

Intertidal Tidings

Newsletter for the Friday Harbor Laboratories • University of Washington • Autumn 2009 • Volume 15

Adam Summers is RAD!

The new FHL Resident Associate Director (RAD), Dr. Adam Summers, has arrived and is getting settled in Lab 9, which he shares with Emily Carrington and Pedro Verdugo.

As the boxes get unpacked and the data books are opened after a year at the National Science Foundation, other projects are getting underway. The rapid prototyper has been resuscitated from the stress of moving and is busily churning out models of stingray jaw sections and gill arches from manta rays.

The stingray jaw sections are part of a long running project to understand how it is that the cartilaginous skeletons of sharks, skates and rays can do the same things as the bony skeletons of more familiar fish. The models are reconstructed from CT scans of the jaws of the cownose ray, *Rhinoptera bonasus*, which eats bivalves, crabs and other hard prey. There are mineralized struts running through the jaws and the models can be printed in very large sizes and from a material that is easy to instrument. This will allow Adam to put strain gauges on the struts and add load to the model to determine just how much the jaws help with the crushing duties.

The gill arch models will be used to test Misty Paig's ideas about the different ways in which cartilaginous fish filter feed. Misty, one of Adam's graduate students, has used simple physical

models to show that swimming speed and shape of the gill slits can determine both efficiency and the size of captured prey. Now these generalized models are going to be replaced with carefully constructed models based on the real anatomy of the devil ray. Particle capture efficiency and the size distribution of plankton gulped

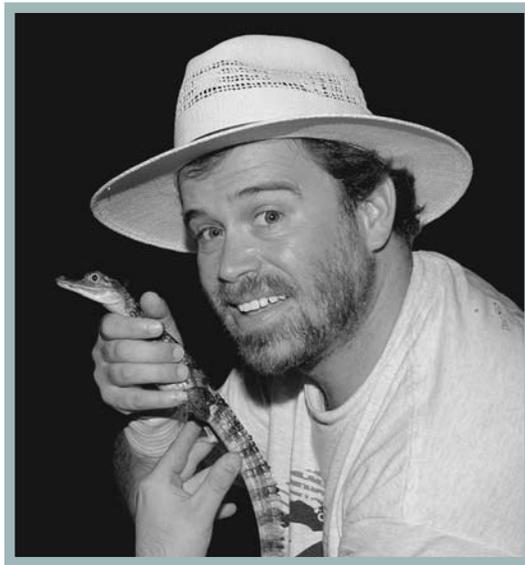


Photo by Pablo Delis

down by the model will be used to predict diet in these large, pelagic rays. Misty will then take to the field, and with Felipe Galván-Magaña in Mexico, will measure the plankton size distribution and abundance at devil ray and manta ray feeding sites. With gut content analysis from fishery-caught animals, she will be able to test her predictions. The aim is to extend the models to all of the cartilaginous filter feeders, which are an evolutionarily diverse group of very large fishes.

Adam's material testing system has been set up and is in use by another graduate student Stephanie Crofts. She is interested in what happens when you stretch the exoskeleton of an invertebrate. If you stretch a rubber sheet, or almost any other material you can think of, the sheet will get narrower in one dimension as you make it longer in another. The ratio of narrowing to extension is called Poisson's ratio. For most materials this number is positive, though for cork it is just about 0. That allows you to push a cork into a bottle without it getting wider and therefore more difficult to reinsert. There are man-made materials with negative Poisson's ratio and unusual structure that resemble a shrimp's exoskeleton. In thinking about the requirements of a freshly shed crab or shrimp, Stephanie proposed that this might be a natural example of a negative Poisson material. The whirring and clanking in the material testing bay is showing that she may well be right.

There is a lot still to do, from unpacking boxes to purchasing new equipment. The flume room is about to be turned into the Ocean Acidification Lab, and Adam will work on upgrading the flume while construction takes place. He is also working on upgrading the scientific visualization facilities with a new scanning electron microscope. The comparative biomechanics lab is up and running, and Adam is looking forward to hosting his friends, colleagues and collaborators at Friday Harbor Labs.

FHL Ocean Research

FHL Awarded Funds to Build a Laboratory for the Study of Ocean Acidification

FHL has been awarded funds by the National Science Foundation (NSF) Field Stations and Marine Laboratories (FSML) Program to build an experimental facility for the study of ocean acidification. The University of Washington provided matching funds for the NSF award and several smaller contributions bring the total project funds to \$600,000 at present. The funds will support construction of a new laboratory and outdoor mesocosm facility dedicated to the study of ocean acidification and its impacts on species, food webs, and ecosystems. The facility will be the first of its kind in the U.S. and will be available to investigators from across the country and around the world. Principal investigators on the grant are UW FHL Director Ken Sebens, School of Marine Affairs professor Terrie Klinger, and School of Oceanography professor Jim Murray. FHL Postdoctoral researcher Michael O'Donnell is conducting preliminary research on design of the carbon dioxide and temperature regulating systems and carbon analytical methods.

The new facility will enable researchers to address a pressing environmental problem of global proportions. The ocean has absorbed about one-third of the carbon dioxide (CO₂) released to the atmosphere through the burning of fossil fuels and other human activities. Once dissolved in the ocean, CO₂ undergoes a series of chemical reactions that result in the production of a weak acid, causing the pH of seawater to drop. Declines of about 0.1 pH unit already have been observed over the past 30 years in the North Pacific. These more acidic conditions cause seawater to become corrosive with respect to animal shells and skeletons. At the same time, carbonate ions naturally present in seawater become less available, making it more difficult for animals to build and maintain shells and skeletons. In extreme cases, shells can even dissolve. Especially at risk are some species of invertebrates and their larvae, but plankton, marine plants and fish species are also vulnerable.

The new facility will include the capacity to produce seawater of varying CO₂ concentrations for use in biological and ecological experiments. The experimental facility will be paired with a new chemical analytical laboratory for the precise determination of seawater chemistry. Outdoors, the facility will include a series of large aquaria for biological experiments and a number of large mesocosms suspended in the water for the study of plankton and food web dynamics.

Investigators will ask how local species respond to ocean acidification, how predator-prey relationships are influenced by ocean acidification, and how the productivity of the ocean will change. The answers to these questions will help us determine what the ocean of the future might look like, and how we might adapt to the changes we have inadvertently caused in ocean ecosystems.

CECO: FHL is establishing a new center for ecological studies

FHL is establishing a new center to lead investigations of the changing ocean and its impact on marine species and ecosystems. The **Center for Ecology of Changing Oceans (CECO)** will use expertise within and beyond the University of Washington to study the influence of multiple stressors (temperature, nutrients, pH, dissolved oxygen, introduced species, habitat modification, over-harvesting) on regional species and systems. Participating investigators include faculty and research scientists from FHL and from all three campuses of the UW, as well as FHL's large population of visiting researchers. The mission and goals of CECO are to propel new investigations and spark innovation in research to address the effects of accelerating change in ocean ecosystems. The results of such research can be used to inform mitigation and adaptation strategies to help sustain marine resources and the services they provide to a grown human population.

Terrie Klinger, UW School of Marine Affairs, is directing the formation of the new center.



New computer classroom and support facility - it was the stockroom!

(Finished October 2009)



Two new graduate student housing units built with NSF FSML funding,

(Finished June 2009)

Adopt-a-Student Program

Concerned about the future of marine science?

Adopt a Student!

by Flo McAlary-McFarland

Nothing gives me a bigger thrill than to meet a student engaged in thoughtful discussion, enthusiastic about learning, excited at the opportunity for discovery and willing to work hard in the endeavor. I've had the pleasure to sponsor five such students as part of FHL's Adopt-a-Student Program. These marvelous young people from as near as UW or UCLA and as far away as Norway, Chile or New Zealand, are selected based on their ability, interest, and financial need. In 2010, the cost to support a single student in an upper division or graduate course is \$4000 which includes assistance with travel, food, tuition and supplies; \$2000 provides partial support; but a donation in any amount can make a difference depending on the student's actual need. Students are incredibly grateful for this support.

Each year I enjoy a lunch meeting with my "adopted" student(s) and have the opportunity to discuss their projects and personal goals. In the last two years there's been an after lunch laboratory tour to feature their work in progress. The students have an exceptional opportunity at FHL. They have access to internationally recognized professors, specialized instruments, novel techniques and the quality of marine resources that bring them to the cutting edge of science. The student's experience in these courses frequently leads to a peer-reviewed publication and more often than not, inspires a new direction in their career choices. At the end of a course, students present their research in a seminar setting to which sponsors are always welcome. I'm impressed at how much they accomplish and the excellence of their presentations. I am particularly fond of fish projects and my students in the last few years have participated in courses involving fish behavior. If the past is any indicator, many will return to FHL as graduate students, postdocs, researchers, and/or teachers to continue FHL's fine tradition of scientific progress. This characteristic is one of many that make FHL a world-class institution. I am delighted to contribute to this effort.

As I see it, the Adopt-a-Student Program, is a commitment to the future of scientific excellence in a time of great human need. Providing financial assistance to make sure some of the brightest young minds have the opportunity to participate in FHL courses is my passion. I am hoping others take the opportunity to "adopt a student" of their own and assist deserving young people to become part of this magnificent adventure.

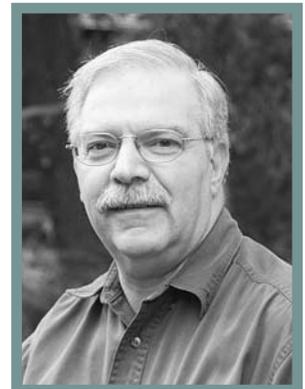
If you are interested in participating in this program, please contact Rachel Anderson at (360) 378-2165, ext. 2, or e-mail fh100@u.washington.edu for further information.



PHOTO: Duncan Reid, a graduate student at the University of Washington, was Flo McAlary-McFarland's Adopt-a-Student in 2009. Her support helped Duncan participate in a multi-disciplinary course exploring the kinematics, ecomorphology and metabolic aspects of fish swimming taught by two internationally recognized experts, Paulo Domenici, International Marine Centre, Italy, and John Steffensen, University of Copenhagen, Denmark. Thirty-two students received support in 2009 bringing the total number of adopted students since 2007 to over 100!

Thank you Bob!

Bob Schwartzberg retired as the Friday Harbor Labs Development Director on June 30, 2009. Bob left an indelible impression on first-time Lab visitors as he convinced them that they had discovered a little-known gem of marine research and learning worthy of their attention and support. One thing was always clear. Bob, like other FHL staff and all of its researchers, was dedicated to the development of its students. He recounted endless stories of how students were inspired by their experiences with faculty and FHL resources to develop outstanding careers.



Bob assisted the staff and Development Advisory Board members to organize and greatly strengthen the Labs' development program. He established the annual **Jazz at the Labs** dinner and concert event to benefit the FHL K-12 Science Outreach Program. The number of endowments doubled under his watch and giving was greatly increased. Bob created the **Sea Star Society** and the **Adopt-A-Student Program**. All at FHL are grateful for Bob's devotion to its growth. He was honored in an afternoon reception on June 19th at the Labs. We wish him success in his future endeavors. In his retirement, Bob continues to consult small non-profits in the Islands and across the country.

New Research Grants at FHL

Effects of Marine Preserves and Nonindigenous Species on Rocky Subtidal Communities: Indirect Interactions, Disturbance and Community Dynamics.

NSF. Biological Oceanography Program. PI: Kenneth P. Sebens, Co-Investigators: Robin Elahi and Kevin Turner, 2009-2013.

Nearshore rocky subtidal communities around the world are faced with changes caused by fishing, climate change, habitat alteration and invasive species, yet we know very little about their community dynamics. The loss of large predators (species removals) and the introduction of nonindigenous species (species additions), are likely to have immediate and large consequences for the structure, resilience and function of subtidal communities. Marine preserves have recently been established in many coastal locations, including the San Juan Archipelago (in 1990). While they are demonstrated to have positive effects on certain fish populations, effects on the rest of the subtidal community are generally not known. This research will explore how the protection of large predators influences small prey and non-prey species. Higher level predators can decrease the abundance of their prey, but can also indirectly increase the abundance of organisms two trophic levels beneath them through a trophic cascade. Additionally, non-trophic interactions (competition, facilitations, behaviorally-mediated effects, etc.) may cause species abundances to change in unpredicted ways after the recovery of large predators. Research on the indirect effects of predators on other community members, through trophic linkages, will examine community change and other mechanisms.

Spatial Subsidy and Trophic Connectivity between Nearshore Macrophyte Production and Subtidal Food Webs.

NSF. Biological Oceanography Program. PI: David Duggins, Co-Investigators: Kevin Britton-Simmons, Kenneth Sebens, Charles Simenstad (School of Aquatic and Fisheries Science) and James Eckman (Office of Naval Research), 2009-2012.

This grant will fund a study of the underlying trophic foundation of regional marine food webs. The relative contribution to secondary production of a range of primary sources (seaweeds such as kelps, phytoplankton, seagrass, and terrestrial plants) will be evaluated in benthic and pelagic consumers of all feeding types. Of particular interest is the role of macroalgal detritus as an organic matter source and the processes that determine and mediate this role. To address this question Duggins, et al, will (1) assess the transfer of macrophyte (seaweeds and seagrass) biomass from shallow nearshore sources to recipient deep subtidal basins, (2) evaluate, using stable isotopes, the extent to which macroalgae (versus phytoplankton and other sources) subsidize subtidal food webs, and (3) investigate the biotic and abiotic processes that alter detrital biomass over time. The research could substantially transform our understanding of the relative importance of sources of organic input to the entire nearshore ecosystem.

Evolutionary Relationships among Heterokont Algae

NSF. Assembling the Tree of Life Program. PI: Robert Andersen, 2009-2011.

This grant will fund a multi-institutional study to resolve the evolutionary relationships among heterokont algae, which include brown seaweeds, chrysophytes and diatoms. These organisms are especially significant because they were major producers of petroleum deposits, and diatoms are a group of algae favored for algal biofuels projects. Other members produce large amounts of polyunsaturated fats such as DHA and EPA, and some members (e.g., *Heterosigma*) cause massive mortalities at fish farms. The heterokont algae, while closely related in a genetic sense, have

very different morphological features, which has prevented an understanding of their evolutionary relationships. For example, the cellulose cell wall of brown algae, the silica cell wall of diatoms and the naked cells of chrysophytes do not share any homologous features. Other participating scientists are Drs. Rose Ann Cattolico and Gabrielle Rocap (University of Washington), Drs. Robert Jansen and Ed Theriot (University of Texas), Dr. Matt Julius (St. Cloud State University), Dr. Hiroshi Kawai (Kobe University, Japan) and Dr. Stefano Draisma (Leiden University, Netherlands). The project has two major thrusts, a seven-gene phylogeny of three hundred taxa and chloroplast genome sequences from thirty taxa.

Physical and Biological Impacts of Shoreline Armoring.

Sea Grant. PI: Megan Dethier, in collaboration with personnel from Fisheries and Oceanography at UW as well as the Washington Dept. of Natural Resources, 2010-2012.

Armoring covers around 30% of all Puget Sound's shorelines and is thought to be detrimental to the health of the marine ecosystem. Numerous restoration projects involving armor-removal are underway. Yet there are surprisingly few local data documenting negative impacts of armoring on nearshore ecosystems. Scientists need to be able to provide managers and policy makers with a biological and physical narrative about the impacts of armoring that makes sense and is backed by hard data. The research will be focused at Seahurst Park (City of Burien), where a major armor-removal project will begin in a year and, in addition, will use a survey approach to investigate broader armoring effects. Hypothesized effects to be tested include: the accumulation and degradation of detritus (wrack and large woody debris) which provides habitat and food for various species; altered wave energy in front of armoring structures and its effects on beach slope and sediment types, including indirect effects on organisms such as juvenile clams; abundance of insects that fall to the beach and are consumed by fishes at high tide and fish foraging behaviors. Finally, a variety of outreach activities to inform park users and shoreline planners about the research will be conducted.

H₂S Poisoning and Community Structure in the Lower Intertidal, Shallow Subtidal Region in Small Embayments of the Pacific Northwest.

NSF EAGER Award. PIs: Sandy Wyllie-Echeverria and Peter D. Ward (Professor, UW Biology and Earth & Space Science) 2009-2010.

This grant will fund the investigation of the potential that H₂S poisoning may be altering community structure in the lower intertidal, shallow subtidal region in small embayments of the Pacific Northwest. In this collaborative effort using a combination of field studies and laboratory experiments, Wyllie-Echeverria and Ward will test the hypothesis that the replacement of large stands of ancient, primarily coniferous, forests with cleared land and a blend of broadleaf trees, conifers and shrubs fuels carbon accumulation in nearshore regions which in turn, can contribute to toxic concentrations of H₂S. The questions driving this research are the following: (1) Is trapped H₂S transforming the lower intertidal and shallow subtidal regions of coastal waters in the Pacific Northwest into hostile environments for flora and fauna common to this region? (2) Can H₂S/O₂ profiles leading to lethal conditions for the seagrass, *Zostera marina*, and invertebrate infauna and epifauna, in the seagrass zone, be discovered using environmental chambers with controlled treatments of light, temperature and H₂S?

Other Grants to Faculty at FHL

The following list illustrates the broad range of externally funded research being carried out at FHL during the past year, by UW faculty working at FHL. This is only a partial list of FHL research, since there are many visiting researchers funded by grants through their own universities.

Carrington, E., Gilman, S., Pls. **NSF**. Effects of Temperature on Ecological Processes in a Rocky Intertidal Community. 2008-2012.

Dethier, M., Pl. **Nature Conservancy**. Subtidal Survey of the Wasp Islands. 2007-2009.

Dethier, M., Pl. **Department of Natural Resources**. Long-term monitoring and focus studies in shoreline biota in Puget Sound. 2007-2009.

Dethier, M., Pl. **King County**. Intertidal biota surveys at Point Wells. 2006-2010.

Munro, E., Lecuit, T., Lenne, P., Pls. **Human Frontiers Science Program**. From Molecular Mechanics to the Dynamics of Cell Shape Change and Tissue Morphogenesis. 2008-2011.

Newton, J., Sebens, K., Pls. **Washington Department of Ecology**. Joint Effort to Monitor the Straits. 2007-2010.

Odell, G., Pl. **NIH-NIGMS**. Gene Networks: From molecules to mechanistic models. 2008-2010.

Sebens, K. Pl. **NSF OACIS**. GK-12: UW Graduate Students with K-12 Teachers. Ocean and Coastal Interdisciplinary Science. 2008-2013.

Sebens, K., Pl. **NOAA**. Marine Mammal Research: R/V Centennial. 2008-2010.

Swalla, B., Halanych, K., Pls. **NSF**. Systematics and Evolution of Hemichordates. 2008-2011.

Strathmann, R., Pl. **NSF-OCE**. Predator-induced morphological defenses of marine zooplankton. 2006-2009.

Wyllie-Echeverria, S., Pl. **Thatcher Bay Restoration**. Skagit Fisheries Enhancement Group. 2006-2009.

Wyllie-Echeverria, S., Pl. **Puget Sound Partnership**. Environmental Education on the Ferries. 2009.

Wyllie-Echeverria, S., Pl. **Washington State Parks**. Recovery of *Zostera marina* following anchor and mooring buoy disturbances: A case study in Echo Bay, Sucia Island, WA. 2007-2009.

Please see the FHL website for research publications by year: <http://depts.washington.edu/fhl/resBibliography00s.html>



Alex Croft (Photo by Josh Stuart)

caught during adventurous mid-day field trips to other beautiful and interesting beaches around the island or from the murky depths of the bays. The combination of lecture, collection, and dissection was crucial to furthering my understanding of the subject matter and it was fun. Not only did we learn about physiology and anatomy in lecture/lab, we were able to step outside of the class room and see where these organisms actually live and thrive.

In addition to lectures and studying, we were able to become involved in other educational and scientific extracurricular activities. During the quarter, we would regularly take students from the local elementary and high school out on field trips into the intertidal zones and do interpretation work. It was a great way to practice what we learned throughout the quarter and give back to the San Juan Island community. One of my favorite parts of my Friday Harbor experience was getting to know and work with the other researchers at the labs. For part of the course, we were told to conduct our own research, you had to talk with other scientists to generate creative research ideas, get help with setting up experiments, and acquire direction on how to formulate methods and analyze results. The mentoring I received during my independent research was so beneficial to my success and my understanding of what it really takes to become a scientist. I also made really great connections and it opened doors for future work opportunities at FHL and the University of Washington.

During down time, whether it was after class or on the weekends, there were plenty of recreational activities to do locally. The labs provide row boats for students and faculty to use when wanted. Rowing into town to buy ice cream or to nearby islands to camp was a common activity. Once you get into town, by foot or boat, there are kayaks you can rent to get up close and personal with whales at the Harrow Strait or simply explore. If you miss being on land, then the Labs provide bikes which is perfect since the island is pretty small and even a novice can take on the small hills. You can either spend your time relaxing in the sun at the beach or exploring hiking trails on the FHL biological preserve. Just make sure that at the end of the day you are by a beach bonfire watching the sun set on the horizon!

Friday Harbor Labs is definitely a magical place to study biology!

(Reprinted with permission from the Autumn 2009 UW Biology Department Newsletter.)

Spring Quarter at FHL

by Alex Croft UW Biology Student

Studying at the University of Washington Friday Harbor Labs in Spring 2009 as a Biology student was one of the most exciting and influential experiences of my undergraduate education. In my opinion, Friday Harbor Labs is one of the most beautiful and interesting places to study biology in all of Washington State. Situated near the water on a 484 acre biological preserve within the beautiful San Juan Island archipelago, Friday Harbor Labs provides a perfect setting for studying biology.

As a student at FHL, my days consisted of several diverse types of learning opportunities, all of which contributed to an outstanding educational experience. Often we would start the day with a lecture in the morning followed then by specimen collection, and then moving on to hands on dissections of marine organisms in lab. These marine organisms were often

Summer 2010

FHL's 10th Annual Jazz at the Labs

All proceeds benefit the
FHL K-12 Science Outreach Program

What we're hearing...

Extraordinary Learning Experiences

by Laura Long, FHL Advancement Board Member

Appearances Can Be Deceiving

The University of Washington Friday Harbor Labs (FHL) make a modest statement in the landscape of San Juan Island. The earth-tone, low buildings blend into their hillside setting and the pier has a modest array of boats as compared to the vacationing yachts moored in the near-by marina.

The summer days are warm in Friday Harbor, so when you walk around the campus you smell the fir and cedar trees mingled with salty sea humidity. The campus is unpretentious, modest, quiet, relaxed and, as such, very much in harmony with its environment. Can anything good come from such an unassuming campus? Yes, extraordinary, wonderful and rare things happen to students at FHL. Undergrad students talk to professors and researchers as they walk to the cafeteria. They sit together and continue their conversations and then go together to their next activity. They are living a communal life of total immersion into research.

Survey

In the Autumn '08 newsletter, we made a request that "Labbies" complete an online survey about their individual experience at FHL. We also sent an e-mail notice or two. We were delighted to receive 764 responses. The survey results show that undergraduate and graduate students studying at FHL have extraordinary learning experiences. For some, a class at FHL was the defining event of their undergraduate degree that nurtured their scientific imaginations and provided intellectual and personal transformations (95.6% of undergraduate research apprentices and 97.8% of graduate students rate their experience at FHL in the Very Good and Excellent ranges).

Students Scores Correlate to Researchers/Faculty Scores

The online survey posed a number of questions including: whether the respondent was ever a student in FHL classes, a member of the Research Apprenticeship Program, a visiting researcher, a professor for FHL courses, a student researcher in the Blinks Program, or a graduate student at FHL. Multiple answers were allowed since many fit in two or more of the categories. The responses were summarized into categories of Apprentice, Researcher, Instructor and Student.

Respondents rated 11 aspects of the FHL experience on a scale of 1 to 10.*

I am a newcomer to the Labs, so I was surprised to see apprentices and students having the same perspectives on the FHL experience as their instructors and professional researchers. Most of the time the undergraduate student and even the graduate student campus experience is 180 degrees different from that of the faculty. But then I read pages and pages of comments and realized that those who have been students/apprentices at FHL know with great clarity that their FHL experience was unique and extremely important to their academic and personal development.

An Unusual Professor/Student Interface

The students have the highest regard for FHL instructors and researchers. They realize that these are top expert, experienced researchers and among the greatest minds in marine research. They describe the FHL instructors as being open, approachable, cordial and available, collaborative, and excited about having students in the labs. The instructors bring energy, knowledge and care to the program and are genuinely interested in engaging the students. The students talk about working with—not for—the professors and researchers. The students are astonished that these prominent, accomplished researchers actually are interested in what they are learning, curious about what they think and enthusiastic about what they hope to accomplish.

Undergraduates at FHL can experience the research process from start to finish (formulation of hypothesis to presentation of findings to peers and the public). The open atmosphere of the Labs allows students to explore interests without inhibitions, albeit with focus. The research model then becomes a process for examining information throughout their undergraduate studies.

The faculty/researcher to student ratio is an outstanding 1 to 3 or 1 to 9. Small class size, hands-on learning, total, intense immersion into research, communal living, and one-on-one time with faculty produces intellectual and personal transformations. It is described as a holistic growth process under which scientific imaginations bloom and mature. It is an enriching and defining experience that springboards the students into careers.

So we hail the founders of the FHL who developed this culture of inclusion and respect for future generations of scientists. We thank all of the intervening lab directors for continuing this respectful, caring regard for students that time and again has nurtured the scientific careers of FHL alumni. There are marine labs whose faculty receive more awards, operate larger fleets, and get millions more in research funding—but none of these labs is more successful in providing the ultimate learning experience to the researchers of tomorrow's world.

In a future FHL e-newsletter article, we will explore the backgrounds of FHL students and discuss what avenues they pursued after they left FHL.

*Detailed results broken down by respondent group can be found at: <http://depts.washington.edu/fhl/survey.html>.



The Whiteley Center

The Helen Riaboff Whiteley Center at Friday Harbor Labs provides a quiet retreat for scholars of all fields so they may reflect, study, write and create in a beautiful setting. They may work in undisturbed solitude or in collaboration with other scholars at the center or with students and marine scientists at FHL. More information on the center may be accessed via the FHL Web site at <http://depts.washington.edu/fhl>.

Over one hundred Whiteley Scholars were hosted in 2009. Some examples of the broad topics of work by scholars at the Whiteley Center include:

Barbara Altmann, University of Oregon. English translations of four epic poems of late-medieval French literature.

Carey Bagdassarian, College of William & Mary. Complex first salmon rituals of Pacific First Nations people as an entry to understanding rituals that connected humans to the land in sustainable ways.

Nancy Beadie, University of Washington. Data analysis and presentations of comparative historical research on education in South Africa, Canada and Australia.

Deborah Bosnan, Sustainable Ecosystems Institute. Impact of marine natural disasters on coastal ecosystems and human communities with implications for managing climate change.

David Carlon, University of Hawaii Manoa. Collaborated with Ann Budd on quantifying heritability of coral skeleton traits.

John Delaney, University of Washington. Collaborative study of boiling submarine hydrothermal systems, a project with almost a dozen colleagues.

Denise Drevdahl, University of Washington, Tacoma. Historical role of public nurses with respect to immigrants and a review of genetics and race/ethnicity in nursing research publications.

Alexander Fisher, University of British Columbia. Relationship of sacred music and religious culture in Europe during the Reformation and Counter-Reformation (1550-1650).

Susan Lewis Hammond, University of Victoria. Introductory essay for her book "The Madrigal: A Research and Information Guide," a comprehensive bibliography of music literature and recordings of Italian Renaissance secular vocal music.

Brad Leithauser, Mount Holyoke College. Wrote "Good and Gone: Laments for Lost Things".

Svetlana Maslakova, University of Oregon. Morphology, systematics and evolution of development.

Edward Miles, University of Washington. Investigates ocean acidification in combination with changing thermal structure in the Northeast Pacific Ocean with a conceptual approach to risk assessment and management along with strategies for ecosystem-based management.

Joan Miyazaki, Marvin O'Neal and Deborah Spikes, SUNY Stony Brook. Grant proposal for redesign and modernization of an introductory biology laboratory sequence.

David R. Montgomery, University of Washington. Presented his book "Dirt" on the role of soil erosion in the history of civilization.

Wadda Rios-Font, Columbia University. Worked on her third book "Quasimodo's Bell: Puerto Rican National Culture and the Spanish Empire, 1808-1898."

Allison Welch, College of Charleston. Researched gray tree frogs for two papers on the heritability of sexually-selected characteristics.

Stephen C. Woods, University of Cincinnati. Conceptual elements and the formal presentation of a new theoretical model of how many systems of the body are regulated.

FHL K-12 Science Outreach Program FHL SOP

The **FHL SOP** is in its ninth year of providing unique science education opportunities that bring exciting, inquiry-based and relevant environmental science into the elementary, middle and high school classrooms of the San Juan Islands. Some of the engaging programs offered to students this year include:

Grade 1 - UW FHL Marine Biology Quarter students introduce students to the idea of scientific inquiry / investigation.

Grade 2 - "Is it an Animal or Plant?" Inquiry Lab Activity

Grade 3 - Introduction to Marine Invertebrates and "Diver for a Day": Students learn about the major marine invertebrate groups through a series of classroom visits by FHL scientists. Students also take a field trip on FHL's Research Vessel Centennial to participate in surveys of subtidal marine organisms and their habitats via video and communication with submerged divers.

Grade 4 - Watersheds and Eelgrass Beds: Through a series of classroom activities and labs, students learn about the importance of these two vital systems. The unit is culminated by a series of beach seines that are taken through local eelgrass beds.

Grade 5 - The Friday Harbor Marina Water Quality Sampling Project

Grade 6 - Soft Sediment and Rocky Shore Ecosystem Surveys: FHL students (ZooBot Program) and scientists lead an "Expert Day" where they share their expertise of marine organisms. The students also go into the field to contrast rocky versus soft sediment intertidal habitats.

Grade 7 - DNA Extraction Lab and Gray Whale Project

Grade 8 - Student-Designed Marine Biology Inquiry Projects: Following a classroom review of local marine invertebrates, students go to nearshore marine habitats to compare marine invertebrate distribution patterns, species diversity and/or species abundance.

Grade 9 - Electrophoresis Exploration: Students explore how the process of electrophoresis works to separate molecules by size, shape and charge.

Grade 10 - Invasive Mussel Project: Students help assess the spread of an exotic species of mussel, *Mytilus galloprovincialis*. They use sophisticated electrophoresis techniques to identify the mussel from its DNA fingerprint.

Grade 11/12 - Oceanography: From the Research Vessel Centennial, students collect water column samples to assess water column parameters in Friday Harbor and San Juan Channel.



To learn more please visit the FHL SOP website:

<http://depts.washington.edu/fhik12>

or contact, Jenny Roberts or Margo Thorp at fhik12@u.washington.edu

Each year our NSF OACIS GK-12 Program puts 2 - 3 graduate students into San Juan County's high schools. They work directly with science teachers for the entire year.

Two FHL Priority Support Opportunities

I. Matching Fund: Ocean Acidification Facility

A very important opportunity for FHL has just become a reality. The National Science Foundation has funded FHL for the establishment of an Ocean Acidification Research Facility, including in-water mesocosms, laboratory mesocosms and aquaria, and an analytical chemistry laboratory building. This is a very timely and critical research field that is now in its very early stages. NSF funded FHL for \$275,000 of a possible \$350,000 total award (mostly for the instrumentation) and the UW has agreed to match this \$275,000 for a lab building. However, our Vice Provost for Research has made a generous offer to match if FHL can raise another \$75,000. The additional funding would mean a larger and better equipped laboratory building that will represent a huge advantage for FHL to generate research for many years to come. This facility will also be the location for several of our new Research Apprenticeships dealing with ocean change and its effects over the next few years.

If you can help us with any part of the match, please contact the FHL Director (sebens@u.washington.edu).

II. Student Financial Aid: Fall, Spring and Summer Quarters

While FHL has offered courses every spring and summer, there has not been a regular program of fall courses, except for the research apprenticeships (which will continue). This fall, we are trying something new - a group of four courses that meet the requirements of the new Marine Biology Minor at UW, and similar major/minor requirements at other universities.

Meanwhile, with the recession of 2008 and 2009, the UW reduced the distributions from its endowments by half; that is where much of FHL's financial aid for students comes from, meaning we had only half as much to give out this summer as last. Annual giving for student support was also down, which left us with very little ability to help students in the new fall program, the spring ZooBot quarter, and the research apprenticeships in fall and spring. The best way to help students take part in these excellent opportunities at FHL is through the Adopt-a-Student Program. With the increase in fees and tuition, plus a decrease in endowment funds, students are having a harder time affording a quarter at FHL.

If you can help support students in our 2010 programs, please contact Rachel Anderson, 360-378-2165 (ext.2) or by e-mail at fhl100@u.washington.edu.

Karel F. Liem

A frequent visitor to FHL and the Henry Bryant Bigelow professor of Ichthyology at the Museum of Comparative Zoology at Harvard University, has died at the age of 74.

Karel taught the FHL summer fish course with UW professor Bruce Miller for many years, bringing vitality and sense of fun that was felt throughout the labs. He had an insatiable curiosity about the ways and means of fishes, and his wonderfully supportive style made a deep impression on students and colleagues alike. His scientific legacy is principally in the areas of morphology and comparative biomechanics, but in the Friday Harbor tradition, his biggest impact has been in the students he mentored. When Karel gave a guest lecture (and cooked dinner) for the fish class in 2008, there were fifteen of his academic children and grandchildren in attendance.

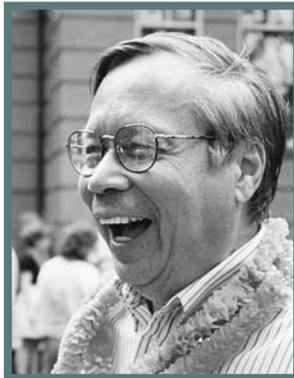


Photo by: Cheryl Souza

Friday Harbor Labs was one of Karel's favorite places and it is fitting that a generous gift from the Lyman B. Brainerd Jr. Family Foundation has established a FHL endowment in his name to benefit ichthyological work at the labs. (http://depts.washington.edu/fhl/help_endowments.html)



Tiffany Johnson, 2009 Blinks Scholar. Photo by Kathleen Ballard

2010 FHL COURSES

Spring Quarter (March 29 - June 4)

I. The ZooBot Quarter:

- Marine Zoology
- Marine Botany
- Research Apprenticeship: Climate Change and Coastal Marine Organisms

II. Research Apprenticeship: Genomic Biology and Physiology of Basil Metazoans and Deuterostomes

III. Research Apprenticeship: Marine Sedimentary Processes

IV. Beam Reach Program

V. Seminar in Organismal Biology

Summer Term A (June 14 - July 16)

I. Marine Invertebrate Zoology

II. Marine Algae

III. Comparative Invertebrate Embryology

IV. Biomechanics

Blinks Research Fellowships (10 wks)

Summer Term B (July 19 - Aug. 20)

I. Neuroethology

II. Ecology of Infectious Marine Disease

III. Larval Biology

IV. Functional Morphology and Ecology of Marine Fishes

Autumn Quarter (Sept. 27 - Dec. 10)

I. Marine Biology Quarter (3 of the following 4 courses)

- Marine Biology
- Social Change and the Marine Environment
- Scientific Diving
- Marine Environment Research Apprenticeship

II. Research Apprenticeship: Pelagic Ecosystem Function in the San Juan Archipelago

III. Beam Reach Program

application and additional information available at: <http://depts.washington.edu/fhl>

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We want to thank our many contributors for their kind and generous support of students and programs at FHL.

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Emily Carrington Student Travel Endowment Fund:

Supports travel for students at FHL

Ellie Dorsey Memorial Fund:

Generates an annual gift presented to a student in memory of Ellie Dorsey

Patricia Dudley Endowment

Supports the study of systematics and structure of organisms and marine ecology

Fernald Fellowship Endowment:

Supports graduate students for studies of marine invertebrate development

FHL Discretionary Fund for Excellence:

Provides funds for student aid and encourages diverse initiatives that benefit FHL

FHL Research and Graduate Fellowship Endowment:

Supports graduate students and postdocs for marine science studies

Anne Hof Blinks Fellowship Endowment:

Supports students of diverse backgrounds in marine science studies

Illeg Distinguished Lectureship Endowment:

Brings specialists to present lectures on invertebrate biology and to meet FHL students and researchers

Kohn Fellowship Endowment:

Supports graduate study of invertebrate biology research and course work

Karel F. Liem Endowment:

Supports research on fishes

Marine Life Endowment:

Preserves FHL foundation courses in Marine Algae / Botany, Comparative Invertebrate Embryology, Marine Invertebrate Biology and Marine Fish Biology

Marine Science Fund:

A current use fund to support students at FHL

Larry McEdward Memorial Fund:

Provides annual support for a graduate student in memory of Larry McEdward

Mellon Mentor Endowment for Excellence in Research Training:

Provides faculty salary in support of internship in marine science, matched 1:1 by the Mellon Foundation

Reed Undergraduate Endowment:

Scholarships to undergraduates for study of marine sciences

Seagrass Conservation Fund:

Promotes investigation, including student directed projects, of the relationship between natural and human-caused stress on seagrass survival in the Northeast Pacific

Kenneth Sebens Student Endowment Fund:

A current use fund to support students at FHL

Richard and Megumi Strathmann Endowed Fellowship:

Supports graduate students working at FHL on natural and physical science problems of the Pacific Northwest

Stephen & Ruth Wainwright Fellowship Endowment:

Fellowships for graduate students studying form and function of organisms

Dennis Willows Director's Endowment:

Provides future FHL directors with discretionary funds for unbudgeted needs including student assistance

From the Director's Office



Photo by Kathleen Ballard

What is Ocean Infrastructure? We are!

Recently, there has been serious discussion about the needs of the ocean research community for new and improved infrastructure. The National Research Council's Ocean Studies Board has asked ocean scientists to consider; what are the types of infrastructure and technology investments needed to continue cutting-edge oceanography for the next 20 years? How are emerging societal needs directing our future infrastructure requirements? How does technology created for other fields drive advances in oceanography? Can today's technology and infrastructure be optimized for future research needs or will current assets (such as ships and satellites) require fundamental changes? This list of infrastructure includes some pretty pricey categories, such as satellites, ocean research vessels and extensive ocean observing systems. In fact, the UW School of Oceanography was recently funded by the National Science Foundation to construct one of the most ambitious cabled observing systems in the world (see: <http://www.ooi.washington.edu/news>).

One other major category of ocean infrastructure, sometimes overlooked in the planning process, is our existing network of marine laboratories. Over 200 marine laboratories and field stations are located along the coasts of the United States. These laboratories support and maintain ocean and coastal research vessels, research and teaching laboratories, ocean observing systems, and facilities for advanced microscopy, genomics, biomedical research, scientific diving, submersibles and many other specialized research areas. Marine laboratories are the primary infrastructure for studies of the coastal ocean, estuaries and inshore habitats and ecosystems, and for research on the interaction of terrestrial and marine environments. Researchers working from these shore-based facilities maintain coastal research sites that comprise all coasts of the United States, including the Great Lakes, and many have regional to global programs as well.

Field sites at and near these laboratories provide a diversity of organisms and habitats, often with protected preserves and/or long-term study sites (e.g., NSF LTER sites). Such resources allow determination of local effects of climate and ocean change (e.g., warming, acidification, invasive species, habitat modification, and resource depletion). These findings are often directly applicable to local community needs in conservation, aquaculture, human health, social impacts and resource management. Field stations and marine laboratories are also the homes of experts in the identification, natural history and ecology of local species, sites of field and laboratory experimental science, as well as test beds for ocean instrumentation. Some laboratories maintain systems for advanced computation approaches to molecular, organismal and ecosystem questions in these complex dynamical systems.

Marine laboratories provide easy ocean access and are excellent locations for graduate and undergraduate courses and research experiences, K-12 interactive learning and

presentation of marine topics to the public (i.e., improving ocean literacy). Marine laboratories offer formal university courses, research experiences for undergraduates (e.g. NSF REU) and internships, usually with substantial mentoring and interaction with faculty and graduate students. Courses are small (10-20 students) and course participants often meet for entire days with substantial field and laboratory time. These laboratories also provide research space and course opportunities for faculty and students from the many universities and colleges that do not have their own marine laboratories, as well as for international visitors.

The small group atmosphere also fosters cross-discipline research. Early experiences at marine laboratories and field stations are often transformative, and are cited as a primary reason many students went on to careers in STEM disciplines. Their programs also encourage diversity and there are many examples of successful undergraduate research experiences aimed at underrepresented groups. More coordination between laboratories is needed; many currently belong to the National Association of Marine Laboratories – NAML (over 100 labs) and the Organization of Biological Field Stations (over 300), which help with such efforts.

So, what are the needs of marine laboratories as ocean infrastructure? First, there are many labs in need of basic building renovation and modernization, including the creation of specialized research laboratories and facilities within existing structures. Second, some laboratories could benefit by construction of new buildings for research, education, outreach and especially housing for visiting researchers and students. Our labs are often hours from the nearest campus, and sometimes in locations where other housing options are nonexistent or very expensive. Third, marine laboratories are constantly in need of updated instrumentation including, computer systems, analytical chemical instruments, oceanographic instrumentation, electron, confocal and other microscopes of all types, and small boat/diving systems. Unfortunately, there is currently only one federal funding source specific to marine laboratories (NSF's Field Station and Marine Laboratories (FSML) Program) and it also funds all of the nation's hundreds of non-marine field stations from coasts to mountains. The total annual funding for this program is only 2.3 million dollars, which means only about 15 very modest awards per year, and only a few of those to marine labs. Compare this to NSF's budget for oceanographic vessel support at over 45 million dollars per year, and around 110 awards (UNOLS fleet).

What about those satellites, observatories and larger ships? We need those too – many marine laboratories host UNOLS vessels, components of the national research fleet, and many researchers at marine laboratories routinely use satellite data, and will do the same for the new ocean observing systems. The message here is simple – in planning for the future of ocean research, marine laboratories are critical “ocean infrastructure” and should be funded as such.

(FHL Director, Ken Sebens, is currently president of the Western Society of Marine Laboratories, WAML, part of NAML.)



**University of Washington
Friday Harbor Laboratories**
620 University Road
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The Inaugural Marine Biology Quarter

A new offering this autumn is the **MARINE BIOLOGY QUARTER**, where students choose from a suite of four course offerings: Marine Biology, Social Change and the Marine Environment, Scientific Diving, and Marine Environmental Research. MBQ students soak up all of the unique opportunities to study marine science and society provided by the San Juan Islands: marching at midnight across the mud flats of False Bay, attending town meetings on NOAA whale regulations and shoreline development, diving at Yellow Island Nature Preserve, tidepooling at Cattle Point at sunrise. You can follow their progress at the **MBQ blog site**, <http://mikenish.com/FHL/>. The following is excerpted from a Cattle Point blog by one MBQer, reflecting on his first encounter with articulated coralline algae and how they might fare in a carbon-enriched environment:

“... my short points are: 1) the biological feedback loops on this planet are so complex that predictions are very limited and flawed; 2) we may see less species loss than predicted while we create a carbon neutral economy; and 3) if we don't cut CO₂ levels, we will definitely see detrimental effects. I know the limitations of using only one study for making an argument, but think about what I've said and give yourself a pat on the back for being part of the solution. I'm optimistic there will be students studying Marine Biology in the generations to come, with the same amount of species diversity (maybe just a bit less).”

- Michael Riederer (UW Chem. Eng. '11)



Meghan Rock at FH town meeting
photo by Sarah Ellison



Students at Lime Kiln Lighthouse
photo by Brit Sojka



Low tide at sunrise - Cattle Point
photo by Brit Sojka

FHL launches Quarterly e-newsletter

This past September, FHL distributed its first e-newsletter, Intertidal Tidings #14. (A special thanks to Laura Long, FHL Advancement Board Member, who took this project on!)

Would you like to receive our e-newsletters?

If so, please send your e-mail address to fhlnews@u.washington.edu. (If you received the September version, you are already on our mailing list.) We plan to send a printed newsletter every November; however, if you'd like to receive *all* newsletters via e-mail, please let us know and we'll make that happen.)

You can find the autumn e-newsletter, and others at http://depts.washington.edu/fhl/help_news_index.html.

We'd like to include news from FHL alums, instructors, visiting scientists, Whiteley Scholars, and friends. Please use the fhlnews@u.washington.edu e-mail address to let us know about your new jobs, awards, research adventures, and publications.