OCEAN TWILIGHT ZONE

WOODS HOLE OCEANOGRAPHIC INSTITUTION

AUDACIOUS PROJECT ANNUAL REPORT
FISCAL YEAR 2022

Contents

We have embarked on a bold new journey to explore one of our planet's final frontiers—the ocean twilight zone, a vast, remote part of the ocean teeming with life, which remains shrouded in mystery. Our goal is to rapidly explore, discover, and understand the twilight zone and to share our knowledge in ways that support sustainable use of marine resources for the health of our ocean and our planet.

(Above) Scientists bestowed the nickname "squidworm" on this previously unknown species found by WHOI scientists using a remotely operated vehicle to explore the deep Celebes Sea in 2007. The 4-inch-long creature has tentacles on its head and rows of bundled spines on its body that paddle like oars of a Roman galley. Photo by Larry Madin, © Woods Hole Oceanographic Institution.

Introduction

Dear friends,

For the past three years, our team of scientists have been in the midst of a large-scale, comprehensive exploration of one of our planet's final frontiers: the ocean twilight zone. This vast, dark swath of the world's oceans is teeming with life, and may play a massive role in global climate—yet much of it remains shrouded in mystery.

Despite the many logistical challenges we faced during the global pandemic, I'm pleased to say that our team has made incredible progress in understanding the twilight zone's global significance. In 2021 alone, our scientists completed a complex three-ship cruise in the eastern Atlantic, tested robotic vehicles from the coast of Bermuda, published dozens of academic papers, and installed parts of a new Ocean Twilight Zone (OTZ) Observation Network that will provide data about the zone consistently over the next several years.

In addition to these scientific achievements, our work is also having a real-world impact. Thanks to a broad new outreach campaign, we've been able to boost public awareness of the zone's importance, and have ensured that twilight zone research plays a key role in global climate talks. With this continued focus, the OTZ team will be able to help inform new policies that sustain a healthy, productive, and resilient ocean in the future.

As we move past the midpoint of our six-year project, three priorities will drive the allocation of remaining resources: 1) applying all our previous learning and technological development to our primary scientific goals, 2) synthesizing all data and knowledge gained to date and 3) exerting as much effort as possible toward shaping international ocean policy development and solving climate-related challenges. To better achieve these goals, the team has brought several areas of study under one umbrella: understanding diel vertical migration, a phenomenon that is central to life and natural processes in the twilight zone.

I hope this report will serve to highlight all the remarkable progress that the team has achieved in the past year. If our momentum continues, we expect another banner year in 2022, with additional fieldwork, technology development, and scientific results that will continue filling in major gaps in our understanding of the zone—and by extension, the ocean as a whole.

With gratitude for all you do for us, for our ocean, and for our planet.

Peter de Menocal

Sincerely,
Peter de Menocal
President and Director, Woods Hole Oceanographic Institution

Key Performance Indicators

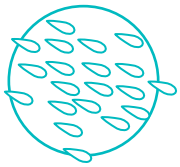
KNOWLEDGE GAINED

At the core of this work is a goal to better understand the ocean twilight zone in order to inform decision making around it. Here we highlight some of the most impactful knowledge gains our project has made.

PREDATOR OR PREY?

Knowledge Gained: Several of the most abundant species of twilight zone fish, like bristlemouth and lanterfish, seem to prefer very specific prey despite the abundance of other food sources. Several other species, by contrast, will eat almost anything they can find.

Impact: Figuring out twilight zone animals' food preferences is a major step towards mapping the complex food webs of the mesopelagic.



HOW MUCH LIFE IS THERE?

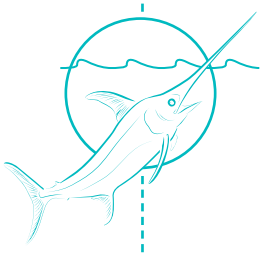
Knowledge gained: Improved accuracy of acoustic biomass measurements by creating new ways of classifying targets with shipboard sonar.

Impact: New methods provide insight into organism size, and can help determine the distribution of marine life.

WHAT LIVES THERE?

Knowledge Gained: Environmental DNA (eDNA) does not drift up or down in the ocean more than a few dozen meters after being shed from an organism.

Impact: eDNA data can be accurately used to identify organisms at specific depths, providing valuable information about both vertical migration and overall populations of the twilight zone.



HOW IS IT CONNECTED TO THE SURFACE OCEAN?

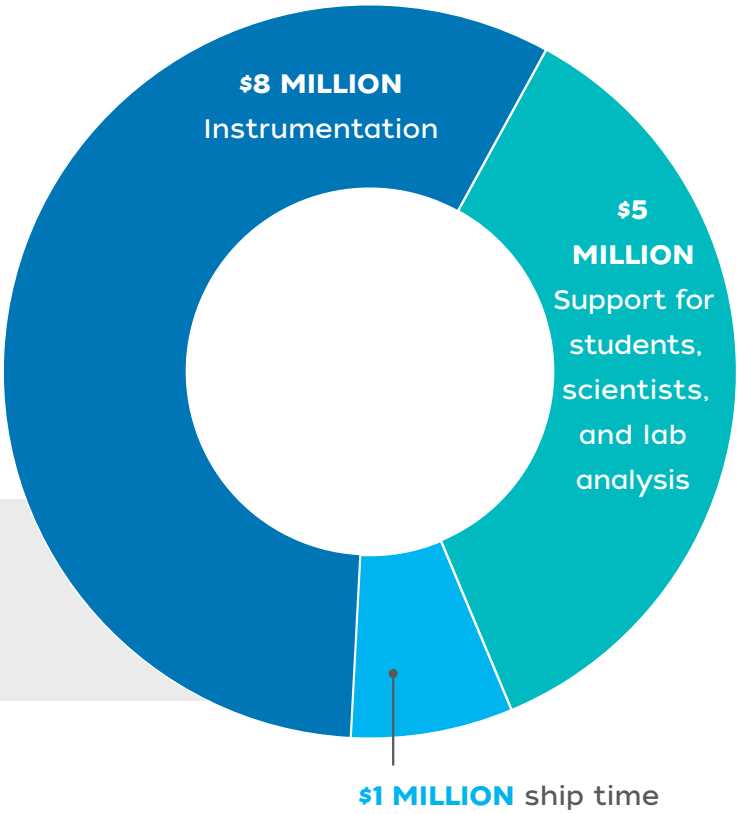
Knowledge Gained: Among top predators like seals, whales, sharks, and swordfish, foraging at great depths is far more frequent and ubiquitous than previously recognized.

Impact: Mesopelagic ecosystems are critical to large predators that live primarily in the upper open ocean.

LEVERAGED FUNDING

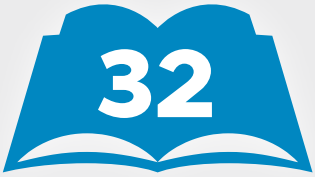
When done collaboratively, scientific research is often the most impactful. Quantifying our leveraged funding, or funding received from outside sources, allows us to highlight how we have extended our research impact through new or existing opportunities. It is an indicator that twilight zone research is seen as critical across many fields and that our scientists are leaders in those fields.

$14 MILLION
BROUGHT IN FROM OUTSIDE SOURCES



PUBLICATIONS

Academic publications are the standard metric used for validating impact within the scientific community, as they allow scientists to share vetted research with their peers. Our robust publication track record is a testament to the scientific advances we've accomplished.



PUBLISHED

IN PREP

NETWORK REACH

Network reach is a measure of where and how our team shares its findings and advances. Collaborations, partnerships, external outreach and engagement have all served to expand the project's overall reach.

COORDINATING WITH
13
DIFFERENT MESOPELAGIC RESEARCH PROJECTS

OVER
80
PRESENTATIONS TO ACADEMIC AND PUBLIC AUDIENCES

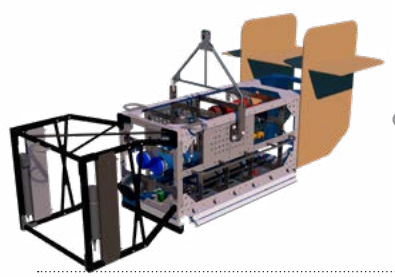
45
ACADEMIC PARTNERS

TECHNOLOGY DEVELOPMENT

Technical innovation is a key focus of the OTZ Project. Our scientists and engineers are designing and building new technology as well as adapting existing technology to help us access and study the twilight zone.

READINESS LEVELS

1	concept
2	prototype
3	lab test
4	ocean test
5	science mission



DEEP-SEE

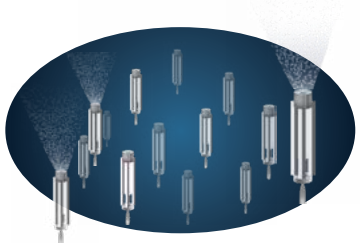
Start: lab test
Current: science mission

At project start *Deep-See* had been tested in the lab. It has since gone through engineering tests and has been used to collect robust science data for the OTZ Project.

MESOBOT

Start: prototype
Current: science mission

The OTZ team field-tested *Mesobot* extensively during a month of shore-based operations in Bermuda, fine-tuning its software and incorporating a highly-sensitive radiometer. The team deployed this tested and improved version in the field on the *E/V Nautilus* in 2021. Mesobot is a collaboration between WHOI, Stanford University, and Monterey Bay Aquarium Research Institute.



MINIONS

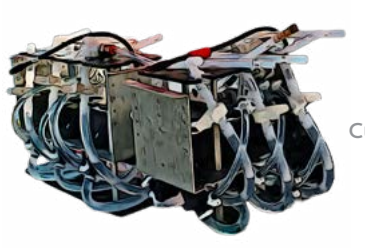
Start: concept
Current: ocean test

At the start of the project MINIONs were in the concept phase. Now after several ocean tests they are being refined for scientific use later in the summer of 2022. This effort is led by Melissa Omand at University of Rhoide Island.

TZEx

Start: concept
Current: ocean test

At the start of the project the Twilight Zone Explorer, also known as TZEX, was a concept. The instrument which descends to specified depths and takes discrete physical samples as well as high-resolution images, gives researchers new insight into the movement of organic carbon through the twilight zone. TZEX was successfully deployed last May for on an open ocean test and will be deployed for scientific purposes in summer of 2022.



eDNA SAMPLER

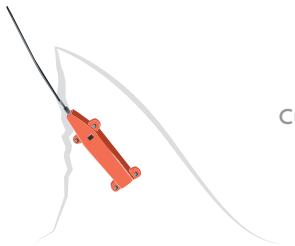
Start concept
Current science mission

the eDNA Sampler was a concept at the start of the project. It has been deployed for scientific missions on two different Ocean Exploration Cooperative Institute cruises.

Stingray

Start concept
Current science mission

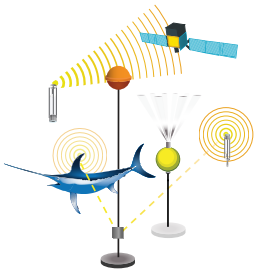
During the past year, the OTZ team developed additional AI software for the In-situ Ichthyoplankton Imaging System (ISIIS) shadowgraph camera system, allowing it to autonomously identify the types of plankton that appear in hundreds of thousands of images. Researchers also added acoustic instrumentation to the *Stingray* to gather additional data.



ROAM TAGS

Start concept
Current prototype

Two prototype ROAM tags, which can track an animal's path through the ocean in three dimensions, were tested at sea in late 2021. Thanks to new funding, the team is currently adding satellite connectivity to retrieve data remotely, without needing to recover the tag itself.



OCEAN TWILIGHT ZONE OBSERVATION NETWORK

Start concept
Current ocean test

In 2021, we built and installed the OTZ Observation Network, which will collect continuous data from the twilight zone over the course of several years. This marks a major advance in our technological capabilities towards understanding diel vertical migration and its impact on carbon sequestration and food webs.

RADIOMETER

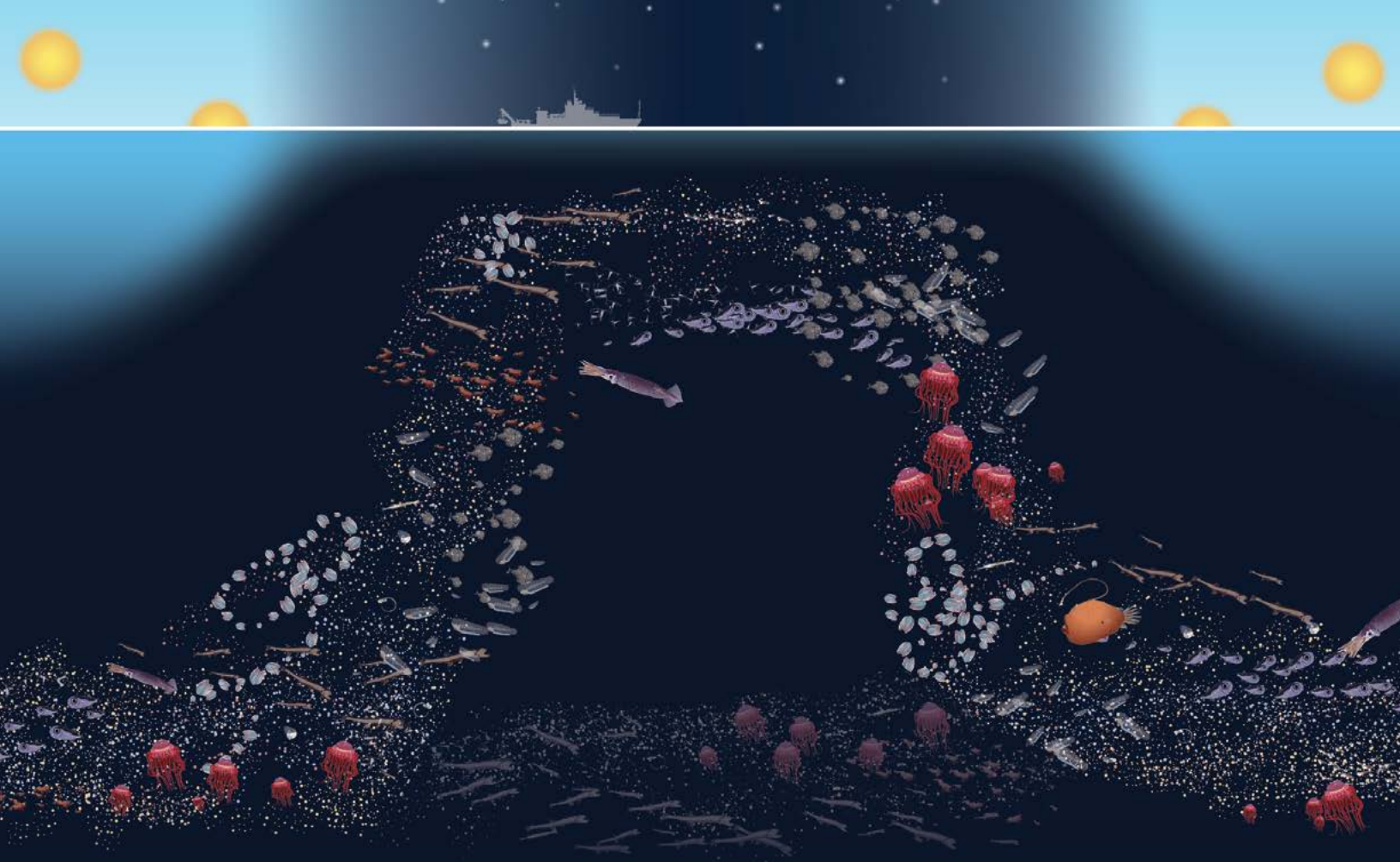
Start concept
Current science mission

At project start, our low-cost, highly-sensitive radiometer was in the concept phase. It has since matured into a prototype that was successfully integrated onto *Mesobot* during field trials in Bermuda. This effort is collaborative between MIT, Oceanic Labs, and WHOI.

Success Drivers

Science is iterative–it advances in countless small steps as each new discovery or insight builds on its predecessors and raises new questions.

The Ocean Twilight Zone Project has established a foundation to track progress toward our goal of achieving a baseline of scientific understanding about the mesopelagic and informing policy-makers and the public collectively to make sound decisions that ensure the long-term sustainable use of our ocean's twilight zone.



Diel vertical migration

THE WORD 'DIEL' MEANS THAT IT INVOLVES A 24 HOUR PERIOD. DIEL VERTICAL MIGRATION REPRESENTS THE LARGEST MIGRATION OF ANIMALS ON EARTH. Each night, trillions of twilight zone animals travel from the twilight zone to the ocean's surface to feed, then return to the deep before dawn with carbon-rich food inside them. In the process, these animals help to transfer carbon out of the upper ocean and into deeper waters, where it can remain safely out of the atmosphere for hundreds to thousands of years.

Understanding the Diel Vertical Migration from a variety of different angles will help to answer a suite of critical questions about the twilight zone's role in the marine ecosystem. Our scientists are now piecing together how migration affects the zone's food web, how it transports carbon, and what role it plays in the zone's overall biodiversity. By gaining a deeper understanding of these processes, our team is also teasing out how human impacts like fishing, pollution, deep sea mining, and carbon emissions will affect vertical migration—and by extension, affect the ocean as a whole.

In the following pages, you'll learn about some of the big-picture questions our team is asking about diel vertical migration, and find descriptions of our steady progress towards understanding the twilight zone itself.

How does vertical migration shape twilight zone food webs?

THE TWILIGHT ZONE IS HOME TO MORE FISH THAN ANY OTHER PART OF THE OCEAN. Upper estimates of twilight zone fish biomass are roughly 10 billion metric tons—about 50 times the amount of wild caught and farm-raised fish harvested each year. The exact ways those animals interact and feed on each other, however, is still unclear. By studying diel vertical migration, a central phenomenon in these animals' lives, the OTZ team is starting to shed light on how the complex food webs of the twilight zone work. Part of the challenge has been determining the scope of these webs—research done in 2020 revealed that at least two key food webs may exist; one for fish that migrate to the surface each day, and one for fish that stay in the dark waters of the zone at all times.

In order to tease out the complex ways that vertical migration affects feeding habits in the twilight zone, scientists like Joel Llopiz and Ann Bucklin continue to process fish caught in net tows at sea, analyzing their stomach contents both visually (Llopiz) and using DNA analysis (Bucklin). Thanks to the pair's complementary work, our team has been able to figure out what some of these fish species are eating down to the species level—including many gelatinous animals that can't otherwise be identified from stomach contents.

Other OTZ scientists, like Simon Thorrold, are taking this work one step further by analyzing the chemical makeup of amino acids in the fishes' muscles. Amino acids can only be created through photosynthesis—in this case, by phytoplankton and bacteria that form the base of the twilight zone's food web. When those organisms are eaten by another, larger predator—which is in turn eaten by yet another—these amino acids are passed along. Thorrold's lab can track minute changes that occur in each molecule's isotopes along the way, and can use them to reveal how far removed a fish is from the bottom of the food web. The molecules also reveal the exact type of animal that originally created them, providing deep insight on how the twilight zone food web works.

While our research is ongoing, the OTZ team is forming a much clearer picture of how predators and prey interact in the twilight zone—information that will contribute to a holistic understanding of its inner workings.

An OTZ team member examines the stomach contents of a freshly-caught Fangtooth. Photo: Woods Hole Oceanographic Institution. Research assistant Helena McMonagle dissects, measures and weighs specimens in the lab after collection at sea. Photo: Woods Hole Oceanographic Institution

Mesobot surfaces after a test dive off the coast of Bermuda in 2021

How does daily migration affect twilight zone animals' behavior?

FIGURING OUT THE VARIETY OF WAYS THAT TWILIGHT ZONE ANIMALS ACT WILL BE ESSENTIAL TO UNDERSTAND THIS COMPLEX AND MYSTERIOUS REGION OF THE OCEAN. Over the past three years, our team has worked tirelessly to understand how and when these organisms migrate, feed, and reproduce. Together, these traits are shedding light on how the zone fits into the ocean ecosystem as a whole—and its role in global climate.

Over the past year, our team has honed a variety of tools to chip away at these questions. During a month-long trip to Bermuda, Dana Yoerger and other OTZ engineers were able to test one of our flagship underwater vehicles, Mesobot, fine-tuning its hardware and software to autonomously follow an organism and record its behavior over several hours. During these field tests, the team also incorporated a highly-sensitive radiometer into the vehicle, an upgrade that lets it travel along with animals that migrate upwards at dusk and downwards at dawn. The data and video footage that Mesobot is gathering will help scientists reveal the specific ways that light levels control diel vertical migration.

The OTZ team is also using more traditional tools like net tows to complement that data. Studies this year by OTZ researchers Peter Wiebe (WHOI) and Melissa Omand (University of Rhode Island) showed that invertebrates may migrate at different rates and in different numbers depending on cloud cover and levels of moonlight, revealing conditions that may have significant impacts on diel vertical migration.

To gain a full understanding of how twilight zone animals behave and interact, OTZ scientists are also working to understand major predators that feed on those animals. To that end, Simon Thorrold's lab is continuing work on next-generation "ROAM" tags that can trace an animal's movement in three dimensions through the ocean. The team has already tested the tags' capabilities by attaching them to ocean gliders, and is now preparing the tags to be deployed on key predators like tuna, sharks, and swordfish. Tracking these animals, which may spend their nights near the surface and dive down into the zone during the day, will help reveal how they prey on migrating species, and will shed light on the role they play in the twilight zone's food web.

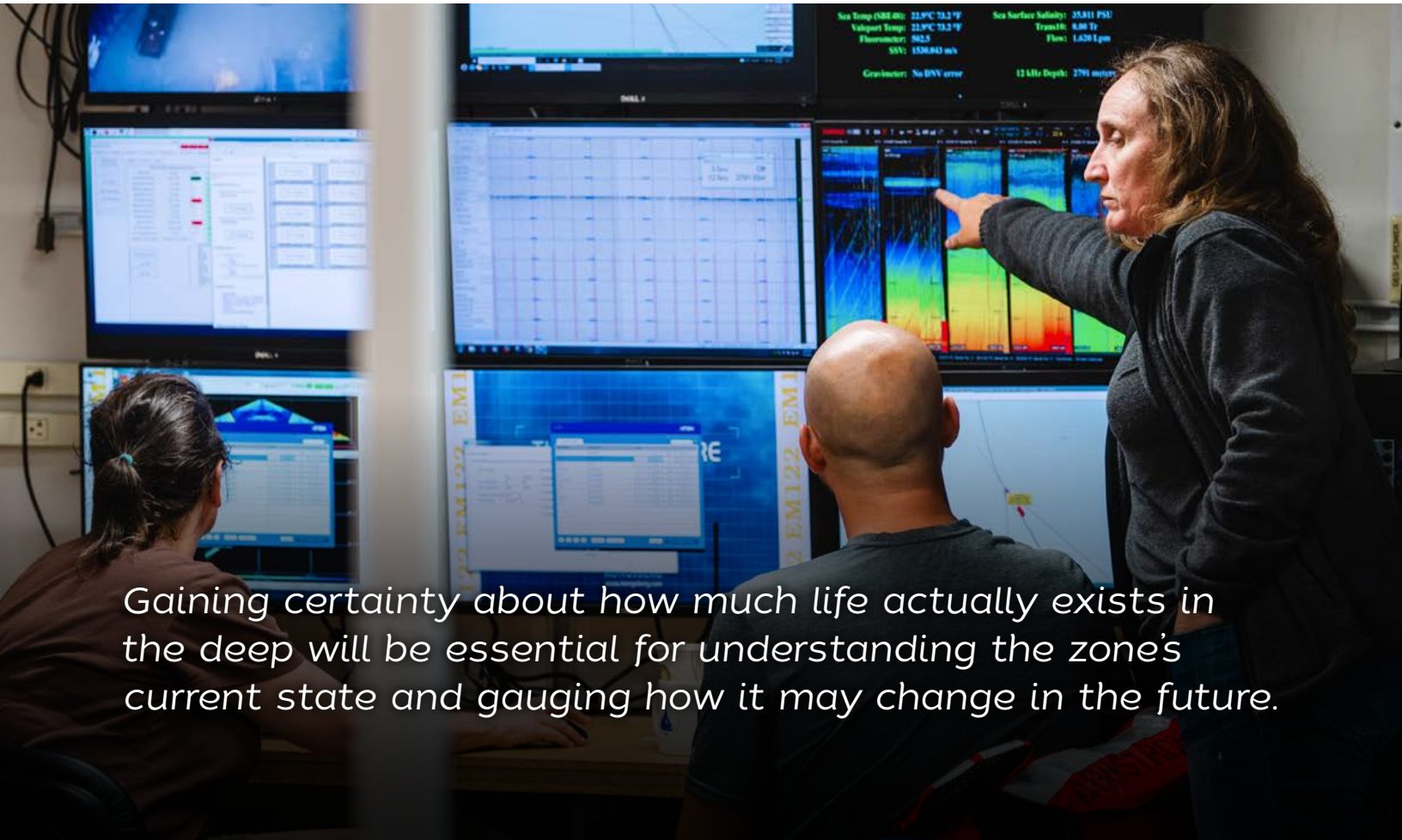
How much life is in the twilight zone, and how many of those organisms are migrating?

ESTIMATES OF BIOMASS IN THE TWILIGHT ZONE RANGE WIDELY, FROM JUST ONE BILLION METRIC TONS TO MORE THAN 15 BILLION. Gaining certainty about how much life actually exists in the deep will be essential for understanding the zone's current state and gauging how it may change in the future—it will not only help to reveal how many organisms migrate to and from the surface, but will also let scientists determine how much carbon those organisms shuttle down into the deep ocean. Knowing the total number of these migrating organisms will be essential data for developing sustainable fisheries regulation.

Over the past year, the OTZ team has improved on a number of techniques to create these biomass estimates. Andone Lavery's lab, for one, has been developing new methods to see individual animals using acoustic (sonar) data, determine their rough size and type, and generate an estimate of their numbers. This work is using shipboard and submerged sonar devices to follow where the bulk of these animals are, helping to reveal how many creatures are migrating vertically in a given region of the ocean.

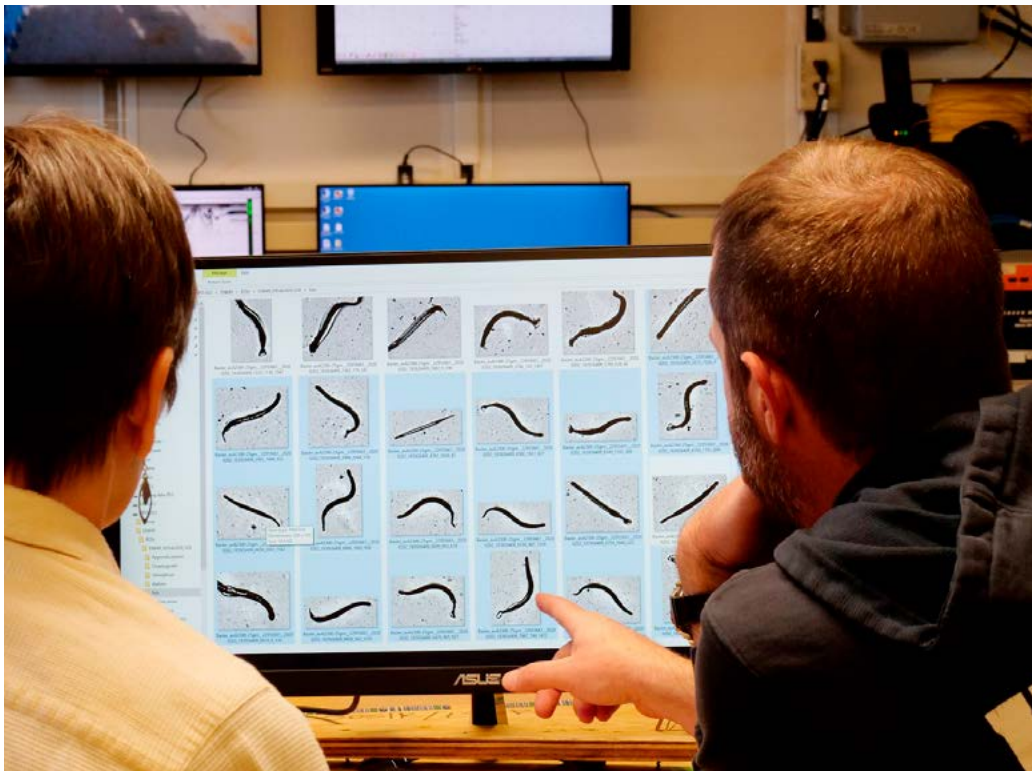
WHOI's new Ocean Twilight Zone Observation Network, installed in the northwest Atlantic ocean in 2021, is also helping Lavery test methods for estimating biomass. Using acoustic data from the first Observation Network bioacoustics mooring deployed in July 2021, the team is collecting records of when and where diel vertical migration occurs in the region throughout the year.

Andone Lavery (right) collects incoming acoustic data with colleagues aboard the *R/V Neil Armstrong*.



Gaining certainty about how much life actually exists in the deep will be essential for understanding the zone's current state and gauging how it may change in the future.

How can we measure biodiversity in the twilight zone?



FIGURING OUT WHAT SPECIES LIVE IN THE TWILIGHT ZONE—AND HOW MANY OF THEM ARE PRESENT—IS A CENTRAL GOAL FOR THE OTZ TEAM. Understanding the diversity of life that exists in the zone can reveal which animals are migrating, how they fit into marine food webs, and how they may impact the movement of carbon through the deep.

In addition to net tows, our scientists are harnessing powerful genetic techniques to find migrating organisms that would otherwise go unnoticed. Annette Govindarajan's lab, has created new ways to use genetic material in seawater (also called environmental DNA or eDNA), to spot animals in the zone without needing to see them directly. In 2021, Govindarajan published a scientific paper exploring the use of eDNA for the ocean twilight zone.

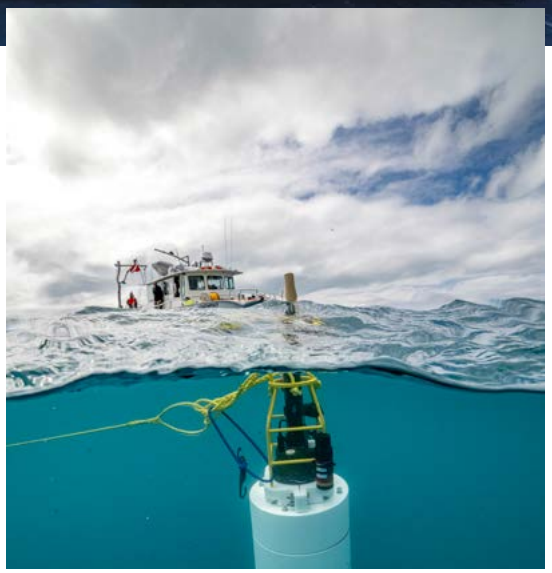
Her lab has also been compiling an extensive library of DNA "barcodes"—stretches of genetic code that are unique to each animal species—creating a valuable resource for studying diel vertical migration. Govindarajan has used these reference barcodes to identify mesopelagic fish species from eDNA samples. She is also using DNA barcoding to document daytime and nighttime depth distributions of twilight zone animals from net tows, in addition to eDNA samples.

Elizabeth Allan, a Postdoctoral Investigator in Govindarajan's lab, also published a paper this year describing a computer model showing that eDNA stays at roughly the same depth after it sloughs off an animal's body, a finding that will help to improve the interpretation of eDNA results.

For animals that can be seen, Heidi Sosik's lab has collected more than three million shadowgraph images using the team's Stingray camera sled. Over the last year, her lab has continued to improve its custom AI software, which can identify zooplankton species automatically from each image. Based on this data, Sosik is determining not only which animals are present, but which ones are migrating to the surface.

With numerous countries showing interest in developing twilight zone fishing industries, the work of the OTZ team is helping to develop a baseline metric for biodiversity in the region. This data will be critical for monitoring the health of the zone's ecosystem, its role in global climate, and the effectiveness of marine fisheries policy in the future.

How does diel vertical migration affect the movement of carbon in the ocean?



(Top) From bottom to top: the R/V Sarmiento de Gamboa, the RSS James Cook, and the RSS Discovery during a 2021 cruise for the EXPORTS program. (Above) TZEx floats near the surface during field testing off the coast of Bermuda.

TINY PLANKTON AT THE SURFACE OF THE OCEAN PLAY A MAJOR ROLE IN REMOVING CARBON DIOXIDE FROM THE ATMOSPHERE. As they bloom and grow, they incorporate that carbon into their bodies, and can multiply into huge blooms—providing a virtual buffet for animals migrating up from the twilight zone to feed. By eating and defecating at the surface, those migrating species in turn create tiny bits of carbon-rich material that sink into the deep, where they can remain for thousands of years.

OTZ scientists are currently trying to understand the variety of ways carbon moves from the surface down through the twilight zone. During a complex, three-ship cruise in 2021, Ken Buesseler's lab was able to collect valuable data on the amount of carbon sinking out of the upper ocean, a key metric that helps determine how much carbon is flowing from the atmosphere into the deep ocean.

During the cruise, the team deployed more than 49 different data collection tools, including gliders, floats, surface drifters, and towed nets. The team was also able to test sediment traps and imaging systems like the TZEx and MINION floats, devices that help to quantify the amount of carbon-rich "marine snow" created during the spring plankton bloom in the northern Atlantic. At the same time, Heidi Sosik's lab worked to identify individual species of plankton using her Imaging FlowCytobot instrument, and members of Joel Llopiz's lab recorded respiration rates of twilight zone fish captured in net tows.

Collectively, this work is also increasing our knowledge of how migrating animals move carbon through the ocean, and how that transport may change in the future. This knowledge will help to predict future climate change, develop appropriate ocean and climate policies, inform ocean conservation efforts, and support sustainable ocean-based climate solutions.

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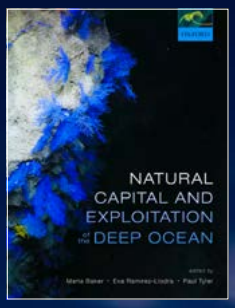
How are we informing policies to protect the twilight zone?

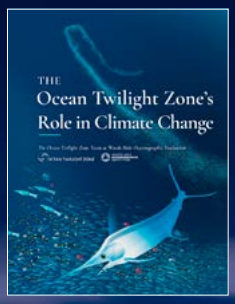
THE TWILIGHT ZONE MAY CONTAIN MORE THAN 10 BILLION METRIC TONS OF FISH, OR ABOUT 95% OF ALL FISH IN THE OCEAN BY WEIGHT, MAKING IT AN ATTRACTIVE TARGET FOR COMMERCIAL FISHING OPERATIONS. At the moment, large-scale fishing efforts have not materialized due to the high cost associated with specific harvesting and processing technologies involved—but if these efforts do become viable, it is not yet clear how it would affect the twilight zone. For this reason, our team's work is helping to inform sustainable fishing policies that will be put in place before large-scale exploitation occurs.

Di Jin and the OTZ policy group has been particularly active in this regard. In 2021, the group presented its work to multiple fisheries economic and policy organizations, authored a chapter in the new book *Natural Capital and Exploitation of the Deep Ocean*, published in several major academic journals, and improved on a multispecies bioeconomic model that estimates the economic and environmental impacts of twilight zone fisheries.

In addition to these achievements, Jin and other members of the team are rapidly increasing public awareness of the mid-ocean. This past year, OTZ researchers helped secure a specific mention of the twilight zone in the National Strategy for Mapping, Exploring, and Characterizing the United States Exclusive Economic Zone. The group also helped gain recognition from the National Academy of Sciences' National Committee for the Ocean Decade, which accepted the OTZ Project into its "Ocean Shot" initiative, and played an integral role in producing our latest report, *The Ocean Twilight Zone's Role in Climate Change*. This comprehensive document has already been widely circulated at major ocean policy conferences, and is helping to communicate the urgency of twilight zone research to both policymakers and lay readers.

Internationally, our progress has been even more significant. The twilight zone enjoyed exceptional visibility at the United Nations Climate Week in New York thanks to a 500-foot-tall video projection of mesopelagic animals, and has become an integral part of crafting an upcoming agreement on Marine Biodiversity of Areas beyond National Jurisdiction. This is a major change from prior years, due in no small part to the dedicated efforts of WHOI's OTZ Project team and those of our partners. All of this work has positioned the OTZ Project for continued progress in 2022 and beyond.





A 505-foot video of migrating twilight zone life projected onto the facade of the United Nations. This installation appeared as part of the 2021 U.N. Climate Week in New York City.

Leveraged Funding

Over the past year, the OTZ team was able to expand its work thanks to a number of generous grants from philanthropic organizations. In 2021, those grants enabled the successful installation of the Ocean Twilight Zone Observation Network, a set of scientific buoys in the northwest Atlantic that will provide year-round data about the zone. They've also made it possible for us to make valuable improvements to the technology we use in the field, including upgrades to the TZEx and MINION floats, adding satellite connectivity to existing ROAM tags, and creating a small, plug-and-play version of the ISIIS shadowgraph imager that can be used on ocean gliders and other autonomous vehicles. These advances will be incredibly valuable tools for our research throughout 2022.

FUNDRAISING HIGHLIGHTS INCLUDE:

$1 MILLION
OTZ Observation Network funded by the Happel Foundation

$1 MILLION
technology innovation grant funded by the Simons Foundation

$550,000
grant funded by an anonymous donor to harden ROAM tag technology

$1 MILLION
Second OTZ Observation Network grant by the Happel Foundation

In 2021, grants enabled the successful installation of a set of scientific buoys in the northwest Atlantic that will provide year-round data about the Ocean Twilight Zone.

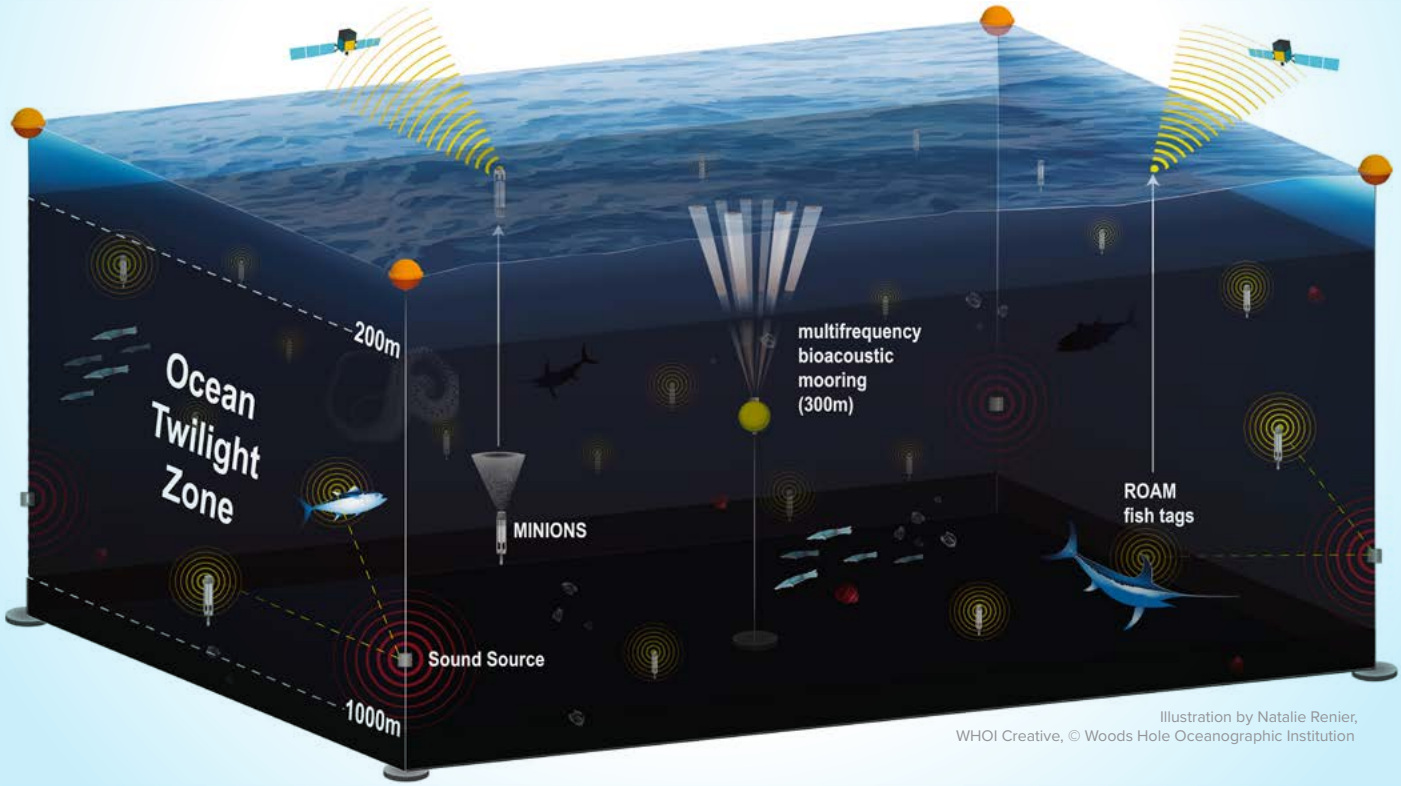


Illustration by Natalie Renier, WHOI Creative, © Woods Hole Oceanographic Institution

Engagement

RAISING PUBLIC AWARENESS

2021 was a fruitful year for OTZ engagement. Despite the challenges posed by a global pandemic, we were able to launch "Keep it Weird", a major public awareness campaign that reached 21 million people. We were also able to bring our scientists into the field for several major expeditions, each of which had dedicated bunks for onboard journalists to cover the work. As a result of those efforts, and several prestigious academic publications, the project earned significant media coverage on major print, web, and television outlets (most notably The New York Times, Wired, and CNN). OTZ staff also collaborated on a 500-foot-tall video art installation projected on the side of the U.N. Secretariat Building in New York. This installation, which featured a large image of a mesopelagic siphonophore, was covered in The New York Times and brought awareness of the project to millions of new people.

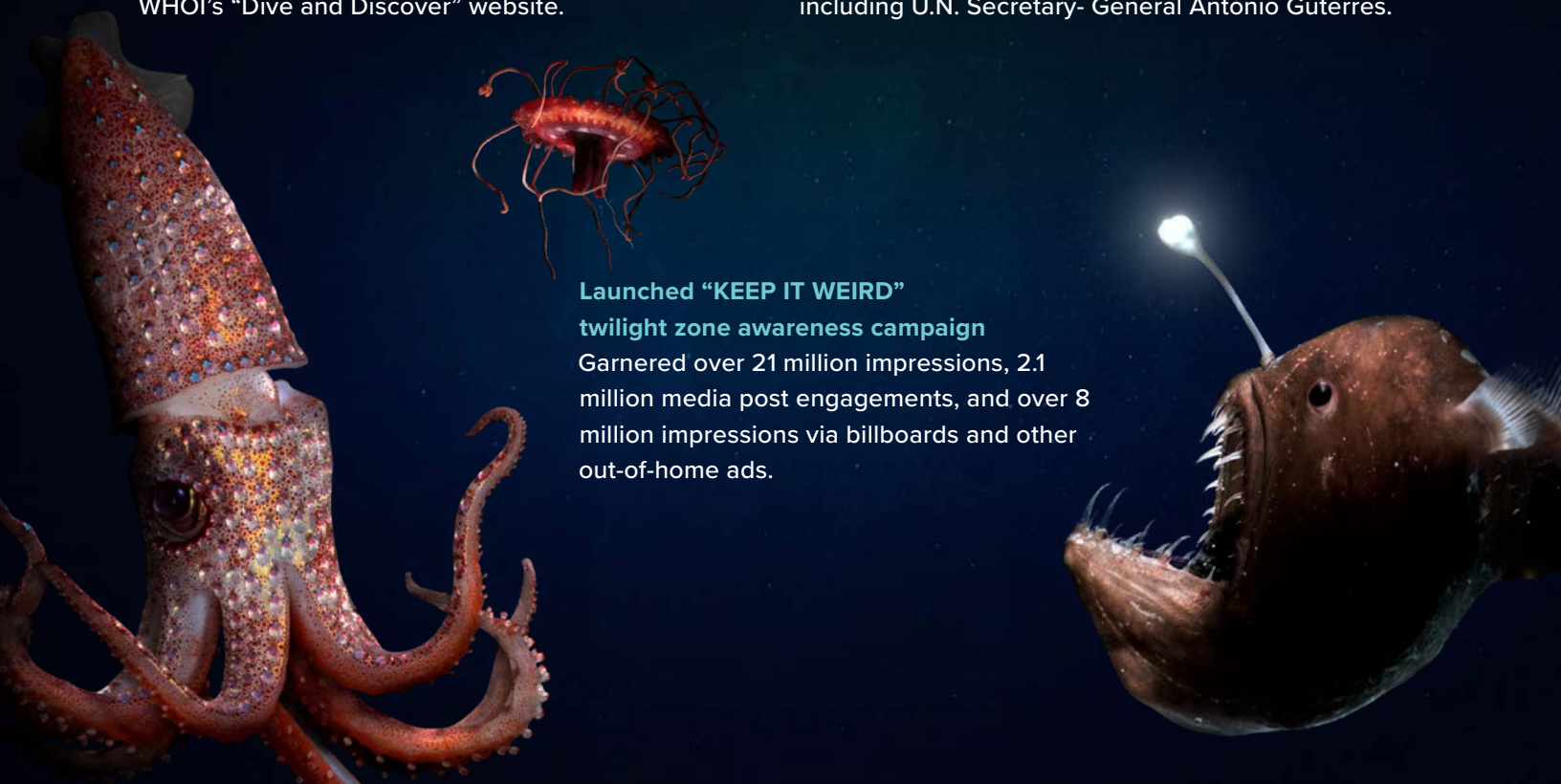
ENGAGEMENT AT A GLANCE

Major paper earned widespread media coverage
A paper published in *Science Robotics* on Mesobot, WHOI's semi-autonomous underwater robot designed to study the twilight zone, was covered by 20+ media outlets including *Wired*, *Newsweek*, *Science*, and *PBS*. Estimated combined reach was over 50 million.

Generated one-hour documentary on OTZ research
Our focus on collecting high quality video in the field enabled us to pitch an hour-long documentary about the ocean twilight zone that was released by PBS' Curiosity Stream in July. Potential reach of 20 million viewers.

Covered research live in the field
Created interactive modules and daily blog posts from aboard an OTZ research cruise, letting students around the world follow alongside our scientists while they were out at sea. This work was featured on WHOI's "Dive and Discover" website.

Collaborated on video artwork for U.N. Climate Week
The OTZ team's video installation, in New York seen by millions of people, led to an article in The New York Times and recognition of the twilight zone as central to global climate by U.N. delegates up to and including U.N. Secretary- General António Guterres.



Launched "KEEP IT WEIRD" twilight zone awareness campaign
Garnered over 21 million impressions, 2.1 million media post engagements, and over 8 million impressions via billboards and other out-of-home ads.

keep it weird

A campaign to preserve the next generation of weird

In the spring of 2021, WHOI embarked on an ambitious public campaign to raise awareness of the ocean twilight zone, one of the least understood—yet vital—regions of the ocean. The first phase of the campaign, called “Keep It Weird", was aimed at children aged 5 to 12 and their parents. It featured fun and educational content, including an entertaining “personality quiz” that let audiences match their own personality traits with those of a twilight zone animal. The campaign leveraged social media, email marketing, merchandising, and paid digital and out-of-home advertising to introduce visitors to this mysterious layer of the ocean. The second phase of the Keep it Weird campaign features a beautifully-illustrated children’s book called “Where the Weird Things Are,” which is scheduled to be released in early 2023. The overall campaign has garnered 21.3 million content views to date.

“Keep it Weird" was by far the largest marketing campaign that WHOI has ever undertaken, and it has had a tremendous positive impact on WHOI brand exposure, consumer interactions, and merchandise sales.

21.3 million

OVERALL IMPRESSIONS DURING CAMPAIGN

SOCIAL MEDIA

2.1 million

POST ENGAGEMENTS

EMAILS

31.3%

OPEN RATE

OUT OF HOME

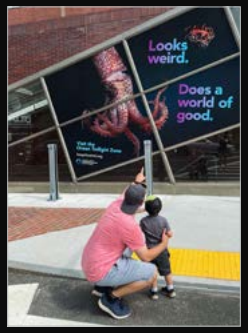
8 million +

OUT-OF-HOME ADVERTISING

RADIO

1.1 million

IMPRESSIONS VIA RADIO UNDERWRITING



Discover your inner weird: twilightzone.whoi.edu/keepitweird

Ocean Twilight Zone Engagement

Earned Media

56%
GROWTH

257
MEDIA MENTIONS

645 million
IMPRESSIONS

TOP STORY: MESOBOT · 50 MILLION VIEWERS
20+ major media outlets covered a paper announcing the Mesobot autonomous underwater vehicle. Outlets included Wired, Newsweek, Science, and PBS.

CNN

143 MILLION VIEWERS
'What we know now is how much we don't know': Enter the strange world of the ocean twilight zone | **CNN.com**

AP

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 | **Associated Press**

NASA

17 MILLION VIEWERS
Tracking Carbon from the Ocean Surface to the Twilight Zone | **NASA.gov**

Social Media

575% GROWTH
27,320,957
IMPRESSIONS

531% GROWTH
2,398,180
ENGAGEMENT

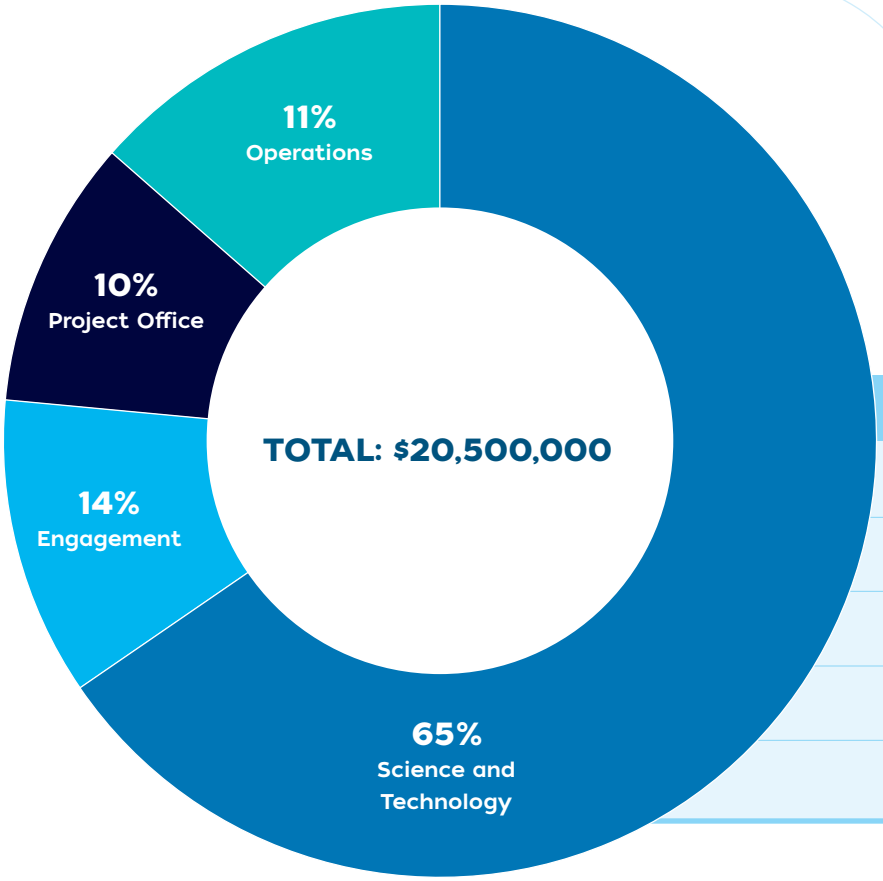
4,476,789
REACH

6.73%
ENGAGEMENT RATE
Industry average rates are 1-5%.

TOP POST: 15-SECOND VIDEO OF BASKING SHARKS
viewed 1.7 million times

Project financial report

Inception through April 2022



ACTUAL EXPENSES	
Science and Technology	**$13,500,000**
Operations	**$2,275,000**
Project Office	**$2,000,000**
Engagement	**$2,750,000**
Total	**$20,500,000**

Thanks to our generous Audacious Project donors, the pledged amount for the six-year, three-phase OTZ Project is: ***$32,100,000***

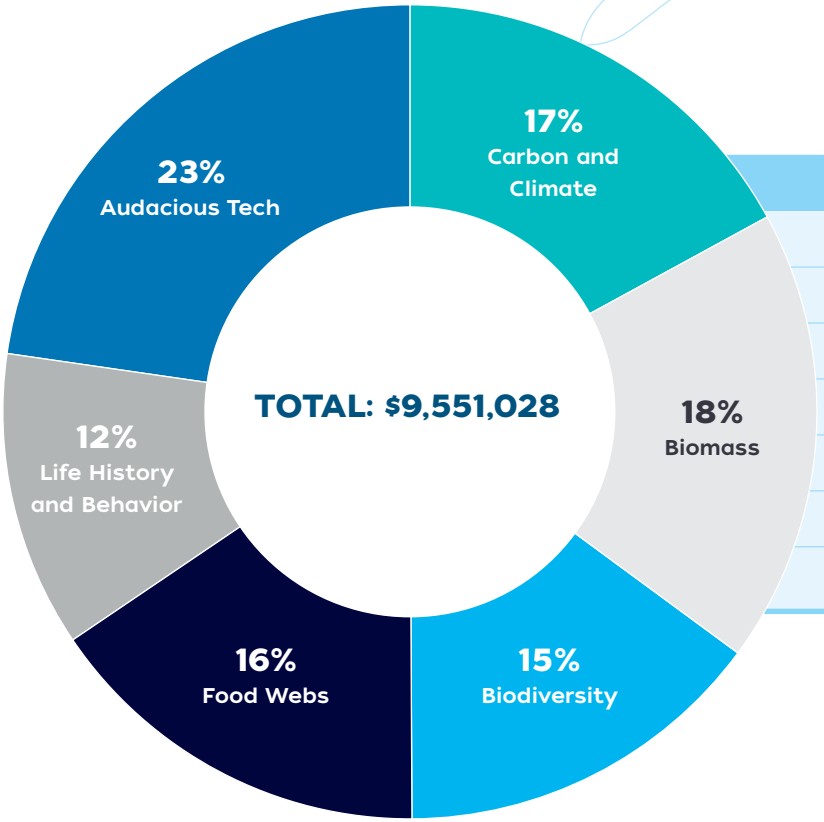
RECEIVED
$24M
Amount the project has received since inception (April 2018)

EXPENSED
$20.5M
Project expenditures from inception (April 2018) through April 2021

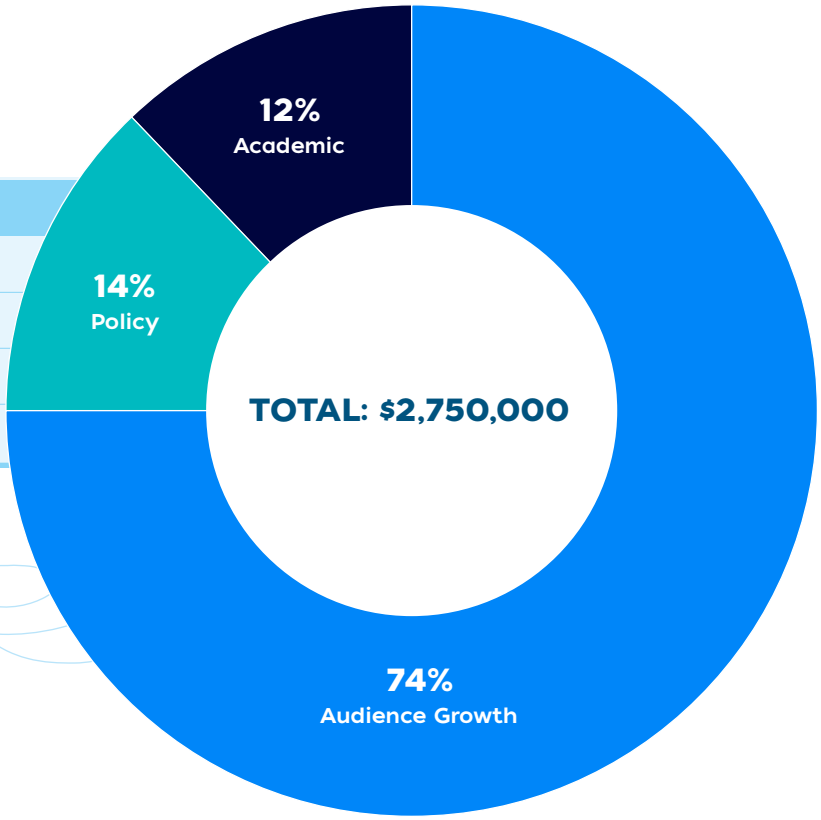
ANTICIPATED
$8.2M
Funds anticipated to be received during Phase II (July 2020–June 2022)

Science and engagement

Total Expensed inception through April 2022



SCIENCE	
Audacious Tech	$2,857,265
Biomass	$2,269,260
Carbon and Climate	$2,145,519
Food Webs	$1,964,203
Biodiversity	$1,865,949
Life History and Behavior	$1,479,515
Total	$9,551,028



ENGAGEMENT	
Audience Growth	$2,100,000
Policy	$400,000
Academic	$350,000
Total	$2,750,000

OCEAN TWILIGHT ZONE

Combining science, innovative technology, and broad engagement to turn knowledge into action

Questions or feedback? Contact:
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prenaud@whoi.edu or (508) 289-2216

twilightzone.whoi.edu

WOODS HOLE OCEANOGRAPHIC INSTITUTION

THE AUDACIOUS PROJECT