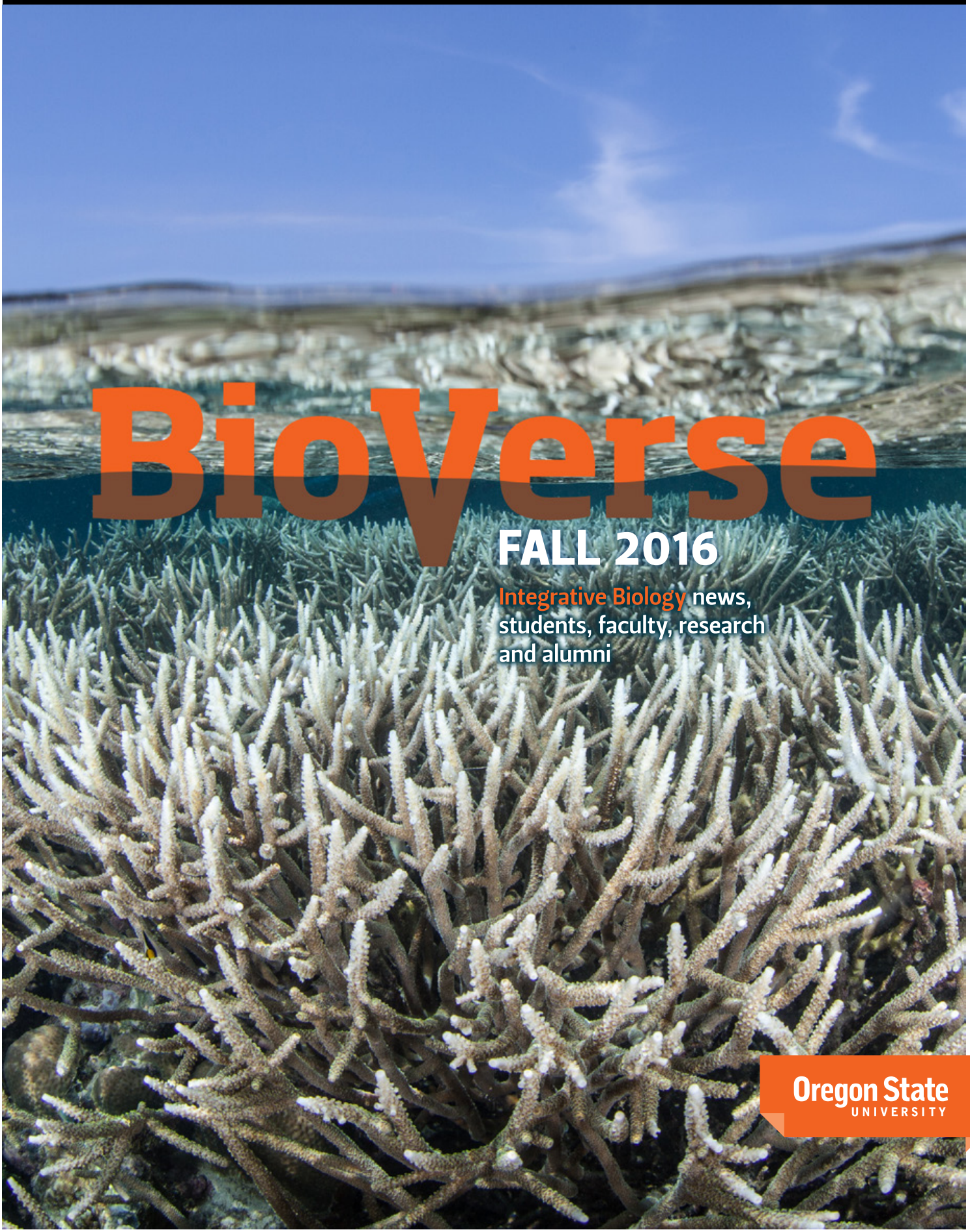
College of Science Department of Integrative Biology



BioVerse

FALL 2016

Integrative Biology news, students, faculty, research and alumni

Oregon State UNIVERSITY

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On the cover
Insight into the basic workings of coral-algal symbiosis are critical to help scientists understand how and if corals can survive and adapt to a rapidly changing planet. See page 19.

BioVerse

FALL 2016

OSU
Oregon State
UNIVERSITY

FROM THE HEAD

Welcome to our first-ever Integrative Biology newsletter!

We are excited to share achievements, activities and upcoming events of our diverse and vibrant department, students, alumni and friends.

In January of 2014, we became the new Department of Integrative Biology when our Zoology Department, with its distinguished 100-year history, combined with our Biology Program, home to a very large undergraduate population. This marriage of zoology with biology has resulted in a powerhouse of faculty, postdoctoral trainees, research assistants, graduate and undergraduate students, academic advisors and staff who are engaged in outstanding scholarship, instruction, learning and outreach.

Our research spans marine, terrestrial and aquatic systems to biological processes and animal collections—including a world-class arthropod collection. Our research is supported by the National Science Foundation, National Institutes of Health and Oregon Sea Grant as well as by private foundations, such as the Packard Foundation and Moore Foundation.

I hope you enjoy reading about our breadth of excellent research . In the last five years, we have said goodbye to several colleagues who are now enjoying their well-earned retirement. Fortunately, we have hired 12 new faculty, including five last year, whom you can read about here.

Our undergraduate programs have produced many of the top-performing graduates at OSU. Last year, 36% of our students graduated with honors. We lead the university in numbers of students who study abroad. You will read about faculty efforts to employ active learning techniques in the classroom and laboratory to enhance student success. We continue to work together to create a strong, diverse community.

Last year, the College of Science launched a five-year strategic plan that will define our path to global excellence. Read more online: **science.oregonstate.edu/sp**.

Finally, I would like to thank our alumni and donors, who have so generously contributed to our faculty and students. You can read the success stories of our alumni and the tremendous impact our friends have made through gifts supporting scholarships, research and teaching.

I look forward to meeting more of you in the future!

Virginia Weis
Head, Integrative Biology

BY THE NUMBERS

Our people

Faculty	44
Academic advisors	4
Graduate students	70
Undergraduate students	1170
Postdoctoral fellows	6
Research assistants	14
Office staff	6
Male/female faculty	57%/43%
National Academy members	1
AAAS fellows	4
OSU Distinguished Professors	3

Research & scholarship (2014–15)

Journal publications	97
Extramural research funds	$4.9M

Undergraduate students (2015)

Male/female	34%/66%
Biology majors	956
Zoology majors	214
Graduates	178
Graduating with honors	65
Honor College students	91
Students studying abroad	29
Int'l degree dual majors	32
Scholarship awardees	67

Graduate students (2015)

Total degrees	14
Master's degrees	3
Ph.D.s	11

Collections

Insects & other arthropods	2.8M
Reptile specimens	85,000
Bird & mammal specimens	550

New Faces

Recruiting outstanding talent

FELIPE BARRETO
Assistant Professor

Dr. Barreto joined the Integrative Biology Department in September 2015, after holding a postdoctoral position at the Scripps Institution of Oceanography. He is an evolutionary geneticist with interests in genomics, adaptation, speciation and population genetics of marine animals.

LINDSAY BIGA
Instructor

An Oregon State alumna, Dr. Biga returned home to Corvallis after teaching for two years at Western Oregon University. Biga teaches nearly 600 students each term and oversees 10 graduate teaching assistants in our Introductory Human Anatomy and Physiology series.

ANDREW BOUWMA
Instructor

Dr. Bouwma earned his Ph.D. from the University of Wisconsin at Madison, and spent several years as a postdoc there and at the USDA-ARS in Gainesville, Fla. Since arriving at OSU in 2014, he has developed and taught a new online introductory biology series.

MOLLY BURKE
Assistant Professor

Dr. Burke held postdoctoral research positions at the University of California in San Diego and in Irvine before joining Oregon State in 2015. She uses yeast as a model organism to test hypotheses about how adaptive evolution shapes population genetics and genomics.

BENJAMIN DALZIEL
Assistant Professor

Dr. Dalziel has a joint appointment in the Departments of Integrative Biology and Mathematics. His lab develops quantitative models of real populations that can forecast growth and change. These models can reveal and predict how interacting organisms respond to disturbances, like environmental shifts or epidemics. His current research focuses on the spread of influenza in animals and humans in the United States and cholera dynamics in rural Haiti.

ELI MEYER
Assistant Professor

Before joining OSU in 2012, Dr. Meyer held postdoctoral positions at the University of Texas, Austin. His research focuses on the genomic basis of complex traits in marine invertebrates, and the responses of these traits to selection in a changing climate.

MARK NOVAK
Assistant Professor

Dr. Novak is an ecologist with interests in species interactions, food web dynamics, and the integration of mathematical theory and empirical fieldwork. He joined our faculty in 2012 from the University of California at Santa Cruz, where his research included work on kelp forests, sea otters, streams and invasive crayfish.

PHILIP PEPE
Instructor

Dr. Pepe came to Oregon State from the Maricopa Community College in Phoenix, Ariz. He is an online instructor and course developer. Currently, he is using competency-based, differentiated, active learning techniques to transform the Baccalaureate Core courses in the life sciences.

CYNTHIA SAGERS
Professor, Vice President for Research

Dr. Sagers was a program officer at NSF's Division of Environmental Biology and the Office of International Science and Engineering as well as Associate Vice Provost of Research at University of Arkansas before joining OSU in fall 2015. She brings her interest in ecology and evolutionary biology with her to her new role as Vice President for Research for Oregon State.

SU SPONAUGLE
Professor

Dr. Sponaugle was a professor and department chair at the University of Miami prior to arriving at OSU in 2013. As a marine ecologist studying the early life stages of marine organisms, she is especially interested in the

physical and biological processes leading to successful population replenishment of nearshore fishes.

JAMES STROTHER
Assistant Professor

Dr. Strother joined our faculty in 2015, after a postdoctoral position at the Janelia Research Campus at Howard Hughes Medical Institute. His research examines the neural circuits that control physiological systems, using zebrafish as a model organism. This work leverages techniques such as calcium imaging, optogenetics, computational modeling and quantitative behavioral assays.

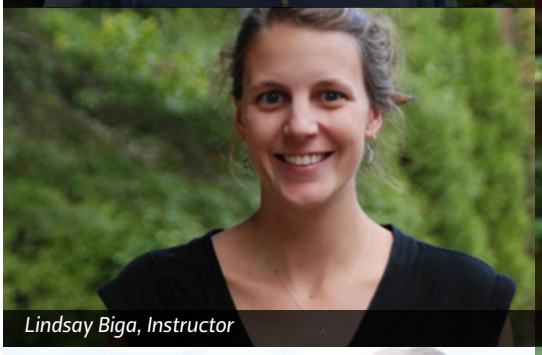
REBECCA TERRY
Assistant Professor

Dr. Terry is a paleontologist with a research focus on reconstructing the responses of Quaternary mammal communities in the desert west to climatic and anthropogenic impacts. She joined OSU in 2012 from Stanford University, where she was a NOAA Climate and Global Change postdoctoral fellow, and before that was at the University of California, Santa Cruz, where she was an instructor in the Earth and Planetary Science Department.

Read more about Rebecca's research on page 11: In the Field.


Felipe Barreto, Assistant Professor


Mark Novak, Assistant Professor


Lindsay Biga, Instructor


Philip Pepe, Instructor

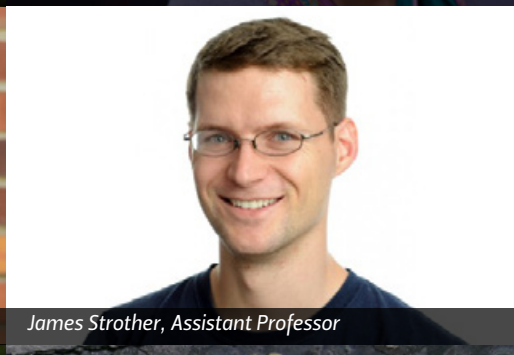

Andrew Bouwma, Instructor


Cynthia Sagers, Professor and VP for Research


Molly Burke, Assistant Professor


Su Sponaugle, Professor


Benjamin Dalziel, Assistant Professor


James Strother, Assistant Professor


Eli Meyer, Assistant Professor


Rebecca Terry, Assistant Professor

On the move

From undergraduates to postdocs, we make a difference

OUR STUDENTS IN ACTION

INTEGRATIVE BIOLOGY CLUB

The Integrative Biology Club (IBC) is a student club that provides a wealth of educational and professionally relevant experiences to more than 1,200 undergraduate students, the heart of our department.

The Club offers students opportunities to participate in weekend field trip adventures, seminars, lab tours and local day trip excursions. Highlights from last year included traveling to the Wildlife Conservation Expo in San Francisco to meet the legendary Jane Goodall and a behind-the-scenes tour of Hatfield Marine Science Center's research facilities in Newport.

Members share their passion for science with K-12 students by participating in outreach events, such as OSU's Discovery Days, and by collaborating with graduate students to bring cutting-edge departmental research to kids. With an eye toward the integration of the arts in STEM education (known as STEAM), IBC's art committee is working to create artistic representations of research in integrative biology by using mixed media formats. Student work will be featured in rotating displays in the new student space, Biosphere, with the addition of a life-sized mural expected in Cordley Hall next year.

Deeply committed to service, IBC partners with local organizations, such as Greenbelt Land Trust, Chintimini Wildlife Center and Salmon Watch. Students receive hands-on training in the fields of conservation, rehabilitation and science education while supporting local organizations. In May 2016, IBC and faculty participated for the first time in OSU's Relay For Life, raising funds and awareness for cancer research. Follow IBC on Facebook (search OSU Integrative Biology Club) and Instagram (integrativebioclub).

STUDENTS RECEIVE NSF AWARDS TO ADDRESS GLOBAL CHALLENGES

By Srila Nayak

Integrative Biology doctoral students **Caroline Glidden** and **Holland Elder** have both received the prestigious National Science Foundation Graduate Research Fellowship Program (NSF GRFP) 2015 awards. Elder and Glidden are among two of 11 students from Oregon State who received an NSF GRFP award last year.

The highly competitive and coveted awards went to 2,000 individuals from among 16,500 applicants in 2015. Established in 1952, the NSF GRFP recognizes and supports outstanding master's and doctoral students in STEM disciplines at U.S. institutions.

The GRFP provides three years of financial support within a five-year fellowship period ($34,000 annual stipend and $12,000 cost-of-education allowance to the graduate institution) for graduate study that leads to a research-based master's or doctoral degree in science or engineering.

Glidden focuses on conservation science in South Africa where she spent the summer, and Elder conducted research on coral reefs at the Institute for Tropical Ecology and Conservation in Panama.

"The GRFP award is one of the most prestigious awards and one of the most helpful to graduate students," said Elder.

The additional time will allow Glidden to pursue a statistics minor alongside her biological research. She spent part of her summer collecting data on foot and mouth disease in the African buffalo in Kruger National Park, one of the largest game reserves in Africa. Glidden was awarded the NSF fellowship to study disease ecology and eco-immunology in South African wildlife with a special focus on disease tolerance versus disease resistance to hemoparasites.

Glidden's personal and research experiences in South Africa have inspired her to bring conservation science to school children in the country. In 2014, she started her own conservation non-profit organization that seeks to distribute books on conservation issues in South African schools to raise awareness. Glidden was able to raise money to distribute

100 copies of *Charlotte's Web* and *Dowlina* to four South African schools.

While Glidden focuses on conservation education in South Africa, Holland Elder will use the GRF award to study the genomic basis of thermal tolerance in corals. As part of her doctoral research, Elder is sequencing the genotype of individual coral samples to look for genomic differences between the corals that pale and the ones that do not.

Elder grew up near oceans in Washington and California and fell in love with sea creatures and marine biology early on. Trained in ballet since the age of eight, Elder chose to pursue a career as a professional dancer after high school. However, an injury at 21 ended her career as a ballerina, bringing her back to academics and rekindling her passion for biology.

Elder began her college career at a community college in San Marcos, Calif., where her advisors actively discouraged her from studying science.

"They told me you won't be able to do it. There is too much math and chemistry. Because there was a chunk of time when I wasn't in school, my advisors thought there was no way I would be able to handle a biology major," said Elder.

Elder was captivated when the professor brought in a coral core to the classroom one day to show layers of coral growth over time.

Grad student Caroline Glidden is a recipient of both the GRFP Award and an ARCS scholarship.

Grad student Holland Elder trained in ballet before embracing her passion for biology.

Postdoctoral scholar Amanda Brown studies symbiotic partnerships in root parasites.

Postdoctoral scholar Dan Preston studies invasive species and parasites in freshwater ecosystems.

MEET OUR POSTDOCS

"I study the evolutionary genomics of symbiosis to understand how microbial symbionts contribute to host fitness. My research is focused on plant-parasitic nematodes, widespread root parasites that cost ~$100 billion in global annual agricultural damage. Until recently, their symbiotic partnerships were largely unknown. In Dee Denver's lab, my bioinformatic analyses helped discover and functionally characterize several key endosymbionts in these nematodes, revealing their roles and identifying potential targets for pest management. I have received the American Association of University Women Fellowship and am President of the Oregon State Postdoctoral Association." —**Amanda Brown**

"I received my undergraduate degree in biology from Oregon State in 2008. I then left for a Ph.D., always hoping I would have an opportunity to return to this department. My research focuses on the ecology of freshwater ecosystems, particularly the roles of invasive species and parasites. In collaboration with Mark Novak, I am currently working on stream food webs in the McDonald-Dunn Research Forest outside of Corvallis. My work has important implications for managing invasive species and wildlife diseases, which are becoming big challenges as humans alter freshwater ecosystems around the globe." —**Dan Preston**

"I remember taking a part with tweezers and thinking, 'Oh my God, this is it! I have been doing the wrong thing my entire life. I need to do this. I don't care what the advisors say,' " said Elder.

Elder's persistence paid off. She eventually earned her degree in biology from California Polytechnic State University. A fortuitous meeting with OSU biology professor Eli Meyer at a conference opened up further academic avenues for her. Elder was intrigued by Meyer's research on thermal tolerance in corals.

"OSU Integrative Biology was my top choice because there is a great cluster of cnidarian biologists here," said Elder. "I look back and I think it was a lot of really hard work and then happening to be in the right place at the right time. Above all, I enjoy my work every day. Every day I wake up and get to see something new, something no one else has ever seen."

STUDENT SUCCESS

STUDENTS LEARN BY DOING AT THE COAST

Student success has been the hallmark of the Marine Biology course (Bi 450) at Hatfield Marine Science Center in Newport. The course, which celebrated its 35th anniversary this past spring, has grown into an internationally recognized destination for students interested in marine biology. Many students consider it a highlight of their undergraduate career at OSU—a hands-on experiential learning opportunity that unleashes their "inner marine biologist."

The course is divided into six sections, each of which focuses on a different topic and is taught by faculty within Integrative Biology.

The topics covered include marine invertebrates (**Sally Hacker**), marine fishes (**Su Sponaugle**), marine algae (**Annette Olson**), community ecology (**Bruce Menge**), and marine conservation (**Sarah Henkel**). A culminating research project of the students' choosing fosters a sense of scientific independence and accomplishment.

The Marine Biology course is an intense, sometimes life-changing experience for students. A typical day might include fieldwork during 5:30 a.m. low tides, where students gather data and specimens, or identify organisms. They might go out trawling for fish on the R/V Elakha or hike up Cascade Head to look for whales. Back at the lab, the rest of the day might include lectures and lab time, identifying and drawing organisms or conducting experiments. Sometimes in the evenings, special activities are scheduled that include talent shows, marine-themed movies, or discussions of career options in the sciences. The students leave the course with extensive knowledge and appreciation of marine biology.

To read more about the Marine Biology course, check out the students' blog at: **marinebio450.blogspot.com**

LEARNING ASSISTANTS PROGRAM ACCELERATES CLASSROOM PROGRESS

One of the challenges we face as educators is finding a way to reach all students so that they can learn and not feel like another number in our gradebooks. Through emerging research, we know that students who engage actively in their classes are generally more successful than those who sit and passively listen. Integrative Biology's **Devon Quick** and **Lori Kayes** developed a Learning Assistants (LA) Program in an effort to improve student success and belongingness at OSU and with funding from NSF's WIDER grant awarded to Enhancing STEM Education at Oregon State (ESTEME@OSU).

Here's how it works: LAs are trained undergraduates who work with faculty to facilitate peer discussions, in-class activities and out of class learning. They engage learners not only with the content, but also with each other, knitting together our learning community. The goals of the program are to improve undergraduate student learning in STEM courses, support curricular reform efforts, provide high performing students an opportunity to learn about science teaching while developing their scientific content knowledge and interpersonal skills, and provide experiential learning opportunities for students.

Being an LA requires three integral pieces: training, practice and content knowledge. First time LAs take an Integrative Biology pedagogy course where they discuss learning theory, teaching strategies, metacognition, and students' conceptions. LAs practice what they learn in the pedagogy course by interacting with other LAs and faculty at weekly preparatory meetings and by interacting with students in the classroom or in informal learning spaces. Working with a lead faculty member, LAs not only deepen their content knowledge, but also identify a research topic about how students learn and present their research at a public poster session.

Since it began in 2014, the LA program has experienced tremendous success: it positively impacts 1,700-2,500 STEM students each term and is part of 10 different courses with plans underway in two other departments.

"MAMO" WAIANUHEA WINS SURE SCIENCE SCHOLARSHIP

Lorraine "Mamo" Waianuhea was ready for more research after she was introduced to it last year thanks to the university's STEM Leaders Program. In summer 2016, Waianuhea, who is part-Hawaiian and a straight-A student, dove into full-time research in a biology lab after winning a SURE (Summer Undergraduate Research Experience) Science scholarship.

That summer, 24 students were awarded SURE Science scholarships for a maximum amount of $5,000 for 11 weeks to focus full time on contributing to impactful and socially beneficial research in the natural and physical sciences. With strong philanthropic support, the program is able to fund students so they can participate in summer research opportunities that can foster meaningful, scholarly connections with faculty mentors early in their academic careers and define their professional career path.

With guidance from her faculty advisor, Waianuhea designed a proposal to investigate how nutrient availability affects the growth of host cells in sea anemones and the efficiency of algal populations of host cells. She hopes to work in the area of conservation biology after she graduates.

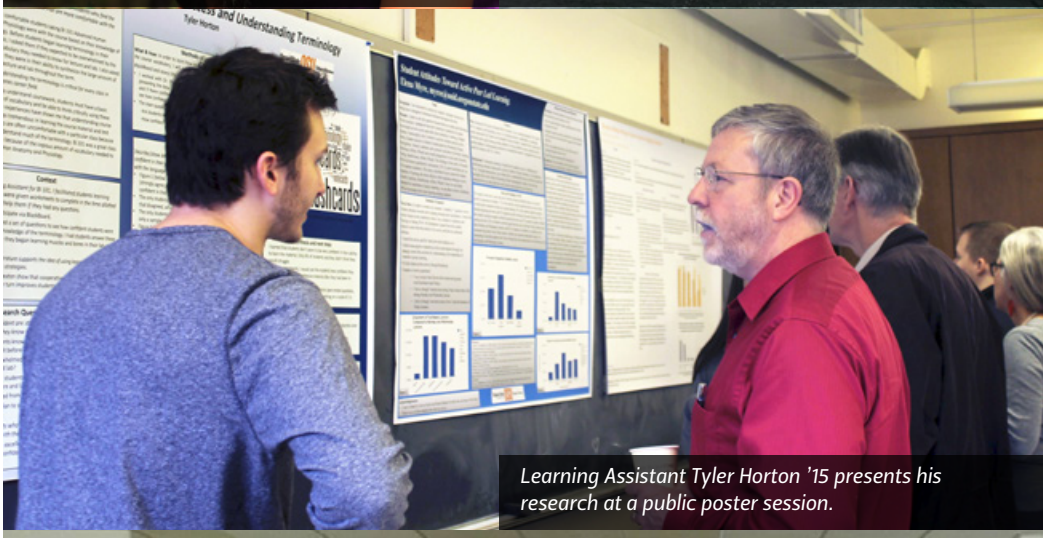
"I am really grateful for the opportunity to continue research. It is a great opportunity to see how working in the lab full time would be like. I already feel like I have learned a lot and it has only been two weeks," said Waianuhea

Read about SURE Science on page 17.

Students experience hands-on learning at Hatfield Marine Science Center.

SURE Scholar Mamo Waianuhea researches the growth of sea anenomes.

Students conduct research on the R/V Elakha as part of their experiential learning.



Learning Assistant Tyler Horton '15 presents his research at a public poster session.

Integrative Biology Open House

A JOURNEY OF RESEARCH AND DISCOVERY IN ENTOMOLOGY: THE TREPANELEVEN

In the spring of 2015, professor **David Maddison** and graduate student **John Sproul** led a group of nine students on a journey of discovery, looking for new species of beetles in Oregon. This unique, full-immersion, experiential-learning course is called Discovering Insect Species and is an actual field experience. Students were part of Dr. Maddison's team, engaging in research about the diversity of ground beetles called *Bembidion*.

The course was focused on a subgenus of *Bembidion*, the *Trepanedoris*, which are small predatory beetles.

First, students learned about the known species of *Trepanedoris*. After examining *Trepanedoris* under microscopes, the team of 11 headed east across the Cascades to scour the marshes of Oregon, looking for ground beetles that live among the grasses and sedges near the water.

Their first weekend field trip was to Klamath Marsh National Wildlife Refuge. After two cold and wet days of collecting, they returned to Corvallis, warmer and relieved and with many specimens in hand.

Back in the classroom, the students learned how to extract and sequence DNA. They watched with growing excitement as the first analyses of the DNA sequences from their specimens were conducted. To everyone's surprise, two of the specimens, collected only a few hundred feet away from the refuge's bunkhouse, revealed a previously unknown species. Just weeks into the term and already the group had made a major discovery!

In the weeks prior to the second field trip, the students learned modern methods for species discovery, including cutting-edge population genetic theory and coalescent analysis, as well as the limits of current methods. They examined their Klamath Marsh captures under microscopes, looking for correlations between structures and the genetic results. Hopeful of recognizing the new species in the field, the group headed east again.

The trip to Malheur National Wildlife Refuge was all that they had hoped for and more. After much searching, one student, **Mamo Waianuhea**, came upon the new species in grasses far from the water's edge. This was entirely unexpected, as *Trepanedoris* is supposed to live near water. The group found 20 more specimens there, enough to be able to study the species' variation. As an added bonus, a new habitat for *Trepanedoris* was discovered.

Through these field trips and subsequent intensive lab work, the 11 budding young scientists bonded into an efficient research team, which they named the "Trepaneleven." In honor of the group, they decided to name their newly discovered beetle "*Bembidion endeca*" ("endeca" means 11 in Greek), a name the species will acquire when it is formally published later this year.

"*Bembidion endeca*" was not all. Students made many other discoveries about these beetles during the term. The most striking of these was courtesy of one student, **Shannon Kieran**, who did some weekend collecting at her parents' home in Eugene. Around a pond there she discovered another new species, still known only from

Graduate student John Sproul prepares products for DNA sequencing.

Shannon Kieran, one of the "Trepaneleven."

Ten of the "Trepaneleven" in the field.

A trip to the Malheur National Wildlife Refuge resulted in an amazing discovery.

Instructor and OSU alumna Lindsay Biga trains TIs in our new meeting space: The Synapse.

that one spot, which will be named "*Bembidion kierani*."

Shannon, now a graduate student at University of California, Davis, said the course was "Easily in the top three most useful classes I took as an undergrad: ... we're all still Facebook friends because you don't forget adventures like that in a hurry."

All of the students loved the course.

Mamo remarked, "The course was exactly what I hoped to get out of my college experience. The most exciting part to me was that the explanations to challenges we encountered throughout the process could not be found in a textbook. We were helping to add to a greater body of knowledge—not just memorizing what someone else had already figured out."

And the students weren't the only ones who benefited.

"This was the most rewarding (and intense) teaching experience of my 23-year career," Dr. Maddison noted. "To see a group of students embrace research, and to see the awe in their faces when they realized they had discovered things no one else knew, was magical."

THE SYNAPSE: LEARNING SPACE FOR STUDENT INTERACTION AND SUCCESS

New connections are forming on the ground floor of Cordley Hall. Last winter we proudly opened Synapse, a meeting space where Anatomy and Physiology students can work collaboratively and find help and encouragement from one another.

Now students seeking places to study can sit at The Synapse's large tables or use the white boards to draw muscles, bones and action potentials. And what's more, former students who had success can return as undergraduate Teaching Interns and Learning Assistants to facilitate learning for other students.

This new space fosters interaction and ultimately, success among students.

A typical Trepanedoris *specimen.*

New discovery "Bembidion endeca"

From the field

Fossilized owl pellets discovered in Utah indicate human activities have disturbed ecosystem resilience.

FOSSILIZED RECORDS

Paleoecologist **Rebecca Terry** discovered fossilized owl pellets in Homestead Cave near Utah's Great Salt Lake from a time when the earth went through a period of rapid warming about 13,000 years ago. The finding suggests that the small mammal community was stable and resilient, indicating human activities have disturbed ecosystem resilience.

Terry, lead author of the recent study published in *Proceedings of the National Academy of Sciences*, set out to examine how mammals responded to natural change by measuring the energy flow in the ecosystem, which combines body size, mammal population abundance and metabolic rate for all the animals in the community.

Looking at energy flow over the last century—both from owl pellet remains at Homestead Cave, as well as from modern mammals—the researchers found overall that energy flow and body size have decreased, and that the community has not been able to compensate.

"Energetically, the modern is distinct from the 13,000 years that have preceded it in terms of how much energy those small mammals represent," Terry says. "Without the fossil record we wouldn't be able to see that [discrepancy] because our modern ecological data don't go back far enough."

Using data from the fossil record to inform how animal populations today are changing is an emerging field. Paleontological information will, more and more, be used to inform decisions in fields like conservation biology because understanding change in ancient ecosystems can help us better understand the severity of changes happening today.

FOSSILIZED FLOWERS

George Poinar, Jr., emeritus courtesy appointment in the Department of Integrative Biology, has discovered a 20-30 million year old flower encased in amber—fossilized tree sap—that is the source of poisons strychnine and curare. The perfectly preserved flower was dug out of the side of a mountain in the Dominican Republic. On February 15, 2016, Poinar's discovery was listed as the most popular science story in the world on Google news and appeared on Time, Forbes, BBC, Reuters, UPI, and other websites.

SCIENTIFIC EVIDENCE IMPELS OCEAN PROTECTION

Two Integrative Biology faculty members, **Jane Lubchenco** and **Kirsten Grorud-Colvert**, recently published an article in the prestigious journal *Science* to highlight the significant progress made over the last decade, but especially in 2015, in creating large protected areas in the ocean. A decade ago, less than 1% of the ocean was in any kind of protected status, and less than 0.1% was fully protected. Now 3.7% of the ocean experiences some kind of protection and 1.9% is fully protected.

The authors attribute this progress to a number of factors, but especially strong scientific findings which show that large, fully protected areas typically result in huge increases in the size, diversity, and abundance of many species within these areas. And some of that increased bounty spills over to adjacent fished waters outside the protected area. In addition, large fully protected areas protect biodiversity and contribute to healthy oceans today, and evidence is mounting that they

enhance resilience to climate change and other environmental changes.

"Scientific evidence has provided the fuel for communities and governments to make smart decisions about their future," says Lubchenco, Distinguished University Professor and Advisor in Marine Studies.

2015 saw six new large, strongly protected marine areas established by a number of countries: Palau, Chile, the United Kingdom, New Zealand, and Seychelles. These marine protected areas, or MPAs, range in size from 115,000 to 325,000 square miles and add a total protected area equal to the size of the United States.

"These new MPAs reflect the race to meet international targets to protect 10% of the ocean by 2020," says Grorud-Colvert. "But even with the increasing number of mega-MPAs, countries are still a long way from achieving their stated goals."

The authors argue that much more work is needed to meet these targets. Simply setting aside large areas is not enough—these protected areas must be scientifically sound, well enforced, and designed to reap benefits for years to come.

"This is where good science will continue to be important," says Lubchenco. Scientists have gained a wealth of knowledge about planning, creating, and sustaining MPAs. "And," says Lubchenco, "as powerful as fully protected areas are, there must also be attention to reducing the pace of climate change, reducing nutrient, plastic and chemical pollution, and ending overfishing."

Communicating the science of marine conservation is a common theme in Lubchenco and Grorud-Colvert's work. "It is imperative that scientific findings be translated into understandable, relevant lay language," says Lubchenco. "This is an essential skill for scientists today," says Grorud-Colvert, "and it's one we are teaching our students."

Jessica Reimer is one Integrative Biology student who has been broadening her science communication skill set. She has worked with Lubchenco and Grorud-Colvert to write science summaries for the United Nations and create outreach tools about MPAs.

It's all part of the larger goal, says Grorud-Colvert, "Science is meant to be shared. An exciting year like 2015 shows the potential of putting good science to work."

DNA EVIDENCE SHOWS THAT SALMON HATCHERIES CAUSE GENETIC CHANGES

Michael Blouin's recent study on steelhead trout in Oregon offers genetic evidence that wild and hatchery fish are different at the DNA level, and that they can become different with surprising speed.

The study, which was published in *Nature Communications*, found that after one generation of hatchery culture, the offspring of wild fish and first-generation hatchery fish differed in the activity of more than 700 genes.

A single generation of adaptation to the hatchery resulted in observable changes at the DNA level that were passed on to offspring, scientists reported. The findings essentially close the case on whether or not wild and hatchery fish can be genetically different.

This new DNA evidence directly measured the activity of all genes in the offspring of hatchery and wild fish. It conclusively demonstrates that the genetic differences between hatchery and wild fish are large in scale and fully heritable.

The study found that the genetic changes are substantial and rapid. It's literally a process of evolution at work, but in this case it does not take multiple generations or long periods of time.

This work was performed using steelhead trout from the Hood River in Oregon. It was supported by the Bonneville Power Administration and the Oregon Department of Fish and Wildlife.

ICE CRAWLER *GRYLLOBLATTA CHINTIMINI* DISCOVERED ON MARYS PEAK

Entomologists **Christopher Marshall** and **David Lytle** discovered a species of insect that appears to live nowhere else in the world. The inch-long arthropod is a type of grylloblattid—a distant relative of crickets, cockroaches and earwigs, which it resembles. They named the ice bug *Grylloblatta chintimini*, using the Kalapuya Indian name for Marys Peak. The announcement appeared in the journal *Zootaxa*.

Grylloblattidae spend most of their time underground, living in caves or loose soil. But when conditions are right, they emerge to prowl the surface of snowfields, where they feast on less well-adapted insects rendered sluggish by the cold.

"They're extremophiles—they need to live right at the edge of freezing," Lytle said.

"If the temperature goes much below freezing, they'll freeze to death. If it gets a few degrees above freezing,

they'll overheat and die — they'll essentially cook in your hand."

Conventional wisdom held that the local ice crawlers belonged to one of the 13 recognized grillobatta species that inhabit mountainous areas from central California to British Columbia and east to the Rockies. But Marshall suspected these gryllos might be different.

"The word was this species was the same as one in the Cascades," he said. "But that struck me as really weird."

Marys Peak, he reasoned, is a long way from the Cascades for a wingless insect to travel. It's also the only place in the Coast Range that consistently gets snow in the winter, and grylloblattidae are specifically adapted to snowy conditions.

BAN ON MICROBEADS OFFERS BEST WAY TO PROTECT OCEANS

Based on an article by Dave Stauth

An outright ban on the common use of plastic "microbeads" from products that enter wastewater is the best way to protect water quality, wildlife, and resources used by people, according to ecologist **Stephanie Green**, a David H. Smith Conservation Research Fellow in the Department of Integrative Biology.

These microbeads are one part of the microplastic problem in oceans, freshwater lakes and rivers, but they pose a special concern because in many products they are literally designed to be flushed down the drain. Even by conservative estimates, the collective total of microbeads being produced today is enormous.

In collaboration with scientists from seven institutions, Green published findings in the journal *Environmental Science and Technology* suggesting that nontoxic and biodegradable alternatives exist for microbeads, which are used in hundreds of products as abrasive scrubbers, ranging from face washes to toothpaste.

"We're facing a plastic crisis and don't even know it," said Green.

Using conservative methodology, the researchers estimated that 8 billion microbeads per day are being emitted into aquatic habitats in the United States – about 2.9 trillion beads per year, enough to wrap around the Earth more than seven times. The other 99% of the microbeads end up in sludge from sewage plants, which is often spread to land and then makes its way into streams and oceans through runoff.

"We've demonstrated in previous studies that microplastic of the same type, size and shape as many microbeads can transfer contaminants to animals and cause toxic effects," said Chelsea Rochman, the David H. Smith Conservation Research Postdoctoral Fellow at the University of California, Davis, and lead author on the analysis. "We argue that the scientific evidence regarding microplastic supports legislation calling for a removal of plastic microbeads from personal care products."

Oregon Steelhead trout being studied by the Blouin lab.

Dr. Lytle (top) and Dr. Marshall (bottom) search for Grylloblatta *on Oregon's peaks at night.*

Microbeads are non-biodegradable plastic fragments <1mm in size. Photo by 5Gyres.

Gifts and gratitude

Alumni continue the tradition of excellence

INSPIRATION FOR GENERATIONS

"Of the professors I've had in my graduate studies in geology and biology, two stand out above all the others. One was a paleontologist at the University of New Mexico and the other is Doc Storm," said zoology alumnus **Bill Lovejoy** (Ph.D., '72).

"Doc had a rapport with students both in and out of the classroom that I tried to emulate in my teaching career at Georgia Southern University," said Lovejoy, Professor Emeritus at Georgia Southern University.

Recently, Lovejoy established the Robert M. Storm Distinguished Lecture in Integrative Biology, an endowed series to promote excellence, advancement and inspiration in biology, particularly vertebrate biology, to the OSU and Corvallis communities.

Doc Storm arrived in Corvallis in 1939 to pursue his master's degree in zoology and never left, except for service in World War II. The title "Doc" is a term of endearment and respect, not for Storm's academic degree, but for his service as a medic on the beaches of Normandy.

After the war, Storm returned to OSU in 1946 to complete his Ph.D. and was hired as an instructor in the Department of Zoology.

Renowned for his pioneering research in herpetology, Doc produced nearly 50 scientific publications. But his most important and cherished contribution is the many students he mentored during his 36 years as an OSU professor. Doc influenced generations of biologists, whose theses and dissertations deal with nearly every group of vertebrates.

Doc was a champion for undergraduate education at OSU winning the College of Science's Carter Award in 1974 for outstanding and inspirational undergraduate teaching and served as head advisor in the Zoology Department for years. Doc is an Emeritus Professor of Zoology and, at 98, still resides in Corvallis.

Lovejoy was one of those students who was inspired and mentored by Doc Storm, describing him as a considerate, thoughtful advisor with strong friendships and connections to many former students and colleagues.

Lovejoy was born in a small Ohio town and came from four generations of coal miners. So by all accounts he should have been a coal miner, but instead he became a first generation college graduate. After serving in the Navy, he attended Muskingum College in Ohio, where he majored in geology. He married his college sweetheart Martha Johnson, and a month later boarded a bus for Albuquerque, NM, where he earned a master's degree in geology.

Lovejoy worked as a geologist for Shell Oil Company in Midland Texas, then after six years enrolled at OSU to pursue a Ph.D. in zoology. Lovejoy has had three interesting and satisfying careers: geologist, biologist, and teacher.

Inspired by his mentors, Lovejoy has established both the Robert M. Storm Distinguished Lecture Series at OSU and the Stuart A. Northrop Distinguished Lecture Series in the Department of Earth and Planetary Sciences at the University of New Mexico.

"By establishing these lecture series at both universities, I hope such inspiration will continue to motivate students for years to come," said Lovejoy.

ALUMNUS KENT THORNBURG: FROM AMPHIBIANS TO MAMMALS

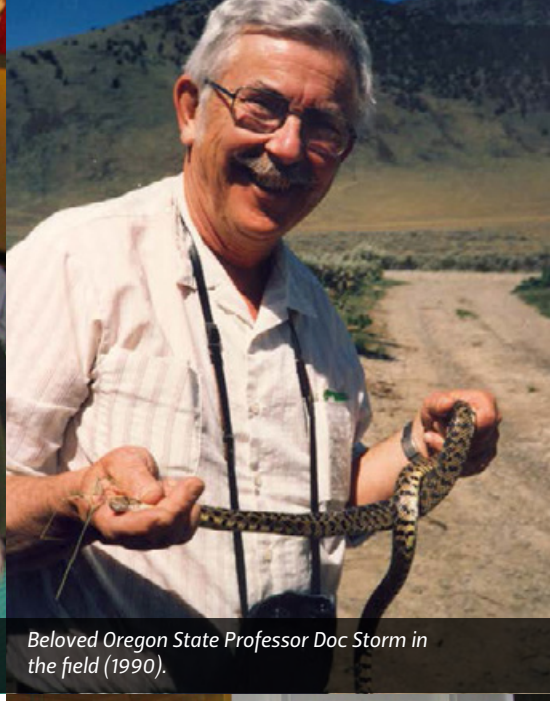
By: Srila Nayak

Dr. Kent Thornburg earned his Ph.D. in Zoology at Oregon State University in 1972 and is now a globally acclaimed scientist in cardiovascular physiology, adult-onset chronic disease and maternal-fetal health at Oregon Health & Science University (OHSU). He holds the M. Lowell Edwards Chair in the Department of Medicine and directs the Center for Developmental Health at the OHSU Knight Cardiovascular Institute.

Thornberg is also director of the OHSU Bob and Charlee Moore Institute for Nutrition & Wellness.

After graduating from George Fox University in Newberg, Ore., Thornburg

Andrew Blaustein, Edmund "Butch" Brodie, Robert Mason, Virginia Weis, Bill Lovejoy and Susan Finger.



Beloved Oregon State Professor Doc Storm in the field (1990).

arrived at OSU in 1967 as a budding young scientist.

"I received a lot of personal attention from my professors. I came in very naïve as a scientist. The courses I took were extremely useful and set the course for what I am doing in my career."

Thornburg studied embryology, or what is now known as developmental physiology under the direction of Dr. Howard Hillemann, who taught courses in comparative vertebrate anatomy and embryology from 1946-75. Thornburg says his graduate work with professor Hillemann was exactly what he needed and set him on the path of becoming a physiologist.

Fascinated by invertebrate cardiopulmonary development, Thornburg focused his doctoral research on how the heart changes in frogs from the embryonic state onwards.

He credits his graduate work on developmental physiology in amphibians with having a strong impact on his scientific career. Even as he switched research gears, Thornberg's interest in the development of the heart remained and he transferred his research to cardiovascular physiology in humans as a postdoctoral researcher at OHSU.

One of Thornburg's pioneering research endeavors has been how early life environment that begins in the womb can be a determinant of disease, including heart and cardiovascular disease, later in life.

Currently, the cardiologist leads a team of scientists at OHSU in an exciting, new field of science called "epigenetics," which explores how genes can be permanently modified by the environment, primarily through maternal diet and stress, and the changes that can be passed along to future generations in a family. Thornburg is the principal investigator on NIH-funded research involving maternal-fetal signaling, training in cardiovascular research, thyroid hormone and heart development and placental function.

Thornberg fondly remembers the department as a deeply nurturing and encouraging place, where professors would readily take students under their wings and impart valuable research advice.

Edmund "Butch" Brodie, inaugural Storm Lecturer, and Professor Emeritus Bill Lovejoy ('72).

Dr. Kent Thornburg ('72)

Making us proud

Faculty and students rack up the honors

2016 LINUS PAULING AWARD

Internationally renowned marine ecologist and integrative biology professor, **Jane Lubchenco** has received the 2016 Linus Pauling Legacy Award sponsored by the Oregon State University Libraries and Press. The Pauling Award recognizes outstanding achievement in a subject of interest to the famous scientist and two-time Nobel laureate. Lubchenco is the ninth winner of the prestigious award, and several of the previous recipients were Nobel Prize winners.

As part of the celebration marking the award, Lubchenco delivered a public lecture in Portland on April 26 at the Oregon Historical Society. Her presentation was titled "Scientists Making Waves and Bringing Hope."

"Your accomplishments and leadership in ecology and environmental sustainability are impressive," said Faye A. Chadwell, the Donald and Delpha Campbell university librarian and Oregon State University press director who announced Lubchenco as the recipient of the award.

Lubchenco is the University Distinguished Professor and Advisor in Marine Studies at Oregon State, and was formerly the administrator of the U.S. National Oceanic and Atmospheric Administration and Under Secretary of Commerce for Oceans and Atmosphere.

In addition to her work at Oregon State, Lubchenco is currently serving as the first U.S. Science Envoy for the Ocean and is an international expert on marine ecology, environmental science and climate change.

BROTHERS IN SCIENCE AND A LIFETIME OF ACHIEVEMENT
By: Debbie Farris

Integrative Biology professor and Director of the Oregon State Arthropod Collection **David Maddison** and his twin brother Wayne Maddison, a professor in the departments of zoology and botany at the University of British Columbia, were honored with the Society of Systematic Biology's prestigious Presidents' Award for Lifetime Achievement.

This honor recognizes outstanding and sustained contributions to the field over the course of many years. It has only been awarded four times since 1998. David Maddison received the award at Evolution2016 in Austin, Tex., in June 2016.

The Society of Systematic Biologists seeks to advance the science of systematic biology, including the aspects of theory, principles, methodology, and practice, for both living and fossil organisms.

Maddison (David) was recognized for his excellence in research, which has had a tremendous impact on the field of systematics, including phylogenetics and taxonomy and has significant importance today.

"I feel incredibly honored to have received this award, and I am humbled when I think about others who have been so honored in the past," said Maddison.

"I am also very aware of how extremely fortunate I am to get to do what I love—to be an explorer, discovering the diversity of beetles and coming to a deeper understanding of the 3.5-billion-year-old tree of life."

Maddison holds the Harold and Leona Rice Endowed Chair of Systematic Entomology in the College of Science, which is generously supported by the Rice family to promote science through the research and teaching activities of an entomologist specializing in Systematic Entomology.

His research focuses on the evolution of beetles and developing methods and software for phylogenetic analysis. His area of specialty is the evolution of adult and larval structure and chromosomes of ground beetles. Currently, he is collaborating on a study of the phylogeny of the major lineages of carabid beetles, using DNA sequence data and morphological characters.

In his spare time, Maddison likes to draw, make cake sculptures, and do other odd things.

Jen Olarra (right) is presented the Olaf Boedtker advising award by Dean Sastry Pantula and undergraduate Kaelie Sivihok (left).

2015 COLLEGE OF SCIENCE TEACHING AND ADVISING AWARDS

Congratulations to **Jen Olarra** for winning the Olaf Boedtker Award for Excellence in Undergraduate Advising, at the College of Science's Winter 2016 Teaching and Advising Awards Celebration for faculty, advisors and students. A biology and zoology advisor, Jen was recognized for her exceptional and inspirational advising and mentoring of undergraduate students.

We are proud of the deep commitment and skill Jen has demonstrated. It speaks to the effectiveness she brings to advising and the tremendous impact she has made on our students. Her outstanding advising and mentoring are essential to our students' success and helps shape them into tomorrow's leaders in science. Jen exemplifies excellence in advising.

An OSU alumna, Jen brings a breadth of knowledge with master's degrees in science education and in soil sciences. She joined our department in 2013.

2015 STAFF AWARDS

Traci Durrell-Khalife: Association of Office Professionals December 2015 Merit Award

2015 PROMOTIONS

Dave Lytle: Full professor
Francis Chan: Associate professor senior research
Eileen Chow: Faculty research associate
Lesley Blair: Senior Instructor II
Mark Lavery: Senior Instructor II

2016 PROMOTIONS

Lori Kayes: Senior Instructor I
Devon Quick: Senior Instructor I

2015 INTEGRATIVE BIOLOGY *CASTOR CANADENSIS* AWARD

This award recognizes outstanding service to the Department of Integrative Biology.

Barbara Taylor: Faculty/staff award
Tye Kindinger: Student award

A SUMMER WELL-SPENT

Last year, we had 11 SURE Science (Summer Undergraduate Research Experience) scholars. SURE Science is a program supported through the Undergraduate Research Frontiers Fund with generous philanthropic contributions from friends and alumni of the College.

The program offers summer scholarships to undergraduate students seeking a research experience to complement their academic experience. Students spend their summer actively engaged in research while working alongside faculty for an engaging, hands-on learning experience.

Isaac Shepherd
Advisor: Mark Novak
Griffin Moser
Advisor: Andrew Buermeyer
Heather Wisner
Advisor: Theresa M. Filtz
Julia Bingham
Advisor: Mark Novak
Melissa Britsch
Advisor: Bruce Menge
Tara Bonar
Advisor: Jaga Giebultowicz
Sophie Means
Advisor: Julie Greenwood
Lorraine Waianuhea
Advisor: Virginia Weis
Yuriyah Reed-Harris
Advisor: Julie Greenwood
Trevor Baley
Advisor: Julie Greenwood

News

The goings-on in our department

DRINK A WASTED SEA STAR ALE, SAVE A VITAL MARINE ANIMAL

In collaboration with Oregon State University and the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO), Rogue Ales and Spirits, a craft brewery in Newport, Ore., has released the Wasted Sea Star Purple Ale. A percentage of the sales of this colorful ale, made from purple corn nectar and similar in hue to purple sea stars, will be used to support research done by OSU and PISCO scientists on the sea star wasting disease that has struck the Oregon coast.

One of the most devastating marine animal diseases on record, Sea Star Wasting Syndrome has been decimating the sea star populations along the entire Pacific Coast for the last two years. **Bruce Menge**, the Wayne and Gladys Valley Professor of Marine Biology in the Department of Integrative Biology, is one of the lead scientists monitoring this unprecedented sea star disease outbreak.

Jenna Sullivan, a student in Menge's lab, came up with the idea of a "wasted sea star" brew to raise funds for Oregon State's research during a lunch at Rogue Brewery. She successfully pitched the idea to the brewery. The funds provided to PISCO will help students in Menge's lab continue their research on the loss of *Pisaster ochraeus*, a top predator and one of the most commonly affected species of sea star. Interested in trying Wasted Sea Star Ale? It can be purchased at Rogue Ale's pubs and online.

SCIENTISTS SOUND ALARM FOR CHANGING OCEAN INDUSTRY

By: Mark Floyd

Integrative Biology Senior Research/ Associate Professor **Francis Chan** is co-chair of a 20-member panel of leading West Coast ocean scientists who presented a comprehensive report outlining a series of recommendations to address the increase in ocean acidification and hypoxia, or extremely low oxygen levels.

The report urged the governments of Oregon, California, Washington and British Columbia to take actions now to offset and mitigate the effects of global carbon dioxide emissions, which is rapidly changing ocean chemistry along the West Coast of North America.

Ocean acidification is a global problem that is having a disproportionate impact on productive West Coast ecosystems," said Chan, co-chair of the West Coast Ocean Acidification and Hypoxia Science Panel.

The panel's recommendations included:

- Develop new benchmarks for near-shore water quality as existing criteria were not developed to protect marine organisms from acidification;

- Improve methods of removing carbon dioxide from seawater through the use of kelp beds, eel grass and other plants;

- Enhance coastal ecosystems' ability to adapt to changing ocean chemistry through better resource management, including marine reserves, adaptive breeding techniques for shellfish, and other methods.

Chan said regional awareness of the impact of changing ocean chemistry started in Oregon. Some of the first impacts were seen about 15 years ago when the state began experiencing seasonal hypoxia, or low-oxygen water, leading to some marine organism die-offs. Then the oyster industry was confronted with high mortality rates of juvenile oysters because of increasingly acidified water. It turns out that Oregon was on the leading edge of a much larger problem.

These and other ocean-monitoring efforts will be important to inform policy-makers about where to best focus their adaptation and mitigation strategies.

"The panel's findings provide a road map to help us prepare for the changes ahead," said Gabriela Goldfarb, natural resource policy advisor to Oregon Governor Kate Brown. "How Oregon and the West Coast address ocean acidification will inform those confronting this issue around the country and world."

STUDY ON SHELLFISH RESPONSE TO OCEAN ACIDIFICATION

By: Tim Stephens, University of California, Santa Cruz

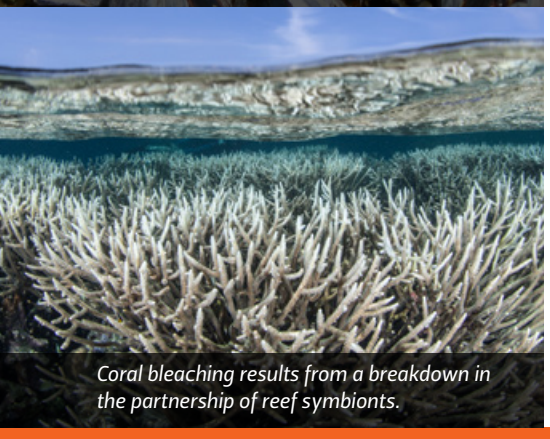
Integrative Biology professors **Francis Chan** and **Bruce Menge** in addition to recent graduate Jeremy

Wasted Sea Star Purple Ale

Healthy purple sea star (Pisaster ochraceus).

Biology alumna Courtney Jackson ('15) studying a sick sea star.

Shellfish response to ocean acidification depends on many factors.



Coral bleaching results from a breakdown in the partnership of reef symbionts.

Rose (Ph.D. '15) co-authored a new study on the effects of ocean acidification on West Coast mussels recently published in *Ecology Letters*.

The study examined how juvenile mussels respond to varying environmental conditions at seven sites spread across 800 miles of coastline in California and Oregon. The results showed that the ability of mussels to cope with more acidic conditions depends largely on how much food is available to them, and both factors vary from place to place in a complex geographic mosaic of environmental and ecological conditions.

This work was funded by the National Science Foundation, University of California, and the David and Lucile Packard Foundation.

FROM OCEAN TO HUMAN HEALTH
By: Debbie Farris

Marine biologist and head of the Integrative Biology Department, **Virginia Weis** has devoted her career to exploring symbiotic relationships. Coral bleaching, so much in the news during this El Niño year, results from the breakdown of the symbiotic partnership and can cause 100% coral mortality and reef destruction.

Weis' research focuses on the molecular and cellular conversations between the partners that result in the formation and maintenance of the partnership and also the communication breakdown that occurs during coral bleaching.

Recently, Weis and two other researchers were awarded a three-year National Science Foundation grant for $583,000 to study these interactions in detail. Insight into the basic workings of coral-algal symbiosis are critical to help scientists understand how and if corals can survive and adapt to a rapidly changing planet.

Weis is collaborating with Boston University biologist Tom Gilmore to examine the role of the coral immune system in managing and communicating with its symbionts and with OSU chemist Sandra Loesgen to identify molecules that participate in interpartner communication. These inter-partner molecular conversations are very similar to those that occur between microbes and other animals including humans.

By gaining a deeper understanding of animal-microbe interactions in an ancient relative of higher animals, we are able to enhance our understanding of the evolution of the immune system.

STORM LECTURE

The inaugural Storm Distinguished Lecture was held March 11, featuring Edmund D. "Butch" Brodie who spoke on "Arms races and the evolution of tetrodotoxin resistance." Dr. Brodie is a professor of biology at Utah State University and also a former student of Doc Storm's.

Travels & Adventures

Integrative Biology is on the move nationally and globally

EMILY BELLIS
Brazil
Panama

HEATHER BROUGHTON
South Africa

CLAIRE COUCH
South Africa

BEN DALZIEL
United Kingdom
New Jersey (USA)

ALEX DAVIS
Bahamas

BRIAN DUGOVICH
South Africa

KATHERINE DZIEDZIC
Panama

MIRAM GLEIBER
Spain
Florida, Louisiana (USA)

CAROLINE GLIDDEN
South Africa

SALLY HACKER
France
North Carolina, Pacific Coast (USA)

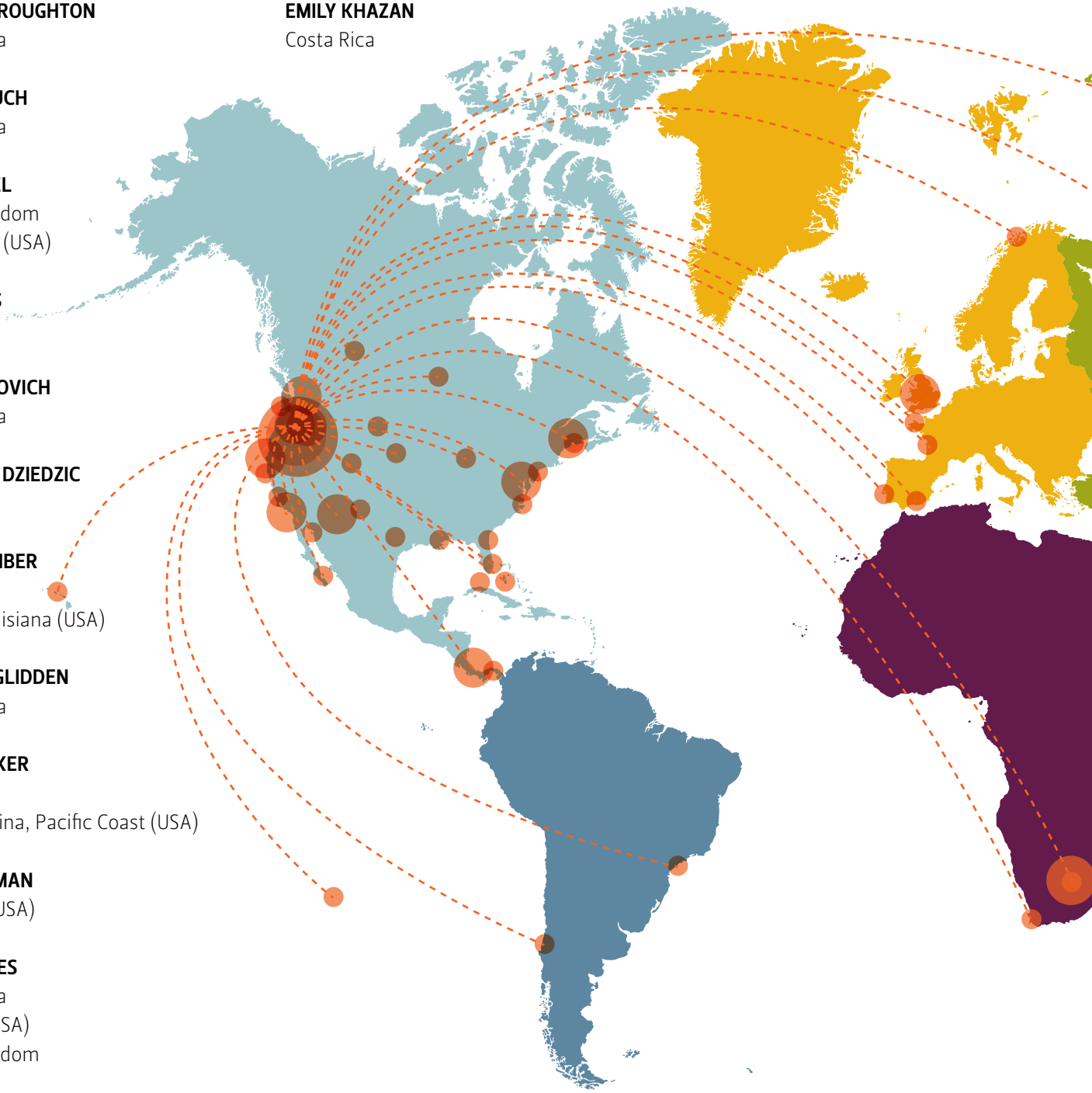
KURT INGEMAN
California (USA)

ANNA JOLLES
South Africa
Montana (USA)
United Kingdom

LORI KAYES
California, Texas, Maine (USA)
British Columbia (Canada)

EMILY KHAZAN
Costa Rica

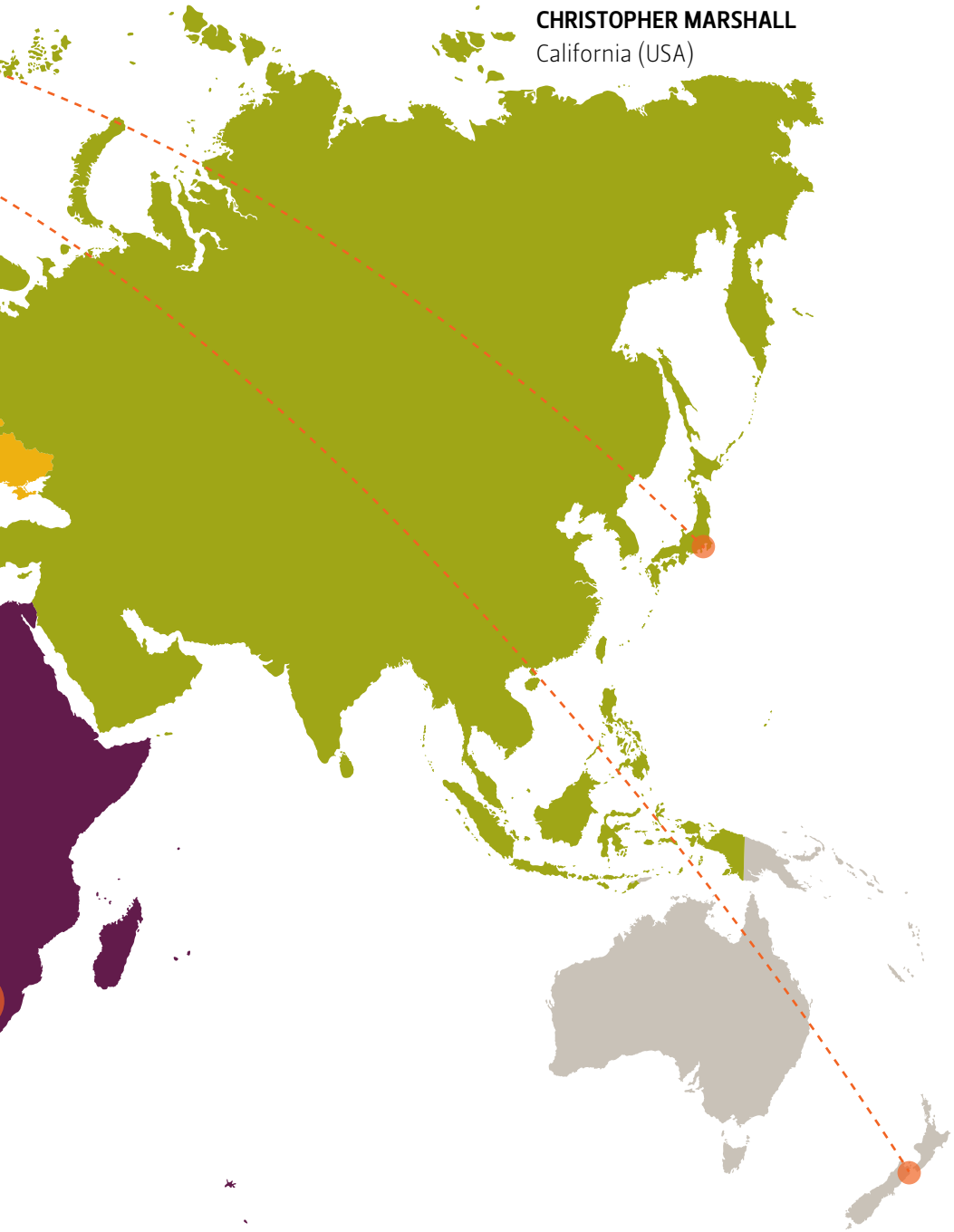
SHEILA KITCHEN
Portugal



DAVE LYTLE
Arizona, New Mexico, California, Utah, Wyoming (USA)
Sonora, Baja California (Mexico)

DAVID MADDISON
California, Arizona, Texas, Washington, Illinois (USA)
Alberta (Canada)

CHRISTOPHER MARSHALL
California (USA)



ROBERT MASON
Manitoba (Canada)

BRUCE MENGE
Chile
Antarctica
Easter Island

HALEY OHMS
Norway

DEVON QUICK
California (USA)

SU SPONAUGLE
Baja California (Mexico)
Florida (USA)
Austria
Japan

JAMES STROTHER
Virginia, California (USA)

BRIAN TANIS
Florida (USA)

HANNAH TAVALIRE
South Africa

LILLIAN TUTTLE
Hawaii

VIRGINIA WEIS
France
Portugal
New Zealand
Florida (USA)

CAITLIN WHITE
California (USA)

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