



WOODS HOLE OCEANOGRAPHIC INSTITUTION

**2021 Q1 REPORT** 

### Introduction

TWILIGHT ZONE TEAM RETURNED TO THE FIELD IN FEBRUARY—but this time, they were based at a shore facility, using a small catamaran as a technical development platform. Following the COVID-safety related cancellation of several OTZ research cruises, the project's steering committee redirected operational funds towards an innovative, month-long field operation at Station B, a new rapid-development center for ocean technology in Bermuda. The team led by Dana Yoerger had a successful mission, capturing underwater footage and testing new software and instruments, including a radiometer built by our collaborator Allan Adams and his team at MIT. In addition to accomplishing its research goals, the Bermuda expedition provided excellent content for our growing social media channels and blog. Immediately after the team sent out its first public newsletter, the OTZ website experienced dramatically increased traffic.

The National Academy of Sciences' National Committee for the Ocean Decade accepted the OTZ Project into its "Ocean Shot" initiative. Similar to NASA's "moon shot," this program recognizes ambitious, transformational research aligned with the goals of the United Nations Decade of Ocean Science for Sustainable Development (UN Ocean Decade). Members of the OTZ team also worked with the international mesopelagic research consortium JETZON to apply for consideration as an official UN Ocean Decade "Programme."

Also in this quarter, OTZ researchers published three new peer-reviewed studies in prestigious journals. In addition, Ken Buesseler and Heidi Sosik prepared extensively for an upcoming May research cruise on the Spanish research vessel *Sarmiento de Gamboa* that will shed light on how the twilight zone regulates the ocean carbon pump. The cruise is a partnership with NASA's EXPORTS program, which concurrently will field two other research vessels in the same area.





# 1<sup>st</sup> Quarter at a glance

- ► Accepted into the NATIONAL ACADEMY OF SCIENCES' "OCEAN SHOT" INITIATIVE as part of the UN Decade of Ocean Science for Sustainable Development
- ► Completed a successful month-long **FIELD EFFORT IN BERMUDA** that resulted in advances to *Mesobot's* sensing systems
- Published THREE NEW ACADEMIC PAPERS in prestigious journals
- ► Completed SUBSTANTIAL PRE-CRUISE
  PLANNING for the R/V Sarmiento de Gamboa
  research cruise, a massive data collection effort
  in the Northeast Atlantic in conjunction with
  NASA EXPORTS

**LEFT:** A team of engineers prepares for a Mesobot deployment in Bermuda. Evan Kovaks © WHOI

## Going into the twilight zone

AT MORE THAT 650 FEET BELOW THE OCEAN'S SURFACE, THE TWILIGHT ZONE IS FAR DEEPER THAN HUMANS CAN EASILY EXPLORE. It also covers a vast area, spanning most of the world's open ocean—so studying its ecosystem requires innovative new science and technology.

Our team is developing powerful new submersible vehicles, 3D-imaging cameras, sonar systems, DNA sampling techniques, and an entire fleet of cutting-edge autonomous sensors. We're also developing new laboratory methods to study the mid-ocean zone, pioneering work in environmental DNA (eDNA) and carbon isotope analysis. Using these techniques, researchers can learn which species are lurking in the twilight zone—without actually seeing them—and identify where they fit into the ocean's complex food web.

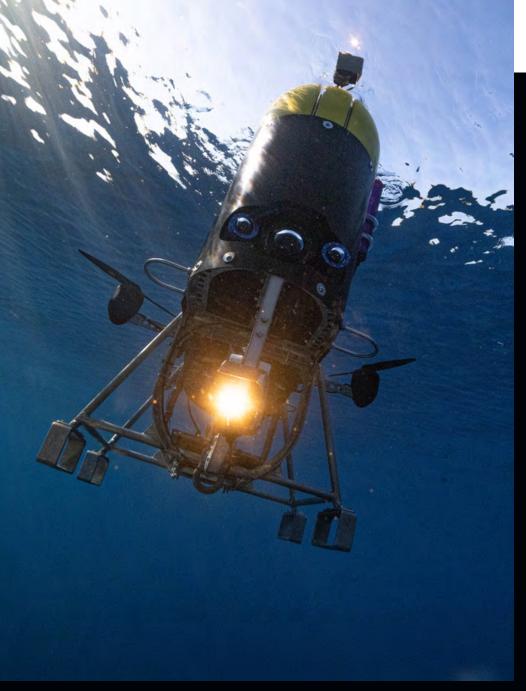
Each of these technologies has inherent strengths and weaknesses. Used together, this suite of tools can help scientists paint a more detailed picture of the twilight zone than ever before.

**RIGHT:** Research Technician Fredrick Marin attaches a highly-sensitive radiometer to Mesobot. Jennifer Berglund © WHOI



#### Going to sea in a pandemic

**OUR SHORE-BASED WORK IN BERMUDA REPRESENTS A NEW AND INNOVATIVE APPROACH FOR TWILIGHT ZONE RESEARCH IN THE COVID-19 ERA.** Instead of working from a large vessel, the OTZ team took day trips to a field site less than a mile offshore where the ocean floor dramatically drops away. This arrangement provided a flexible way to test and fine tune oceanographic instruments in the field, allowing the team to rapidly advance technologies in preparation for the next research cruise.



ABOVE: Mesobot descends into the Twilight Zone. Evan Kovacs © WHOI

## Tracking light in the twilight zone

THROUGHOUT THE FIELD CAMPAIGN IN BERMUDA, MESOBOT WAS DISASSEMBLED SEVERAL TIMES, PUT BACK TOGETHER AGAIN, AND EXHAUSTIVELY TESTED IN SHALLOW AND DEEP WATER.

As *Mesobot* swam through the twilight zone—<u>interrupted only once by a whale</u>—the robot's high-resolution cameras bore witness to the largest migration on Earth: the nightly journey of twilight zone animals to and from the surface to feed. It successfully tracked individual creatures as they moved within the deep scattering layer, the agglomeration of twilight-zone animals as "seen" by sonar.

Perhaps one of the most exciting technological developments was integrating a radiometer that will allow *Mesobot* to follow a specific light level throughout the day, just like the migrating twilight zone organisms it observes. At the core of this radiometer—designed by MIT collaborator Allan Adams—is an ultrasensitive instrument that can precisely calculate how many photons hit a sensor every ten-thousandth of a second. When integrated into the robot's software, the radiometer's readings will allow *Mesobot* to autonomously track specific light intensities. Like migrating twilight zone animals, *Mesobot* will be able to sense the dimming of light from above at nightfall and rise to the surface, then descend back to darker waters when surface light levels increase at daybreak.

OTZ researchers think that light levels strongly influence (and perhaps trigger) the migration of twilight zone animals, so much so that cloud cover can alter migration patterns. *Mesobot*'s ability to directly measure light in this deep, dark region of the ocean will allow researchers to finally test this hypothesis—a breakthrough for ocean science.

### Spotlight on Emma Cotter

As ocean technologies advance, the pace of data collection accelerates along with it—but researchers can only analyze so much data by themselves. That's where WHOI postdoctoral scholar Emma Cotter comes in.

Cotter's machine-learning algorithms can sort through massive data sets in a fraction of the time it would take a human.

Cotter applied Artificial Intelligence technology to acoustic measurements collected by the ship-towed sonar-equipped platform, the *Deep-See*, to create a "picture" of the ocean sounds cape from echoes that bounce off creatures in the twilight zone.

"The real advantage of working with acoustics, as opposed to camera-based sensors, is that we can measure a broad array of things in the deep ocean from a relatively long distance away," Cotter says. "Acoustics give us a sense of what's happening right now in the twilight zone without needing to sneak right up on an animal."

The challenge lies in interpreting the data to figure out what—and how much life (or biomass)—is in the twilight zone. Researchers are currently able to estimate how many fish are there and roughly what size they are, but so far cannot determine the species from acoustics alone. That's why cameras are used in tandem with acoustic techniques.

"It's been incredible to see how much life and biodiversity there is in the deep ocean. It's also been a little bit surprising to learn just how complicated it is to study," Cotter says. "We need all of these different mechanisms and technologies to start wrapping our heads around it."

Cotter's latest publication, co-authored by OTZ Project researcher Andone Lavery, was chosen as the Editors Pick by the Journal of the Acoustical Society of America (JASA) Express Letters.

**READ MORE**: <u>twilightzone</u>.whoi.edu/spotlight-emma-cotter



**ABOVE:** WHOI Postdoctoral Scholar Emma Cotter with the Adaptable Monitoring Package, an instrumentation platform developed at the University of Washington for environmental monitoring at marine renewable energy sites. James Joslin © APL/UW

