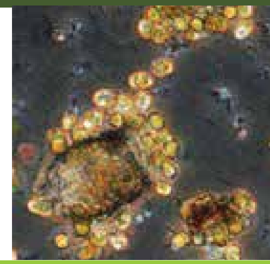
# SEA STAR

Washington Sea Grant

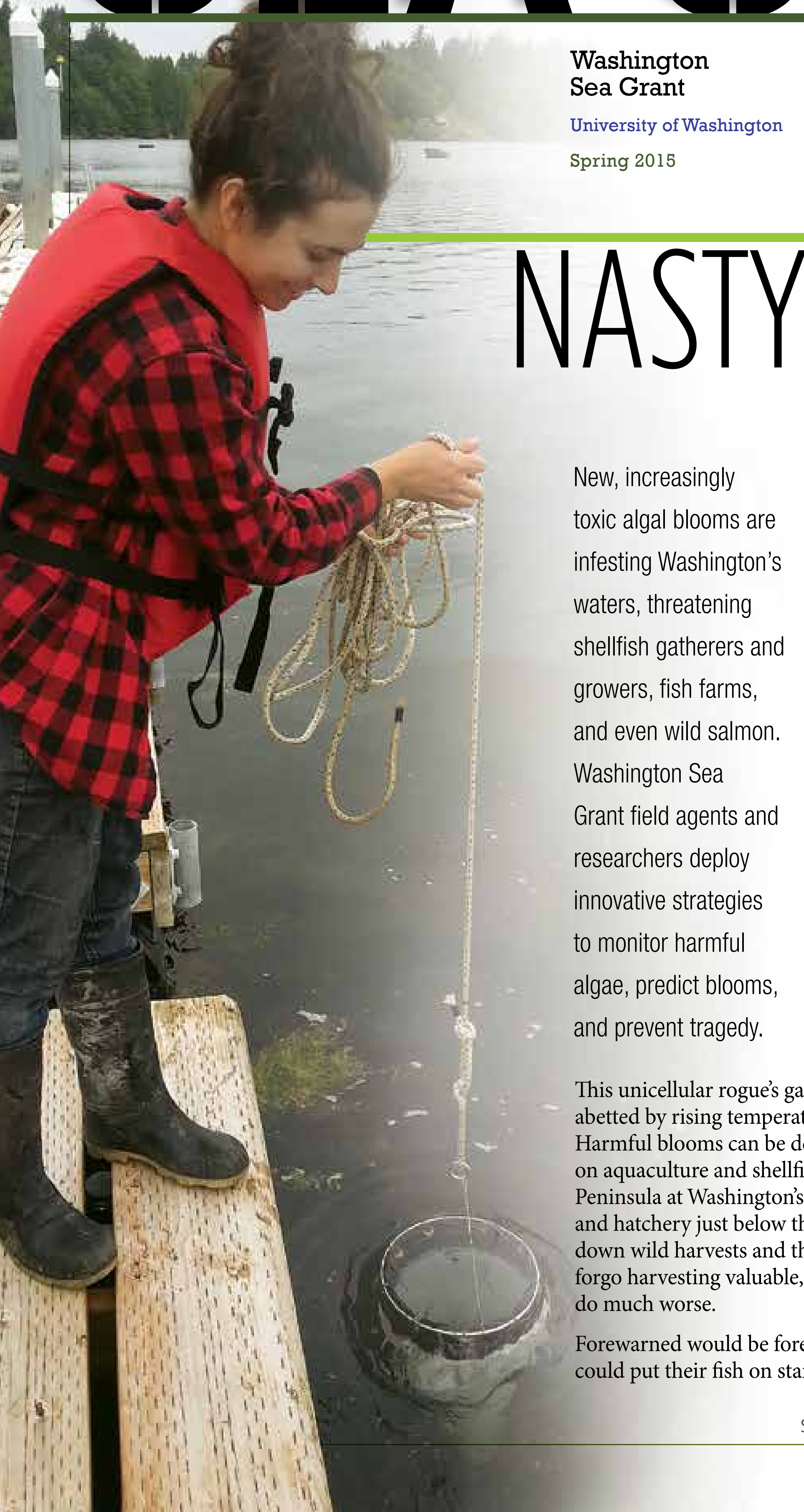
University of Washington

Spring 2015

## From sleeper cells to 3-D printers

Special issue on new research and innovative strategies to take the harm out of harmful algal blooms



# NASTY HABITS

New, increasingly toxic algal blooms are infesting Washington's waters, threatening shellfish gatherers and growers, fish farms, and even wild salmon. Washington Sea Grant field agents and researchers deploy innovative strategies to monitor harmful algae, predict blooms, and prevent tragedy.

The muck and sand under Washington's coastal waters are a bivalve Garden of Eden, a standing banquet of delicious, nutritious shellfish. Oysters, mussels, scallops, geoduck, and other clams sustained the first residents along these shores and the European Americans who followed them. The region's unofficial anthem, "The Old Settler" (with its exuberant refrain "acres of clams") and its hoariest aphorism — "When the tide's out, the table's set" — both celebrate these molluscan riches.

But there's a serpent in this garden. More and more of these riches are contaminated by harmful algal blooms, HABs for short. Some, such as *Alexandrium catenella*, the source of paralytic shellfish poisoning (PSP), and the *Pseudo-nitzschia* species behind amnesic shellfish poisoning (ASP), produce toxins that spare the shellfish that absorb them but can sicken and kill vertebrates further up the food chain, from seabirds to human clamdiggers and oyster fanciers. Others, such as *Heterosigma akashiwo*, don't harm humans but can afflict and kill fish, especially fish concentrated in aquaculture pens and tanks.

This unicellular rogue's gallery continues to grow and spread to new shores, abetted by rising temperatures and the more stratified waters they bring. Harmful blooms can be devastating for the coastal communities that depend on aquaculture and shellfish gathering, from Willapa Bay and the Long Beach Peninsula at Washington's southwest corner to the Lummi Tribe's oyster beds and hatchery just below the Canadian border. Once detected, they can shut down wild harvests and the economies built around them, and force growers to forgo harvesting valuable, otherwise healthy product. Undetected, they would do much worse.

Forewarned would be forearmed. With enough warning, finfish aquaculturists could put their fish on starvation diets, slowing their metabolisms and reducing

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SoundToxins monitor Lisa Abdulghani tracks the algae in Spencer Cove.

their vulnerability. Officials would gain an extra margin of safety in their efforts to protect harvesters from financial loss and potential tragedy. But that is just one solution.

Washington Sea Grant (WSG) is at the forefront of a statewide effort to predict and monitor harmful algal blooms, fighting the battle on many research and outreach fronts. WSG field agents organize and supervise grassroots monitoring networks that multiply the reach of the state's shellfish-safety program. Some WSG-funded researchers are unraveling the mysteries of two harmful algal species' surprisingly complex life cycles. Others are using 3-D printing and online video to build low-cost automatic remote sensors that can detect in real time when free-swimming algal cells start forming deadly blooms.

## SoundToxins: a force multiplier for shellfish safety

Washington's Department of Health receives thousands of shellfish samples each year. It tests them for three algal toxins — those that cause PSP, ASP, and diarrhetic shellfish poisoning (DSP). When state health officials find too much toxin, they close beaches and stop sales.

It's an effective system, one reason no Washingtonians have died from shellfish poisoning since the 1940s. But even its practitioners know it's too little, too late. Testing the waters for the algae that produce these toxins before they show up in tissues would provide early warning and an extra margin of safety. "But we just don't have the resources to do it ourselves," says Jerry Borchert, who coordinates the Health Department's marine toxins program. With just one half-time colleague (and various partner groups) to help him, he's hard-pressed to keep up the shellfish testing and enforcement.

In 2006, Vera Trainer, the manager of the Marine Biotoxin Program at NOAA's Northwest Fisheries Science Center, saw a chance to help. NOAA had launched a national Oceans and Human Health Initiative dedicated to reducing health risks through better management and understanding of marine resources. It designated the Northwest Fisheries Science Center as the initiative's West Coast Center of Excellence.

"I was asked, 'What should we do?'" Trainer recalls. Her answer: enlist partners to do the additional monitoring needed. Muster the power of volunteers as "citizen scientists" to extend the reach of state sampling. And the SoundToxins program was launched.

Local monitoring had already proven itself on the Olympic Peninsula. Communities there were alarmed at recurrent high levels of domoic acid, the toxin behind amnesic shellfish poisoning, in razor clams, their most valuable wild harvest. In 1999 they launched ORHAB, the Olympic Region Harmful Algal Bloom Partnership. NOAA provided start-up funding, but ORHAB then managed to spin itself off. Its work proved so valuable that Washington's legislature dedicated a small share of recreational shellfish-harvesting license fees to its ongoing operation.

## How would you like to take that on?

Meanwhile, the SoundToxins program hit a wall: It had outgrown the capacity of Trainer's NOAA office to manage it. "We realized we needed 24-7 coordination and an online database," Trainer recalls. She turned to WSG and asked, "How would you like to take that on?"

The result has been what Trainer calls "a great partnership — Sea Grant has been a huge help." WSG marine water quality specialist Teri King (since joined by aquaculture outreach specialist Jennifer Runyan) took over the care, feeding, and coordination of what is now a network of about 50 trained SoundToxins monitors, strategically deployed at 33 sites spaced from Budd Inlet at the bottom of Puget Sound to Orcas Island in the north and Sequim Bay in the west. In addition to WSG support, they received funding from the National Sea Grant Office and the Washington Department of Ecology.

SoundToxins volunteers commit to sampling the water at their sites every week in spring, summer, and autumn and twice monthly in winter, examining the samples under microscope for the target algae, and reporting their findings promptly (immediately if they find harmful species) to King and Runyan. They also post those findings in SoundToxins' online database.

Some monitors have a professional interest in the findings. Lisa Abdulghani is a research biologist with Seattle Shellfish LLC, which grows geoduck in South Puget Sound. There, she says, "nature works its magic and feeds the shellfish naturally. The downside to farming that way is that you cannot control what the shellfish eat." Participating in SoundToxins allows growers to at least know what their shellfish are eating. "Through the training and equipment [NOAA and WSG] provided, we are now able to understand how particular species of algae can contribute to low or high growth rates during certain months. We now also know when harmful algae are present so that we can be aware of their potentially harmful effect."

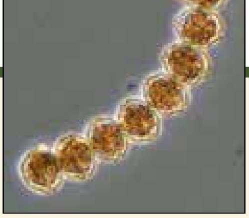
Karlista Rickerson became a SoundToxins volunteer for more personal reasons. "I'm a scuba diver," she explains. "I'm always curious about what's in the water I'm gulping." Rickerson, a retired nurse practitioner, gathers plankton samples for SoundToxins and mussels for the Health Department from the marina at Vashon–Maury Island's Quartermaster Harbor, a confined bay subject to particularly persistent *Alexandrium* blooms. "Here it is January and we're still running positive for PSP!" she exclaimed last month.

"It's always a teaching moment for anybody who sees me doing it," Rickerson says. "They see me drop the plankton net in the water and think it's a crab net. They ask if I'm fishing and I tell them about harmful blooms."

Washington Sea Grant's outreach strategy for protecting citizens from HABs and shellfish contamination has three prongs: research, monitoring (as in SoundToxins), and public education. Under the rubric "Bivalves for Clean Water," field agents King and Runyan use workshops, publications, field trips, beach walks, site visits, shellfish plantings, community festivals, and whatever other forums become available to teach coastal dwellers to be water quality and marine habitat stewards, pollution watchdogs, and safe shellfish harvesters. But as Rickerson's dockside nettings show, sometimes monitoring and public education are one and the same. There's nothing like a net tow to get people thinking about what's in the water.

Above: SoundToxins volunteer Karlista Rickerson heads out to track and teach at Quartermaster Harbor. Below: SoundToxins and ORHAB founder Vera Trainer digs for razor clams. Inset left: SoundToxins volunteers at a 2014 training session with WSG's Jennifer Runyan (front row, second from left) and Teri King (back, second from right). Inset right: Karlista Rickerson introduces students to the algae around them at the McMurray Middle School Science Fair on Vashon Island.

# Riddle of the cysts: stalking the elusive *Alexandrium*



A chain of *Alexandrium.*

Given the many challenges in tracking algal blooms, regulators and shellfish growers might be better off anticipating HABs on a seasonal rather than weekly scale. Cheryl Greengrove of UW's Interdisciplinary Arts and Sciences Program, together with colleagues at NOAA and UW and with support from Washington Sea Grant, is trying to determine how best to do just that for algal public enemy number one, *Alexandrium catenella*, the dinoflagellate whose toxin causes paralytic shellfish poisoning (PSP).

Blooms of *Alexandrium* are often referred to as "red tide," a double misnomer. Red tides actually aren't tides at all; they're visible slicks of various planktonic species. They may be red, brown, yellow, purple, or pink as well as red. And they're usually harmless.

*Alexandrium*, however, can be very dangerous. Its toxins can build up in shellfish even when it can't be seen on the water. Those who eat these shellfish may suffer eerie symptoms: PSP starts with a tingle on the lips and tongue, spreads to the extremities, and leads to shortness of breath and, in about 15 percent of recorded cases, death.

*Alexandrium* is a familiar peril off Washington's coast and in several other temperate regions around the world; more than 200 years ago, Captain George Vancouver noted that several of his crewmen died of PSP-like symptoms after eating shellfish. But for many decades Puget Sound seemed to be protected, even as poisoned shellfish appeared around Bellingham and the San Juans and forced seasonal shellfish-gathering shutdowns along the ocean coast and Strait of Juan de Fuca.

That changed in the 1970s and '80s as *Alexandrium* moved south into the Sound. High levels of PSP toxin have appeared in shellfish with increasing frequency since then. But predicting when and where *Alexandrium* blooms will erupt has proven elusive.

Researchers have tried to anticipate summer algal blooms through "cyst mapping" — tallying the concentration of dormant *Alexandrium* cysts wintering over in the sediments beneath potential bloom-initiation sites. Greengrove and her colleagues set out to test the effectiveness of this strategy. They gathered dormant cysts from 30 sites around the Salish Sea, incubated them, and tallied the percentage that actually germinated. This share proved highly variable, even in different samples at the same site; it ranged from 16 to 66 percent at Quartermaster Harbor and across all values in between at the other sites.

Greengrove's team hypothesized that cyst "fullness" — whether cysts are plump and fresh, or their cytoplasm has shrunk with age and receded from their cell walls — might instead serve as an indicator of viability. They photographed each of the cysts they isolated and used image-analysis software to gauge its fullness. So far they have not found any correlation between fullness and viability, though they are still analyzing some of the photographs.

*Alexandrium* has proven a stealthy adversary. Greengrove notes the case of Quilcene Bay, an important shellfish harvesting area. Quilcene had never been known to suffer *Alexandrium* blooms, and the concentration of cysts in its surface sediments was very low, just five to 10 per cubic centimeter in 2011, 2012, and 2013. Quartermaster Harbor's concentrations were higher by an order of magnitude. But last year Quartermaster had no major blooms and Quilcene suffered a big one. Greengrove is still trying to puzzle out why.

# Carnage at Jimmycomelately Creek

Champion swimmer *Heterosigma akashiwo.*

Fish-killing *Heterosigma akashiwo* is another single-celled bundle of puzzles and surprises — and a growing concern in Washington's waters. Until September 16, 2014, *H. akashiwo* had only been confirmed to cause fish kills in aquaculture pens. On that day Jamestown S'Klallam tribal biologist Neil Harrington, a linchpin in SoundToxins' monitoring network, took some routine water samples at the south end of Sequim Bay, beside the tribal center. He noted that the water's surface was "quite reddish-brown." When he examined the water under the microscope he discovered that it was "full of *Heterosigma*." He estimated a whopping 24 million cells per liter and sent a sample to NOAA's Northwest Fisheries Science Center for confirmation. The NOAA scientists found even more, 66 million cells per liter.

Later that afternoon Harrington spotted a chum salmon that had been on its way to spawn in nearby Jimmycomelately Creek, washed up on a mudflat. Four more appeared by evening. The brown bloom lasted another week. By the end, 345 chum, three perch, and a flatfish had washed up. On the night of September 23, the winds rose and blew away the bloom, and no more dead fish appeared.

"We think this is the first confirmed kill of a wild fish population by *Heterosigma*," says SoundToxins director Vera Trainer. It adds one more level of complexity to the profile of this elusive but widespread alga.

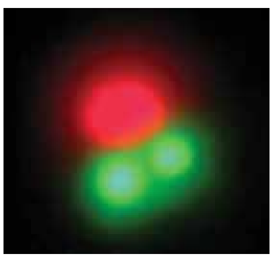
"*Heterosigma* is difficult to study," says UW algae biologist Rose Ann Cattolico, who nevertheless has been doing just that under a grant from Washington Sea Grant. "It has an enormous genome, the size of yours or mine" — unlike many other algal species. This gives *H. akashiwo* a big bag of tricks, including one Cattolico is especially interested in: its ability to lie in sediment in a dormant resting state when environmental conditions are uncongenial and then emerge, with devastating speed, when conditions improve.

Unlike *Alexandrium*'s cyst stage, this "sleeper cell" state is not a mandatory growth phase with a hardwired minimum duration; it's an opportunistic response to conditions — a sleek "bioweapon," as Cattolico puts it. When they emerge from their torpor, *Heterosigma* cells swim rapidly to the surface and resume their active lives, photosynthesizing and growing, forming massive blooms, and poisoning fish and other animals that cross their path.


*Heterosigma* on the move.

Then-UW graduate student Elizabeth Tobin added another layer of complexity to the picture. By incubating *H. akashiwo* in the lab, she showed that it could emerge from its sea-bottom torpor with surprising speed, within hours of receiving the right heat and light cues. And it is versatile: Tobin compared two strains and found that one can transition faster to the active state but the other swims faster once it makes that transition. *Heterosigma* thus hedges its bets, with two alternate strategies at a key point in its lifecycle.

Cattolico is working to parse out exactly how these single-celled biowarriors effect this change, right down to the cellular and molecular levels. She's undertaken the first closely integrated study of the behavioral, metabolic, and genetic foundations of *H. akashiwo's* dual lifestyle. This includes sequencing its transcriptome, after first sequencing a proxy alga, *Chrysochromulina tobin* (named after Cattolico's son; she was the first to identify this species), that has a much smaller, easier-to-analyze genome. That provided a roadmap for identifying important *Heterosigma* genes; otherwise, Cattolico explains, "it's sort of like a molecular archaeological dig. If you go in blind, it's too much."

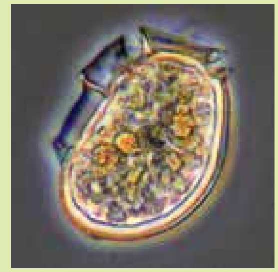

*Chrysochromulina tobin.*

She and her colleagues found a number of "really cool genes that hadn't been described before," and the molecular markers needed to distinguish (or "barcode") the various *Heterosigma* varieties floating in Northwest waters. "We've tested various strains on fish and gotten very different responses." They don't necessarily need to kill the fish outright to do damage; some strains have been shown to kill eggs in both finfish and sea urchins.

Follow the fat: Cattolico, who is also working on extracting biofuels from algae, has found that the levels and types of lipids *Heterosigma* produces are key to its swimming feats and metabolic transformations. Lipid levels soar when the algae enter their active swimming state, filling large balloon-like sacs in their cytoplasm, which empty when they go dormant. Understanding how *Heterosigma* utilizes this fat may provide the key to anticipating *Heterosigma* blooms.

# NEW HABS ON THE BLOCK

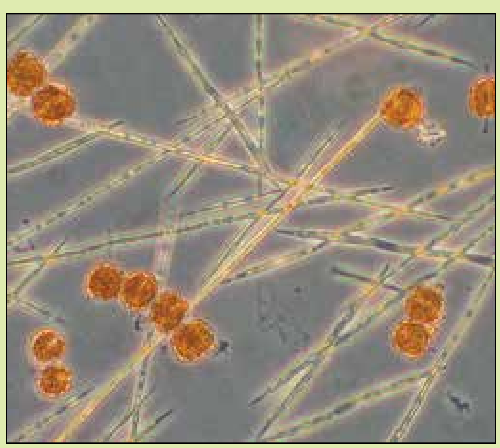
Not only do the familiar *Alexandrium* blooms seem to be striking earlier and lasting longer, they've been joined by a new bad actor, plus a formerly benign alga that has lately broken bad. *Dinophysis*, the dinoflagellate whose toxins cause the self-descriptive diarrhetic shellfish poisoning (DSP), drifted for decades in local waters without apparent harm. Then, in June 2011, three people came down with DSP after eating mussels from Sequim Bay; soon after, 60 mussel fanciers on Canada's Saltspring Island got sick. In 2012, SoundToxins and ORHAB began screening for *Dinophysis*, and the Health Department found elevated levels of its toxins in mussels and clams from many sites around the Salish Sea.


Diarrhetic culprit *Dinophysis*.

And now yet another potential HAB threat has appeared: a tiny dinoflagellate called *Azadinium spinosa*, which produces a particularly potent toxin called azaspiracid. At just 7 microns, *Azadinium* is so small it slips through the mesh of the plankton nets used to collect other HAB samples. SoundToxins monitors gather trial samples using circle SPATT bags, hoops filled with beads of plastic resin that collect lipophilic (fat-loving) compounds such as azaspiracid. They first identified *Azadinium* off North Seattle in 2009; they've since found it throughout the Sound and along the coast.

In Europe, where it first appeared in 1995, *Azadinium* has caused outbreaks of illness and closures of shellfish beds. Has it made people sick in Washington? SoundToxins and the Health Department have sought but so far failed to find a correlation between *Azadinium* outbreaks and bouts of unexplained illness in shellfish eaters.

Given these new and accelerating perils, the State Health Department's Jerry Borchert would love to see SoundToxins extend its monitoring to more corners of Puget Sound: "There's a lot of bays here, and every one is unique," he explains. Volunteers are eager to pick up the slack; the problem is getting the funds to equip them. "We always have folks who want to join and never have enough microscopes for them all," sighs Trainer. "So we prioritize."


Chains of *Alexandrium* and *Pseudo-nitzschia*.


Tiny *Azadinium*.

## Spiking toxins and early warnings

At the Washington Department of Health, biotoxins coordinator Jerry Borchert reviews SoundToxins' monitoring reports and scans its database regularly for emerging HAB threats. "It's an early-warning capability we've come to rely on," he says. "It helps me prioritize where and how often we collect samples to test for those biotoxins." Borchert recounts one incident, shortly before SoundToxins' monitoring was in place, that could easily have led to tragedy. In two weeks, the levels of PSP toxin in mussels gathered at Port Ludlow soared from zero to 1,000 micrograms per 100 grams of tissue — more than 12 times the "action level" triggering shellfish closures, and more than enough to sicken most consumers.

Luckily, that toxic spike caused no known illnesses. SoundToxins is now in place to help ensure that future eruptions don't have tragic effects. As Trainer and Borchert describe it, the need for early warning grows ever more acute. "In the past decade, especially the last five years, we seem to get much higher, more rapid spikes in toxin levels," says Borchert.

Adi Hanein, a WSG-funded Marc Hershman graduate fellow working in Borchert's office, is now reviewing decades of Health Department records to determine whether PSP spikes and shellfish closures are starting earlier in the year or lasting later as the climate warms, or both. She's also probing to see whether they correlate with temperature fluctuations, wind patterns and, in recent years, spikes in the algal toxins that cause another illness, diarrhetic shellfish poisoning.

Hanein plans to analyze data from all Washington's saltwater counties, starting with Whatcom and Island Counties' histories of mussel closures. She found a pronounced trend toward earlier blooms in Whatcom. In the early and mid-1990s closures typically started in late June or early July, sometimes as late as October, with the last typically ending in mid-October. "Now they're showing up in early to late May," says Hanein — and recurring until mid-November. In 2009–10, PSP toxin levels spiked at a whopping 7,000 to 8,000 micrograms per 100 grams of mussel tissue in three Whatcom County bays — nearly four times as high as previous local peaks.

Two aspects of *Alexandrium* particularly worry Borchert. "It can bloom in any season, and its toxins can linger as long as one or two years, long after the alga itself has receded, in butter clams and, especially, purple varnish clams, a prolific nonnative species."

## Cellphone imagers and 3-D printers vs. harmful blooms

Coyle and Grünbaum print a plankton sensor case.

It was Rose Ann Cattolico who first got UW oceanography professor (and fellow algae aficionado) Daniel Grünbaum interested in *Heterosigma*, and they coauthored several papers on its behavior. But Grünbaum has taken a very different approach to the mission of catching harmful blooms before they cause damage: to try to spot *Heterosigma* cells the moment they emerge from their torpor and begin swimming to the surface. This means monitoring continuously rather than sampling periodically. And that means automation.

With support from Washington Sea Grant, Grünbaum and graduate students Owen Coyle and Elizabeth Tobin (who's since gained her doctorate and an NSF grant in Alaska) have developed and progressively refined automatic, wirelessly networked in-the-water sensors with video and image-recognition capabilities. These sensors have manifold potential uses; Grünbaum and Coyle have used them to sample protists and other zooplankton in the seawater flowing by a cruising ship. Working with the Suquamish Tribe's Chief Kitsap Academy, they have also developed a simplified version that students can build and deploy to measure tides, waves, currents, and water temperature.

But their prime goal is to track HABs reliably, inexpensively, and in real time. Advances in microprocessing, networking, and imaging technology have made this increasingly feasible, using cellphone parts and other off-the-shelf gear. Now 3-D printing has filled a key missing link.

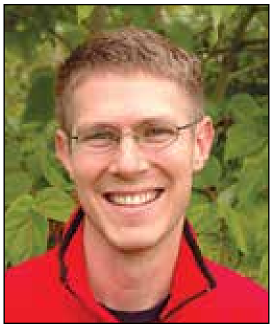
The sensors exploit one trick in the alga's evolutionary bag. *Heterosigma* thrives in low-salinity waters that repel many of its predators and competitors. The sensors have two miniature pumps, one of which fills an underwater chamber with fresher water from a storage tank. The other then pumps the seawater to be tested into the bottom portion of the chamber, and a halocline barrier forms between the salt and semi-fresh water. Any *Heterosigma* present swim up into the latter and stay there; other plankton stay below the halocline. A built-in video camera captures and transmits real-time imagery. Image-recognition software can then count the algae present.

A prototype deployed in summer 2011 at American Gold Seafoods' Bainbridge Island salmon farm accurately counted *Heterosigma* in the surrounding water. But the rig was as big as an outhouse, with a garbage can-sized water supply, and prone to break down. "There was no way you'd get 10 sensors that would still be working," says Coyle, "much less get 10 people to let you put them on their docks."

Coyle arrived after graduating from Princeton and set about refining and streamlining this bulky rig. He eliminated its biofouling-prone PVC piping and replaced its exterior lights, which were exposed to the salt water and suffused

3-D printers • continued on back

# FIELD NOTES



**Jeff Adams**, WSG's Bremerton-based marine water quality specialist, and citizen science specialist **Kate Litle** are working with UW colleagues to organize a regionwide volunteer network to monitor Washington's inland seas for one of a notorious invasive species, the European green crab. These voracious crabs, which have wreaked havoc on East Coast shellfish, appeared on Washington's outer coast in 1997 but didn't appear to enter inland waters. But in 2012, a population was discovered in the Salish Sea, near Victoria. In response, starting this summer and continuing long-term, participating groups and individual volunteers coordinated by WSG will monitor pocket estuaries and other habitats favored by the crabs. WSG will also reach out to encourage the public to watch for the crabs at other sites. To join the effort or receive green crab updates, contact Jeff Adams at *jaws@uw.edu*.

On a happier note, volunteer monitors organized by **Jeff Adams** and **Melissa Miner**, a Bellingham-based, WSG-supported ecologist, report a hopeful sign for Pacific sea star species devastated by a mysterious wasting disease. From Bellingham to South Puget Sound and at some California sites, monitors are seeing surges of new sea stars. "We're seeing a lot fewer big stars, but the ones we're seeing are mostly healthy," reports Jeff. "We're also seeing a lot of young healthy stars and maybe a bit of a shift in species, from more purple to more mottled stars, but that's definitely anecdotal. It feels good to not be seeing much disease" – at least in inland waters. Stars on the ocean coast are still faring badly. The test on the Salish Sea will come in late May and June, when the water warms; that's when wasting disease has previously peaked. Meanwhile, Melissa and her husband, Ben Miner, are among the coauthors of a paper published last month in the *Proceedings of the National Academy of Sciences* identifying a virus involved in the disease. See "Densovirus associated with sea star wasting disease and mass mortality," *pnas.org/lens/pnas/111/48/17278.*

WSG's coastal hazards specialist and resident geologist, **Ian Miller**, has coauthored a paper in Geomorphology on the dramatic changes that have come to the Elwha River delta following the removal of two dams and restoration of natural sediment flow. Ian's Port Angeles base gives him a ringside seat on this historic process. See "Large-scale dam removal on the Elwha River, Washington, USA: Coastal geomorphic change," *sciencedirect.com/science/article/pii/S0169555X15000148.*

The numbers are in from the Washington State Parks Department's Clean Vessel Act Program, and WSG boating specialist **Aaron Barnett** has something to celebrate. Thanks in good part to the clean practices and convenient pumpout stations promoted by Pumpout Washington, a State Parks/WSG collaboration, boaters diverted 6 million gallons of raw sewage from Washington's waters to proper treatment onshore. That's 200,000 gallons more than they pumped out in 2013 and 1.2 million gallons more than in 2012. Or consider another measure: It's enough to fill downtown Seattle's Arctic Building.

**MaryAnn Wagner**, a fourth-generation UW alum, is pleased to be back on campus as WSG's new assistant director of communications. MaryAnn brings a solid portfolio of experience in communications and marketing for local nonprofit educational organizations. She was previously director of community relations at Classical KING FM, where she developed the station's first communications department. Always seeking ways to meld her love of science, history, and art, she has also held positions in communications at the Burke Museum, Frye Art Museum, and Museum of History and Industry. She has a BA in journalism and, of course, communications with a certificate in technical editing, both from UW.

Spring is the season for two cherished celebrations: Mardi Gras and, for budding young oceanographers and marine biologists, **Orca Bowl**. Once again, on February 28, 20 teams from high schools around the state gathered at the University of Washington's Fishery Sciences Building to vie for a slot at the National Ocean Sciences Bowl, to be held in April in Ocean Springs, Mississippi. Last year, Washington Sea Grant hosted the nationals and WSG education specialist **Maile Sullivan**, education specialist **Nancy Reichley**, and research analyst **Chelsea Kahn** somehow managed to coordinate both bowls. This year Maile and student assistant **Skadi von Reis Crooks** stuck to the local Orca Bowl, sponsored as usual by UW's College of the Environment. There were plenty of non-trivial contest thrills for this year's audience. Two new contenders — Newport and Interlake high schools, both strictly freshwater — made an impressive first splash. In fact, Interlake B team claimed the Megan Vogel Sportsmanship Award. Past champs, San Juan High School A team won the coveted first place in a tight competition, with Tacoma's Science and Math Institute (SAMI) A team winning second and Seattle's Garfield Pirates laying claim to third place. More than 115 students on 20 teams enthusiastically competed, making the 2015 Orca Bowl a huge success.

Orca Bowl angels (clockwise from right) Maile Sullivan, Skadi von Reis Crooks, Chelsea Kahn, and Nancy Reichley, with a non-marine friend.

Sea Grant Washington

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## National Sea Grant Office Will Review Washington Sea Grant May 12-13

Every four years, a site review team from the National Sea Grant Office visits each Sea Grant program. The team assesses, discusses, and reports on broad issues related to:

- Program management and organization
- Stakeholder engagement
- Collaborative network/ NOAA activities.

We welcome your comments on our programs in advance of the site visit. Please send comments to *oar.sg.feedback@noaa.gov* at least one week before the visit on May 12, 2015. Thank you!

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the algae in glare, with internal lights and an angled mirror that yielded a crisper image. And he set about producing a smaller, more precisely calibrated structure via 3D printing.

At first Grünbaum, who was on sabbatical in Tasmania, exchanged designs with Coyle by email, printing out prototypes on nocturnal visits to a maker club called the Hobart Hackerspace. "When things didn't work, which was most of the time, there was usually someone around who could help." A buddy at Google helped out with a little after-hours time on the office 3D printer. Finally Grünbaum sprang for a $2,000 printer, greatly speeding the development process.

The resulting structure contains about $3 worth of plastic and looks like an oversized inkjet cartridge. Grünbaum wants to get the system's total cost down to less than $500 per unit and deploy the sensors throughout the inland sea, on a "crowdsourcing" scale; he's aiming for 10 to 20 in his current WSG grant. It's the same principle that underlies the SoundToxins network, only automated. The sensors could complement the human monitors, and track much more than just *Heterosigma*. They've already succeeded in spotting *Alexandrium* chains as well as passing protists and copepod and gastropod larvae.

Could this technological boost give humans a decisive edge over the elusive blooms? After years of trying to suss out *Alexandrium's* ways in Quartermaster Harbor, SoundToxins volunteer Karlista Rickerson is skeptical: "The more our technology improves, the more scientific equipment and molecular data we have, the more DNA we test, the more puzzles we find. The more we know, the more we don't know."

## FLOATABLE & QUOTABLE

### Our Toxic Algae, Ourselves

"*Heterosigma* is difficult to study. It has an enormous genome, the size of yours or mine." — UW biologist Rose Ann Cattolico, in this issue's story on "Carnage at Jimmycomelately Creek."