



OCEAN
TWILIGHT
ZONE

WOODS HOLE OCEANOGRAPHIC INSTITUTION

2021 Q4 REPORT



Introduction

APEX PREDATORS, THE HUNTERS AT THE TOP OF OCEAN FOOD WEBS, ARE AN ESSENTIAL PART OF THE OCEAN TWILIGHT ZONE. THEY FORM A BRIDGE BETWEEN THE SURFACE, WHERE THEY SPEND MOST OF THEIR TIME, TO DEEP WATERS OF THE MESOPELAGIC, where they feed on a buffet of sea life. These predators include a diverse range of animals: sharks, whales, northern elephant seals, and commercially-important species like tuna and swordfish, to name a few. Yet despite the large variety of predators that rely on the zone for food, OTZ researchers are still working to understand how they fit into the region's larger food webs—and how changes in that food web due to human impacts will affect the predators themselves.

COVER: Adult Swordfish. Steve Daugherty © WHOI

Estimates of twilight zone biomass range upwards of 15 billion metric tons, making it an attractive target for future commercial fishing operations. The global fishing industry has already begun to explore the possibility of harvesting mesopelagic animals, primarily to meet growing feedstock demands of the aquaculture industry. If commercial fishing in the twilight zone becomes widespread, it may affect the food sources that commercially important apex predator species rely on to survive. To that end, our team has been working hard to unravel these questions over the past quarter, and has been steadily improving the research methods and infrastructure needed to find scientific answers.

ABOVE: Blue Sharks, one of the apex predators of the twilight zone, swim just under the ocean's surface. Nuno Sá © WHOI



4th Quarter at a glance

- ▶ Simon Thorrold's lab received an anonymous two-year grant of \$550,000 to integrate satellite communication capabilities into the RAFOS Ocean Acoustic Monitoring (ROAM) tags used to track apex predator foraging behaviors in the twilight zone.
- ▶ Heidi Sosik's lab worked with the open data platform developers to create Photic, a web-based image display and annotation system that helps train AI-based algorithms to process large datasets. Photic will be used to improve analysis of millions of images from OTZ's StingRay towed platform.
- ▶ OTZ researchers continue to test ROAM tags using long-range ocean gliders deployed in the fall. This data will help to fine-tune the geolocation accuracy of assets deployed with ROAM tags in the new OTZ Observation Network.
- ▶ Postdoctoral scholar Elizabeth Andruszkiewicz Allan published a [new paper](#) on the vertical and temporal variability of eDNA in the twilight zone. The article was co-authored by OTZ principal investigators Annette Govindarajan and Andone Lavery.

In order to study the behaviors of apex predators in more detail, the OTZ team has continued to develop and test elements of the new Ocean Twilight Zone Observation Network, a study area spanning more than one million square kilometers (400,000 square miles) in the northwest Atlantic Ocean. Using multi-frequency sound transmitted from moorings on the edge of this area, the team will be able to triangulate positions of submerged floats, gliders, and fish tags in three dimensions within 1-10 kilometers. This level of tracking detail has never before been possible for most marine fishes. Existing technologies can record vertical movement—i.e., how deep an animal or piece of technology goes at any given time—in increments of just a few meters. When it comes to horizontal motion throughout the deep water, however, current methods, which rely on light observations, can be off by up to 400 kilometers (248 miles).

This quarter, researchers from Simon Thorrold's lab at WHOI and Melissa Omand's lab at the University of Rhode Island have been testing ROAM tags, a next-generation tracking tool for twilight zone animals. In mid 2021, the team attached several tags to long-distance ocean gliders, and are now retrieving them to gauge how accurate their positional data from the Observation Network currently is. By optimizing placement of the buoys accordingly, the OTZ team will be able to fine-tune the measurements that the network provides, setting the groundwork for tagging individual tuna and sharks later this year.

These combined technologies will show scientists exactly when these apex predators are diving into the twilight zone to feed, how long they're spending in its waters, and how they use oceanographic currents and eddies to reach its murky depths. Understanding these behaviors will provide real-world information on where these predators normally hunt within the zone, how they catch their prey, and what their impact on the food web may ultimately be. This information will be critical for shaping effective fishery management strategies in the future, both for individual species and for entire ecosystems.

BACKGROUND: An image of a siphonophore taken by WHOI's In-situ Ichthyoplankton Imaging System (ISIIS). These creatures are probably underestimated in the ocean twilight zone because traditional net sampling techniques don't preserve their fragile bodies. Whole image on back. © WHOI

ROAM around the world

Thanks to a new anonymous grant of \$550,000, OTZ team members will be able to continue upgrading ROAM tags to improve their capabilities.

These tags record the exact three-dimensional position of animals or equipment in the ocean. Existing models, however, store information only in onboard memory cards, meaning that scientists must physically find and retrieve the tags from the water in order to download their contents.

The new grant will allow Simon Thorrold (WHOI) and Melissa Omand (University of Rhode Island) to continue adding functionality to the tags—in this case, incorporating satellite connectivity directly into their design. With that feature, the tags will be able to transmit data remotely whenever they reach the surface

and connect with the satellite network. The labs are working directly with a third party vendor, Wildlife Computers, to put that functionality into place.

Thanks to their previous work on the Twilight Zone Observation Network, the Thorold and Omand labs were shovel-ready for this phase of the project when a grant arrived, letting the teams expedite technology development for the tags. In addition to putting acoustic sound sources in place to allow tracking with the tags, the team also secured a partnership with a commercial company, Wildlife Computers, to allow prototyping of the

next generation of ROAM tags once funding came in. Developing low-cost sensors such as this has been one of the strategic technological goals of the OTZ project from the outset.

The OTZ project's infrastructure continues to grow in this way, letting our team gain more insight on the zone at a faster pace—and deliver that information to policymakers more quickly—which can have a direct impact on international ocean policy decisions and fisheries management.

ABOVE: A porbeagle shark swims at the surface wearing a SPOT tag, one of the precursors to the new ROAM tags. Craig LaPlante © WHOI



2021 Engagement by the numbers

SOCIAL MEDIA

27,320,957 IMPRESSIONS

2,398,180 ENGAGEMENTS

4,476,789 REACH

6.73% ENGAGEMENT RATE

TOP FACEBOOK POST



**Woods Hole
Oceanographic Institution
(WHOI)**

June 18, 2021 · 🌐

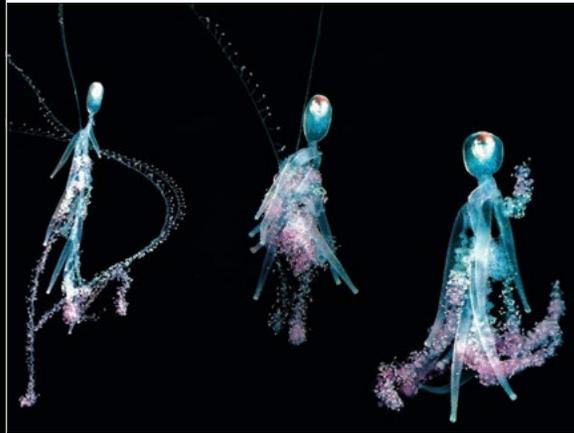
The #baskingshark is the second-largest fish in the ocean, but doesn't flaunt its size. It does like...

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👍❤️😮 5.7K

141 Comments 900K Views

TOP INSTAGRAM POST



whoiocean Happy #WeirdWednesday!

Three views of one animal look like a magical dancing sprite in the night sea. A relative of the Man-o'-War, the predatory siphonophore Rhizophysa is four inches high when contracted (middle) but its stinging tentacles stretch to a couple of feet when fishing. A scuba diver captured this one in the mid-Atlantic, and part of its DNA was analyzed and recorded for the



Liked by oysterpearl84 and 1,616 others

TOP NEWS STORIES

CNN.COM

143 MILLION VIEWERS

Enter the strange world of the ocean twilight zone

ASSOCIATED PRESS

29 MILLION VIEWERS

Explorers, Scientists, and Advocates James Cameron, Ray Dalio, Peter de Menocal, and Dr. Edith Widder to Discuss Ocean Twilight Zone for Public Unveiling of Historic Art Installation

NEWSWEEK

22 MILLION VIEWERS

Robot Dives 3,000 Feet to Film Creatures in Mid-Ocean 'Twilight Zone'

NASA.GOV

17 MILLION VIEWERS

Tracking Carbon from the Ocean Surface to the Twilight Zone

VOX

17 MILLION VIEWERS

"It's deep. It's dark. It's elusive." The ocean's twilight zone is full of wonders.

Spotlight on *Ciara Willis*

WHOI PhD student Ciara Willis has one major criteria for any research she takes on: it must have a real-world impact.

Willis, a member of WHOI researcher Simon Thorrold's lab, studies fish ecology, a field that examines the complex relationships between large organisms in the ocean. She's currently focusing her efforts on understanding top predators in the ocean twilight zone, like tuna and swordfish—species that are fished commercially, yet also play a major role in the twilight zone.

"Those species typically migrate between the surface and the mesopelagic daily," she says. "The big question is, when they dive into deep water, to what extent do they rely on the ocean twilight zone for their wellbeing? They spend a lot of time there, but we don't completely know why."

Getting to the bottom of that question could help to reveal the ecological link between major commercial species and other, smaller species that live at depth. This will be particularly important over the next decade, she adds, when commercial fishing may start to expand into the deep waters of the twilight zone.

"If you fish one group of species, what does that do to its predators, and vice versa? That's one of the big dark holes in our understanding. The twilight zone is kind of a new frontier for fisheries, so it's really important that we don't just go blindly into that harvest, and that we first establish some foundational science on its ecosystem," she says. "I always try to tie that theme into my work—whatever I do, it has to generate data that's useful for making policy decisions."

RIGHT: Ciara Willis deploys an expendable Bathy-Thermograph to survey the depth, pressure, and temperature of ocean. Daniel Hentz © WHOI



twilightzone.whoi.edu

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 combines 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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