICATION

the power of one to mobilize action on a very big issue.

tion — were an irresistible combination, she reasoned; they should be speaking not just to fisheries insiders at UW but to policymakers, media, the wider environmental community, even the general public. After each of them spoke, she strode up, introduced herself, and said she wanted to help get the word out. Then she cast about for a forum to do that.

She started at home. Chadsey's husband, Matt, was a of the Sustainable Path Foundation, a group that sponsors an annual seminar series at Town Hall. "Do you think they'd go for an OA seminar?" Meg asked Matt. She wrote up a pitch and told the group, "If you'll hold it, I'll do all the legwork and get your speakers." They told her to go ahead.

Once Baird and Feely committed, Chadsey started thinking. "It was likely Dick and Brian would be available the following day, too. What else could I do with them?"

Caroline Gibson, now with the Northwest Straits Commission, had an idea. She knew that Washington Sea Grant was interested in ocean acidification: Why not seek help there? Chadsey approached WSG director Penny Dalton and proposed a symposium on acidification, with a science panel anchored by Feely and a policy panel moderated by Baird. Again she volunteered to assemble and coordinate the program.

Dalton, like the others Chadsey called, was impressed. "It's really unusual to have a volunteer come to us knowing exactly what she wants to do," she recalls. "Particularly one as enthusiastic, experienced, and prepared as Meg was. For me it was very easy to say 'Yes.'"

The symposium, held November 9, 2011 at UW's Center for Urban Horticulture, surpassed everyone's expectations. The crowd filled the hall's 200 seats and all the available standing room; latecomers lined the back of the room. Feely explained the physical science of acidification, and three biologists — UW's Carolyn Friedman and Terrie Klinger, and Western Washington University's Brady Olson — described its effects on marine organisms. The policy panel ranged even more widely: from Makah Tribal Chairman Micah McCarty and Taylor Shellfish Policy Director Bill Dewey to journalist (now WSG science writer) Eric Scigliano and Ron Sims, the environmentally minded former King County executive and deputy director of the U.S. Department of Housing and Urban Development.

Again, Chadsey took advantage of a fortunate connection. David Dicks, the director of the state Puget Sound Partnership, lived across the street from her in Wallingford. When all other attempts to reach Sims failed, Dicks made the connection. But she did not think to ask him to invite his own father, Norm Dicks, Washington's senior congressional representative, whose long record of securing federal funding for local marine conservation earned him the sobriquet "the congressman from Puget Sound."

Nevertheless, late in the symposium, "Stormin' Norman" rose from the audience and delivered a ringing pep talk for the effort to understand and deal with acidification. That was just one of two big surprises that day.

Neither Chadsey nor anyone else knew what Ron Sims would say. In steam-rolling style, Sims (who's also an ordained Baptist minister) delivered a passionate version of President Franklin D. Roosevelt's famous line, "Okay, you've convinced me, now go out there and put some pressure on me."

"Acidification, we have to deal with it and we have to deal with it early," Sims declared. The question is, how do we do that, because we cannot do everything." Boil it down, he urged. Cut the fancy explanations and give us political and policy types concrete steps we can take to fix it. "Step one, step two, step three — provide a clear, concise program!"

One pair of ears that perked up upon hearing this belonged to Brad Warren, a veteran journalist who had labored for nearly five years to mobilize the fishing industry to confront acidification. "Several of us there turned to each other and said, 'Did you hear what I heard? Yeah! He just gave us an actionable challenge."

Warren immediately drafted a two-page memo laying out a program for state action on acidification. After vetting it with Feely and Klinger, he handed it off to two compatriots he knew had then-Governor Chris

Chadsey • continued on page 6

"There are three kinds of people, those who see what's needed but don't act. Those who would act but don't see the need. And those who get it and act on it. Meg's the third."

Brian Baird

Even Chadsey's shoes celebrate the ocean. She reminds students at the Northwest School that no matter how dire the threat of acidification, they can still find reason to hope — and smile — by taking action.

Chadsey • continued from page 5

Chadsey talks ocean chemistry with Philippe Cousteau, Jr. (center) and NOAA's Dick Feely.

Gregoire's ear: Bill Dewey and Terry Williams, the Tulalip Tribes' fisheries and natural resources commissioner. Dewey had earlier helped prod Gregoire to launch the state's Shellfish Initiative, directed toward boosting both shellfish growing and water quality. Now he and Williams urged her to add acidification to the brief. Four weeks after the symposium, she announced the formation of a blue-ribbon panel that would bring research, government, environmental, and industry sectors together to sift strategies for mitigating, remediating, and adapting to acidification. Washington Sea Grant, NOAA, the Rockefeller Brothers Foundation, the Washington Department of Ecology, U.S. EPA, UW's Climate Impacts Group, and Warren's Global Ocean Health Program kicked in money and staff time.

The panel met intensively through the spring and summer of 2012, but the toughest work unfolded into the autumn, backstage, in a flurry of report writing and committee-level debate. Chadsey was at the center of it, staffing the panel's education and outreach committee, assisting the committee on mitigation and remediation, and helping write and edit the scientific report, riding herd on the overbooked scientists to write their portions, rounding up photos for the final panel report, and in a hundred unsung ways keeping the process on track.

The report's impact was immediate in Washington, and it continues to ripple far beyond the state's borders. The state promptly funded a UW research center on acidification and new chemical monitoring of local waters. Other states (seven by Warren's count) have since undertaken their own acidification initiatives, often closely following the Washington panel's model and using its scientific findings.

Chadsey speaks modestly about how all this took her by surprise: "I didn't realize for a while how unique Washington was, how we're in a position to be a global leader." But Warren thinks her focus on Washington set the stage for the state to become a national trailblazer. Few now recall that his Global Ocean Health Program and the Marine Conservation Institute hosted an earlier symposium on acidification at UW, the year before the Sea Grant-sponsored event. "But we and others saw it as something we had to address at the federal level," Warren recalls. "We invited a lot of congressmen — Dicks, Inslee, and Baird came. There was a big push to put ocean acidification on Congress's agenda. But Congress was essentially stuck — it was not ready to pass any legislation. The focus on the federal level really led to deadlock.

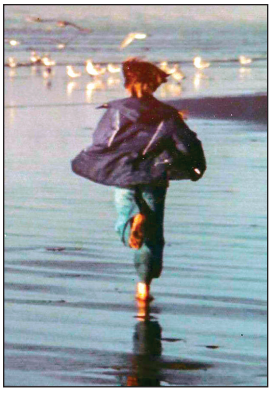
"Meg understood what we didn't: that action had to come at the state level. She deserves credit for helping advance this. She pulled the cork out. The first state to create a comprehensive strategy to address acidification was Washington, and she created the conversation that led to that."

That conversation continues. Two years ago the Paul G. Allen Family Foundation issued its "Ocean Challenge," with a $10,000 prize to the most promising strategy for addressing ocean acidification. Others proposed ideas for monitoring or adapting to acidification. But a team of local researchers, led by shellfish scientist Joth Davis, and Betsy Peabody of the Puget Sound Restoration Fund, proposed remediating the acidified waters themselves by growing and harvesting large arrays of carbon-extracting seaweed — an idea explored during the Blue Ribbon Panel process. This idea didn't win the marquee prize, which went to a Hawaiian–Australian team's proposal for breeding resilient reef corals. But it was one of very few that the Allen Foundation eventually funded.

Again, Chadsey was in the thick of it, from the initial brainstorming over strategies —"We just sort of proposed ideas and then shot them down"— to the drafting of both the initial concept and the full proposal. In her newer role as Washington Sea Grant OA Specialist and liaison to PMEL, where she works with Feely, she's continued to find new ways to alert and educate the public about ocean acidification. She speaks to groups and schools; has put together widely distributed OA fact sheets and other printed and posted materials; helps maintain an online collection of OA curricula for students and teachers, in partnership with the Suquamish Tribe; and trains students from Bainbridge Island and Seattle high schools to monitor OA in Puget Sound.

"There are three kinds of people," says Brian Baird. "Those who see what's needed but don't act. Those who would act but don't see the need. And those who get it and act on it. Meg's the third. Not only does she understand the problem, she acts to correct it. She makes a commitment and sticks with it. She's really extraordinary."

All the more so because she moved mountains without any of the usual levers — professional credentials (though her science background served her well), political clout, an influential position, or even funding. "She's proof," says Dalton, "of the African proverb, 'If you think you're too small to be effective, you haven't been in the dark with a mosquito.'"



Young Meg gets a running start on her marine career. Courtesy Shepherd family.

To learn more about ocean acidification and what we all can do to counter it, see:

wsg.washington.edu/our-northwest/ocean-acidification

On our OA Outreach and Education Resources page you can find:

- videos
- slide presentations
- demonstrations
- handouts
- teaching materials

See *wsg.washington.edu/our-northwest/ocean-acidification/oa-outreach-and-education-resources.*

FIELD NOTES

WSG social scientist **Melissa Poe** has wrapped up an 18-month project, funded by the Puget Sound Institute and U.S. EPA, on the relationship between sense of place and the restoration of Puget Sound. Working with Swinomish Environmental Health Analyst Jamie Donatuto and the University of British Columbia's Terre Satterfield and Robin Gregory, Melissa examined traditional harvesters' and other residents' connections to the Sound through extensive interviews and workshops along the South Sound and Skagit Delta. The team delineated four ways that people become tied to places along Puget Sound: activities such as harvesting shellfish, bird watching, and relaxing at the beach; cultural and family heritage; cognitive and emotional experience; and social connections. They found three factors connecting people to place that might help guide restoration efforts: access, knowledge, and ecological integrity. Melissa presented the team's final report to the Puget Sound Institute and Puget Sound Partnership in April 2015 and at a special symposium in June honoring the late environmental economist Mark Plummer at NOAA's Northwest Fisheries Science Center.

The American Planning Association held its national conference in Seattle in April, and **Nicole Faghin**, WSG's coastal management specialist and working waterfronts maven, was there to show the delegates what works or doesn't on Seattle's shoreline. Nicole took 70 planners from Canada, Bermuda, and coastal and riverine cities throughout the United States on a boat tour from Fishermen's Terminal to South Lake Union. Like any tourists, they inevitably wanted to see the *Sleepless in Seattle* houseboat. But they also got a duck's eye view of current controversies in a city that, for all its gentrified glamour, still has boatyards and fishing fleets within sight of downtown: boat shops vs. an intrusive bike path, city regulation vs. unplumbed house barges, noisy tour boats vs. houseboat dwellers, chic dockside restaurants vs. a working waterfront. Their reaction: "This city is beautiful!" And, upon viewing the F/V *Tordenskjold*, moored at Fishermen's Terminal: "I can't believe that thing is 104 years old and still goes to Alaska!" They talked about their own cities' waterfront woes. "From the delegate comments about what's been done to their waterfronts, I saw that we've done a pretty good job of keeping ours," says Nicole. "We've been more proactive than a lot of places."

And a big wet Sea Grant welcome to WSG's new student assistants, both in their first year at the School of Marine and Environmental Affairs: **Thea Rogier**, who is assisting this year's RFP process and other administrative projects, and **Annie Hillier,** who helped Maile Sullivan host this summer's NOAA Science Camp and is taking on other administrative work.

Top: Dean Lisa Gramulich congratulates WSG's Teri King.

Bottom: Albatross saver Ed Melvin with some fine feathered friends.

Editor, Eric Scigliano; Designer, Robyn Ricks; Web Editor, Marcus Duke; Assistant Director for Communications, MaryAnn Wagner.

It's been a bumper season for awards at Washington Sea Grant. On May 12, UW's College of the Environment honored **Teri King**, WSG's veteran aquaculture and water quality specialist and Shelton bureau chief, for "Outstanding Community Impact" by a staff member. Dean Lisa Graumlich noted that Teri had staged more than 1,000 events and presentations in 20 years on the water-quality beat, 100 since 2013. "That works out to one a week," noted Graumlich — and that's not counting the State of the Oyster, SoundToxins, and Well Education and Training programs that Teri operates in collaboration with Aquaculture Outreach Specialist **Jennifer Runyan**. They test shellfish, Puget Sound waters, and residents' well water for nasty things like toxic algae and fecal bacteria.

The same week, news came that WSG senior fisheries scientist **Ed Melvin**, together with colleagues at NOAA, Oregon State University, the Oregon and California Sea Grant programs, and many other federal, tribal, and fishing-industry partners, had received the 2015 Presidential Migratory Bird Stewardship Award, honoring a federal program for outstanding efforts on behalf of bird conservation. Like Teri's award, it's overdue recognition for 20 years of dogged effort. Ed's research has proven and refined the use of streamer lines to protect endangered albatrosses and other bait-chasing seabirds from getting hooked and drowned in longline fisheries. From Alaska's halibut fleet to the Japanese tuna fishery in the South Atlantic, these bait-scaring lines have dramatically reduced, sometimes eliminated, seabird bycatch. Based on his research, NOAA Fisheries has begun requiring streamer lines on West Coast sablefish longliners, and Ed and his colleagues are helping fishermen deploy them.

Sea Grant Washington

Washington Sea Grant
University of Washington
Box 355060
3716 Brooklyn Avenue NE
Seattle, WA 98105-6716

Nonprofit
Organization
U.S. Postage
Paid
Seattle, WA
Permit No. 62

Sea Grant Washington

206.543.6600
seagrant@uw.edu
wsg.washington.edu

Tweeting @WASeaGrant
www.facebook.com/WaSeaGrant

Carrington • continued from page 3

For any future problems, there are many potential solutions. For example, Penn Cove grows both the native *M. trossulus* and the warm-water-friendly *M. gallo-provincialis*. Jefferds and his team could use environmental data to determine which species will fare better and manage accordingly. Carrington's lab also has plans to investigate whether altering the food supply could strengthen mussel attachment during times of high energy demand such as spawning season.

To learn more about Penn Cove Shellfish's collaboration with the Carrington Lab and the mysteries of mussel rafting, see our web-only companion story, "Sinking Barges and Chlorophyl Feeding Frenzies."

See *wsg.washington.edu/wsg-news*

Although Carrington and her lab have made progress in discerning patterns in mussel attachment, many questions remain. "I often give these seminars," she explains, "and I show mussel attachment over the course of the year, and there's such a strong pattern. They're twice as strong in winter as they are in summertime. After 15 years I still don't know why." By working together, however, the farmers and researchers have a better chance of uncovering answers.

Many other countries, including China, Canada, and Spain, have mussel-growing industries larger than the United States'. "What we're learning here in Washington will be transferable to all these other industries," says Carrington. She muses on the way her offbeat research vocation has taken on global significance: "It is really cool that the problem I happen to be passionate about, how mussels attach underwater, has important implications for a major global industry."

Washington Sea Grant Succeeds

The National Sea Grant College Program conducted a site review of Washington Sea Grant on May 12-13, 2015. While the official report has not been released, the Site Review Team found that Washington Sea Grant meets the Standards of Excellence expected of all Sea Grant programs.

Thank you to all who gave of their time and contributed to the success of the 2015 Site Review.

WSG-funded students present their research to the Site Review Team, researchers, and WSG staff.