



# Sea Star

## The Puzzle of Puget Sound Herring

### Washington Sea Grant-funded Scientists Examine the Genetic Relationships Among Regional Herring Stocks

By Jeff Bowman, Washington Sea Grant Science Writing Fellow

When most people picture herring, they see jars of small, pickled tidbits sold in the grocery store. But when University of Washington scientist Lorenz Hauser and graduate student Danielle Mitchell think of these silvery schooling creatures, they see a living model of how fish populations are structured in Puget Sound.

With support from Washington Sea Grant, Hauser and Mitchell have developed a way to identify unique stocks of herring in Puget Sound. With this information, they hope to answer some important questions. Perhaps the most puzzling of these is why a distinct stock of herring at Cherry Point, north of Bellingham, is in decline while other stocks at other locales are increasing.

Like other estuaries, Puget Sound supports a vast and complex ecosystem. From tiny phytoplankton at the base of the food web to large predators such as salmon and orcas at the web's top, many species are uniquely linked by food preferences and habitat needs. Scientists have long thought this kind of interdependence represented a natural system of checks and balances. For example, if any one species is pressured through overfishing, water pollution or natural events, other species are present to take its place. However, within the Puget Sound ecosystem, there are several keystone species — fish, birds or marine mammals that occupy unique niches between the bottom of the food pyramid and its top.

Herring • continued on page 2





Puget Sound's herring are among these keystone species. They feed on copepods and other small marine invertebrates and, in turn, are preyed on by salmon, seabirds, spiny dogfish, seals and other large predators. No other species in Puget Sound occupies the exact same position in the food web. As a result, the entire Puget Sound ecosystem is dependent on the health of local herring.



It stands to reason that scientists and fisheries managers would have an interest in maintaining healthy herring populations. However, because of the way that herring and other fish populations are structured, this has not been an easy task. Puget Sound herring are divided among 18 distinct stocks, with each stock spawning in the nearshore environment of a specific locale. The rest of the year, the stocks mingle freely throughout Puget Sound and beyond, making it difficult to monitor the health of any single stock of herring.

(Above) Herring tissue samples awaiting analysis in Hauser's lab; (middle) UW School of Aquatic and Fishery Sciences graduate student Danielle Mitchell at sea; (below) Lorenz Hauser in his office at the UW Marine Studies Building.

Take the example of the Sound's Cherry Point herring stock. Cherry Point herring were once Puget Sound's most numerous stock. However, this population has declined by as much as 90 percent in recent years. These fish spawn near the mouth of the Fraser River, at a later time in the year than any other stock in Puget Sound.

Did the fish really disappear or did "missing" Cherry Point herring simply join stocks elsewhere in the Sound? Scientists had long noted that decreasing



numbers of herring at one spawning site are often matched by increasing numbers at other sites. This suggested that migration, not a low survival rate, might account for the Cherry Point herring's decline. To confirm this theory, scientists needed a way to determine the rate of migration among Puget Sound's herring stocks.

For Hauser and Mitchell, the best way to track herring migrations was by comparing herring microsatellite DNA markers — a class of noncoding "junk" DNA, which consists of short, repetitive DNA sequences that vary in length because of transcription errors during cell division. The microsatellites perform no real function, neither helping nor hindering an organism. As such, they are largely unaffected by selection pressures. Geographically isolated subpopulations develop different microsatellite frequency distributions — a fact that enables scientists to determine who's who among fish populations. The more isolated a stock of herring is, the more distinct its members' microsatellite markers will be. Herring stocks that recruit members from neighboring stocks have less distinct markers.

Working with the Washington Department of Fish and Wildlife's Kurt Stick and Greg Bargmann, Hauser and Mitchell captured herring from places in the Sound the fish are known to congregate prior to spawning. While studying these fish's microsatellite DNA, the two researchers learned that most Puget Sound herring stocks were indistinguishable, indicating that plenty of migration occurs among the members of individual stocks. However, the Cherry Point herring stocks were genetically divergent — a finding supported by an earlier study conducted by Maureen Small and others at WDFW.

Hauser and Mitchell also report that a small, genetically distinct population identified by Small at Squaxin Pass could not be found. Instead, the fish they collected at Squaxin Pass appeared to originate from stocks further north. This finding supports the idea that some of the fluctuations in herring numbers in southern Puget Sound may be due to migration. The Squaxin Pass stock may have completely disappeared between 2002 and 2005, only to be "reborn" through migration from neighboring stocks. Hauser and Mitchell are currently analyzing new samples to test this theory.

Evidence from Hauser's and Mitchell's studies suggests that herring in Puget Sound exist as a complex of ever-changing stocks. Some of these stocks, such as the one at Cherry Point, are isolated. Others, such as the Squaxin Pass stock, may decline or disappear only to be replaced by migrants from

# Marinas: Safeguarding Washington's Waters

By Eric Olsson, WSG Oil Spill Prevention Education Specialist

This is the fourth in a series of essays exploring the opportunities and issues addressed by Washington Sea Grant specialists in offices throughout western Washington.

Some people view marinas as sources of water pollution. I tend to see them as environmentally friendly gatekeepers, controlling the chaos of unmanaged boating operations that might otherwise severely damage Washington's marine habitats.

Marinas frequently take the blame for water quality degradation, simply because they are usually situated at the water's edge, where contaminants from upland sources may become concentrated. Depending on one's source, estimates of this polluting runoff can reach millions of gallons each year...each drop adding to the toxic load of Puget Sound and other state waters. The real culprits behind water quality degradation may often reside upstream, in the form of unwise (and often unregulated) land-use activities.

Our state's marinas have many important functions. One of these is the consolidation of water-based activities. Without marinas as focal points, commercial and recreational boating would be haphazardly distributed throughout Puget Sound and other Washington waterways. There would be minimal monitoring of these vessels and an absence of best management practices and policies to deter pollution-prone maintenance practices and unintentional discharges of contaminants. An environmental crisis would unfold — the result of countless pollution incidents stemming from this lack of oversight and control.

In my position as WSG's Small Oil Spill Prevention Education Specialist, I've worked to promote greater environmental awareness and to assist ports and marinas to institute effective pollution prevention policies and education programs. As a member of the Washington Clean Marina Partnership, I provide technical assistance and oversight in certifying marinas throughout our region to ensure they meet the highest environmental protection standards and demonstrate leadership in promoting pollution prevention.

Since its inception in 2006, the Clean Marina program has recognized nearly 40 marinas statewide for their dedication to preserving our waters. This represents almost a third of marinas operating throughout Puget Sound and has established the momentum and acceptance to prompt expectations of certifying over 80 percent of marinas within the next few years.

I've chaired the Pacific Coast Congress (PCC) of Harbormasters and Port Managers' education committee for the past five years, working to ensure that environmental issues and concerns are resolved through presentations, facilitated discussions and online networking. The PCC's 200 members have instituted measures to further their commitment to the elimination of pollution threats related to marina operations, offering seminars at all PCC conferences and through active participation in Internet exchanges. I am directly involved in promoting this effort to secure solutions from within the industry and other sources.

In addressing some of the most serious causes of pollution at marinas, I've developed a comprehensive online course titled Oil Spills: Prevention, Preparedness and Response. This course identifies the sources and causes of small oil spills related to boat and marina operations and maintenance and offers strategies to eliminate these sources. It is currently available through the University of Alaska Southeast at [uas.alaska.edu/sitka/coed/ports\\_marinas.html](http://uas.alaska.edu/sitka/coed/ports_marinas.html).

I'm also the chair of the Pacific Oil Spill Prevention Education Team (POSPET), which, through its Spills Aren't Slick and 1-800-OILS911 campaigns, is engaged in promoting oil spill prevention throughout the Pacific Northwest. Both campaigns provide simple steps to eliminate spills, while also offering an easy-to-remember, toll-free number for reporting oil spills. POSPET representatives from agencies and environmental groups in Alaska, British Columbia, Washington, Oregon and California recognize that small oil spills are a regional problem, best resolved with regional resources. Such an approach ensures an accurate and consistent spill prevention messages drawn from the innovation, skills and experiences of individuals throughout the Pacific Northwest.

After many years spent raising awareness and providing technical assistance through potent WSG outreach programs and by simply roaming the docks, I've observed that marina operators have become progressively more sensitive to preserving our waters and more demanding about instituting marina policies that eliminate the most pollution-prone operations. Things have become much better because marina operators *do* care. With help from WSG and other institutions and individuals, they will continue to serve as the gatekeepers, safeguarding our waters from pollution originating with the boats moored at their facilities and from other sources, throughout the state. Contact Olsson at 360.221.4636 or [olsson@u.washington.edu](mailto:olsson@u.washington.edu)



Eric Olsson

**J**im Brennan, WSG Marine Habitat Specialist, has contracted with the state departments of Fish & Wildlife and Ecology to draft a marine riparian guidance document for use by local jurisdictions as they complete Shoreline Master Plans and other planning elements for shorelines. Brennan and his team will complete a draft document and then coordinate a workshop in August or September to critique and review this piece. The completed document will be available in the fall. For information: Jim Brennan, 360.337.5625 or [jbren@u.washington.edu](mailto:jbren@u.washington.edu).

**T**wo Washington Sea Grant staff members attended meetings near Washington, D.C., in June to help the National Sea Grant Office develop plans for addressing key national marine issues. **Marine Ballast Water Specialist Russ Herwig and Communications Manager Dan Williams** represented WSG at the meetings. Herwig, who is also a Research Associate Professor in the UW's School of Aquatic and Fishery Sciences, served on a panel focusing on healthy coastal ecosystems. Williams' team is looking at ways to ensure a safe, sustainable supply of seafood. Their work will help develop a national plan, giving state Sea Grant programs direction

in addressing critical national needs in coastal, ocean and Great Lakes environments.

**A**s she has done for several prior summers, **Teri King, WSG Marine Water Quality Specialist** in Mason County, is working with Hood Canal and South Puget Sound residents to ensure that the shellfish on their beaches are safe to eat. For the State of the Oyster Study, waterfront residents gather oysters and clams from their beaches, delivering them to drop-off stations, where the samples are sent to a lab for testing. If the test results reveal high bacteria levels, King recommends actions for people to keep their beaches disease-free. The next scheduled collection days

are July 20 and August 17. Contact King for details, at 360.432.3054 or [guatemala@u.washington.edu](mailto:guatemala@u.washington.edu).

**WSG's Program Leader for Marine Advisory Services, Pete Granger** is coordinating business and financial training workshops for Lummi tribal fishermen with the Northwest Indian College and Lummi Ventures Program. College business teachers will conduct the workshops, which will be held throughout the summer. This program is facilitated by a grant from USDA under the Trade Adjustment Assistance Intensive Technical Assistance program. Contact Granger at 206.685.9261 or [pgranger@u.washington.edu](mailto:pgranger@u.washington.edu).

## New Geoduck Research Projects Announced

**W**ashington Sea Grant recently awarded grants for three major projects to examine the possible environmental effects of geoduck aquaculture in and around Puget Sound, including the Strait of Juan de Fuca. The projects will meet the State Legislature's directive to commission research studies to examine current geoduck aquaculture practices and inform future decisions about the management of on-bottom shellfish aquaculture activities.

Geoduck aquaculture is a potentially valuable industry for the state. Geoducks exported to Asia can fetch prices of up to \$30 per pound, fueling a market currently estimated at about \$80 million annually in Washington and British Columbia. However, geoduck farming has raised concerns. These include the possibility that seed from hatchery broodstock could reduce the genetic diversity among wild populations, making them less resistant to disease and the range of conditions in Puget Sound.

Another consideration is the effect of geoduck farming and harvesting on intertidal and subtidal communities of animals and plants. Today's geoduck farmers use short segments of PVC pipe and plastic netting to exclude clam-eating predators during the young geoducks' early years of growth. Harvest methods include liquefying the sand around geoducks with high-pressure hoses — measures that could affect nearshore habitats.

"There's been a tremendous surge in interest in geoduck aquaculture," says WSG Assistant Director Raechel Waters, who is coordinating the geoduck research. "But we just don't have enough information to assess the potential benefits and drawbacks to the ecosystem. Research findings will provide the scientific foundation for policy decisions that balance the needs and concerns of shellfish growers, environmental groups and property owners."

Based on the recommendations of peer-reviews, a specially convened panel of experts and the state-appointed Shellfish Aquaculture Regulatory Committee, WSG has selected the following projects for funding:

### **Geochemical and Ecological Consequences of Disturbances Associated with Geoduck Aquaculture Operations in Washington**

Principal Investigators: Glenn VanBlaricom, David Armstrong and Tim Essington, UW School of Aquatic and Fishery Sciences, and Jeffrey Cornwell and Roger Newell of the University of Maryland's Horn Point Marine Laboratories

As part of a large-scale multidisciplinary study, researchers will address several of the most pressing issues regarding the effects of geoduck aquaculture on the Puget Sound ecosystem:

- What are the effects of aquaculture structures on communities of plants and animals living in or on Puget Sound beaches?
- Do structures change the behavior or movements

In May, **Marine Field Agent Steve Harbell** and **Eric Olsson, WSG's Oil Spill Prevention Education Specialist**, conducted safety training exercises for over 400 crewmembers of American Seafood's factory trawler fleet. Conducted at Fishermen's Terminal in Seattle, in collaboration with the US Coast Guard's Marine Safety Office, NOAA Fisheries and other organizations, the hands-on training was in response to the sinking of a similar vessel in the Bering Sea this past spring.

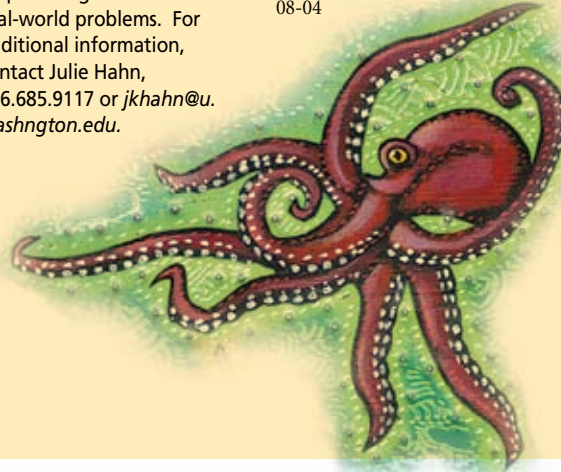
As of this writing, the WSG-cosponsored NOAA Science Camp has set an all-time attendance record — 105 seventh and eight graders enrolled in two week-long sessions. "We've quite a long waiting list, too," says **WSG Education Coordinator Julie Hahn**.

"That's a reminder to parents to register early and to watch for registration to open in mid-March of 2009! Thanks to camp supporters, Sea Grant and NOAA continue to offer full scholarships to a minimum of 10 percent of each week's campers, making it possible for kids who may not otherwise attend to experience science first-hand."

Held each July at NOAA's Sand Point, Seattle, facility on Lake Washington, the camp introduces kids to earth and ocean sciences and to science careers through hands-on activities emphasizing solutions to real-world problems. For additional information, contact Julie Hahn, 206.685.9117 or [jkahn@u.washington.edu](mailto:jkahn@u.washington.edu).

Editor, David G. Gordon; Designer, Robyn Ricks; Web Editor, Marcus Duke; Communications Manager, Dan Williams. Photos © Washington Sea Grant, except as noted. ©2008, University of Washington, Board of Regents. WSG-MR 08-04

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- of salmon, Dungeness crab and other commercially and ecologically important fish and shellfish?
- How does disturbance during geoduck harvesting affect communities of plants and animals and subsequent recovery of the ecosystem?
  - How does disturbance during harvesting alter the physical and chemical properties of Puget Sound beaches?

Throughout the geoduck culture cycle, researchers will specifically investigate ecosystem-level effects, including initial conditions and patterns of recovery, following activities such as installing structures or harvesting clams, for an array of organisms. The research team will compare periodic disturbances associated with culture activities to those of storms and other naturally occurring disturbance.

### **Resilience of Soft-Sediment Communities after Geoduck Harvest in Samish Bay, Washington**

Principal Investigator: Jennifer Ruesink, UW Department of Biology

In 2002, geoducks were planted in a soft-sediment tideflat in Samish Bay to establish a commercial shellfish bed. Since then, eelgrass has colonized the bed. This project will explore changes in soft-sediment tideflats and eelgrass meadows within and nearby the geoduck bed during the culture cycle, from harvesting the clams through the reseeding of a new crop and the removal of predator exclusion pipes and netting. Detailed surveys from before and after these events,

both inside and outside the geoduck bed, will produce data on initial impacts on and rates of recovery for eelgrass meadow and soft-sediment invertebrate communities. These data will shed light on interactions between commercial geoduck aquaculture practices and local marine habitats.

### **Cultured – Wild Interactions: Disease Prevalence in Wild Geoduck Populations**

Principal Investigators: Carolyn Friedman and Brent Vadopalas, UW School of Aquatic and Fishery Sciences

A lack of baseline information on geoduck health and condition hinders the management of this resource. In this project, researchers will characterize parasites and other disease organisms associated with geoducks and determine their prevalence in three wild populations representing southern Puget Sound, Hood Canal and the Strait of Juan de Fuca. Animals will be collected during summer and winter to facilitate detection of both warmwater and coldwater infectious organisms.

**More information about geoducks and WSG geoduck research is available at [wsg.washington.edu/research/geoduck/current\\_research.html](http://wsg.washington.edu/research/geoduck/current_research.html).**



Hauser's herring, frozen and bagged, may hold valuable clues to the health of Puget Sound fish stocks.

other herring stocks.

This system appears to be working for herring populations as a whole. When one stock is in trouble, migrants from another stock may reinvigorate it. Still, the fish's tendency to migrate makes management of herring and their spawning habitats difficult, because migration masks potential environmental problems within a single stock. And while migrants from other stocks can make up for

losses of herring from a declining stock, this strategy does not compensate for any loss in genetic diversity.

“Estuaries are not static environments,” Hauser explains. “It may be that each stock has slightly different adaptations to its environment. As conditions change, regional herring populations can make use of this stockpile of adaptive strategies to survive, and currently less important stocks may become major components in the stock complex. This ‘biocomplexity’ has been shown previously in Alaskan sockeye salmon, but is undervalued in marine fishes. Support by Washington Sea Grant is crucial to improve our understanding of such interactions in marine ecosystems.”

Hauser plans to continue working to solve the herring population riddle. Currently, he and Mitchell are analyzing the data from the 2007 season and intend to publish the findings.



## New Publication Opens Many Academic Doors

*Fellowships for the Future: Opportunities for Career Enhancement and Academic Growth* is an informative eight-page overview of support programs for undergraduates, graduate students and doctoral and post-doctoral candidates to gain direct experience in marine policy-making, coastal planning, marine population dynamics, resource management and communications. Washington Sea Grant leads all other Sea Grant programs in successfully placing fellows in these disciplines. For copies, contact WSG Publications, [sgpubs@u.washington.edu](mailto:sgpubs@u.washington.edu).

# A Wealth of WSG-Nominated Fellows

Congratulations to Mark Gleason (UW School of Marine Affairs) and Caroline Paulsen (UW School of Aquatic and Fishery Sciences), newly accepted Dean John A. Knauss Marine Policy Fellows for 2009. This national fellowship provides graduate students one-year work experiences on the staffs of the U.S. Congress or federal agencies addressing marine issues.



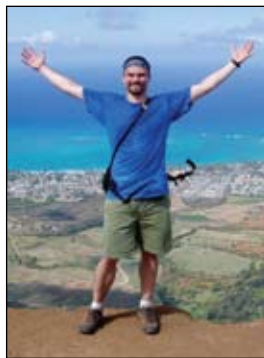
Caroline Paulsen

Gleason is a familiar face at Washington Sea Grant's Seattle office, where he has been assessing the need for professional training of seafood counter help and their managers. He is a Master's candidate at the UW and working toward a Certificate of Global Trade, Transportation & Logistics Studies. Paulsen is a UW Master's candidate at SAFS, studying low dissolved oxygen (hypoxia) levels in Hood Canal.



Mark Gleason

Congratulations also to Kevin See (UW's Quantitative Ecology & Resource Management program), who received the 2008 Sea Grant/NOAA Fisheries Fellowship in Population



Kevin See

Dynamics. See will be working under UW professor Jennifer Ruesink. His research focuses on estimating population growth and interspecies interaction parameters that will be applied to West Coast groundfish communities. "I'm hoping to refine techniques that can be applied elsewhere, to other fisheries," See says.

Another round of applause for Deborah Purce, the 2008 Coastal Management Fellow. Purce has a Master's degree in marine and estuarine science from Western Washington University and received a U.S. Student Fulbright Scholarship to help address marine conservation issues in Chile. In her fellowship role, she'll be working with the state Department of Ecology to develop a public access component of the Washington Coastal Atlas.



Deborah Purce

The first recipients of the Marc Hershman Marine Policy Fellowship have also been announced. They are Angie Fredrickson, a Master's candidate at SMA, and Nathalie Hamel, who is finishing her doctoral degree at SAFS. The Hershman Fellowship places graduate students with Washington State Ocean Caucus agencies in Olympia to work on ocean and coastal policy issues.



Angie Fredrickson



Nathalie Hamel

# WSG Helps Launch Kitsap Program



by Carolyn White

Washington Sea Grant and Washington State University (WSU) Extension have partnered to launch the Kitsap Beach Naturalist Program for residents of Kitsap County and surrounding areas.

The program provides training for would-be environmental stewards along the Kitsap Peninsula's 360-plus miles of shoreline habitat. Each Kitsap Beach Naturalist is given a hat and vest to identify them as a volunteer with the new program. Backpacks filled with resources — field guides and books about shoreline processes and other relevant topics — are also available for volunteers to share with the public.

The Kitsap Beach Naturalist Program is modeled after several existing volunteer programs, including WSU/Island County Beach Watchers, and The Seattle Aquarium's Beach Naturalists programs.

"The ultimate goal of this program is to teach people how to tread lightly on their beaches — to understand and appreciate the beauty and fragility of what's around them and under their feet," says Jeff Adams, WSG's Marine Water Quality Specialist in Kitsap County.

To become Kitsap Beach Naturalists, volunteers must attend four classroom sessions, led by scientists from

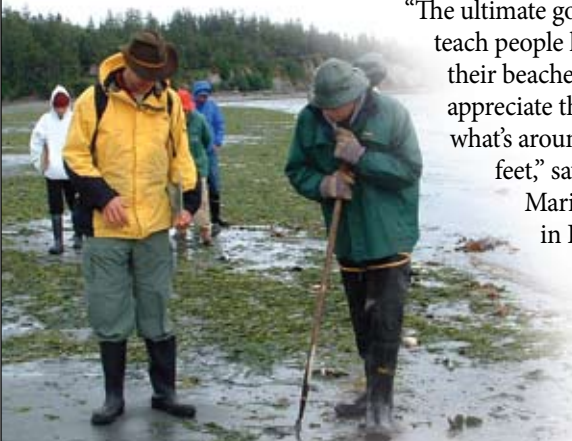
a range of marine-related fields. For the initial training, held at the Poulsbo Marine Science Center in May, the classroom speakers included UW marine scientist Greg Jensen, Washington Department of Natural Resources researcher Tom Mumford and Doug Myers, Director of Science with People for Puget Sound. As the co-coordinator for the program, Adams also shared his insights and expertise. Classroom topics ranged from basic oceanographic processes to proper beach etiquette and shoreline restoration. Classroom sessions were followed by expert-guided beachwalks designed to introduce the trainees to the wide range of coastal habitats along the Kitsap Peninsula's extensive shoreline.

Thirty-two people attended the first round of training. "The feedback from participants and from partnering organizations has been very positive, Adams says. "In fact, the staffs of several Washington State Parks have expressed interest in having Kitsap Beach Naturalists provide their services along their beaches."

In the future, program participants will have opportunities to attend lectures and presentations on a wide range of topics, including aquatic invasive species, shellfish farming and stormwater management. A refresher course is also in the works, to prepare volunteers for winter's nocturnal low tides.

For more information about the Kitsap Naturalists Program, contact Jeff Adams at 360.337.4619 or [jaws@u.washington.edu](mailto:jaws@u.washington.edu)

Tides were low and turnout was strong at a recent Kitsap Beach Naturalist training day.



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