OCEAN TWILIGHT ZONE

WOODS HOLE OCEANOGRAPHIC INSTITUTION

2020 Q3 REPORT

Science in the time of COVID

THE OTZ TEAM HAS BEEN ABLE TO MEET THE "NEW NORMAL" OF COVID-ERA RESEARCH WITH REMARKABLE CREATIVITY, pressing forward with innovative scientific work while prioritizing the safety and health of staff, students, and colleagues.

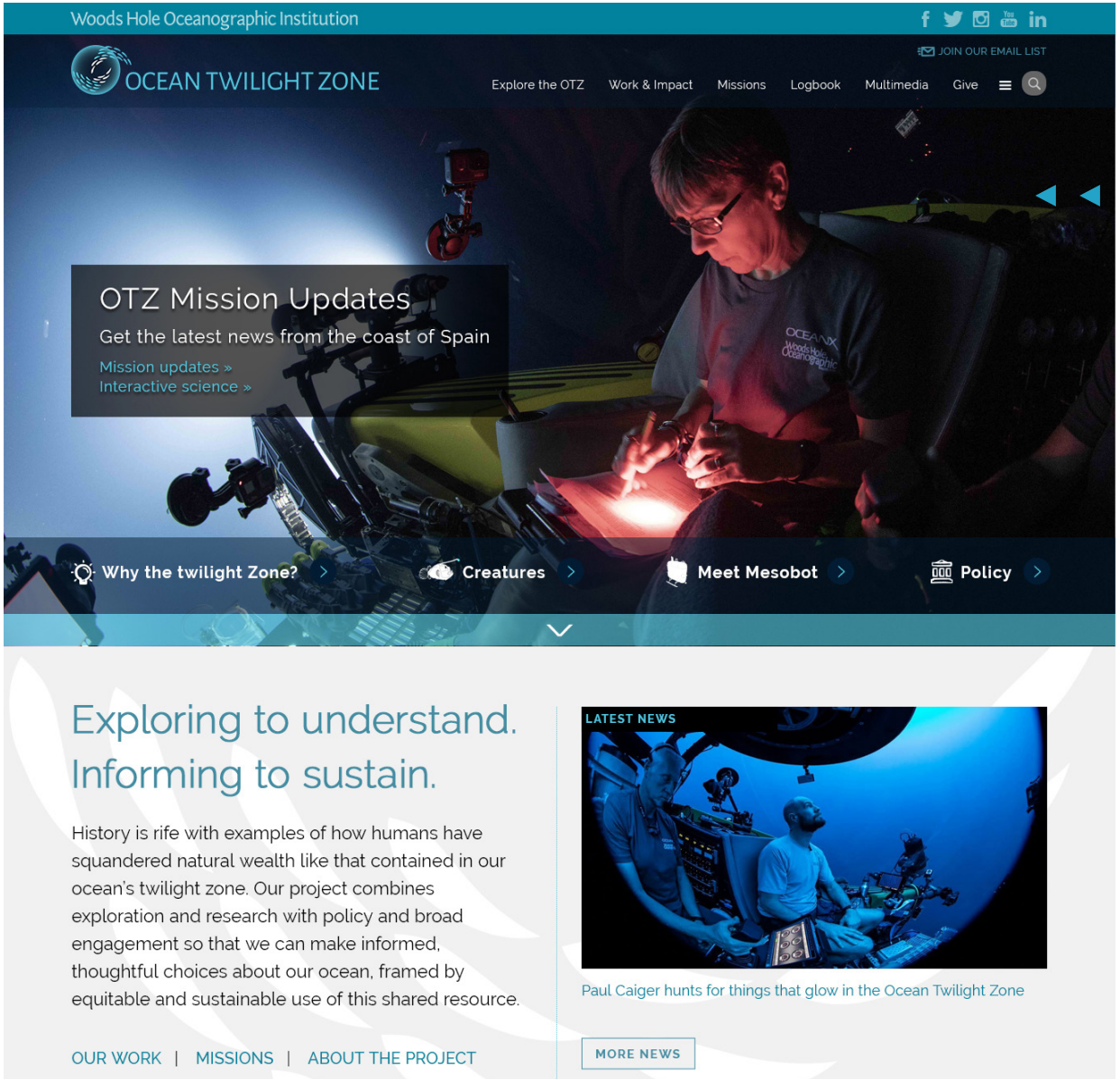
Although our team is cautiously optimistic about returning to sea by late 2020 or early 2021, we also have begun to develop contingency plans and are exploring options to collect data remotely via autonomous robotic vehicles and existing moored ocean observatory infrastructure.

Taking advantage of time gained from postponed research cruises, the team has accelerated data analysis efforts, generating a number of new publications and manuscripts based on pre-COVID samples. It has also continued to build strong relationships at the United Nations, create robust international policy recommendations for the ocean twilight zone, and present (virtually) at a number of conferences—including one held by the World Economic Forum.

LOOKING AHEAD

With limitations on our ability to access the sea aboard University-National Oceanographic Laboratory System (UNOLS) research ships, a subset of OTZ Principal Investigators are pivoting from this conventional model to an emerging, shore-based, economical mode of operations. This type of operation will let us recover some of the lost momentum in our fast-moving, competitive field at a fraction of the cost of research ship time. We are exploring the possibility of a 4-week operational campaign to take place from a shore facility in Bermuda (along with the use of a day-boat) in the spring of 2021. Technological development and operational protocols will be advanced on OTZ technologies such as Mesobot, novel eDNA samplers, the MIT radiometer, minions and and a new submersible system called a Twilight Zone Explorer or TZEx for short. This operational model could become the new standard for oceanographic technological and operational development if our vision is realized.

2020 Q3 Highlights



NEW OTZ WEBSITE (LEFT)

We are excited to announce the launch of a completely redesigned OTZ project website. The site has over 70 webpages featuring unusual creatures, new technology, missions at sea, and much more. This new, nimble web design will enable us to tell the OTZ's highly visual story of exploration and discovery through a uniquely engaging medium.

PUBLICATIONS

OTZ Principal Investigators and Postdocs published two scientific manuscripts this quarter, they have recently submitted three others and have more than 10 in preparation. In addition, our team prepared a book chapter for the UN World Ocean Assessment on economics of the natural capital of the deep ocean with specific reference to mesopelagic fisheries.

ENGAGEMENT

The team has been actively engaged in maintaining and building relationships with UN Decade planning activities, Biodiversity Beyond National Jurisdiction activities, and UN Ocean Conference planning activities.

Spotlight on twilight zone food webs

One of the key ways our team is working to understand the ocean twilight zone is by studying its food webs.

OUR RESEARCHERS ARE CURRENTLY EMPLOYING environmental DNA (eDNA), net tows, animal stomach contents, holographic imaging, and sonar readings to identify which species are present and how they interact with each other. Mapping out who eats whom, from the smallest microorganisms to the largest predators, will reveal complex relationships between predators and prey, and will offer new insight on both the biology of the twilight zone and its role in removing carbon from surface waters to the deep ocean. These data will be essential for deciphering the function and importance of the twilight zone ecosystem as a whole.

SO FAR IN 2020, OUR TEAM HAS:

- Identified two distinct, interconnected food webs (composed of migrating organisms that travel to the surface at night to feed and non-migrating organisms).
- Published several studies quantifying the amount of time that large pelagic predators spend in the ocean twilight zone.
- Closely examined more than 600 individual animals to better understand each organism's lifespan, growth rate, and age at maturity. These characteristics are critical to understand a species' resilience to fishing pressures.

DO ANIMALS FROM THE SURFACE INTERACT WITH ANIMALS FROM THE TWILIGHT ZONE?

Over the past year, OTZ researchers have discovered that animals in the twilight zone don't just interact within a single food web. Instead, they appear to make up at least two distinct, yet related systems: one that interacts with surface food webs and another that appears to remain at depth, largely separate from the surface.

The OTZ team revealed the link between the twilight zone and surface food webs using a powerful tool called "compound-specific stable isotope analysis," that quantifies the ratio of carbon 13 and carbon 12 isotopes in certain amino acids. Researchers can use isotope signatures to track the flow of carbon from primary producers at the base of ocean food webs all the way to top predators foraging in the ocean twilight zone.

Eventually, this stable isotope method may help identify the source of primary production that is fueling the remarkable biomass located in the ocean twilight zone.

ABOVE: The black swallower fish pictured above is chasing a young angler fish. The swallower has a mouth that's hinged at the back of its head so that it can open wide and engulf an immense meal in one gulp. Photo composite by Paul Caiger © Woods Hole Oceanographic institution.

Whale sharks forage in the twilight zone

New data show that whale sharks, blue sharks, and white sharks all feed in the twilight zone – we need to know more.

AFTER FITTING SOME OF THESE ANIMALS WITH powerful satellite tags last fall, WHOI's OTZ team showed for the first time that the sharks also spend time hunting in the twilight zone. Data from the tags revealed that the sharks speed down the center of warm-core ocean eddies—large, swirling masses of water—to reach the abundant food that exists nearly 1,000 meters below the surface.

This insight is critical to shaping flexible management strategies for individual species and entire ecosystems. Although researchers deployed the tags on porbeagle sharks and swordfish last fall, they are still receiving valuable data from them today. The team also recently tagged five whale sharks in the northwest Atlantic, and are gathering important information on the horizontal and vertical movements of these giant animals. We have new data from satellite tags deployed on whale sharks last year in the Azores that indicates whale sharks are also feeding in the twilight zone during ocean migrations. The data the team generates from these tags will help us understand how each of these important predators forage in the mesopelagic, offering further detail on the function of food webs in the twilight zone.

What's the value
of studying the ocean's biological carbon pump?

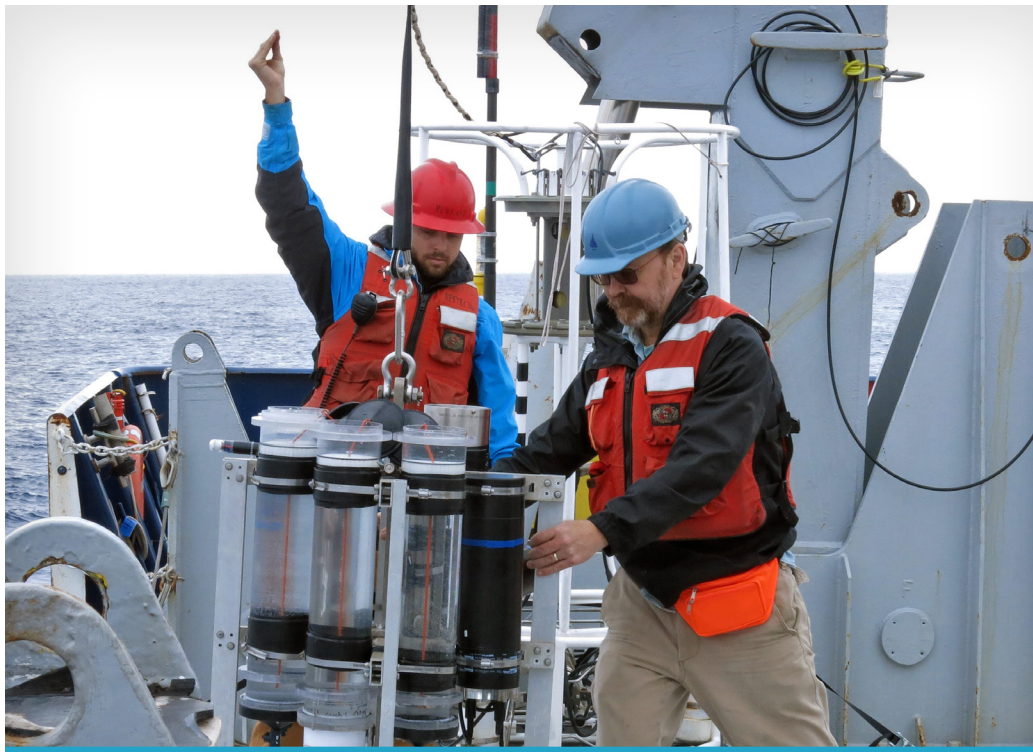
IT'S NOT JUST A PHILOSOPHICAL QUESTION. The WHOI OTZ team estimates the value of research efforts to improve our understanding of the "biological carbon pump" at roughly $500 billion—a few more zeros than you might expect.

Scientists have long known that the ocean's twilight zone plays an essential role in capturing carbon from the atmosphere, but the efficiency of the ocean's "biological carbon pump" remains uncertain, which could have significant implications for future climate policy.

HIGHLIGHTS FROM THE VALUE OF SCIENTIFIC RESEARCH ON THE OCEAN'S BIOLOGICAL CARBON PUMP INCLUDE:

- Ocean's biological carbon pump (BCP) constitutes one of Earth's most valuable ecosystem services,
- The value of marine scientific research on BCP carbon sequestration is investigated,
- The benefit of narrowing the range of uncertainty about ocean carbon sequestration is on the order of $0.5 trillion,
- The value is affected by the accuracy of predictions, the economic parameters, and the initial range of uncertainty.

Click below to read more about the team's analysis, which will be published in the December 2020 issue of the journal Science of the Total Environment.



Marine chemist Ken Buesseler (right) deploys a sediment trap from the research vessel Roger Revelle during a 2018 expedition in the Gulf of Alaska. Buesseler's research focuses on how carbon moves through the ocean. Buesseler and co-authors of a new study found that the ocean's biological carbon pump may be twice as efficient as previously estimated, with implications for future climate assessments. Photo by Alyson Santoro © Woods Hole Oceanographic Institution

The economics of natural capital and its relevance to deep-sea conservation

The OTZ marine policy investigators (Porter Hoagland and Di Jin, working with WHOI biologist Stace Beaulieu) recently contributed a chapter in a book entitled "Natural Capital and Exploitation of the Deep Ocean" published by Oxford University Press. The chapter reviewed the economic underpinnings of the concept of natural capital, examined how it could be measured for pertinent types of deep-sea natural assets, and developed recommendations for future research and practice to enhance its policy relevance for the high seas.

The chapter points out that coastal fishing has been practiced for millennia. Deeper and more remote fishing began in earnest in the eighteenth century. In the present day, the bounty of the deep sea is increasingly attracting interest from commercial fishing interests, which potentially could lead to "profound changes in its physical characteristics and to its ecological structures and processes."

LEFT: Bean's bigscale (*Scopelogadus beanii*). Photo by Paul Caiger

Web, Earned Media, and Social Media

ALL DATA REPORTED OCTOBER 1, 2019–SEPTEMBER 30, 2020

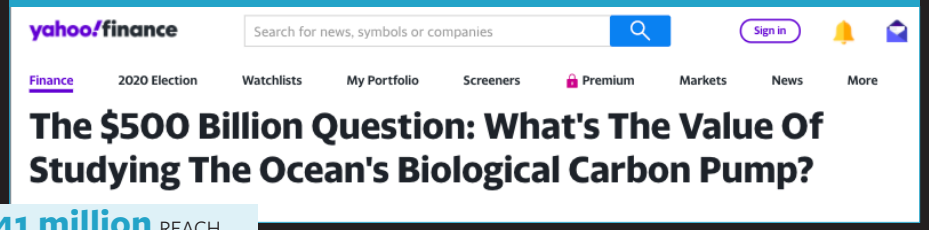
WEB

25 NEWS STORIES **31,995** PAGE VIEWS

EARNED MEDIA

284 STORIES WORLDWIDE **573,485,927** POTENTIAL REACH

TOP MEDIA



41 million REACH

SOCIAL MEDIA

3,479,587 TOTAL IMPRESSIONS **181,916** TOTAL ENGAGEMENTS

1,372,149 IMPRESSIONS
82,377 ENGAGEMENTS

1,240,736 IMPRESSIONS
35,849 ENGAGEMENTS

803,397 IMPRESSIONS
59,248 ENGAGEMENTS

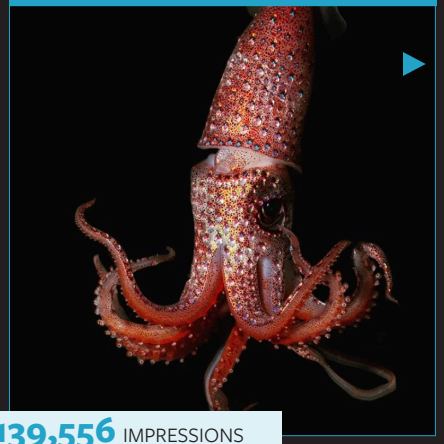
63,305 CLICKS
4,442 ENGAGEMENTS

32188 VIEWS
1658.20 WATCH TIME

TOP VIDEO

7,196 VIEWS

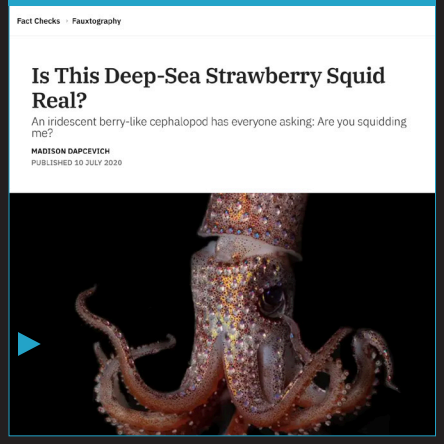
TOP POST



139,556 IMPRESSIONS

The Strawberry Squid Instagram post went viral leading to increased engagement across all channels. The image was then picked up by Snopes, the definitive fact-checking site.

SNOPES



Emerging scientist spotlight

Kayla Gardner has always been fascinated by small things. As a high school student, she fell in love with marine biology—not by watching dolphins or whales, but tiny zooplankton under a microscope.

"These are my kind of animals," she said, laughing. "When you see a high density of diverse organisms, watch them move, see how colorful and vibrant they can be—that's what first hooked me."

Since arriving at WHOI as a PhD candidate in the MIT-WHOI Joint Program, Gardner has continued her focus on all things small. Instead of examining zooplankton through a microscope, however, she has begun to zoom in even more closely, studying amino acids from fish muscle tissue. Today, she works with her WHOI advisor, Simon Thorrold, to analyze ratios of carbon 12 and carbon 13 isotopes in those molecules, looking for clues about the fishes' diet.

By comparing isotope ratios between samples, she notes, it's possible to tell if a fish eats most of its prey at the surface or at depth, information that will be essential for the OTZ team's efforts to map the food web of the twilight zone for the first time. By doing so, the team will give policymakers a tool to craft better informed and more nuanced guidelines for human activities like commercial fishing, preserving the twilight zone for future generations.

Gardner finds that element of her work especially important. "I have this heart for the ocean; it's something that's always given me peace on a personal level, and I want to repay that," she says. "People look out and see the flat surface of the ocean, but there's so much more underneath."

The Ocean Twilight Zone Project is embarking on a journey to explore and understand one of our planet's last great frontiers—the ocean twilight zone. Our project will combine exacting science, innovative technology, and broad engagement to turn knowledge into actions that improve understanding of our planet and how to live sustainably on it.

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FRONT: Swarm of krill. RIGHT: Bristlemouth.
Photos by Paul Caiger.