UPWELLING

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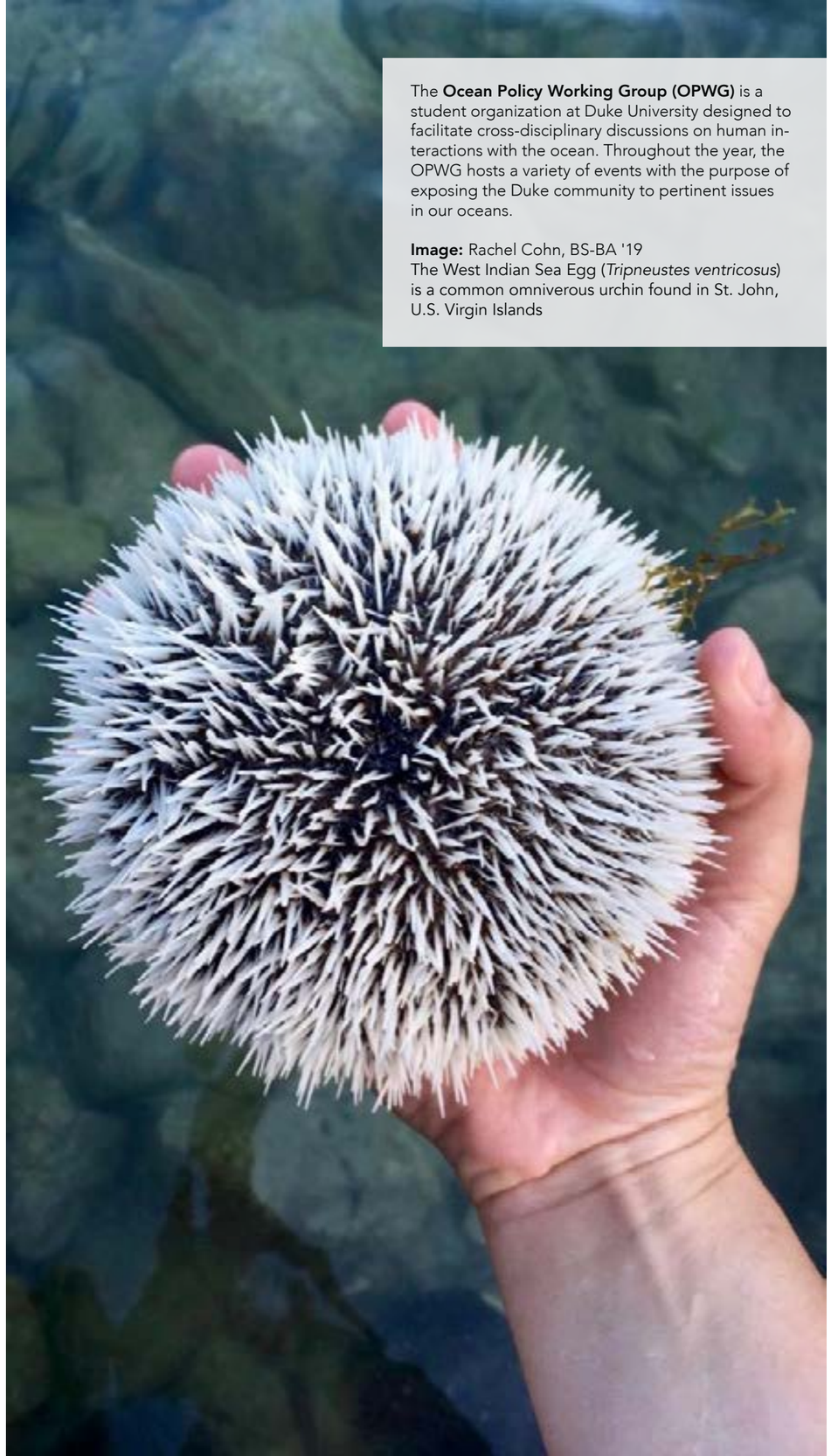
OPWG
Ocean Policy Working Group



The **Ocean Policy Working Group (OPWG)** is a student organization at Duke University designed to facilitate cross-disciplinary discussions on human interactions with the ocean. Throughout the year, the OPWG hosts a variety of events with the purpose of exposing the Duke community to pertinent issues in our oceans.

Image: Rachel Cohn, BS-BA '19
The West Indian Sea Egg (*Tripneustes ventricosus*) is a common omniverous urchin found in St. John, U.S. Virgin Islands

A Note from the Editor:

Volume 7 of UPWELLING focuses on some of today's most pressing ocean issues, covering a wide array of international topics.

Our authors have explored the dispersal patterns of krill in the Antarctic, how 3D modeling can be used to conserve coral reefs, and how descending devices could help revive red snapper populations in the South Atlantic. Each article provides an interdisciplinary look into the science, policy and management strategies needed to address marine and coastal challenges.

A special thanks to the Nicholas School of the Environment, the Graduate and Professional Student Council and the Duke University Center for International Studies for their continued support of the Ocean Policy Working Group and UPWELLING.

Sincerely,

Jill Hamilton
OPWG Publication Coordinator
MEM-CEM '18

In this edition

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Preventing Coral Collapse: How 3D Modeling Can Combat our Ebbing Global Reefs

Kelsey Johnson-Sapp, MEM-CEM '18

Coral reefs have experienced significant global decline as climate change continues to disturb the chemical balance of our oceans. Compounding stressors like pollution, destructive fishing practices, and ocean warming have threatened the integrity of an otherwise resilient ecosystem. The ocean is dynamic, and its components often highly migratory, with conventional assessment techniques capturing only a still-frame of what is actually a constantly moving picture. Coral reefs provide the biological complexity that maintains ocean equilibrium, and significant resources have been allocated towards survey research in assessing coral cover, diversity, and growth as indicators of reef health. However, these approaches have proven to be expensive and do not always yield reliable results.

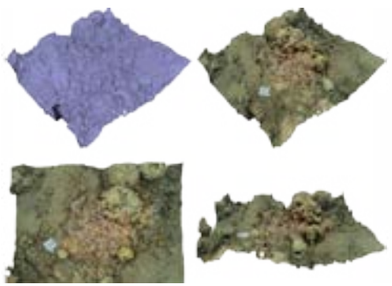

***Figure**: An example of coral 3D models; courtesy of Coral Health Atlas*

Sophisticated geospatial techniques have allowed researchers to render entire reef assemblages on a digital platform to millimeters of precision. A state-of-the-art tool described as "Structure-from-Motion" is a photogrammetry technique that models large-scale reef areas in 3D to reveal nuances in reef mechanics. This method provides cheaper, more comprehensive data that can be applied on a number of key coral conservation initiatives. By translating reef data to tangible, interactive images, researchers can begin to identify growth trends, genetic drift, coral recruitment, and rugosity (complexity) for study sites of interest.

This summer, I will have the unique opportunity to conduct coral reef research at the University of Hawaii, Hilo under Dr. John Burns from the Gates Laboratory. Armed with a precise, data-driven perspective, researchers at the Gates Lab have begun to isolate coral species that are essential for stabilizing biodiversity and diagnose potential areas with negative growth trends. It will be my task to utilize SFM in measuring reef response to bleaching events, modeling coral recruitment, and formulating projections of coral recovery after human disturbance. Mapping abiotic factors like temperature and ocean currents in relation to 3D trends will provide a lens into areas with a high likelihood of coral recruitment, turning attention towards areas that may otherwise fall under the radar of marine resource managers.

This approach has major implications for the future of coral reefs. Because corals grow at an abysmally slow pace, SFM is crucial in exposing the nuanced recovery or blatant decay of certain areas and infer what factors contributed to their respective success or destruction. For instance, modern SFM research in Hawaii's newly expanded Papahānaumokuākea Marine Protected Area has the potential to catalyze future policy if sufficient data demonstrates the sanctuary's role in coral recovery. Growth trends exhibiting significant reef rebound in Papahānaumokuākea as opposed to other similar sites without protection would evidence a need for policymakers to implement more regulations and curb the effects of anthropogenic damage.

Indeed, SFM has the capacity to build on existing research addressing a dire global issue. In honing our understanding of what lies beneath the waves, we further our capacity to inspire behavioral change and shoulder the necessary measures to salvage our resources and, in time, allow them to thrive again. ■

Top image: Kelsey Johnson-Sapp diving in one of Cuba's Marine Protected Areas in the Bay of Pigs, Dec. 2016

Bottom image: Coral restoration work at the Mote Marine lab, Jan. 2016

Both images by Kelsey Johnson-Sapp

Singapore: A Clean City?

Reflections on a Duke travel course to Singapore

Emily Hall, MEM-CEM '17

Singapore is known around the world for being one of the most forward-thinking cities, and has a reputation for being extremely clean. When you walk along the streets of downtown or around a particularly touristy section of the city, this is very true. Trash cans are not hard to find, and with Singapore's strict rules on gum, you will never see anything sticky on the streets.

However, when you leave the city center and enter some of the outer lying coastal parks or nature reserves, you will come across a very different scene. Mangroves and coastal forests, exposed at low tide, are covered with plastic wrappers, bottles and bags. Coney Island, off of Punggol Waterway Park, was a particularly saddening beach walk. We went to walk along a sand bar in search of carpet anemones for possible sampling on later trips, which we did find, but they were accompanied by masses of marine debris. Plastics were exceptionally dense, with numerous plastic bags, containers and straws seen. There were also some interesting finds like shoes, a tablecloth, and even a small tote.

By now, marine debris has become a well-known and publicized issue. Notable examples include videos and images of sea turtles and marine mammals consuming plastic bags, straws stuck within the nostrils of sea turtles, and the stomachs of dead coastal birds filled with plastic fragments they consumed.

But what was particularly interesting on this walk was the presence of a Gorgonian (a close relative to soft corals) growing on a plastic bag. In one of Dr. Dan Ritschoffs talks on the trip, he spoke about his research feeding plastic to anemones. What he noted was that "plastic tastes like food" to many marine creatures and that when ingested, plastics will release potentially toxic chemicals. With this particular Gorgonian, it was 1) growing on a plastic bag that was leaching likely-harmful chemicals and 2) growing on a plastic bag that is unstable in the ocean currents, causing the animal to wash up on some driftwood where we found it.

It is evident that plastic pollution in the ocean will have far-reaching ecological effects, and therefore is a global issue of concern. However, while on our course in Singapore, we wanted to know: What are the local conservation efforts being done to curb plastic pollution, and how are they progressing?

Culturally in Singapore, it has been difficult in the past to educate people on the potential harm of discarding trash into the environment and the consequences these actions can have for marine ecosystems. However, it was mentioned during a nature walk on a nearby island that the environmental mindset toward proper disposal and clean-up has been improving. For instance, there is wide participation in the Singapore branch of the International Coastal Cleanup Day. Since 1992, the cleanup has had over 3,000 volunteers collecting more than 35,000 lbs of trash.[1] In 2016, there were also 21 "Year-Round" coastal cleanups, cleanups organized separately from the International Coastal Cleanup Day[2] .

(continued on the following page)

A Singaporean "wet market"
Most of Singapore's food, including seafood, is imported.
Image: Emily Hall

Top image: A washed up Gorgonian settled and growing on a plastic bag.

Bottom image: A view of Coney Island and Singapore's marine debris problem.

Images by Emily Hall

There are efforts in Singapore to curb the issue of plastic pollution, but what I have had to keep in mind is that marine debris on Singapore's coast is not necessarily from Singapore. With the proximity to other countries like Malaysia and Indonesia, many of which may not have a growing environmental ethic like Singapore, there is a lot of "international" debris making its way to Singapore's coast. Moving forward, it will be interesting to consider how Singapore, Malaysia, and Indonesia could work together to form a regional solution to combat this global problem. ■

[1]"About the International Coastal Cleanup," Internation Coastal Cleanup, Singapore, 2017. [Online]. Available: http://coastalcleanup.nus.edu.sg/aboutcleanup.html.
[2]"21 Year-Round Coastal Cleanups in 2016 - here's to more tender loving care for our coasts!," Coastal Cleanup, [Online]. Available: https://coastalcleanup.wordpress.com/2017/02/06/21-year-round-coastal-cleanups-in-2016-heres-to-more-tender-loving-care-for-our-coasts/.

Hypoxia

William Schlesinger, James B. Duke Professor Emeritus of Biogeochemistry

For the past couple of decades, late summer brings a bloom of algae to the Gulf of Mexico, just off the mouth of the Mississippi River. Last year, the bloom covered 17000 square kilometers –somewhat larger than the state of Connecticut. When the bloom dies, the decomposition of algal biomass consumes all the oxygen dissolved in the water—creating hypoxia. Without oxygen, fish and shellfish die. Hence, the bloom is known as the Dead Zone.

Similar blooms are found at the mouth of estuaries in other regions of the world, especially when their watersheds harbor a large amount of agricultural activity. Chesapeake Bay, the northern Adriatic, and parts of the Baltic Sea are good examples, and a similar phenomenon is found in central Lake Erie. There is evidence that hypoxia began to occur in large rivers and lakes more than 100 years ago. What causes hypoxic zones to occur?

The answer lies in the large amount of nitrogen fertilizer used in modern agriculture, and also incidentally on home gardens and golf courses. When nitrogen fertilizer contains nitrate, it is easily lost to runoff waters, because nitrate is highly soluble in water. Applications in excess of immediate plant demand are lost. Even when nitrogen fertilizer is applied in other forms, such as ammonium or urea, these are easily converted to nitrate by soil microbes and also lost in runoff. By one account nearly 8-12 percent of the nitrogen fertilizer applied worldwide is lost from fertilized fields and transported to the sea. In some individual fields, the value can be as high as 50 percent.

Still more nitrogen is lost during the disposal of animal wastes from modern industrialized production of pork and chickens. Here, nitrogen is lost during inadvertent overflow of waste lagoons, and it percolates to groundwater, which makes its way to stream channels. In North Carolina, the nitrogen isotopic composition of animal waste closely matches that in groundwater, establishing a close link between the two.

When the nitrate arrives at the coastal waters, it stimulates a bloom of algae. (It is fertilizer, after all). This may be aided by the simultaneous transport of phosphorus from agricultural lands, although phosphorus is by no means as mobile as nitrogen when it comes to runoff waters. The hypoxic zone in Lake Erie appears closely related to both nitrogen and phosphorus inputs.

Hypoxia is one of the side effects of modern agronomic systems which strive to feed seven billion of us with a nutritious diet. Unfortunately, hypoxia saps the ocean's ability to supply protein by way of fish and shellfish, just at the moment that these resources are most needed by the human population. If there were fewer of us, the problem would be easier.

The solution will stem from a more judicious use of fertilizer, so that the largest percentage of it is assimilated by the crop plant of interest. We also need to treat nitrogen and phosphorus in human and animal wastes as a resource to be recycled, not an unfortunately byproduct to be discarded. ■

Blesh, J. and L.E. Drinkwater. 2013. The impact of nitrogen source and crop rotation on nitrogen mass balances in the Mississippi River Basin. Ecological Applications 23:1017-1035.
David, M.B., L.E. Gentry, A.D. Kovacic and K.M. Smith. 1997. Nitrogen balance in and export from an agricultural watershed. Journal of Environmental Quality 26: 1038-1048.
Gao, S. P. and 11 others. 2016. Quantifying nitrogen leaching response to fertilizer additions in China's cropland. Environmental Pollution 211: 241-251.
Gardiner, J.B. and L.E. Drinkwater. 2009. The fate of nitrogen in grain cropping systems: a meta-analysis of 15N field experiments. Ecological Applications 19: 2167-2184.
Jenny, J.-P., P. Francus, A. Normandeau, F. Lapointe, M.-E. Perga, A. Ojala, A. Schimmeimann, and B. Zolitschka. 2016. Global spread of hypoxia in freshwater ecosystems during the last three centuries is caused by rising local human pressure. Global Change Biology 22: 1481-1489.
Karr, J.D., W.J. Showers, J. W. Gilliam and A. S. Andres. 2001. Tracing nitrate transport and environmental impact from intensive swine farming using delta nitrogen-15. Journal of Environmental Quality 30: 1163-1175.
Chang, C.C.Y., C. Kendall, S.R. Silva, W.A. Battaglin, and D.H. Campbell. 2002. Nitrate stable isotopes: tools for determining nitrate sources among different land uses in the Mississippi River Basin. Canadian Journal of Fisheries and Aquatic Sciences 59: 1874-1885.
Rabalais, N.N., and 12 others. 2014. Eutrophication-driven deoxygenation in the coastal ocean. Oceanography 27:172–183,
Schlesinger, W.H. 2009. On the fate of anthropogenic nitrogen. Proceedings of the National Academy of Sciences. 106:203-208. [doi:10.1073/pnas.0810193105]
Sebilo, M., B. Mayer, B. Nicolardot, G. Pinay, and A. Maniotti. 2013. Long-term fate of nitrate fertilizer in agricultural soils. Proceedings of the National Academy of Sciences 110: 18185-18189
Smith, M.D. and 6 others. 2017. Seafood prices reveal impacts of a major ecological disturbance. Proceedings of the National Academy of Sciences doi: 10.1073/pnas.1617948114

Krill are Key to Understanding the Antarctic

Spatial Assessment of Southern Ocean Krill Density in the Palmer Long-Term Ecological Research (LTER) Study Site Using Acoustic Doppler Current Profiler (ADCP) Technology

Nicholas Alcaraz, MEM-CEM '17

Antarctic krill are believed to be the most abundant species on the planet, with some estimates of biomass near 500 million tons. Krill are a prey source for marine mammals, birds and fish. They are a keystone species within the Antarctic ecosystem, meaning that they have a disproportionately high effect on the environment, and if they were removed the balance of the ecological community would be disrupted. Determining where and when krill are available is important to understanding the life history of many Antarctic species, and will facilitate management efforts to protect krill along with the organisms that feed on them.

Recent studies have suggested a possible decline in Antarctic krill biomass. Researchers believe this may be due to the recent rapid regional warming occurring on the Antarctic Peninsula. Temperatures on the peninsula have risen by half a degree Celsius, on average, each of the last five decades. Sea ice is an integral component in krill life history, used for feeding and shelter. Loss of sea ice due to climate change may correspond to a reduction in the abundance of krill. Although the importance of krill is well understood, information on distribution near the Antarctic Peninsula is lacking. The Palmer Long-Term Ecological Research (LTER) study area is located along the western side of the Antarctic Peninsula. The goal of the Palmer Station Antarctica LTER marine research program, which was created by the National Science Foundation (NSF), is to investigate "the oceanic, atmospheric and biogeochemical processes that result from natural disturbances, environmental change, and human impacts". Studies are conducted within an oceanic sampling grid which consists of an 180,000 sq km region surrounding Palmer Station. Research methods include standard measurements taken at established sites within a series of nested grids to better understand annual ecological variation.

Acoustic survey techniques were developed in the early 1990's, and have become the main biomass assessment method. An Acoustic Doppler Current Profile (ADCP) is a type of active acoustic instrument common to oceanographic ships which measures water current speed. Active acoustics involves transmitting sound waves in the ocean and receiving the signal which has been reflected back from particles in the water column. ADCPs consist of a phased array of transducers, each producing an acoustic beam. The four beams may be averaged together across time and depth. ADCP data can be manipulated to give relative density estimates of ocean biomass, as well as determine distributional relationships. The Laurence M. Gould is a ship which has been collecting ADCP data for the past 20 years within the Palmer LTER.

The intent of my Master's project within Duke's Nicholas School of the Envrionment is to develop tools and methodologies in MatLab and ArcGIS to qualitatively assess krill patch size and distribution. Pre-processed ADCP backscatter data from one-month cruises across 5 years will be used as a template to develop the necessary tools and deliverable maps, tables, and graphs. These standardized products will allow for comparisons across multiple years within the LTER. Eventually, whale satellite tag data can then be cross-referenced to determine if the spatial scale of whale feeding behavior coincides with the krill patch size or location. ■

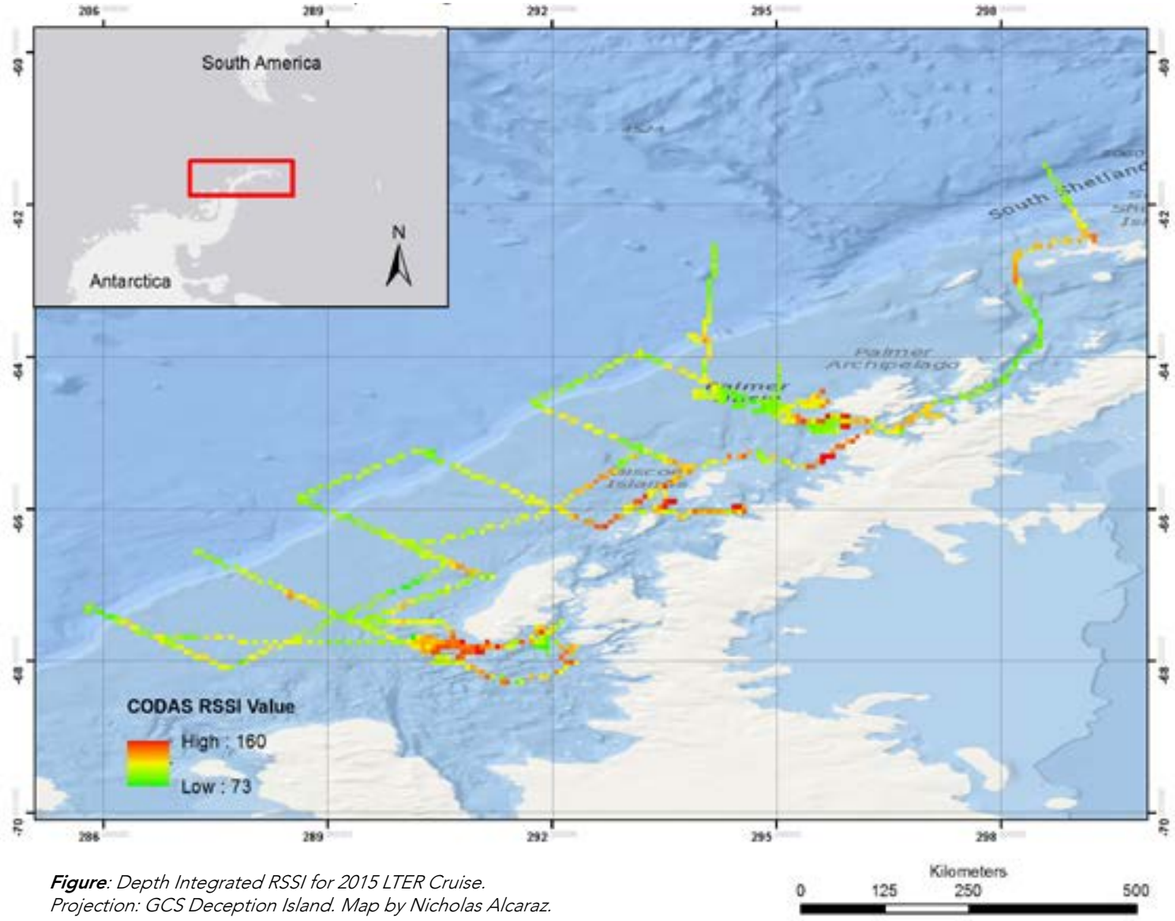

***Figure**: Depth Integrated RSSI for 2015 LTER Cruise.*
Projection: GCS Deception Island. Map by Nicholas Alcaraz.

Red snapper suffering from barotrauma, stomach protruding from mouth.

Image: Sportfish Research; sportfishresearch.org/research/projects/redsnapper

The Bottom Line on Integrating the use of Descending Devices into Fisheries Management

Kelsey Dick, MEM-CEM '17

How can a closed fishery continue to be overfished? That is the case for the South Atlantic red snapper. The stock continues to be overfished without an open season.

Red snapper are caught incidentally when anglers target other species that live in the same habitat such as black sea bass, scup, red porgy, grouper and vermillion snapper. Unfortunately, even though red snapper and other reef fish are released, many of them do not survive. The amount of released fish, also called discards, continues to exceed the acceptable biological catch, resulting in a systematic closure of the fishery.

The probability that a fish will die after being thrown back is known as discard or release mortality. Release mortality can be influenced by a number of factors: handling time, air exposure, post-release predation, injury to the fish during the process of release and barotrauma. Barotrauma is a pressure-induced depth dependent condition caused when a fish is rapidly brought to the surface from depth. Barotrauma results in ruptured swim bladders, emboli, bulging of eyes, protrusion of the intestines and ultimately death. Snapper and other bottom fish are extremely vulnerable to the effects of barotrauma. This is no different than the barotrauma that can affect scuba divers. Returning a fish to the depth where it was captured can reverse barotrauma. Anglers can use descending devices to return red snapper to or near their original capture depth – increasing the chances for survival. Descending devices can range from simple, cheap weighted hooks, to upside down milk crates, to more expensive devices such as the Seaquilizer. This practice lowers the release mortality and potentially prevents the stock from being overfished.

South Atlantic Fishery Management Council seeks to reduce the number of discarded fish and improve the survival of discarded red snapper. My Master's project analyzes opportunities and challenges of integrating descending devices into the South Atlantic red snapper fishery. Through interviews and document analysis, I investigated and characterized the process of successful descending device utilization in the Pacific rockfish fishery (three species). Accounting for use of descending devices by anglers in the Pacific has lowered discard mortality rates and ultimately led to more opportunities for recreational fishermen on the Pacific coast by opening previously closed areas and increasing bag limits.

Findings from my study indicated outreach, cohesion, and coordination of the fishery council with state and federal government made accounting for the use of descending devices in the Pacific successful. While incentives for use of descending devices was similar across groups, study participants in the South Atlantic discussed the challenge of the multispecies complex and lack of scientific data regarding red snapper and descending devices. Pacific respondents indicated descending devices were effective as a means for flexibility in management, allowed for more accurate data collection, and created more opportunities for recreational anglers. Groups across the Pacific and Atlantic all agreed descending devices should be used as a best practice by anglers. The findings of my study will be provided to the staff and members of the South Atlantic Fishery Management Council in order to provide them with considerations and information regarding the use of descending devices in the South Atlantic. ■

***Figure**: An example of a descending device used to reduce barotrauma.*
***Source:** Sportfish Research; sportfishingmag.com/fish-descender-devices-release-fishing*

Author Kelsey Dick (middle) and fellow Duke classmates enjoy a day of recreational fishing.
Image: Kelsey Dick

Tide pools at low tide in Playa Pelada, Costa Rica. Nearby, researchers were studying the effects of uplift from a 2012 earthquake.

Image: Alison Petro, MEM-MF '18

Gasping for air
Swallowed by the sea
Wide wingspan of consumption

Albatross at Midway Atoll Refuge
Haiku: Justin Lindenberg, DEL-MEM '17
Image: Chris Jordan (via U.S. Fish and Wildlife Service Headquarters; CC by 2.0)

Share your story.
Now accepting submissions for UPWELLING Volume 8

UPWELLING is a biannual journal that allows the Duke community to share their thoughts, opinions and research pertaining to the oceans and ocean policy. We are interested in any ocean-related work, including short research articles, OpEds, photographs, maps and other creative content. Content is fairly flexible, and topics may include a summer internship experience, a conference that you attended, the research that you are currently involved in, or other experiences. We welcome work from Duke University students in any department, researchers, faculty, alumni and professors.

Please send submissions to dukeOPWG@gmail.com.

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