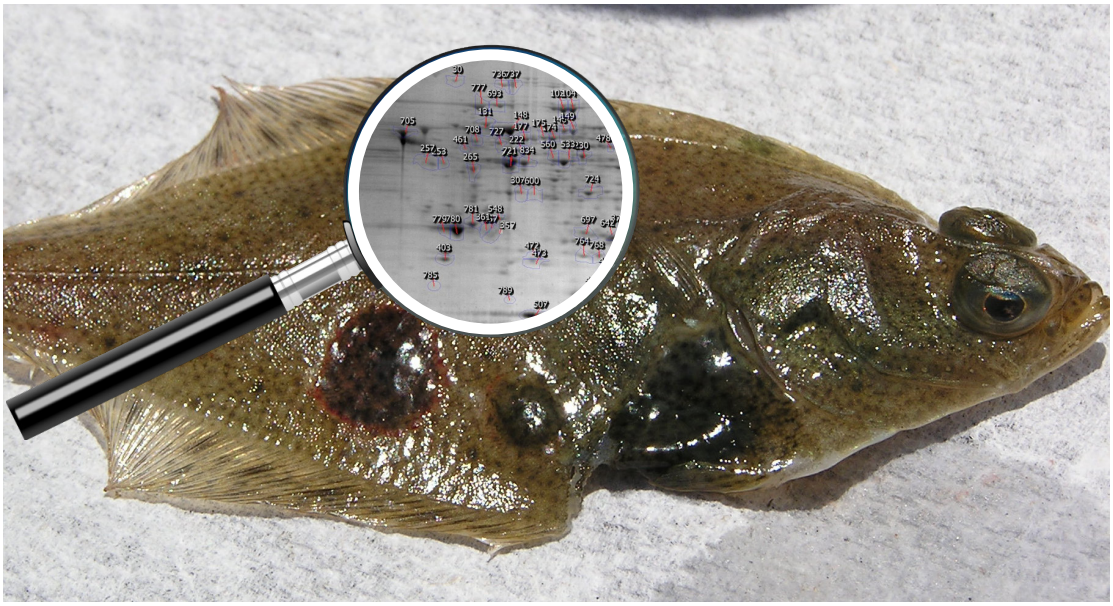
URBAN MARINER
USC Sea Grant's Urban Ocean Report, July 2013, Vol 4, No. 2



(Photo credit: Jesus Reyes)

Detecting the "Fingerprints" of Endocrine Disruption

Pioneering use of technology sheds new light on endocrine-disrupting chemicals in Southern California's urban ocean

If you can't see something with your eyes, can it leave fingerprints? According to Professor Kevin Kelley of California State University, Long Beach, something invisible indeed leaves fingerprints; to find them you just have to use the right tools and know where to look. Dr. Kelley and his research team use cutting-edge technologies to "see" the molecular fingerprints caused by chemical pollution in marine organisms off the urban Southern California coastline. These methods provide new, more cost-effective mechanisms to detect negative health effects of contaminants in organisms, and insights into potential effects on human health.

Although thousands of anthropogenic compounds are detectable in urban aquatic environments today, less than 200 are routinely monitored and regulated by governmental agencies. Worldwide, wildlife and humans are exposed to increasing quantities and types of persistent industrial, domestic, and pharmaceutical chemicals, many of which are classified as **endocrine-disrupting compounds (EDCs)** since they significantly alter endocrine systems and consequently disrupt important physiological functions and health. The list of currently monitored chemicals includes compounds formerly found in coolant fluids (e.g. polychlorinated biphenyls or PCBs) and pesticides (e.g. dichlorodiphenyltrichloroethane or DDT) and current fossil fuel byproducts (e.g. polycyclic aromatic hydrocarbons or PAHs). Missing from the list are the increasing numbers of **contaminants of emerging concern (CECs)**, which include pharmaceuticals (including steroids), personal use compounds (e.g., triclosan), current-use pesticides (e.g., bifenthrin, permethrin), and various industrial and manufacturing-related compounds (e.g., flame retardants, nonylphenol, phthalates). The effects of most CECs in marine organisms or humans are not understood. Some will undoubtedly become identified as EDCs once they are investigated, while some others may have effects unrelated to the endocrine system but which also threaten health.

(Con't on page 3)

NOAA National Oceanic and Atmospheric Administration U.S. Department of Commerce
Sea Grant University of Southern California
California Ocean Protection Council

At the Helm: *From USC Sea Grant*

At the helm of this eleventh issue of the Urban Mariner is USC Sea Grant's Associate Director, Phyllis Grifman.

At its best, Sea Grant's research program allows scientists to develop cutting-edge methodologies for investigating emerging problems and to utilize those new methods in field research. Kevin Kelley's exciting proteomics work is a perfect example of this type of research. Work like Professor Kelley's helps to pinpoint the sources of serious problems of coastal water quality, to understand the consequences that derive there from, and to inform managers charged with protecting both ocean habitats and human health. As part of these efforts, USC Sea Grant sponsored a technical short course, "Non-Reproductive Forms of Endocrine Disruption" at the international ecotoxicology conference, Pollutant Responses in Marine Organisms-16 (PRIMO-16). Held at Wrigley Institute for Environmental Studies on Santa Catalina Island, forty experts from around the world discussed their scientific findings. The course was led by Dr. Stephen D. McCormick (USGS, Massachusetts), Dr. Matt M. Vijayan (University of Waterloo, Ontario Canada) and Dr. Kelley.

One of the many ways in which the OPC achieves its purpose—to ensure that California maintains healthy, resilient, and productive ocean and coastal ecosystems for the benefit of current and future generations—is by supporting innovative research that directly informs and improves the stewardship of ocean resources through a partnership with USC Sea Grant. Beginning in early 2007, the OPC awarded funds to USC Sea Grant to administer peer-reviewed scientific research to address specific OPC research priorities, which were included in USC Sea Grant's annual Call for Proposals. This partnership resulted in a cost-savings to both programs as they collaborated on the scientific peer review and selection of proposals. The OPC-Sea Grant partnership has funded a total of 12 projects since 2007 including Dr. Kelley's work. Other research has focused on topics such as: the fish ecology surrounding coastal oil rigs scheduled for decommissioning; the effects of stormwater runoff on Santa Monica Bay; feeding interactions of native consumers on non-native algae long the Southern California coastline; the impacts of algal toxins on species composition of phytoplankton communities; copper pollution in California marinas; and quantifying contaminants of emerging concern in urban watersheds using bivalves and passive samplers.

Previous issues of the Urban Mariner can be found at: urbanmariner.urbanocean.org
For more information on the OPC: www.opc.ca.gov/
For more information on PRIMO: www.visitlongbeach.com/primo/

What is Sea Grant?

Sea Grant is a nationwide network--administered through the National Oceanic and Atmospheric Administration (NOAA)--of 33 university-based programs that work with coastal communities. The Sea Grant Program at the University of Southern California has served the Southern California coastal region since 1972, funding research, transferring results to government agencies and user groups, and providing information about marine resources, recreation and education to the public.

USC Sea Grant Staff

Linda Duguay, Ph.D., Director
Phyllis Grifman, Associate Director
Lyndell Whitley, Director of K-12 Education, Wrigley Institute for Environmental Studies
Linda Chilton, Education Coordinator
James Fawcett, Ph.D., Marine Transportation/Seaport Specialist, Extension Leader
Juliette Hart, Ph.D., Regional Research and Planning Specialist
Alyssa Newton, Regional Research and Planning Specialist
Charlotte Stevenson, M.S., Science Communications Specialist
Rick Hayduk, Information Technology Specialist
Ruth Dudas, Office Manager

The Urban Mariner is written by Charlotte Stevenson, with editorial assistance from Phyllis Grifman and technical assistance from Rick Hayduk.

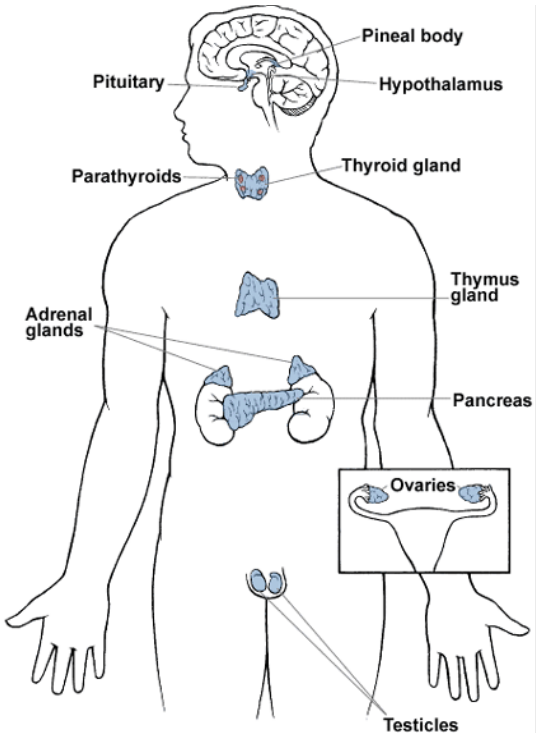
USC Sea Grant Contact Information
seagrant@usc.edu | 1.213.740.1961
http://www.usc.edu/org/seagrant/
http://urbanmariner.urbanocean.org

Dr. Kelley's research team is particularly concerned about marine organisms that live in urban coastal waters that are contaminated with legacy or industrial compounds (like PCBs, DDTs or flame retardants) as well as wastewater treatment plant (WWTP) outfalls farther off the coastline that contribute many CECs into the environment. Coastal WWTPs in Southern California discharge over 942 million gallons of treated wastewater into the ocean every day. Although this water meets some of the highest cleaning treatment standards that exist in the country for discharged wastewater, it still carries the difficult-to-remove contaminants (e.g., estrogen in birth control preparations, nonylphenol, valium, and many others). Moreover, stormwater runoff, most of which does not get captured and treated, carries with it to the ocean additional contaminants. Clearly, these highly populated "urban ocean" settings make a perfect laboratory for the study of environmental toxicology and endocrine disruption in California's marine wildlife.

With the financial support of the California Ocean Protection Council and University of Southern California (USC) Sea Grant Program from 2008-2013, Dr. Kelley and his research team have pioneered the use of a cutting-edge technology—**proteomics**—to investigate the impacts of contaminants in urban ocean fish. Traditionally, effects like endocrine disruption in an organism have been determined by picking a biomarker, or indicator of a biological state, and testing for its presence or absence (or increase or decrease) in a population of organisms suspected of EDC exposure. This type of approach, however, has some limitations. It requires an initial prediction of which biomarker(s) to test for in a given environmental setting and then the possible trial-and-error follow-up testing if the initial prediction is wrong. From the perspective of an environmental manager, this means time, and time means funding. More importantly, single-biomarker testing does not provide a comprehensive picture of what is occurring physiologically inside an organism in polluted water; in most real-life scenarios—especially in situations where an organism is exposed to wastewater from an outfall filled with a broad mixture of potential chemicals—there are likely to be multiple and integrated physiological effects inside an organism. (con't page 4)

A Basic Primer on Endocrine Disruption

The endocrine system is made up of glands throughout the body (e.g., the hypothalamus, pituitary, thyroid, pancreas, adrenals, testes, ovaries) and the hormones that are produced by the glands. These hormones (e.g., estrogen, testosterone, growth hormone, insulin, epinephrine, cortisol, and many more) travel through the bloodstream, acting as chemical messengers, regulating many critical bodily functions such as metabolism, blood sugar levels, reproductive function, development, immune function, stress responses, and growth. Mammals (including humans), fish, birds, and all other living organisms have endocrine systems. An endocrine disrupting chemical (EDC) is one that affects the normal functioning of the endocrine system by mimicking the behavior of hormones, by blocking the effects of hormones, or by altering the levels of hormone or their receptors in tissues. At a cellular level, the presence or absence of hormones (or mimickers) regulates the expression of many genes within a cell, which, in turn, up- or down-regulate the production of particular proteins within a cell. For example, the hormone cortisol is produced by specialized 'interrenal' kidney cells in fish (or by the adrenal gland in humans) when the fish encounters stressful environmental circumstances. Cortisol then turns on the appropriate genes in various cells and tissues that make proteins necessary to change the physiology of the fish to cope with the stress and turn off various genes that control unnecessary bodily functions during stressful times (like growth or reproduction). This up- and down-regulation of **proteins** is a key to Dr. Kelley's research.



The Human Endocrine System
(Image credit: American Medical Association's Current Procedural Terminology, Rev. 1998 Ed.)

Alternatively, a proteomics map shows all proteins expressed in a given tissue, and each protein has its own specific position in the map. This allows the team to screen for proteins that may be abnormally elevated or depressed in tissue samples. By lining up the proteome map of a test fish with the proteome map of a reference fish from a non-contaminated site, Dr. Kelley and his team are able to characterize the molecular and physiological effects associated with contaminant exposures and endocrine disruption. For example, if a male fish shows increased expression of egg proteins, then the environmental presence and action of an estrogen-mimicking chemical is indicated. Along with a panel of endocrine measures, the resulting protein expression changes can then be correlated with concentrations of contaminant chemicals that have accumulated in the tissue of the animals.

Dr. Kevin Kelley and graduate student student Jesus Reyes sampling halibut with City of Los Angeles Environmental Monitoring Division. (Photo credit: Kelley Lab)

Dr. Kelley's results have clear implications for state and regional environmental managers working toward effective ecosystem-based management. Traditionally, water quality objectives and monitoring have been based on measuring contaminant concentration alone and assuming risk often based upon limited published laboratory studies. But knowing that a contaminant is present in the water does not help managers understand *if* and *how* it is affecting wildlife. There is a critical need for a scientifically based understanding of the *impacts* of water quality on wildlife in the urban ocean habitats of coastal California, and Dr. Kelley's research addresses this need. Further development of bioanalytical technologies such as endocrine and proteomic screening methods could allow these water quality agencies and managers to develop objectives in a more ecosystem-based manner by linking endocrine disruption and other important effects directly to the anthropogenic contaminants causing the disruption.

Naturally when discussing endocrine disruption, the issue inevitably arises of if and how the results apply to humans. The U.S. Environmental Protection Agency (EPA) is responsible for determining the possible threat of chemicals to the health of humans and wildlife and then establishing acceptable levels of exposure in the environment, including fresh and ocean waters. Because endocrine systems are similar in all animals with a backbone (including humans), identifying the effects of a new contaminant in fish will ultimately help in understanding environmental levels that are acceptable for humans. Dr. Kelley's work provides an important first step in this direction. In addition, there is a large population of people, especially in Southern California, who use the public piers for subsistence fishing. USC Sea Grant is a partner of the Fish Contamination Education Collaborative, which, since 2003, has been working to protect the most vulnerable populations in Southern California from the health risks of consuming DDT- and PCB-contaminated fish. Dr. Kelley's research expands upon these already known contaminants, shedding light on new contaminants affecting commercially and recreationally important species.

As more and more protein biomarkers are identified and added into a developing proteomics map screening method, it becomes increasingly powerful and valuable as a screening tool. From the perspective of an environmental manager, proteomics screening has the potential to provide for an assessment simultaneously of the expression of 100s to 1000s of proteins, revealing: the effects of trace contaminants that may fall below analytical chemistry detection limits; the synergistic effects of combinations of contaminants; the effects of contaminants of emerging concern; the effects of yet unknown ("new") chemicals; and even the effects associated with environmental changes such as ocean acidification, hypoxic events, and changes in water temperature.
(con't page 5)

Visualizing the effects of stress caused by environmental conditions like pH and temperature may help fishery managers generate strong predictions of population and ecosystem effects associated with impending climate change. Using such adaptive, ecosystem-based management strategies are an important goal of the state, especially for economically important fishery species. Perhaps this screening technology would also be useful in monitoring the effects of negatively impacted water quality on marine resources protected by California's new network of marine protected areas (MPAs) established under the Marine Life Protection Act (MLPA).

This emphasis on scientific research that has direct and immediate implications for environmental management is the hallmark of OPC/Sea Grant funded work. One of the greatest aspects of Dr. Kelley's work is that it has provided a real-time, direct link between academic science and the regulatory community by collaborating with Dr. Jeffrey Armstrong, Environmental Supervisor at the Orange County Sanitation District (OCSD). "Our collaborations with Dr. Kelley and his students have given us valuable information about potential effects from our discharge that we would have missed otherwise," says Dr. Armstrong. "Plus, his work in other areas of Southern California allow us to put our results into a regional context which is very helpful from a potential regulatory perspective."

Dr. Kelley also collaborates with a very active nonprofit organization called the Pacific Coast Environmental Conservancy (PCEC), which focuses on environmental contaminants and their effects, and, importantly, has a unique, strong education and outreach component reaching into low-performing, inner-city Los Angeles schools. PCEC was started by Jesus Reyes, one of Dr. Kelley's previous graduate students (interviewed in the *Getting Underway* section of this issue), who recognized a need for people in these low income communities, many of whom fish for subsistence from public piers, to understand the impacts of human activity on the health of fish. With the assistance of the Kelley Lab, Jesus Reyes and PCEC are able to take school children out sampling so they can learn the science first hand. (con't page 6)

Field collection of fish onboard *M/V Nerissa* with staff from the Orange County Sanitation District Monitoring Division (Photo credit: Kelley Lab)

Reaching even farther into the world of public education, Dr. Kelley has partnered with the Cabrillo Marine Aquarium in San Pedro, California to provide the foundation and guidance for a new public exhibit opening September 2013 called "Pollution in our Sea – What Happens to the Fish?" This exhibit will address the entry of contaminants like pharmaceuticals and personal care products into the ocean and explain how they then impact fish health (and by extension, us). The exhibit will feature the concept of "environmental endocrine disruption" and the role of good conservation and personal behavior practices in terms of trying to reduce this threat to coastal health. "We are grateful for the opportunity to be able to share the results of Dr. Kevin Kelley's Sea Grant-OPC funded research," says Dr. Julianne Kalman Passarelli, co-investigator and Exhibits Curator at the Aquarium. "These findings will be useful to help us inspire our aquarium visitors to take better care of our local ocean." Also, a web portal is being developed for conservation, under which one of the four main topics is "pollution." The portal will link to state agencies, laboratories, and technical information. In addition to this exciting exhibit, Dr. Kelley and his students participate in ongoing Cabrillo Marine Aquarium outreach through public lecture series and K-12 beach surveys.

So often we find that academic research, environmental management, and public education operate in separate spheres. It is rare to find an academic researcher like Dr. Kevin Kelley who not only is producing novel and exciting work in his field, but also reaching across the divide to actively and concurrently involve environmental managers, policymakers and even the public in his work. USC Sea Grant and the California OPC are proud to have supported the research, outreach and students of Dr. Kelley and look forward to seeing more of his work in the future.

The close link of this type of research to human health makes this kind of work extremely important and urgent. Infamous contaminants like DDT and PCBs have not been produced in the U.S. for almost twenty years, and yet their legacy, especially in locations of high production like Southern California, will continue for some time as they slowly leech from contaminated ocean sediments. However, there may be new chemicals invented within the last decade (or will be invented in the near future) that we may still have time to identify and discontinue use before they become legacy environmental contaminants and known endocrine disruptors. Work like Dr. Kelley's will help us identify these new contaminants, figure out their effects, and hopefully make changes before it is too late.

More information: www.cabrillomarineaquarium.org; www.PCEConservancy.org

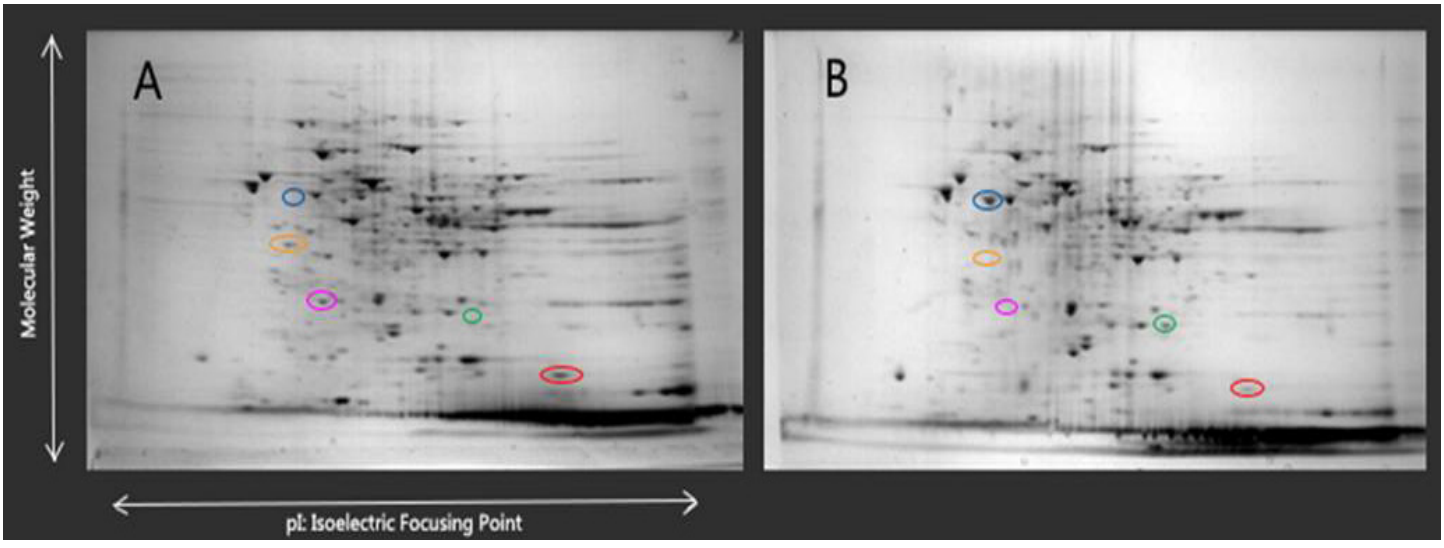
Left: Dr. Julianne Kalman Passarelli holding a fish parasite. Endocrine-disrupted fish often have a higher level of parasitism, suggesting immune system impairment. (Photo credit: Dr. Kevin Kelley)

Right: Dr. Kelley has worked with co-investigator and Exhibits Curator, Dr. Julianne Kalman Passarelli at the Cabrillo Marine Aquarium in San Pedro, California to provide the foundation and guidance for a new public exhibit opening September 2013 called "Pollution in our Sea – What Happens to the Fish?" (Photo credit: Dr. Julianne Kalman Passarelli)

In Depth: *The Stories Proteins Can Tell*

From the research completed to date, it is clear that environmental endocrine disruption is occurring in several different coastal fish species (i.e. flatfish, surfperch, sculpin, scorpionfish). Furthermore, different hormone systems may be impacted in a given species depending upon the specific environmental contaminants present. Along with the disrupted endocrine systems are multiple effects on protein expression that indicate impacts on energy metabolism, immune functions, or toxicological responses to organic compounds or oxidizing agents known to be present in the environments under study. These studies have begun to directly link the specific effects in the fish with exposure to specific types of environmental chemicals. For example, fish sampled from contaminated inshore locations in both San Francisco Bay and coastal Southern California exhibit significant disruptions in their thyroid endocrine system, and these impacts are linked in particular to PCBs (whose molecular structure is not dissimilar from the thyroid hormones themselves). It has also been determined that a critical enzyme involved in 'activating' thyroid hormone (converts T4 into T3, in target tissues) is altered in association with exposure to chlordane-type pesticide compounds. Impairment of this enzyme means reduced thyroid hormone actions and resulting physiological impacts. One such impact appears to be related to growth, meaning affected fish could end up smaller than otherwise identical fish not exposed to these pesticides.

The team has also found that male flatfish living offshore of Southern California exhibit quite high levels of female hormones (as high as in reproductive females). These findings prompted a multi-institution collaboration on reproductive endocrine disruption in the hornyhead turbot, a flatfish species whose males showed this condition. Partners included U.C. Riverside, Orange County Sanitation District, City of Los Angeles Bureau of Sanitation, Southern California Coastal Water Research Project, Los Angeles County Sanitation Districts, U.C. San Diego, and City of San Diego. Several of the findings were published in the December 2012 edition of Environmental Toxicology and Chemistry. While the study did not directly implicate WWTP outfall sites or specific chemicals in causing the high estrogen levels, a wide variety of potentially active CECs were measured in fish tissue composites and in the fishes' environment. Follow-up studies are aimed at characterizing the potential environmental cause(s) and effects, using proteomic-screening methods to identify which functionally important proteins may by altered in testicular tissue (since evidence indicates that the testes are aberrantly producing the estrogen). Studies will also evaluate whether the high estrogen levels are impacting male physiology (e.g., expression of estrogen-regulated proteins in liver?). Ultimately, these studies are expected to lead to the development of biomarkers that will facilitate finding the environmental agents at play. (Con't page 8)



Stained liver proteomes of a fish from a reference location (A) and a fish from a contaminated location (B): two-dimensional gel images of proteins separated out on the horizontal axis by isoelectric focusing point (pI) and molecular weight on the vertical axis (kDa). Each individual protein has its own particular location within the proteome "map", and therefore can be compared between different fishes' proteomes (Photo credit: Rickesh Patel)

An additional, less widely recognized form of endocrine disruption involving the steroid hormone, cortisol, has been observed in several fish species. This hormone is critical for normal metabolic regulation and in regulating the physiological and behavioral responses to stress (discussed in more detail earlier in the box on endocrine disruption). By studying wild fish living near the Orange County Sanitation District (OCSD) WWTP outfall pipe, Dr. Kelley's team and co-investigator Dr. Jeffrey Armstrong, Environmental Supervisor at the OCSD, found that two classes of contaminants may be disrupting the ability of the fish to produce cortisol normally. Polycyclic aromatic hydrocarbons (PAHs found in fossil fuels) and polychlorinated biphenyls (PCBs found in coolant fluids for capacitors and motors) were specifically associated with disrupting the cells in the interrenal tissue that produce the cortisol. Similar results were subsequently found in fish residing at other types of impacted locations, including areas with heavy industry and shipping activities that also contain elevated PAHs and PCBs.

Why do we care if a fish cannot produce cortisol normally? Drs. Kelley and Armstrong along with Dr. Julianne Kalman Passarelli, a fish parasitologist and Exhibits Curator at Cabrillo Marine Aquarium in San Pedro, have taken the study a few steps further to determine whether there are maladaptive physiological consequences. Sure enough, they found that fish with this form of endocrine disruption experience substantially increased rates of parasitic infestation, suggesting impaired defense and immune-system function. Some of the fish also showed significantly altered expression of proteins necessary for normal energy metabolism and for body growth. These changes are pointing to potentially important health consequences in the impacted fish.

Project Research Papers Published To Date Under USC Sea Grant/OPC Funding

Reyes, J.A., Vidal-Dorsch, D., Schlenk, D., Bay, S.M., Armstrong, J.L., Gully, J., Cash, C., Baker, M., Stebbens, T., Hardiman, G. and Kelley, K.M. **(2012**). Evaluation of Reproductive Endocrine Status in Wild Hornyhead Turbot Sampled from Urbanized Coastal Southern California Environments. *Environ. Toxicol. Chem*. 31:2689-2700.

Bay, S.M., Vidal-Dorsch, D.E., Schlenk, D., Kelley, K.M., Maruya, K.A. and Gully, J.R. (**2012**) 2006 Integrated Coastal Effects Study: Synthesis of Findings. *Environ. Toxicol. Chem*. 31:2711-2722.

Reyes, J.A., Vidal-Dorsch, D., Schlenk, D., Bay, S.M., Armstrong, J.L., Gully, J., Cash, C., Baker, M., Stebbens, T., Hardiman, G. and Kelley, K.M. (**2012**). Evaluation of Reproductive Endocrine Status in Wild Hornyhead Turbot Sampled from Urbanized Coastal Southern California Environments. Annual Report 2012 Southern California Coastal Water Research Project, (www.sccwrp.org)

Pribyl, A.L., Schreck, C.B., Kent, M.L., Kelley, K.M., and Parker, S.J. (**2012**). Recovery potential of black rockfish, Sebastes melanops Girard, recompressed following decompression. *J. Fish Diseases* 35:275-286.

Schlenk, D., Mason, Z. and Kelley, K. (**2012**). Pollutant responses in marine organisms (PRIMO 16). *Marine Environmental Research* 75:1-2.

Sedlak, M., Kelley, K., and Schlenk, D. (**2011**). Effects of pollutants on bay fish. San Francisco Estuary Institute (SFEI). 2011. The Pulse of the Estuary: Pollutant Effects on Aquatic Life. *SFEI Contribution* 660: 66-77 (www.sfei.org)

Bay, S.M., Vidal-Dorsch, D.E., Schlenk, D., Kelley, K.M., Baker, M.E., Maruya, K.A. and Gully, J.R. (**2011**). Sources and Effects of Endocrine Disruptors and Other Contaminants of Emerging Concern in the Southern California Bight Coastal Ecosystem. *S.C.C.W.R.P.* Report 650. (www.sccwrp.org)

Brar, N.K., Waggoner, C., Reyes, J.A., Fairey, R. and Kelley, K.M. (**2010**). Evidence for thyroid endocrine disruption in wild fish in San Francisco Bay, California, U.S.A. Relationships to contaminant exposures. *Aquatic Toxicology* 96:203-215.

Baker, M.E., Ruggeri, B., Sprague, L.J., Eckhardt, C., Lapira, J. Wick, I., Soverchia, L., Ubaldi, M., Polzonetti-Magni, A.M., Vidal-Dorsch, D., Bay, S., Gully, J.R., Reyes, J.A., Kelley, K.M., Schlenk, D., Breen, E.C., Šášik, R., and Hardiman, G. (**2009**). Analysis of Endocrine Disruption in Southern California Coastal Fish using an Aquatic Multi-Species Microarray. *Nature Precedings* http://hdl.handle.net/10101/npre.2009.2823.1.

Baker, M.E., Ruggeri, B., Sprague, J., Eckhardt, C., Lapira, J. Wick, I., Soverchia, L., Ubaldi, M., Polzonetti-Magni, A.M., Vidal-Dorsch, D., Bay, S., Gully, J.R., Reyes, J.A., Kelley, K.M., Schlenk, D., Breen, E.C., Šášik, R., and Hardiman, G. (**2009**). Analysis of Endocrine Disruption in Southern California Coastal Fish using an Aquatic Multi-Species Microarray. *Environmental Health Perspectives* 116:223-230.

Rempel, M.A., Reyes, J.A., Steinert, S., Hwang, W., Armstrong, J.L., Sakamoto, K., Kelley, K.M., and Schlenk, D. (**2006**). Evaluation of relationships between reproductive metrics, gender, and vitellogenin expression in demersal flatfish collected near the municipal wastewater outfall of Orange County, California, USA. *Aquatic Toxicology* 77:241-249.

Kelley, K.M., Price T.D., Galima, M.M., Sak, K., Reyes, J.A., Zepeda, O., Hagstrom, R.K., Truong, T.A., and Lowe, C. (**2006**). Insulin-like growth factor-binding proteins (IGFBPs) in fish: beacons for (disrupted) growth endocrine physiology. In: *Fish Endocrinology*, Vol 1 (Eds. Reinecke, M., Zaccone, G., and Kapoor, B.G., Science Publishers, Plymouth, UK, pp.167-195.

Scientist's Quarters: *Dr. Kevin Kelley*

Dr. Kevin Kelley,
California Sate University, Long Beach
(Photo credit: Julianne Kalman Passarelli)

Dr. Kelley's areas of interest include environmental and comparative endocrinology, physiology and toxicology. While his research keeps him on the cutting edge of the mechanisms, causes, and impacts of environmental endocrine disruption in urban ocean fish, Dr. Kelley still prioritizes teaching and mentoring the next generation of scientists, as well as outreaching to various management entities and organizations. In the last four years under this project funding, Dr. Kelley has organized, co-organized or chaired six workshops and symposia, given fourteen invitational lectures at various management agencies, societies, academic institutions, and local aquaria, and presented (or mentored his students in presenting) twenty-four conference presentations.

Notably, since 2009, Dr. Kelley has been a Coordinator of the Environmental Effects in Coastal Organisms (EECO) Network, a California State-wide organization of environmental scientists, stakeholders, and scientific resources whose goal is to advance our understanding of the coastal environment and the consequences of environmental change on the health and adaptability of marine and coastal organisms and, using state-of-the-art scientific technologies and approaches, to support informed decision-making and the development of responsible policy. Since 2009, Dr. Kelley has also been a Science Advisor for the Pacific Coast Environmental Conservancy, a nonprofit organization that aims "to improve the understanding of human impacts in marine and terrestrial environments of the Pacific coast region with support for and facilitation of scientific and technology driven assessment and studies, with a unique educational component that facilitates and supports direct participation of students (university, K-12) and the public in environmental studies, assessment, and other beneficial activities that lead to increased awareness of modern environmental problems and possible solutions."

Despite this busy schedule of research and outreach, Dr. Kelley still teaches several courses at California State University, Long Beach, including: Comparative Animal Physiology and Lab, Fish Physiology and Endocrinology, Environmental Physiology and Toxicology of Marine Organisms, and a Biology of Regulation Seminar. During the term of this OPC-USC Sea Grant funded project, Dr. Kelley has mentored and funded five Masters students and fourteen undergraduate students.

Dr. Kevin Kelley received his Masters of Science and Ph.D. in Endocrinology at the University of California, Berkeley. He is a member of the Society for Environmental Toxicology and Chemistry (SETAC); Southern California Society for Environmental Toxicology and Chemistry (SoCal SETAC); Society for Integrative and Comparative Biology (SICB); and the American Fisheries Society (AFS).

For more information on Dr. Kevin Kelley and his research: www.csulb.edu/depts/endo/

EECO: www.calstate.edu/coast/EECO

Dr. Kevin Kelley teaching children about the effects of pollution on fish during a field trip to the Cabrillo Marine Aquarium (Photo credit: Julianne Kalman Passarelli)

Getting Underway: *Young Researchers*

In addition to funding and facilitating research and developing partnerships to address some of the critical issues facing the State's urban ocean environment, USC Sea Grant and the California Ocean Protection Council places great importance on developing the next generation of scientists, policymakers, and educators. Below we feature five of Dr. Kelley's students mentored during this project, who have all gone on to explore the complicated yet imperative integration of science and policy in managing the marine environment.

Claire Waggoner, M.S., 2011

Thesis title: *Endocrine disruption and hepatic protein expression in contaminant-exposed English sole in the Southern California Bight*

Has your graduate work influenced what you are doing/want to do in the future? *This work has inspired me to want to take a more active role in protecting marine and estuarine environments. I really enjoyed being able to interpret the results from my graduate research and tell a story about how human-derived chemicals were negatively affecting fish in an area of Southern California where I had lived my whole life. In the future, I would like to be able to interpret the results from scientific studies and share them with the public in order to increase environmental stewardship.*

How has working with Sea Grant and the OPC changed or helped you develop your understanding of how science and policy interact? *Now as a 2013 State Sea Grant Fellow with the California Water Resources Control Board in Sacramento, I see how science is used to inform policy on a daily basis. Any time a regulation, plan, or policy is updated, there must be solid scientific evidence to support the updates because plans and policies are under such scrutiny by stakeholders. The Water Board uses the scientific peer review system to evaluate amendments to regulations, plans, and policies to ensure the best science is used.*

If you could tell policy-makers in California one thing in regards to your research finding, what would it be? *I would advise that policy-makers use the precautionary principle in decision making so that in instances where there is not a scientific consensus on the potential impacts of the policy-makers' decision, they err on the side of caution to adequately protect the public and the environment.*

Favorite marine creature? Favorite Invertebrate: Caprellids; Favorite Elasmobranch: zebra shark; Favorite Fish: Mola mola

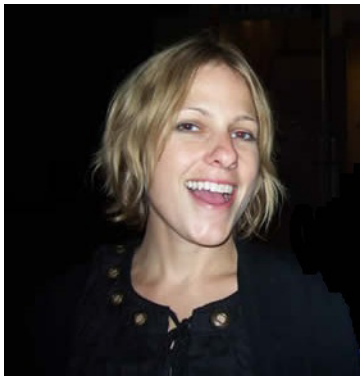
Dwight Causey, M.S., Graduating August 2013

Thesis title: *Disruption of the stress-response endocrine system in English sole of southern California: A study of potential interrenal mechanisms and environmental causes*

Has your graduate work influenced what you are doing now or want to do in the future? *The funding that I received from USC Sea Grant for my graduate work has absolutely, positively influenced my current research as well as my future goals. I was unaware the scope to which contaminants are adversely affecting many different physiological systems of fish in the wild. In the future, I hope to pass on the knowledge I have gained to the next generation of young scientists in the form of education and continued research in the field of endocrine-disruption.*

If you could tell policy-makers in California one thing in regards to your research finding, what would it be? *Although this type of endocrine disruption is not as flashy as male fish with ovaries, it is nonetheless important for the everyday survival of all vertebrate animals. Cortisol is released in response to a stressor, and if an organism does not respond to the stressor properly, chronic stress can ensue which would have negative impacts on growth, reproduction, and immune function. The cortisol-producing stress response system is in constant balance with the other physiological processes of the body and if one system does not function properly, it can throw off this delicate balancing act. The extent to which these physiological changes would affect populations and communities is still unknown, and further research in these fields is still necessary and required.*

If a 10 year old asked you what you liked most about being a marine scientist, what would you say? *I don't have to wear a suit or sit in a cubicle all day. My office is the ocean! I get to work outside and see amazing animals all the time. There is always something new and cool to learn about in the ocean every day!*



Hayley Zemel, M.S., 2013

Thesis title: *Disruption of the stress-response endocrine system in shiner perch of San Francisco Bay: a study of potential interrenal mechanisms and environmental causes*

Has your graduate work influenced what you are doing/want to do in the future? *Absolutely. My graduate work that was funded by Sea Grant and OPC helped me to realize my drive to help find links between science and policy. My research involvement with ecoproteomics has helped me to see the great potential this technique has as a tool that can increase the effectiveness of ocean and coastal monitoring. I was then drawn to a California Sea Grant Fellowship with the California Ocean Science Trust (OST), where I worked toward the mission to advance a constructive role in state ocean and coastal decision-making. That fellowship led me to my current position with OST as a Program Associate.*

How has working with Sea Grant and the OPC changed or helped you develop your understanding of how science and policy interact? *I now have a much greater understanding of the barriers that exist between science and policy. I used to think it was all about communication but it has become clear to me that other barriers exist, such as the difficulties that stem from the timing of California's information needs (usually a short timeframe) versus the structure of academic science (which might take 5 years to produce the desired information).*

If you could tell policy-makers in California one thing in regards to your research finding, what would it be? *I think the greatest finding of this research is the power of the technique and the possibilities it has to offer as a fast and cost-effective ocean and coastal environmental monitoring tool.*

Favorite marine creature or jargon term? *My favorite ocean phenomenon is the Global Ocean Conveyor Belt (GOCB) because it helps to remind me that the ocean, vast and spanning all continents in places I may never visit, is not only connected but also constantly moving globally because of differences in temperature and salinity. It may take 1,000 years, but the same water in the deep, cold Antarctic Ocean will eventually find itself on the surface in the warm Gulf of Mexico.*

Dawn Petschauer, M.S., 2008

Thesis title: *Studies on Environmental Steroids and Their Possible Impacts on the Endocrine Physiology of Pleuronectiformes in Santa Monica Bay*

Has your graduate work influenced what you are doing/want to do in the future? *My research had everything to do with my current work, as I am a Water Biologist II at the Hyperion Wastewater Treatment Plant in Playa del Rey. Not only did it introduce me to the important aspects of nationally-implemented monitoring programs, but also helped lead me to avenues for pursuing a position with the City of Los Angeles where I currently work with many who helped me achieve my graduate research goals.*

If you could tell policy-makers in California one thing in regards to your research finding, what would it be? *I would reiterate the importance of funding programs like Sea Grant for environmental and scientific research. Not only does it afford the opportunity to pursue a diverse range of projects pertinent to the overall safeguarding of our primary coastal resource, but it also provides a platform for continued education for individuals, some of whom may be unable to pursue it otherwise, and we all as a community can only benefit from having more people with a higher education in our workforce.*

Favorite marine creature? *I did a report in 6th grade in NH on unusual sea creatures and that is when I came across the sea cow, or manatee as most people refer to them. That was the moment I knew I wanted to be a marine biologist! But, after visiting FL in the dead of summer I decided to pursue marine biology in a warm rather than hot location, and so my dream of working with manatees faded. I'd still love to dive with them some day though!*

Jesus Reyes, M.S., 2006

Thesis title: *Altered Endocrine Physiology in Marine Flatfish Associated with Southern California Wastewater Treatment Plant (WWTP) Outfalls- Stress, Growth and Reproduction*

Has your graduate work influenced what you are doing now or want to do in the future? *It definitely has influenced my career goal: I have since started an environmental research and education non-profit organization called the Pacific Coast Environmental Conservancy (PCEC). There I have continued and expanded the type of human impact research I did in Dr. Kevin Kelley's lab. We focus on many types of disruption and impacts based on both natural and non-natural forms of pollutants in all types of aquatic environments. PCEC is also very active in its educational programs and promotes hands on learning for all students of all ages. We have been fortunate to work with various schools in the Southern California area, but the ones we really aim to work with are those such as Lynwood Middle School, Montebello High School and Bell Gardens High School, all low performing science schools and inner city schools. By exposing the kids to the actual science that we do, they get hands on experience of what it's like to be a scientist, and they are engaged in finding a solution to the problem. Students learn field techniques and learn to communicate with the public to educate them on what we/they are doing, and the effects of human activity on the fish (which in some cases people catch to consume).*

How has working with Sea Grant and the OPC changed or helped you develop your understanding of how science and policy interact? *It's definitely given me a broader sense of how important policy is and how much work goes into putting together policies that make sense from a scientific standpoint and a community standpoint. I really didn't understand the process entailed in drawing up policies, and now as president of a nonprofit NGO, I see how critical these steps are in assuring that we do our best to protect the environment as well as the public.*

If you could tell policy-makers in California one thing in regards to your research finding, what would it be? *Our research looks specifically at how human activities impact our environments on a daily basis and at what scale these effects are occurring. It is essential to continue to monitor key locations and areas of interest due to the sensitivity of some of these environments and environmental hierarchies. The impacts placed on our fish species and marine mammals are not only directly related to the impacts that we are also exposed to (since we are all vertebrates), but also are magnified even more by the fact that many people consume the organisms in these exposed areas for sustenance. With human activity increasing every day, every month and every year, the impacts are getting worse and in some cases getting to the point where they will be too large to deal with. By monitoring the issues now and taking steps to change policies for the betterment of the environmental health as well as human health, we can work towards solving or minimizing some of these issues and impacts.*

If a 10 year old asked you what you liked most about being a marine scientist, what would you say? *I get to work in a place that I love: the ocean. I get to investigate it so I can continue to protect it and make sure others will enjoy for a long time to come.*

Favorite marine creature? *DOLPHIN!!!*

For more information on PCEC*:*
www.PCEConservancy.org

Jesus Reyes, President of the Pacific Coast Environmental Conservancy (PCEC), collecting samples. (Photo credit: Kelley Lab)