Washington Sea Grant
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# Sea Star

## On the Trail of the Brown Rockfish

### Using advanced scientific techniques, tracking fish larvae gets easier in Puget Sound

*By Alex B. Berezow, Winter 2010 WSG Science Writing Fellow*

University of Washington associate professor Lorenz Hauser isn't exactly looking for Nemo the clownfish, separated at birth from his Pixar-animated mom and dad. But he *is* using cutting-edge methods in genetics, chemistry and oceanography to track down the far-ranging offspring of brown rockfish, *Sebastes auriculatus*, in Puget Sound. The aim of his Washington Sea Grant-funded research is to clarify the poorly understood population dynamics of this fish and, more importantly, to determine the ecological efficacy of the region's marine protected areas.

Brown rockfish inhabit shallow waters near artificial or natural reefs. They live about 25 years and can grow up to 22 inches. They reach adulthood at about four years of age, at which point they become "homebodies" and seldom travel outside their home territories. Throughout their lives, they play vital roles in the Puget Sound ecosystem. As juveniles, they are prey for salmon; as adults, they feed on crabs and smaller fish. However, little is known about the first three months of their lives, when the hatchlings drift in the water column as tiny larvae, much at the mercy of ocean currents and chance encounters with predators and prey. Because they are so tiny, it is very difficult to establish what happens to offspring born at a specific location.

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It is this poorly understood phenomenon that Hauser and his UW School of Aquatic and Fishery Sciences graduate student, Maureen Hess, are studying in Puget Sound. Collaborators on the project include Mitsuhiro Kawase of the UW's School of Oceanography and Raymond Buckley and Larry LeClair of the Washington Department of Fish and Wildlife (WDFW).

Members of the brown rockfish-tracking team (from left to right) Mitsuhiro Kawase, Larry LeClair and Raymond Buckley relax at the Des Moines, prior to deploying a drifter at Point Heyer.

Hauser's team first had to don dive gear and catch both adult and juvenile brown rockfish. "We dove in pairs, with two or four people doing the sampling," Hauser explains. "The juveniles were particularly difficult to catch because they are so small."

Indeed, rockfish juveniles settle while about an inch to 1.5 inches in length and are very capable of hiding in small crevices on rocky shores. Older, bigger adults tend to be wary of divers and other potential predators. "It's no coincidence that they became so old," says LeClair.

After the fish were captured, their genetic information was carefully analyzed. Contained within each fish's DNA are microsatellites — sequences of so-called "junk" DNA that have no known functions. However, because they consist of repetitive DNA sequences, these microsatellites are tremendously useful to population geneticists. The number of repeats for any given microsatellite can vary considerably from fish to fish. For instance, one individual rockfish might have 20 sequence repeats at a particular microsatellite while another might have 25 repeats. By determining the number of repeat sequences for several different microsatellites, a DNA profile can be constructed for each individual fish. Because such profiles are inherited from the parents, Hauser can use this information to identify parent-offspring pairs among the sampled rockfish.

Another fish-tracking technique is being used to corroborate the genetics data. This involves tagging the internal ear bones (otoliths) of the larval brown rockfish. Composed of calcium carbonate, otoliths are always growing and form concentric rings, which, like the rings in a tree, can be used to determine a fish's age. More importantly, otoliths accumulate environmental chemicals and, therefore, reflect the chemical composition of the fish's surroundings. In the case of rockfish (which, unlike egg-layers, give birth to live young), those surroundings can be either the water or, for the unborn rockfish, the body cavity of their mother. When a gravid female is injected with strontium chloride, a harmless salt that is rare in the natural environment, the salt is incorporated in the otoliths of the larvae and, later, is detectable. The injected mothers are then released where they were captured — in this instance, at Point Heyer on Vashon Island. Several months later, when the larvae have settled as juveniles, Mari Kuroki of the University of Tokyo, another collaborator on the project, can determine if a juvenile rockfish had parents from Point Heyer by looking for strontium in the fish's otoliths.

Over the same period, Mitsuhiro Kawase is analyzing Puget Sound currents to determine the most likely places for rockfish larvae to drift and settle. Because of their small size, rockfish larvae have limited mobility early in life. While they are able to migrate up and down in the water on a daily basis, their horizontal movements are largely determined by currents. To study the effect of currents on larval dispersal, the Hauser team is deploying drifters from Point Heyer. These contraptions looks like enormous fishing bobbers with large underwater sail attached by long, thin ropes. Each drifter is also outfitted with a global positioning system unit and a satellite transmitter that can easily be tracked. By changing the depth of the 52-foot-long sails, Kawase can study the movement of different currents and determine the most likely locations where rockfish larvae will be deposited.

The combination of techniques chosen by Hauser's team adds significant strength to the study of Puget Sound's brown rockfish populations. Preliminary results seem to indicate that larvae born at Point Heyer are carried away by the currents, but that a few of them might return to their natal site.

"We know a lot about adult brown rockfish populations, but the larval stage is a black box," notes Hauser. "Mortality is highest at that stage, so events during the larval period have huge effects on the adult population." Because brown rockfish are important for the Puget Sound ecosystem as well as for recreational fishermen, it is vital from a conservation standpoint to fully understand the entire life history of the species.

Indeed, so little is known about the brown rockfish that its Puget Sound population is listed as a candidate species of concern in Washington —

a designation that signifies that basic research on this species needs to be conducted. The latest estimate places the number of brown rockfish in Puget Sound between 100,000 and 300,000. According to WDFW's Larry LeClair, the most recent data indicate Washington's overall population is healthy and increasing in abundance.

Another important and practical aspect in need of further study is the determination of how removing highly fertile adults impacts the overall size of the population. A female brown rockfish becomes sexually mature after about four years, at which point she starts producing tens or even hundreds of thousands of eggs. However, she keeps on growing and larger females produce more larvae than smaller females. Moreover, there is evidence that larvae from larger females survive better than those from small ones. Unfortunately, fishing removes exactly the large old females that may be so important for reproduction. Information from Hauser's research will hopefully provide clues about the sustainability of such fishing practices.

Hauser's investigations also could inform resource managers about the roles played by marine protected areas (MPAs) in rockfish conservation. MPAs are areas in which certain human activities have been restricted in order to conserve the biodiversity of oceanic populations or to protect stocks of commercially important species for fishery enhancement and sustainability. According to Raymond Buckley, all existing MPAs in Washington have been delineated based on geopolitical boundaries, not on specific biological boundaries that represent the complete habitat requirements of all the life stages of the fish species concerned. In other words, MPA networks are not always built with the precise needs of the fish in mind. Most MPAs are designed to protect adult fish, but it is not known if larvae and juveniles receive the same benefit. Fundamental questions about whether the newborn fish stay or leave, or if the MPA has afforded the larvae any protective advantage, remain unanswered. "As far as I know, our study has been the first to examine this very important question," Buckley notes. The answer to this question could have implications on the design and placement of future MPAs.

"The effectiveness of MPAs depends on the species and the management goal," says Hauser. "For example, MPAs by themselves may not reduce fishing effort because fishers will simply go elsewhere. However, they are useful for protecting specific habitats or ecosystems — we just need to work out if we are protecting the best, most productive ones."

A drifter is launched (left); Maureen Hess (right), a SAFS graduate student, suits up to conduct a scuba search for brown rockfish; Lorenz Hauser in his UW office (below).

Yet another gain from Hauser's work is a better understanding of Puget Sound currents. For instance, Hauser's team discovered that currents unexpectedly circled clockwise around Vashon Island, when it was previously thought that the currents went north, leaving Puget Sound. Furthermore, his team found that Puget Sound currents exhibited seasonal variation. Information such as this would not only benefit marine biologists, but it would also aid in pollution control and search-and-rescue missions.

Over the next few months, Hauser's team will be finalizing and publishing their findings from this three-year project. And if everything goes as planned, he just might find Nemo.

For additional information, contact Lorenz Hauser (206.685.3270 and *lhauser@u.washington.edu*) or visit the project page on the WSG Web site, *wsg.washington.edu/research/resources/sustmgmt/Larval_rockfish.html*.

# Field Notes

WSG has been awarded a contract from the Bainbridge Island Land Trust to provide project management and ecological assessment services on a restoration design project in Port Madison Bay. This 18-month contract will involve coordination with stakeholders, engineering and cultural resources subcontractors, the development and implementation of a monitoring plan, report writing and initiation of the permitting process. "It's a great project, which illustrates how shoreline armoring can be removed to restore a shoreline," **Jim Brennan**, WSG's marine habitat specialist, reports. "It's been a pleasure working with the Bainbridge Island Land Trust, the private property owners and other stakeholders, including city, state, federal and tribal representatives, on such a positive and collaborative process."

WSG Marine Fisheries Senior Scientist **Ed Melvin** and UW Research Assistant **Sarah Jennings** shared the podium at the FirstWorld Seabird Conference in Victoria, British Columbia, in September. Their presentation described the mechanics of seabird interactions and bycatch in tuna fisheries on the high seas. Jennings also spoke on albatross conservation in the West Coast groundfish fisheries, on behalf of **Troy Guy**, WSG marine fisheries research associate, who was conducting shipboard research in South African waters.

WSG's Water Resource Educator **Sue Blake** helped coordinate Whatcom Water Week, Sept. 18-25, which featured a rich roster of workshops and special events in celebration of regional water resources and the many roles they play in our lives. Among the workshop topics: rain gardens, marine plastic debris, septic system maintenance and landscaping with native plants. "We also scheduled beach cleanups, a guided kayak expedition, a tour of the Bellingham waterfront and a moonlight walk that followed a water drop's journey through a watershed," says Blake. "And, thanks to our sponsors, which included Washington State University Whatcom County Extension and Washington Sea Grant, it was all free!"

In August, WSG's Marine Education Coordinator **Sarah Fisken**, Marine Field Agent **Steve Harbell** and **Eric Olsson**, oil spill prevention education specialist, travelled to Hood River, Ore., to

# Working Like a Dog

## Using trained "detective dogs," researchers are probing the causes of killer whale declines

*By Sara Reardon, WSG Communications Intern*

Tucker at the ready, skillfully restrained by dog handler Heath Smith.

On windy summer days in Puget Sound, the iconic killer whales of the San Juan Islands might find their celebrity status eclipsed by an unlikely usurper: a hyper-energetic black Labrador retriever named Tucker.

While riding in the bow of a University of Washington research vessel, Tucker is busy working at what dogs do best — sniffing for scat. More specifically, he's tracking the leavings of Southern Resident Killer Whales that populate the region between May and October. The scat that Tucker locates will allow Samuel Wasser, director of the UW Center for Conservation Biology, and his research group to better understand stress factors that may be putting this population of killer whales in danger of becoming extinct. With only about 85 southern residents remaining, the loss of even a single killer whale is a major concern.

Wasser has been using scat detection dogs since 1997 to track everything from African elephants to spotted owls. Using modified K-9 narcotics training methods, his dogs have learned to accurately and precisely locate the scat of individual species, both on land and at sea. The scat can then be tested for biomarkers — hormonal hints of the killer whales' environmental stressors.

"Our center has developed a whole suite of noninvasive, physiological measures that we can get from scat," says Wasser, whose group received funding from Washington Sea Grant for its ongoing research into the mysterious recent decline in killer whale numbers. "Killer whales were an interesting problem which nicely complemented what we do in general," he adds.

Like most of the Center's scat dogs, Tucker was rescued from a shelter after being abandoned by owners who couldn't handle his obsessive personality. His rescuers' adoption criteria were unorthodox. "We look for the most extreme maniac dogs with a ball focus," says Wasser. "When they see you have a ball, they'll do *anything* for you." Once the dogs recognize the ball as a reward for finding scat, they become invaluable research assets. Wasser claims that killer whale scat sampling has increased several-fold since he brought the dogs onboard. "They've proved to be a godsend for this whole method."

provide much-needed open-water safety training at the Columbia River Indian Fishers Expo. The trip gave them a rare opportunity to interact with fishermen from the Yakama, Nez Perce, Umatilla and Warm Springs tribes. "The attendees were interested and attentive, and a number of tribal elders were gracious in their comments supporting safety for their high-risk fishermen and for our WSG efforts in promoting safer practices," says Olsson. "Some of the tribal leaders were emphatic that all tribal fishermen must adopt safer practices and welcomed this WSG training. To schedule a marine safety or technical training session for your crew or yourself, contact Sarah Fisken at 206.543.1225 or *sfisken@u.u.edu*.

As part of the NOAA-sponsored Energy Use in Fisheries symposium (Nov. 14-17 in Seattle), **Pete Granger**, program leader for Marine Advisory Services, is assembling a panel discussion on reducing "food miles" and increasing profits through direct-sale marketing of locally caught and grown seafood. The symposium will provide a forum for commercial and recreational fishermen, processors, engineers, boat and engine developers, aquaculturists, fisheries managers, administrators, scientists and others from around the world to meet, address both the direct and indirect effects of energy costs related to fisheries, and share solutions. For information on the symposium: *www.energyfish.nmfs.noaa.gov.*

For the second year in a row, WSG Communications team members **Dan Williams**, **Robyn Ricks** and **David G. Gordon** have created an interpretive sign for a kiosk at Mukilteo Lighthouse Park, west of Everett. Working with volunteers from Snohomish County's Beach Watcher program and with technical assistance from WSG's **Jim Brennan**, the team created a poster on natural beach processes and what people can do to keep Puget Sound's beaches alive and well. For a peek at the sign, visit the WSG Communications Web page, *wsg.washington.edu/communications/index.html.*

Editor, David G. Gordon; Designer, Robyn Ricks; Web Editor, Marcus Duke; Communications Manager, Dan Williams. Photos: cover, John Rawlings; pages 2-3, Lorenz Hauser; 4-6, Sam Wasser; 7, submitted images. All other photos © Washington Sea Grant, except as noted. ©2010, University of Washington, Board of Regents. WSG-MR 10-04

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Scat sampling requires the researchers to work in close harmony. Although Tucker can scent scat up to 650 feet away, the UW vessel's navigators need to constantly track the wind direction to keep their dog's extremely sensitive nose downwind of the scat's "scent cone." They use complex navigation algorithms for following the killer whales, allowing them to stay within this cone without coming too close to the whales themselves. All eyes are on top dog Tucker, watching his behavior. The retriever knows that if he finds a sample, he'll get to play fetch. "If there's an opportunity, he gets really excited; that change in behavior tells us he's got something," says Wasser.

When Tucker is all but leaping off the boat, the navigators make corrections to their course until they locate the floating scat. Tucker's handler rewards him with a game while the scat is collected with an aquatic pooper-scooper, dried with a centrifuge built from mountain bike parts and processed for later testing in the lab.

By testing these samples, Wasser hopes to discover what pressures are preventing recovery of the Southern Resident Killer Whales. Their numbers suddenly and inexplicably plunged by 20 percent in the late 1990s, causing this group of marine mammals to be listed as an endangered population. Several schools of thought have emerged, suggesting the killer whales' inability to recover may stem from a lack of food, the presence of industrial toxins in Puget Sound, stress from whale-watching boats or a combination of the three factors.

"This is one of the biggest challenges for conservation biology. If you want to do something about a problem, you really have to know what disturbances are having an impact," says Wasser. "It can be really difficult to tease them apart."

Having already pioneered methods for extracting a variety of hormones and genetic measures from the scat of other animals, Wasser recognizes that hormone excretions in feces could serve as biomarkers of killer whales' physiological condition. High levels of the hormone cortisol can indicate emotional and/or nutritional stress, while low levels of thyroid hormone indicate nutritional stress

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Members of the research team (clockwise, from front left): Kristin Hodge, Rose Cendak, D. Giles, Nicole Brandt, Jessica Morten, Katherine Ayres, Tucker.

independent of emotional stress. By measuring both hormones, the researchers can create a portrait of the killer whales' primary stressors. In addition, analysis of the DNA in feces can confirm a killer whale's identity, helping researchers monitor individuals within the endangered population.

The use of scat-tracking dogs is making it easier for the researchers to collect more samples over a time-scale that corresponds to changing conditions. "The power of our method is that, once you figure what these pressures are and make changes, you can continue to monitor how effective the mitigation measure is," says Wasser.

According to research by Katherine Ayres, one of Wasser's graduate students, food deprivation is emerging as the crux of the issue. After a nutritionally challenging winter off the California coast, the killer whales return to Puget Sound where, typically, they can gorge themselves, feeding on salmon and flatfish during the summer months. If the numbers of salmon in the Fraser River, British Columbia, run are low, the researchers will see hormonal signs of nutritional deficits, possibly leading to increased killer whale mortalities across the years. Stress from whale-watch boats may compound the problem, although thus far, pressure from the flotilla of small, largely unrestricted recreational boats appears to have greater negative impacts than those linked to larger, commercial whale-watch vessels.

The lack of salmon may have a secondary effect by increasing the harmful actions of toxins. Biopsies have revealed that Puget Sound's killer whales have accumulated more organic toxins in their blubber than in most other mammals. Normally, this layer of fat beneath the skin sequesters the toxins and prevents harm to the creature's complex physiology. However, once the killer whales start burning fat during nutritional deficits, the toxins may be released, causing damage to the animals' immune and endocrine systems. Wasser's team is now measuring changes in toxin levels excreted in scat to determine how dire the consequences may be.

Wasser's dog-dependent research has not gone unnoticed by the media. He considers this a good thing, especially if it helps the owners of commercial and recreational vessels become more mindful of their unintentional contributions to the killer whales' stress load.

"We're reaching hundreds of people every day," says Wasser. "People on commercial boats love to see Tucker and the other dogs, and the crews frequently talk about the research, in response."

## Orca Bowl 2011 Needs YOU!

Help Washington's high-school teams as they prepare for Orca Bowl, at the UW, on Saturday, Feb. 26. Volunteer judges, team aides and techies are needed before, during and after this exciting event. For information, visit the Orca Bowl Web site, *wsg.washington.edu/education/events/orca.html*, or contact Julie Hahn at 206.685.9117 and *jkhahn@uw.edu*.

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## Tell Us

Is our *Sea Star* newsletter truly meeting your needs? Please take a few minutes to answer some questions and share your thoughts about *Sea Star*. Take our short online survey at *www.wsg.washington.edu/seastar* and, in return, we'll enter your name in a drawing for one of five copies of *Heaven on the Half Shell: The Story of the Northwest's Love Affair with the Oyster*. You can also request a copy of the survey form by mail, from David G. Gordon, *Sea Star* editor, at 206.685.8191 or *davidg@uw.edu*.

## Fellowship Update

Two new Marc Hershman Marine Policy Fellows have been selected — **Jamie Mooney** (University of Washington School of Marine Affairs) and **Dan Crowther** (Washington State University). Mooney will be working on coastal hazards planning with the Washington Military Department Emergency Management Division, and Crowther on marine spatial planning at the Washington Department of Ecology. The program was initiated as a three-year pilot in 2008 and, thus far, has offered both students and state host agencies an outstanding learning and working environment.

For information on fellowships go to *wsg.washington.edu/education/fellowships/index.html.*

Jamie Mooney

Dan Crowther

# Mark Your Calendars

### Share your thoughts and acquire some free publications when you visit our booth at these fall events.

**Saturday, Nov. 6** at Elliott's Oyster New Year, a benefit for shellfish restoration efforts in Washington, featuring the world's longest oyster bar, hosted by Elliott's Oyster House in Seattle. For information and tickets, visit the Elliott's Web site, *elliottsoysterhouse.com,* or call 206.623.4340.

**Thursday through Saturday, Nov. 18 - 20,** at Pacific Marine Expo, the West Coast's largest marketplace for the working waterfront, at the Qwest Field Event Center in Seattle. For information, visit the Expo site, *pacificmarineexpo.com/10/public/enter.aspx*, or contact Pete Ganger at *pgranger@uw.edu* or 206.685.9261.

## Announcing New AIS, Aquaculture Initiatives

This past summer, WSG received word that two proposals submitted to the National Sea Grant Office were selected for funding.

One, jointly created by the Oregon, California, Southern California and Washington Sea Grant programs, will address aquatic invasive species (AIS) issues over the next two years. WSG's role will help address the potentially harmful pathway of introduction that originates with school curricula, biological supply houses and pet stores and ends with releases of AIS by K-12 classroom teachers or students.

"When the school year ends, these animals may be released into the wild, often with damaging effects on the local environment," says Jeff Adams, WSG's marine water quality specialist in Kitsap County. "Crayfish species that have been sold to schools on the West Coast are voracious omnivores and highly aggressive, having impacts across entire food webs. In other parts of the country, these crayfish have been associated with impacts on aquatic plants, other invertebrates and fish. School release is a likely pathway for several introduced populations in Washington."

As part of this project, Adams will help coordinate the completion of an AIS classroom toolkit. He'll also work with his colleague, Julian Olden of the University of Washington's School of Aquatic and Fishery Sciences, and other partners to come up with alternatives that will satisfy both the need for live animals in the classroom and the protection of the state's aquatic ecosystems.

The second project will be led by Pete Granger, WSG's program leader for Marine Advisory Services, and Walton Dickhoff of NOAA Fisheries' Northwest Fisheries Science Center in Seattle. Teri King, long-time marine water quality specialist in Mason County, will be transitioning into a new position of WSG aquaculture coordinator to facilitate WSG outreach and research on aquaculture issues, targeting seafood producers, state and regional agencies, tribes, stakeholder groups and the public.

"We'll be developing a suite of outreach products, including publications, continued support for our annual conference and a Web site solely devoted to aquaculture," says Granger. "By conducting a statewide survey, we'll also assess the perceptions of Northwest seafood consumers regarding the safety and sustainability of seafood. Survey results will help guide our future work with seafood consumers."

Jeff Adams

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# NOAA Science Camp Sets Record

July 2010's NOAA Science Camp attracted a record 104 middle-schoolers representing 56 schools in 22 different Washington cities. Campers also travelled from New York and California to participate in the two weeklong sessions. For information on next year's sessions, visit *wsg.washington.edu/education/events/noaa.html* or contact Julie Hahn at 206.685.9117 and *jkhahn@uw.edu*.