



Photo credit: Dan Witting, NOAA

# The Sea Grant X-Files: Halibut Sexing and the No-Eyed, Many-Spined, Grazing, Purple, Kelp-Eaters

*Collaborative, Applied Fisheries Research with the Santa Monica Bay Restoration Commission*

Sometimes things happening in the ocean can sound a bit like the quirky 90s sci-fi TV series, The X-Files. Eyes can move around on bodies as some fish get older. Some sea creatures change gender depending on their surroundings. Giant armies of purple sea urchins mysteriously congregate and march across the sea floor mowing down entire kelp forests. Unlike the X-Files, though, these strange, natural occurrences are not relegated to the jurisdiction of a top-secret FBI team; these types of occurrences are talked about by fishermen, studied by scientists, and are of interest to managers trying to find a sustainable balance for using the ocean's resources.

USC Sea Grant has recently funded two very successful research projects that have illuminated two mysterious coastal California issues. Both projects were spearheaded by The Bay Foundation, a non-profit environmental group focused on the restoration and enhancement of Santa Monica Bay and local coastal waters.

Although fishery science has come a long way in the last few decades, it is still very difficult to accurately predict the size and health of a fishery stock. You cannot simply send someone down underwater to count, sex, and estimate ages of a fish species. In fact, in the case of the popular sportfish, California halibut (*Paralichthys californicus*), you cannot determine gender simply by sight; you have to dissect the fish to see if the fish has testes or ovaries. Using complex population models, the California Department of Fish and Wildlife can use gender dissection data, length measurements, and catch frequency per unit time to make estimates on halibut population health and catch limits for the next season. (con't page 2)



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## Ship to Shore (Continued): The Sea Grant X-Files...

The number of old, large, fertile females in a population make a big difference in the size of the next generation. Unfortunately, California halibut populations are likely depleted, so even the process checking the population health each year is detrimental to the species.

With funding from USC Sea Grant, marine scientist Lia Protopapadakis with The Bay Foundation successfully proved the accuracy of using portable-veterinary ultrasound machines as a non-lethal method for sex determination in California halibut (study details can be found in the “In Depth” section of this journal). The project involved the help and cooperation of The Marina Del Rey Anglers fishing club, the California Department of Fish and Wildlife, and college students learning about fishery science and management. The ultrasound techniques and collaboration generated in this study have led to further studies and partnerships between fishery managers and local anglers all united around the common goal of improving the California halibut stock.

In addition to shining light on the mystery of halibut sex, The Bay Foundation has been working on the spread of urchin barrens—coastal areas that were once diverse, thriving kelp forests that are mowed down very quickly by large, eerie swarms of grazing, purple sea urchins. Why and when these armies of urchins decide to march through an area is still unknown in the world of marine biology. Clear-cutting a kelp forest is, of course, an ecological issue since kelp forests provide habitat and sustenance for hundreds of marine species. However, this clear-cutting has also become a major economic issue for red sea urchin fishermen, who sell the male and female gonads (testes and ovaries) as valuable “uni” in the sushi markets. The red urchin fishery is ranked in the top five in California by weight and value (\$8.4 million in 2012).

With funding assistance from USC Sea Grant and others, The Bay Foundation has teamed up with researchers at Occidental College and local red urchin fishermen to show that purple urchin barrens have a significant negative effect on the population and gonad size of red urchins as well as other commercially important fishery species dependent on kelp forests (study details can be found in the “In Depth” section of this journal). More importantly, Tom Ford, Executive Director of The Bay Foundation and co-lead PI on this project, has shown that kelp forest restoration is possible in barrens when purple urchins are selectively removed. These results provide support for the large-scale habitat restoration that is now being performed along the Palos Verdes Peninsula in cooperation with other local non-profits and commercial fishermen.

Uniquely, much of the success of both of these research projects—halibut sexing and urchin barrens—can be attributed to their collaborative nature. Diverse interests and perspectives were built into these projects from the beginning, forming the foundation for future collaborative work. Like poster-children of the Sea Grant mission, these projects both quickly and easily bridged the gap between basic scientific research and practical application of science to make immediate improvements in the Southern California urban ocean.

“Put simply, we go from barren rocks to kelp forest stretching to the surface within a year to a year and a half. This means more larger fish and invertebrates...the changes are dramatic and rapid. It’s really cool to see.”

-Tom Ford, The Bay Foundation



Red urchins had reduced gonadal tissue production in barrens due to reduced availability of algal food resources. (Photo credit: Tom Boyd)

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## *At the Helm: From USC Sea Grant*

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

Yes, it's fun to remember Agents Mulder and Scully from the hit TV show, *The X-Files*, and yes, this issue of the *Urban Mariner* is about the weird world of eggs, sperm, sex, and death of three very important Southern California marine species—halibut, red urchins, and kelp. But in all seriousness, these two projects are exemplary of the partnership-based, adaptive management focused, and immediately-applicable work that USC Sea Grant sees as critical to solving the problems of urban ocean. Our mission is to contribute to solving the problems of the urban ocean, while recognizing the opportunities for coastal commerce, recreation and improving the quality of life in coastal regions such as Southern California.

As the largest urban settlement on the west coast, and the second largest in the nation, the City of Los Angeles is a prime location to study the effects of urbanization on our coastlines. It is also the ideal laboratory to test out solutions to the effects of urbanization on our coastlines. Limited resources, the small size of USC Sea Grant's professional staff, coupled with the huge geographical region and large population, require that we develop formal partnerships with the wide range of stakeholders in the Southern California region, and work with them to achieve common goals, leverage resources, and form long-term collaborations.

In both the kelp/urchin and halibut projects, we can see collaboration between research scientists, non-profit organizations, resource managers, and industry as well as the leveraging of multiple sources of funding. We can see simultaneous and immediate benefits to research science, resource management, habitat restoration and health, and even coastal commerce.

USC Sea Grant is proud to have provided funding for two such immediately informative, practical and beneficial studies, and looks forward to supporting and collaborating on more work in the future that takes into account the immediate needs of the urban ocean. We agree with Terry Hetzik, a local sea urchin fisher interviewed for this story, as he expresses optimism about the health of the ocean and our ability to understand its delicate ecosystem balance. Sea Grant is devoted to making his vision a reality.

Previous issues of the *Urban Mariner* can be found at: [dornsife.usc.edu/uscseagrant/urban-mariner](http://dornsife.usc.edu/uscseagrant/urban-mariner)

Photo credit: Tom Ford



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## Interview: Terry Herzik, Commercial Red Urchin Fishermen, Palos Verdes, CA

**USC Sea Grant:** How long have you been an urchin diver?

**Terry:** I've been urchin diving for 41 years. I moved from Washington DC to California in the early 1970s when my brother told me about under-utilized fisheries like sea urchins off the Southern California coast.

**USC Sea Grant:** Among commercial fishermen, it seems that urchin divers like yourself may have a unique perspective since you actually see what the underwater environment is when you fish, instead of blindly pulling up a line or net from a boat. Have you seen changes underwater during your years fishing for urchins?

**Terry:** Have we seen changes? Yes, we sure have. A lot are natural cycles...but certainly the water has become quite a bit dirtier over the last few decades...run-off will always be a problem of mega populations along the coast like we have here in Los Angeles.

**USC Sea Grant:** What do you think of the Bay Foundation "urchin removal/kelp restoration project"?

**Terry:** This whole project has been an eye-opener for me and the other urchin divers...and it has been an education for us...it is very rewarding to feel like we are giving back a little bit. I raised my family here in Southern California from the bounty of the ocean. I, for one, am an avid proponent of sustainable practices and being a steward of the ocean. I've been really happy working with the Bay Foundation...Tom and Lia are great. I've even started going to some of Tom's presentations on the research. He really knows his stuff and explains things really well to everyone.

**USC Sea Grant:** Have you personally seen differences in the areas you have cleared of purple urchins?

**Terry:** We swam back over the barrens we have cleared in the last four months and now we see many species of algae, including kelp, and many different species of fish...whole schools of fish! It's pretty amazing to see changes like that so quickly, but kelp grows quickly when you let it, and once there is kelp then everything else starts to come back.

**USC Sea Grant:** Do you think collaborative projects like this one, involving fishermen and scientists, are helpful?

**Terry:** Yeah, I think it's part of a wider evolution. It's going to take a lot of work. And we're all going to have to work together in the long run. It may seem small when you are dealing with square meters and acres...but it's the first step in the right direction in a long process.

**USC Sea Grant:** Should there be more collaborative projects like this in the future?

**Terry:** Collaborative projects like these are the way of the future...these projects promote respect both way...we [scientists and fishermen] all have a lot to learn about each other and from each other.

**USC Sea Grant:** Anything else you would like to say?

**Terry:** I'm not a doom-and-gloomer. I'm optimistic about the health of the ocean. And I'm optimistic that mankind can understand the delicate balance of the ocean.



Commercial urchin fisherman with urchin pots.  
(Photo credit: Rene Rojas)

## In Depth: A Closer Look at the Research

**Project Title:** The ecosystem impacts of kelp forest habitat restoration, including important fishery species

### Lead Investigators:

- Daniel Pondella, Associate Professor of Biology, Director, Vantuna Research Group, Occidental College
- Tom Ford, Executive Director, The Bay Foundation, Los Angeles
- Jeremy Claisse, Postdoctoral Research Fellow, Vantuna Research Group, Occidental College

### Partners:

- USC Sea Grant
- Los Angeles Waterkeeper
- Montrose Settlements Restoration Program
- NOAA Restoration Center

### Rationale:

High densities of the unfished purple urchin (*Strongylocentrotus purpuratus*) have resulted in 61 hectares (~150 acres) of urchin barrens (i.e., rocky reef areas largely devoid of macroalgae/kelp) along the Palos Verdes Peninsula in Southern California. This study evaluated the potential effects of kelp forest habitat restoration (i.e., targeted purple urchin removal) by comparing differences among urchin barren sites, kelp forest sites and sites adjacent to urchin barrens.

### Methods:

The study sampled 25 sites in both 2012 and 2013 using a comprehensive monitoring protocol (e.g., fishes, invertebrates, algae, benthic cover and habitat characteristics)

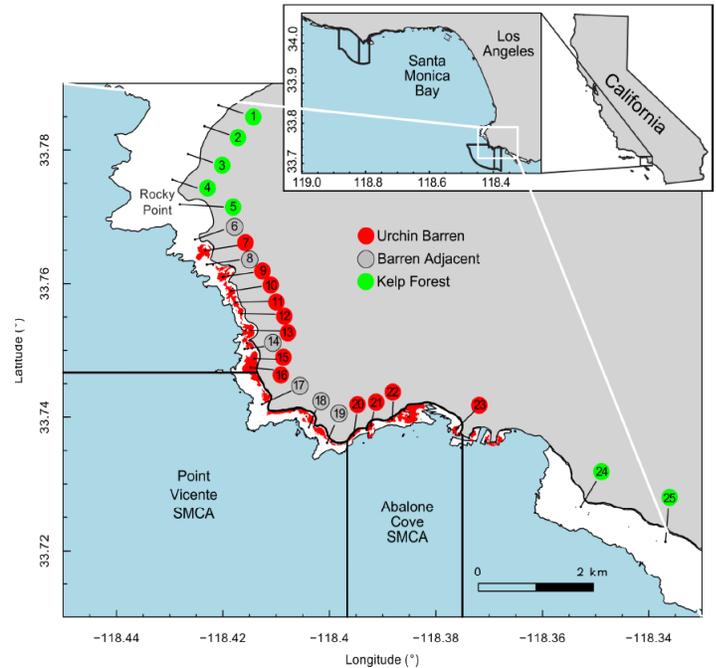
### Results:

- Found significant community level differences among these site categories (urchin barren sites, kelp forest sites and sites adjacent to urchin barrens) for fishes, invertebrates, kelps and benthic cover.
- Clear differences in the fish, invertebrate and kelp communities between urchin barren and kelp forest habitat.
- Urchin barrens not only contained significantly lower densities of some important fishery species, such as kelp bass and lobster, but these negative effects extended beyond their boundaries into adjacent kelp forest habitat.
- The lack of kelp in barrens also resulted in reduced gonad production in the commercially fished red urchin (*S. franciscanus*), which are fished for their gonads that are eaten as “uni” sushi. This commercial fishery is one of the most important in the State.

### Impacts:

- Results have provided support for large-scale habitat restoration that is now being performed (started in July 2013) along the Palos Verdes Peninsula by a new coalition of non-profits and commercial red sea urchin harvesters.
- Kelp restoration has potential to be one of many integrated tools in an ecosystem-based management approach.

**Scientific Journal Publication:** Claisse JT, Williams JP, Ford T, Pondella DJ, Meux B, Protopapadakis L (2013) Kelp forest habitat restoration has the potential to increase sea urchin gonad biomass. *Ecosphere* 4:3 article 38 (open access: <http://www.esajournals.org/doi/pdf/10.1890/ES12-00408.1>)



Sampling sites along the Palos Verdes Peninsula. The extent of nearshore rocky reefs are shown in white and mapped urchin barrens are displayed in red. The boundaries of two adjacent MPAs in the study area (SMCAs) are also shown. (Claisse et al. 2012 PLoS ONE 7:e30290)

## In Depth (Continued): A Closer Look at the Research



Middle: The Los Angeles Times covered the project in August 2013. Left top and bottom: The kelp restoration and urchin barren study was featured in ECO magazine in February 2014. Right top: a diver removes purple urchins with the hammer protocol. (Photo credit: Tom Boyd Images 2013) Right bottom: a mature giant kelp forest (Photo credit: Tom Ford)

### Urchin Barrens and Marine Protected Areas

In California, the 2001 Marine Life Protection Act (MLPA) mandated the designation of an integrated state network of marine reserves along the entire coast. Since 2007, a stakeholder-based program has worked in five regions to designate a system of no-take reserves, conservation areas and parks. On January 1, 2012, a new system of MPAs went into effect in Southern California, including one in Malibu and two along the Palos Verdes (PV) coastline. Both PV MPAs are protected from commercial red urchin fishing (among other restrictions), which raised concern in the red urchin fishery about the amount of healthy (kelp forest) red urchin habitat remaining outside the MPAs. This study has calculated that if all 36 hectares of urchin barren habitat on PV but outside of the new MPAs were restored to kelp forest, the increase in gonad biomass available to the fishery could potentially offset 52% of that which is now protected in the new MPAs. Not surprisingly, this projection has garnered support among environmentalists, marine scientists, and some local fishermen to move forward cooperatively with large-scale kelp forest habitat restoration in the region.



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## *In Depth Continued: A Closer Look at the Research*

**Project Title:** Testing a non-lethal method for determining the sex of California halibut, *Paralichthys californicus*, in non-spawning condition

**Lead Investigator:**

- Lia Protopapadakis, M.E.M., Marine Scientist/Project Manager, The Bay Foundation

**Partners:**

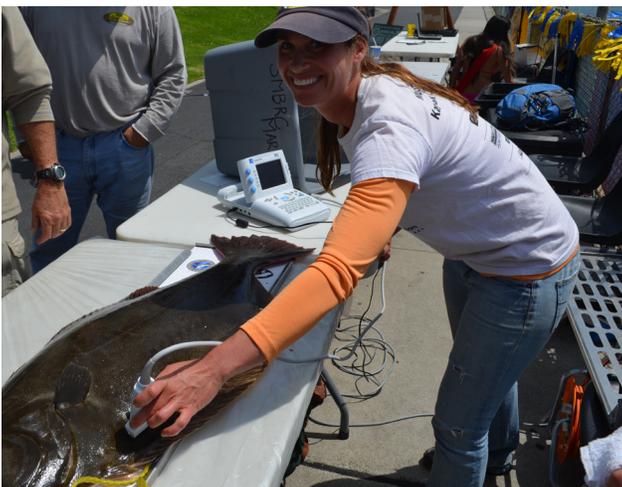
- California Department of Fish and Wildlife (CDFW)
- Marina Del Rey Anglers (MDRA)
- Hubbs-SeaWorld Research Institute (HSWRI)
- Loyola Marymount University (LMU)
- Sea Lab
- USC Sea Grant
- Sanitation Districts of Los Angeles County

**Rationale:**

California halibut are an important commercial and recreational species, but their populations are depleted from historic levels, like many fisheries along the urbanized Southern California coast and most other highly urbanized areas of the world. Accurate population and gender assessments are extremely important to sustainable management of fisheries, as the greater presence of old, large, fertile female fish usually is an indicator of greater population health and greater recruitment of juveniles for the future population. Until this study, the only method to determine sex in immature or unripe halibut was dissection of the fish, resulting in unwanted additional mortality.

**Methods:**

To limit the impact of this study on the halibut population, samples were obtained from the following sources: bycatch from the commercial purse seine fleet in Santa Barbara, recreational landings from the Santa Monica Bay as part of the Marina Del Rey Anglers annual halibut derby, recreational landings at the Marina Del Rey Boat Launch, aquaculture stock from Hubbs-SeaWorld Research Institute, and aquaculture stock from the Sea Lab in the Redondo Beach. Ultrasound sonography was performed using a refurbished Sonosite 180 veterinary ultrasound equipped with a 10-5 MHz, 38mm aperture linear transducer. The accuracy of veterinary ultrasound was determined using gross morphological comparisons between live ultrasound sonography images and either visual inspection (in landed fish) or examination of genetic material (in aquacultured fish). The effects of reviewer experience and training were also assessed.



Left: Demonstrating visual inspection technique to students.

Right: An example ultrasound image of California halibut ovaries. (Photo credits: The Bay Foundation)



**Scientific Journal Publication (In Prep):** Protopapadakis, L, K Penttila, and W Dowd. Testing a non-lethal method for determining the sex of California halibut, *Paralichthys californicus*, in non-spawning condition.

## Results:

Ultrasound is a quick and highly effective way to determine sex in live California halibut. Of 81 fish, only 1 was misidentified upon first reading and this same fish was later accurately identified using saved images. However, live images are generally easier to read than saved images as the ability to manipulate the transducer in real-time gives the reader additional information.

## Impacts:

- This technique will enable the CDFW to expand their sex-specific data set on California halibut and other researchers to conduct sex-specific studies using live animals (i.e. tag/recapture studies), improving the reliability of the next halibut stock assessment.
- Capacity for collaborative research with CDFW and MDRA has been expanded. Immediate proof of this is that the SMBRF and MDRA will be partnering on a new project related to halibut (developing methods for citizen scientists to collect essential fishery information) in collaboration with CDFW.
- Thirty-one (LMU) college students participated in data collection and learned about essential fishery information, fishery management and this project.

“The fishermen involved in this project became so engaged that we are now working together to develop a citizen science monitoring program for California halibut that will report high-quality data to the Department of Fish and Wildlife”

*-Lia Protopapadakis, The Bay Foundation*



Sampling a recreationally caught halibut in Marina Del Rey  
(Photo credit: The Bay Foundation)

## 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.

The Urban Mariner is written by Charlotte Stevenson with editorial assistance from Phyllis Grifman.

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