

UPWELLING

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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 academic year, the OPWG hosts a variety of events with the purpose of exposing the Duke community to pertinent issues in our oceans. This working group strives to be a hub for ocean resources.

Letter from the Editors:

Welcome to the fifth volume of *Upwelling!* We are delighted to share with you the thoughts, opinions, and research of members of the Duke community pertaining to the world's oceans.

This volume features pieces pertaining to issues surrounding different species of whales and how we interact with them, the dynamic of small island conservation in the face of economic growth, the role of marine spatial planning in offshore wind development, and highlights some of this year's graduating MEMs master's project. The volume also features visual works that capture both the beauty and the essential functions that our oceans provide, including everything from recreation to wildlife viewing to Nicholas students in action.

We would like to thank the Nicholas School of the Environment, the Duke University Center for International Studies, and the Graduate and Professional Student Council for their support of the Ocean Policy Working Group.

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Cover Photo: Sarah Roberts
Sargassum seaweed floats through the water in South Caicos, Turks and Caicos Islands.

3 | Characterizing the Environments of Whale Feeding Grounds

Jennifer Imm

5-6 | Marine Conservation Education in Action - A Study Abroad and Teaching Experience Like No Other

Joseph Fader

7-8 | Getting to the Root of the Problem - Dominica, “The Nature Island”

Emily Hall

9 | Words to a Sperm Whale Spirit

Ruici Ong

11-12 | Using Marine Spatial Planning to Combat Conflict in Long Island, NY

Emily Hall

13-14 | Spotlight on Master’s Projects

Photo by *Talia Sechley*
A school of pacific Creolefish off Champion Island, Galápagos



Characterizing the Environments of Whale Feeding Grounds

Jennifer Imm is senior undergraduate majoring in Environmental Science and Policy with a concentration in Marine Science and Policy and a minor in Biology.

Baleen whales are some of the most charismatic and beloved creatures in the ocean. Yet, we know surprisingly little about the migratory behaviors of these species. Most baleen whales travel between summer feeding grounds in higher latitudes and winter calving grounds in equatorial waters. However, the precise feeding and calving locations of many populations are not well known. For whale populations with better available information regarding the location of feeding grounds, it is unclear what separates the chosen feeding areas from other regions. Are these areas more productive? Are they more predictable? These are the questions that I seek to answer with my senior thesis, under the mentorship of Research Scientist Dr. Andre Boustany in Duke's Marine Geospatial Ecology Lab.

Climate change is expected to affect not only average sea surface temperature and net primary productivity, but also the variability of these environmental factors. Understanding the environmental characteristics of areas utilized by marine organisms is therefore critical to understanding how

these species might be affected by future ocean change.

To understand the environmental characteristics of baleen whale feeding grounds, we first had to determine where these feeding grounds were located. We began by looking at humpback whales because of the relatively large amount of data available for this species. Using maps from scientific literature, as well as observational data from the Global Biodiversity Information Facility database, we identified 14 coastal areas that appeared to be important areas for humpback feeding in the northern hemisphere.

Next, we looked at mean temperature and productivity values within these areas during the feeding months of May to September. We were also interested in the variability of these environmental factors both within and across years. However, determining a procedure for calculating variability has presented a challenge, and we are still experimenting with different methodologies. Once we have quantified both the average values and measures of variability

for temperature and productivity, we will compare these values to randomly selected coastal areas at similar latitudes. In doing so, we hope to determine what makes these feeding grounds unique. We also hope to apply our methodology to other baleen whale species, as well as other migratory marine animals.

Below

Photo by **Sarah Roberts**

The flamingo tongue snail, *Cyphoma gibbosum*, is a mollusk that can usually be found feeding on sea fans and sea plumes. These gastropods consume toxins from sea fans and store the toxins in their skin for protection. Their beautiful shells attract many shell collectors; however, the complex colors are a part of the snail's fleshy mantle and disappear once they die.





Above
Photo by *Talia Sechley*
Whale Bones on Bahia Garner, Española Island, Galápagos

Below
Photo by *Joseph Fader*
Humpback whale escorted by a group of bottlenose dolphins off the coast of South Africa. Humpbacks migrate north along the coast from their Antarctic feeding grounds to breeding grounds in the Indian Ocean.



Marine Conservation Education in Action - A Study Abroad and Teaching Experience Like No Other

Joseph Fader is a first year PhD student in the University Program in Ecology concentrating in Marine Biology.

Shark – shark – whale – shark – whale. This was how we started keeping track of our time in South Africa as our ‘once in a lifetime’ experiences started to blur together. A typical day included a sunrise shark-dive in the morning, lunchtime lecture on marine protected area design, and an afternoon whale watching expedition to top it off. The next day it was another combination of things you thought you’d only see narrated by David Attenborough.

I was one of two instructors on this adventure, keeping a small group of undergraduates happy, healthy, and uneaten by sharks as we tracked South Africa’s spectacular wildlife cross-country

from Cape Town to Kruger. The trip, unassumingly known as ‘Ultimate Predators’, is a college-level, 3-credit hour course in predator ecology and conservation offered every year by the company Broadreach, Inc. It also takes place in one of the world’s best places for seeing big, top predators in action, and every day we were in the field to observe, study, and contribute to the conservation of these magnificent animals.

We spent three weeks along the southern coast of Africa, diving with breaching great white sharks in Cape Town, whale watching in the best place in the world to see right whales, and swimming in one of the greatest collisions of

predators in the world, the Sardine Run, where seabirds, dolphins, whales, and sharks converge on billions of unsuspecting sardines migrating along the coast. We finally checked out the terrestrial predators in the last week, what would a trip to Africa be without a little safari?. We lived at a research station on a large game reserve near Kruger National Park where we went on daily game drives and assisted with wildlife surveys and active management of a large, conservation-minded reserve.

The company that makes all these superlative-laden experiences happen is Broadreach, Inc., an experiential-education company based in Raleigh, NC that offers

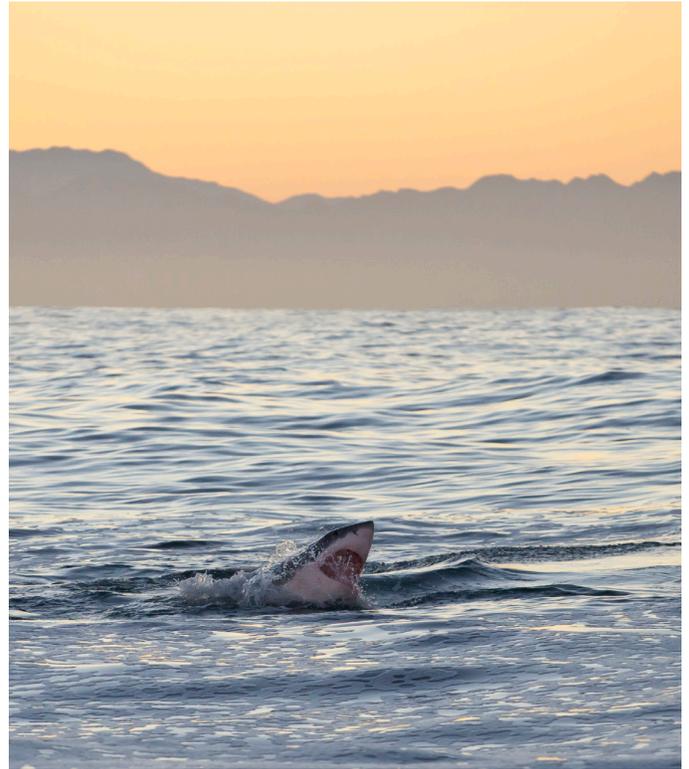
Photo by **Joseph Fader**

Southern right whale dives near Hermanus, South Africa



unique, study-abroad experiences across the globe for middle-school through college-aged students. Broadreach is dedicated to outdoor learning and experiential-education, and their trips combine fully accredited courses (college students receive 3 course credits) with hands-on learning, field experience, community service, and a really, really great time. I have been an instructor for Broadreach for three years and worked in some spectacular places because of it. I encourage anyone interested in outdoor education or conservation outreach with students to check them out. They hire bunches of eager, post-graduate students every summer!

Disclaimer: Although I (obviously) have worked for Broadreach, the company in no way solicited this article and all the views are expressly my own. Their trips are just that awesome.



Above

Photo by **Joseph Fader**

Great white shark lunges in to capture a Cape fur seal in False Bay, South Africa. White sharks target fur seals in the early morning hours as the seals commute to and from their haul-out locations to forage. The seal got away this time.

Below

Photo by **Tricia Hooper**

Beach and Island Geological Processes Field Course: Cape Lookout, NC



Getting to the Root of the Problem - Dominica “The Nature Island”

Emily Hall is a first year Masters of Environmental Management Graduate Student concentrating in Coastal Environmental Management.

As you fly over the crystal blue waters embracing the mountainous terrain, you can't help but imagine yourself transported back to a time of exploration and adventure; when the Caribbean was an untouched treasure trove enriched with royalty and pirates. Dominica is known as the Caribbean's "Nature Island" and has been continually attempting to balance preserving their terrestrial and coastal resources, while trying to grow their young economy, primarily through ecotourism and agriculture.

Dominica is located in the Lesser Antilles which, as a region dominated by volcanic activity, has caused these Caribbean Islands to have a unique structure and complex array of biodiversity. For instance, the coastline of the island consists of a short shelf with rapid drop off that has allowed distinctive sponge dominated reefs to develop. Other areas have a more gradual transition from reef structure to sea grass, where volcanic activity produces hydrothermal vents that release bubbles into the water, living up to the name of "Champagne Beach" in the Southwest region of

the island. Additionally, with the steep slope of the island there is also a prominent orographic effect; where the windward (east) side of the island sees much more rain and harsher wind conditions than the west side of the island. This condition produces a coastal littoral forest, where the tree line is so curved that it almost seems as if the trees are hugging the coastal cliffs.

As I was able to travel amongst these varied ecosystems on the island, with a Tropical Ecology course I took in my undergraduate university, it became obvious that there may be some underlying debate and tension pertaining to the successful management of Dominica's coastal and terrestrial resources. Dominica is, again, a young country that achieved their independence in 1978, and it is of vital importance to the country to not only preserve their natural resources but to also grow their economy. Our tour guide, Clem, touched on this potential conflict when he referred to how the island combats problems by, "watering each individual leaf, and not the root of the plant." As Clem made this statement, it became clear that

this type of political dynamic may become an issue when dealing with environmental concerns.

One potential concern is tourism on the island, as some believe that tourists, especially through the cruise industry, take away value from the island [1]. For instance, another one of our instructors mentioned that some snorkeling and diving shops have found it to be a problem that people have been removing coral or other sea life from the island's reef system. A second potential concern, especially when dealing with coastal issues, is the island's heavy reliance on an unstable agricultural system. The island's affinity for heavy rainfall and hurricane activity has increased the runoff of agro-chemicals, which run into the marine system producing harmful algal blooms, killing marine life [2].

Even with some of these environmental concerns, it is evident that Dominica truly is the Caribbean's "Nature Island," and that they believe in conserving the untouched atmosphere the island has to offer. However, as our guide Clem mentioned, Dominica's citizens must get to the

“root” of the problems, approaching environmental management from an all-encompassing perspective so the island can develop economically and environmentally as an independent and prosperous nation.

References

[1] T. Bedgood, A. Ajayi and M. Vest, “Dominica: A Study of the Island’s Culture and Current Issues,” Texas A&M, 2001.

[2] “FAO Agricultural Damage Assessment Mission to Dominica Following Hurricane Dean,” GIEWS & TCEO, 2007.



Above

Photo by *Emily Hall*

Black Sand Beach in Dominica

Below

Photo by *Emily Hall*
Coastal Forest in Dominica



Words to a Sperm Whale Spirit

Ruici Ong is senior undergraduate majoring in Environmental Science and Policy with a certification in Latin American Studies.

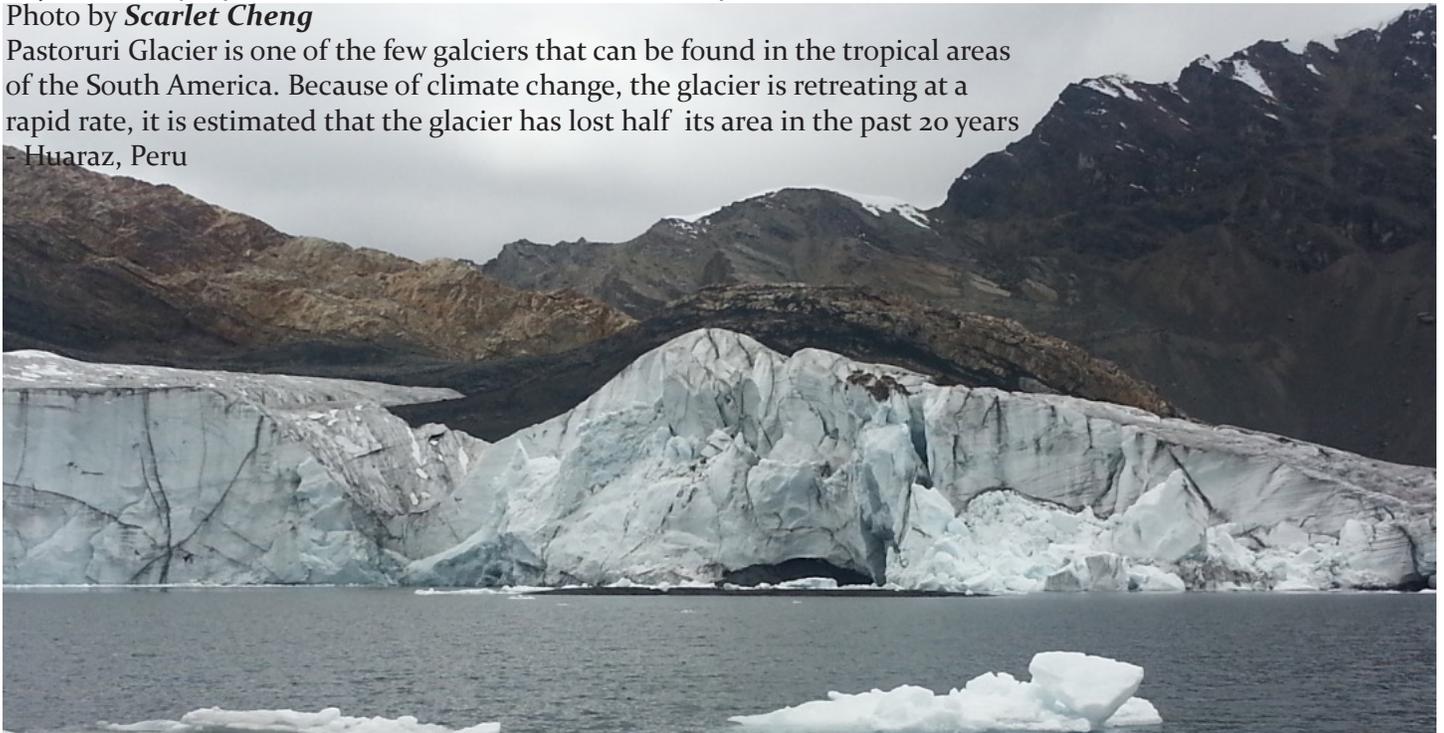
In July 2015, a dead female sperm whale was found by an oil industry worker. He spotted the body afloat off-shore from Jurong Island, an industrial artificial island located southwest off the main island of Singapore. The whale was a massive find, 10.6m long, the first sperm whale recorded dead or alive in the island's waters, and the second whale carcass ever found. Curators and science officers from the National University of Singapore's recently-opened Lee Kong Chian Natural History Museum worked hard to dissect the carcass, examine its gut contents, collect valuable tissue samples and clean the skeleton. In less than a year, the preparations for the

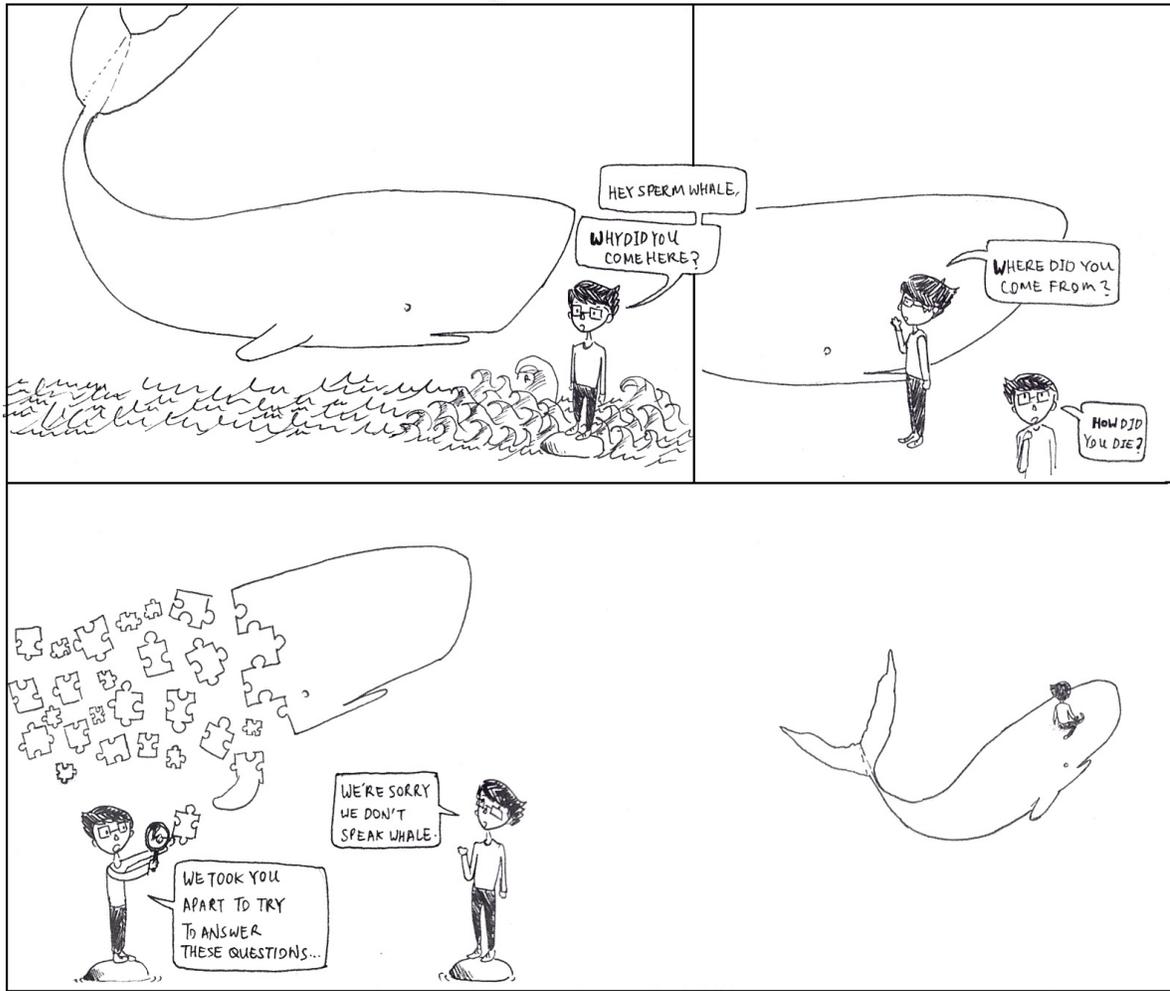
skeleton to go on display in the museum were complete. These are the facts. Reading the news while studying abroad, the swiftness of the operations impressed me. I was struck by the technical nature of the words: species record, dissecting, examining its gut, tissue samples. Indeed, this is the way through which we, modern Singaporeans, seek to gain a better understanding of nature. The human character in the comic tries to start a conversation with what seems to be the spirit of the whale, asking questions of "how?," "why?," "when?". It reflects a personal curiosity about old stories about whales; the merchants and fishermen who plied our waters

before modern Singapore must have had encounters with them and been struck by their majesty. Yet the whale in the comic remains silent as a reminder of my bias as a student of ecology and the environmental sciences, which is, like all perspectives, limited by its frame. The whale, which the human character interrogates using the tools of scientific inquiry, will not respond to ill-chosen methods.

Photo by **Scarlet Cheng**

Pastoruri Glacier is one of the few glaciers that can be found in the tropical areas of the South America. Because of climate change, the glacier is retreating at a rapid rate, it is estimated that the glacier has lost half its area in the past 20 years - Huaraz, Peru





Above
 Cartoon by **Ruici Ong**
 Words to a Sperm Whale Spirit

Right
 Photo by **Talia Sechley**
 Snorkeling with a playful Galápagos sea lion
 off the coast of Champion Island, Galápagos



Using Marine Spatial Planning to Combat Conflict in Long Island, NY

Emily Hall is first year Masters of Environmental Management Graduate Student concentrating in Coastal Environmental Management.

The offshore region surrounding Long Island, NY has been noted as being a prime location for wind energy development; so much so that President Obama has deemed helping New York State cultivate offshore wind energy as a top priority [1]. The proposed location for the windfarm is approximately 11 nautical miles of the coast of Long Beach, in the south western region of the island. The process behind planning for the wind farm is said to potentially take several years; consisting of environmental assessments, an environmental impact statement, and a final auction for the site [2]. However there are already mixed emotions surrounding the implementation of a wind farm in this particular area.

Former long-standing concerns about the appearance and visual unpleasantness of wind turbines don't seem to be the main problem for residents, as many in the Long Beach area see the potential energy benefits to outweigh the costs of viewing the turbines [3]. In spite of this optimism for wind farm energy generation, there is grave concern coming from the shellfish industry in the region

that the implementation of the turbines will not only restrict their fishing grounds, but will also harm the grounds miles away [3]. It is evident that Long Island is suffering from a conflicting view of how to best use the coastal resources off the island, and here would be a perfect opportunity for continuing efforts of marine spatial planning.

Marine spatial planning (MSP) is known to be a tool, where through informed and coordinated decision making, several different stakeholders can come together and address ocean management challenges while promoting economic development [4]. Essentially the goal of marine spatial planning is to analyze and allocate human activities in a spatial and temporal manner to harmonize with marine environments. The process of MSP has already proved as a successful aid in the development of the first commercial wind farm off of Block Island, approximately 200 miles from the proposed Long Beach wind farm.

Due to Rhode Island's Coastal Resources Management Councils

(CRMC) extensive effort in marine spatial planning, they were able to oversee a collection of studies to minimize the environmental impacts of wind farm implementation while ensuring that all stakeholders would have a role in the planning process. In the end, the CRMC was able to produce an Ocean Special Area Management Plan (Ocean SAMP), that provides a regulatory and spatial zoning framework for alternative offshore energy development [5].

As time progresses it will be interesting to see how New York may use marine spatial planning to combat the conflict between offshore energy development and a prosperous shellfish industry; and how they may bring these stakeholders together to create mutually advantageous solutions.

[1] L. Rulison, "Obama official says offshore wind in NY is "No. 1 priority"; timesunion, 29 October 2015.

[2] T. Schlossberg, "Wind Farm May Be Built Off Long Island," The

New York Times, 16 March 2015.

[3] C. Gusoff, "Long Island Community Divided Over Offshore Wind Energy Site Proposal," CBS New York, 16 March 2016.

[4] "Coastal and Marine Spatial Planning," NOAA, [Online]. Available: <http://www.cmsp.noaa.gov/>. [Accessed 18 March 2016].

[5] "First Offshore wind farm in US under construction," Rhode Island Coastal Resources Management Council, 28 August 2015.



Above

Photo by *Micheal Ash*

Swing till the Tides Come Home, photo of MEM Mark Sowers pensively looking into the distance on the shores of Puerto Viejo, Costa Rica while lounging on a swing

Below

Photo by *Devon McGhee*
Dunes along the beach of Cape Lookout



Spotlight on Master's Projects

As a prerequisite for graduation from the Nicholas School of the Environment, each student completes a Master's Project, an opportunity to apply knowledge from the classroom to real-world analyses. Here are the abstracts from three graduates of the class of 2016.

Using Stable Isotopes to Identify Depredation by Short Finned Pilot Whales (*Globicephala macrorhynchus*) in a Longline Fishery

by Austin Allen MEM'16

Adviser: Dr. Andy Read

Each year, hundreds of short-finned pilot whales are killed or seriously injured in interactions with a longline fishery off of the US East Coast. In order to assess population level impacts of these interactions and to design effective management measures, it is important to understand any population demographics of depredation. This project uses stable isotope

analysis on samples collected from pilot whale biopsies, tuna, and cephalopods (the main prey of both predators) to answer this question. My Master's Project addresses a section of this ongoing project: collecting and identifying cephalopod prey species that are not caught commercially. After collection, we identified squid by morphometric characteristics of their mantles

and beaks. Comparing tuna cephalopod prey to data-poor pilot whale trophic ecology is crucial to piece together the stable isotope puzzle. This project aims to determine whether depredation occurs infrequently throughout the population, or if instead certain segments are depredating more frequently than others.

An Analysis of the Correlation between Shoreline Curvature and Shoreline Change at Texas and the mid-Atlantic Coast of the United States

by Scarlet Cheng MEM'16

Adviser: Dr. A. Brad Murray

Increasing human development along the coast, together with climate change and sea level rise, has drastically changed the shape of the coastline. Because of the widespread impacts of shoreline change, studies have been conducted by USGS and various researches, in attempt to understand shoreline change rates and its connection to local, regional,

and global factors. However, one of such factors, shoreline curvature, is not well-addressed in current literature. As a continuation of work that was conducted by another student last year, the main objective of this project is to expand the scope of the study by examining the shorelines of Texas, and the rest of the East Coast (up till Long Island at New York) of the United

States. More importantly, this study aims to investigate how different temporal and spatial scales contribute to different strength, or even direction of the correlation between shoreline curvature and shoreline change.

Learning how to glue underwater: Inspiration from nature

By Zoie Diana MEM'16

Adviser: Dr. Daniel Rittschof

In opposition to the current scientific proposition that *Diopatra cuprea* produce a mucus tube, we hypothesize that *D. cuprea* produce a proteinaceous bioadhesive that uses phosphates as substrates.

an underwater adhesive promoter to build and decorate its tube. I tested the worm's viability as a new model system for studying biological adhesives and antifouling substrates. Preliminary

findings include that this glue is a protein-based bioadhesive. Next steps include looking for phosphate presence, a common underwater adhesive promoter.



Photo by **Zoie Diana**

Here is a microscope photograph of the Decorator Worm. This common, intertidal polychaete lives in a self-engineered tube that you can't see in this photograph. This worm is utilized as a new model system for studying biological adhesives.

Photo by *Hannah Shapiro*
Fisherwomen, Halong Bay, Vietnam



Get Involved!

The Ocean Policy Working Group publication, *Upwelling*, is a semi-annual publication with the purpose of showcasing the work of members of the Duke community as related to the oceans. We are interested in any short research articles or OpEds (500 words or less) on ocean policy-related subjects as well as any ocean-related pictures to publish. We welcome work from graduate students, researchers, alumni, and professors.

If you are interested in contributing to the upcoming edition, or if you have any questions about the publication, please contact dukeOPWG@gmail.com.

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