

WOODS HOLE OCEANOGRAPHIC INSTITUTION

Audacious Project Annual Report April 2018–April 2019

#### On the Cover

Siphonophores, gelatinous creatures such as this, are well known for their dramatic appearance and thought to be one of the most abundant creatures in the twilight zone. Photo by Paul Caiger

#### Below

Ocean Twilight Zone project lead scientist Heidi Sosik experienced the twilight zone in person for the first time during an expedition aboard the research vessel M/V *Alucia* operated by OceanX. Photo by Paul Caiger

#### 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.

#### LETTER FROM THE PRESIDENT AND DIRECTOR



This is a remarkable time here at the Woods Hole Oceanographic Institution. History is rife with examples of how humans have squandered natural wealth like that contained in the twilight zone. Today, however, we have a unique opportunity to balance use with conservation and make informed, thoughtful choices about the twilight zone based on hard-earned knowledge and framed by equitable and sustainable use of a shared resource.

As scientists, we are inspired to learn more about the twilight zone because we see a void of knowledge. We are also inspired to act precisely because we see ourselves standing at the brink of a process that has, in the past, been carried out hidden away from view or presented to succeeding generations as a fait accompli. The Ocean Twilight Zone (OTZ) project offers a rare opportunity for us to transform how people relate to an unknown and unexplored ecosystem so that we all become better stewards of the ocean and conserve newly discovered resources rather than attempting to recover them after they've suffered the heavy imprint of human activity.

Our work is like a moonshot driven by the urgent need to understand twilight zone ecosystems before it is too late, one that is drawing collaborators from around the globe and across the spectrum of ocean sciences—and unearthing new wonders along the way. Until now, much of what is held there has been hidden from view of science and industry alike. Now, however, we are building the tools to reach down and understand the abundance, diversity, and connectedness of life in the twilight zone at the same time that fishing fleets are poised to begin dipping their nets into this newfound bounty.

We don't often have an opportunity like the one presented to us today, one that allows us to shed light on the myriad paths available to us rather than to lament those not taken. With your help, we are leading the formation of a research agenda, shaping the future technical innovation, and bringing news of our discoveries to new audiences. In the process, the Ocean Twilight Zone project has become a transformative initiative for the institution.

WHOI has a rich history of bringing talented, passionate people together to do remarkable things in impossible places. The OTZ project is one of our most ambitious, transformative initiatives to date, and it demands just this sort of creativity and intensity of purpose.

In the past year, the OTZ team has made great strides in understanding a region as vast and ever-changing as the twilight zone. This period of focused, intensive effort has laid a strong foundation for the development of new scientific insights about the twilight zone, as well as for technological breakthroughs that will accelerate future discovery.

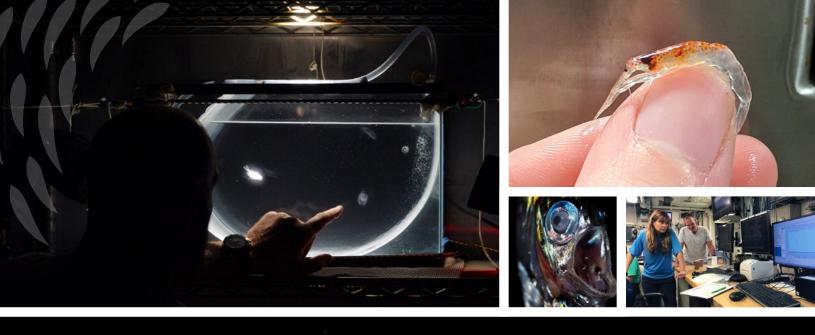
The team has also recognized the vast potential that exists in bringing this knowledge to diverse audiences. As the project gains momentum, they've made it a priority to build partnerships that increase our ability to share what we learn and to develop new communications channels and products that will drive change on a global stage in the years to come and ensure that our science has far-reaching impacts across public, policy, and academic arenas. This model of deliberate, intense focus has only been possible because of the flexibility provided by private philanthropy, which is allowing us to push boundaries in new and exciting ways.

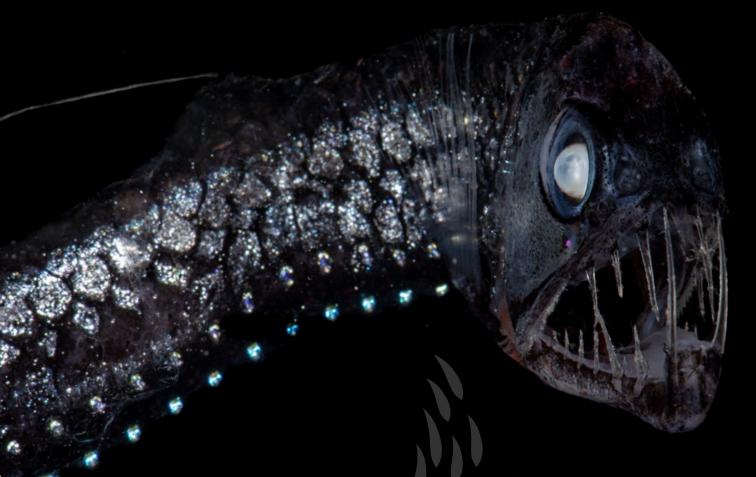
We look forward to your feedback. You and your teams have an open invitation to visit Woods Hole and see firsthand the great work the OTZ team has accomplished and the incredible next steps we're planning. We can't wait to find out what the next year will bring.

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Mark Abbott, President & Director\_\_\_\_\_

### "The Ocean Twilight Zone project has become a transformative initiative for the institution."





# Science

Science has a unique opportunity to influence how policy makers and the public view a massive and unexplored natural resource like the twilight zone before it has been exploited. Data from each of the three research cruises in our first year alone has transformed our understanding of this complex ecosystem almost before our eyes and has already led us to rethink the questions we need to ask as we look forward to another year of sustained, focused activity. We've also leveraged existing relationships and built new partnerships that will allow us to expand our research objectives and expand the reach of our findings to living rooms, boardrooms, and policy conferences around the world.

- More than 700 fish specimens collected, with 250 dissected, prepared, and preserved
- Over 22 TB of acoustic and image data from the first Deep-See expedition
- 500,000 holographic images of life in the twilight zone
- More than 1,000 samples from the 2018 EXPORTS expedition
- More than 200 compound-specific stable isotope analyses shedding light on the twilight zone food web
- Several hundred thousand sequences obtained from 55 environmental DNA (eDNA) samples

### One Fish at a Time

At sea, almost every net tow yields a surprising and often alien-looking bounty of animals that live in the twilight zone. But bringing these rare and valuable specimens to the surface is only the beginning of a chain of steps, as technicians first "work up" specimens—carefully identifying, measuring, weighing, and dissecting each one—and then send samples to colleagues. Each of these samples supports a wide range of analyses that advance the forefront of knowledge about the twilight zone one fish at a time.



#### **BIOMASS AND BIODIVERSITY**

Animals from net tows are used to help interpret acoustic measurements that paint a broad-brushed picture of life in the twilight zone. One of the most abundant animals in the twilight zone is the tiny lanternfish, estimated to have a worldwide mass of 550–660 million metric tons—several times the global fisheries catch. These are an important food source for large, open-ocean predators such as swordfish and tuna.

#### BEHAVIORS

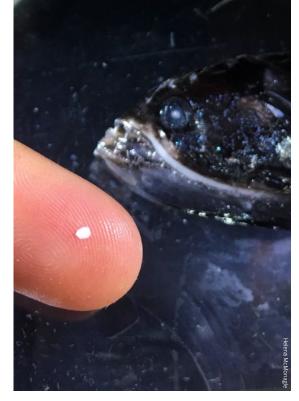
The MOCNESS (Multiple Opening/Closing Net and Environmental Sensing System) designed at WHOI enables researchers to relate individual fish to the depth at which they were captured. This, together with information from eDNA analysis, will help identify which fish migrate vertically each day and how different species use the vast space of the twilight zone.

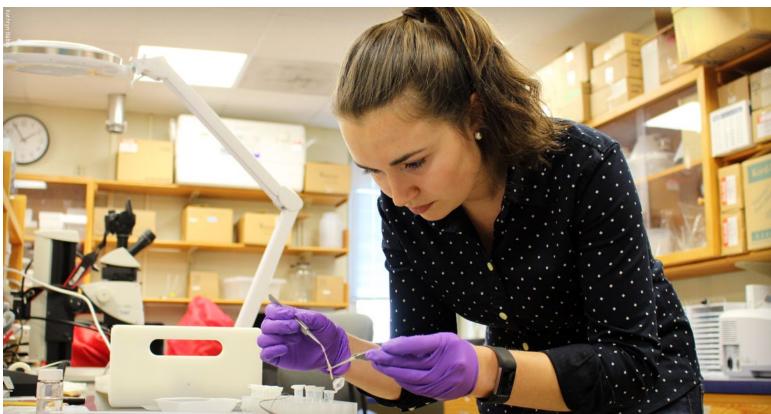
#### AGE AND LIFE STAGE

The ear stones (otoliths) from fish such as the snipe eel and the viper fish, some of the most common fish found in the twilight zone, reveal their age when caught. This helps researchers better understand an organism's life span, growth rate, and age at maturity, all of which are critical components to understanding a species' resilience to fishing pressures.

#### **FOOD WEBS**

Stomach contents of individual fish help reveal who is eating whom deep beneath the surface. This data is complemented by the compound-specific stable isotope analysis to help untangle the twilight zone food web.





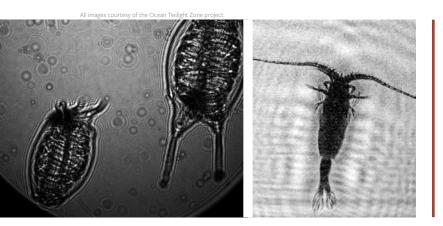
## Sounding the Depths

Two questions underpin a basic understanding of any ecosystem: How much and how many different organisms live in it or use it? The twilight zone is no different, but we are hampered by the fact that it is perpetually dark, constantly changing, and buried under as much as a half mile of seawater. As a result, we know shockingly little about even what lives in the twilight zone.

This is why we built *Deep-See* (more about *Deep-See* on page 18). From the surface, acoustic sonars can detect large groups of animals that reflect sound well, but they usually can't distinguish individual organisms or differentiate among species that live deep beneath the surface. Different frequencies of sound "see" through the darkness differently; nets can bring only some animals up to the surface; and even cameras will miss animals that are scarce, moving, or very small.

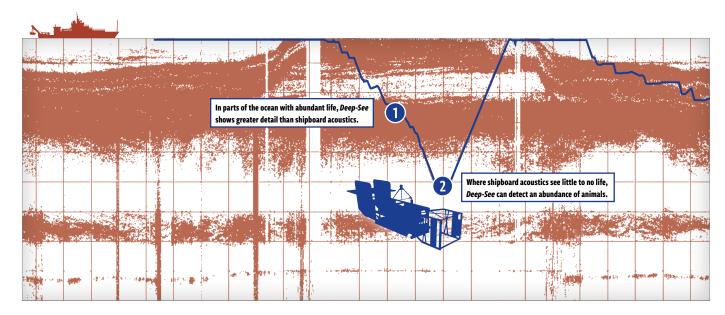
Deep-See overcomes these challenges by combining key technologies, each of which is uniquely suited to a particular task, and puts the entire system right inside the twilight zone. The result is one of the most sophisticated instruments ever developed to observe and measure life in the ocean's midwater. It can even answer questions we didn't know to ask.

On its first deployment, *Deep-See* collected 21 terabytes of acoustic and optical data. One of the most exciting early discoveries was an abundance of animals at depths that traditional shipboard acoustics had not been able to detect. The data also suggested that specific species of animals congregate in distinct layers, something that could have implications for regulatory decisions governing plans to harvest the twilight zone.



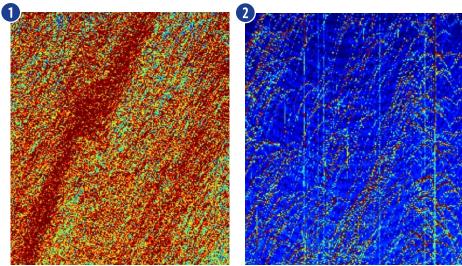
#### **UNDERWATER 3-D MICROSCOPE**

Deep-See is equipped with a holographic camera system, essentially an underwater microscope, that can resolve organisms less than 1 millimeter long in minute detail. The camera uses a laser to capture hundreds of cross-sectional images of each microscopic animal that can later be reconstructed into a single high-resolution, three-dimensional model. This enables us to make detailed size and volume measurements and to see details down to the hairs on an animal's legs. On its first cruise, *Deep-See* returned over 500,000 images.



#### A DEEPER LOOK AT THE TWILIGHT ZONE

Preliminary data from Deep-See's broadband acoustic sensors (right) have demonstrated both greater resolving power within dense collections of animals (1); and better detection of animals in places where shipboard acoustics had shown almost nothing in the water (2). The first-ever *Deep-See* deployments in the summer of 2018 showed us that there is probably more, both in quantity and diversity, living in the twilight zone than previously imagined.





### The Carbon Question

Climate change is undeniably one of the most pressing issues facing humanity, and ocean science is in a position to make some of the most significant gains in our understanding of the relationship between human activity and the climate system.

The changes we are already witnessing, coupled with added pressure from commercial fishing operations, will most likely affect natural functions of the twilight zone that help move carbon from the atmosphere to deep waters in untold ways. Before we can understand that, however, we need to shed light on the basic processes that control the flow of carbon through the twilight zone. Only then can we hope to improve predictions of how climate change will play out in the future.

The ocean as a whole sequesters between 4 and 12 billion metric tons of carbon per year, much of which originated as greenhouse gases such as carbon dioxide in the atmosphere and was converted to organic carbon by photosynthesizing marine plants. Over the past eight months, more than 1,000 samples from a monthlong cruise in the Northeast Pacific as part of the National Aeronautics and Space Administration (NASA)- and National Science Foundation (NSF)-funded EXPORTS program have begun to shed new light on this deep-ocean cog in Earth's climate engine.

A second EXPORTS cruise in 2020 will include both of WHOI's large ships in the Northeast Atlantic and will shed additional light. The OTZ project is also organizing a third ship that will help expand the research program to include net tows, acoustic measurements, and eDNA analysis to provide an even broader look at the importance of the twilight zone.

"The big question we still need to answer is, How much carbon gets from the surface to the deep ocean—and how quickly?" ~ WHOI Marine Chemist Ken Buesseler

### A Tangled Web

The roles that different animals play in their environment is one of the mysteries that alternately fascinate and challenge anyone who turns their attention to the twilight zone. With exploratory commercial fishing in the twilight zone already underway, however, this is one of the most urgent tasks before us.

To assess the impacts that widespread fishing might have on the twilight zone, we need to better understand what lives there, the main sources of food, and how life there links to other parts of the ocean. To do this, we are using a novel technique known as compound-specific stable isotope analysis that allows us to follow the fate of amino acids as one animal eats another and these compounds move progressively from the base of food webs to top predators.

More than 200 analyses of samples from cruises over the past year are already beginning to trace the outlines of the twilight zone food web. This web also supports life in the surface ocean, including economically important fisheries, such as tuna and swordfish, as well as endangered or threatened species. Combined with research on life history and behavior and eDNA analysis, these data will provide new insight into how fishery activity in the twilight zone will affect the entire ocean ecosystem.

#### **FOOD SOURCE FOR SHARKS**

Data from tagged animals has demonstrated the importance of the twilight zone as an essential food source for high-value species such as sharks, tuna, and swordfish. It is also likely to be critical to protecting endangered or threatened species.

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## **CSI: Twilight Zone**

Among the biggest challenges in studying the twilight zone is its sheer size. So imagine the challenge that faces us as we hunt for rare and elusive creatures that call this vast, dark environment home. That's why we're turning to a new approach that uses environmental DNA (eDNA) to identify what animals have passed through the twilight zone and left a minute genetic trace in their wake.

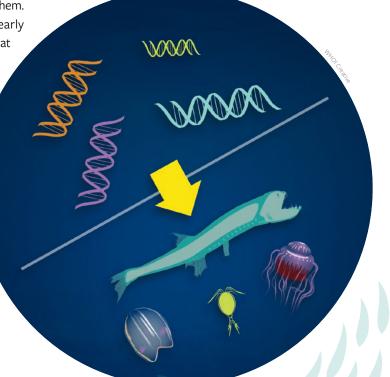
In many ways, the technique resembles forensic technology used in police labs. Instead of its being used at a crime scene, however, we're applying it to samples collected from the twilight zone on three expeditions: aboard the NOAA vessel *Henry B. Bigelow*, on OceanX's M/V *Alucia*, and, most recently, during Sea Education Association's annual student trip on the *Corwith Cramer*. The technique uses filtered seawater samples to reveal traces of DNA left by animals in the water without researchers ever laying eyes on them.

Some fascinating insights are already emerging from early results, including intriguing differences in the animals found at different depths. It is also likely that the method will reveal rare or previously unknown species, and we are developing in situ samplers that will improve our ability to detect species and streamline sample processing.

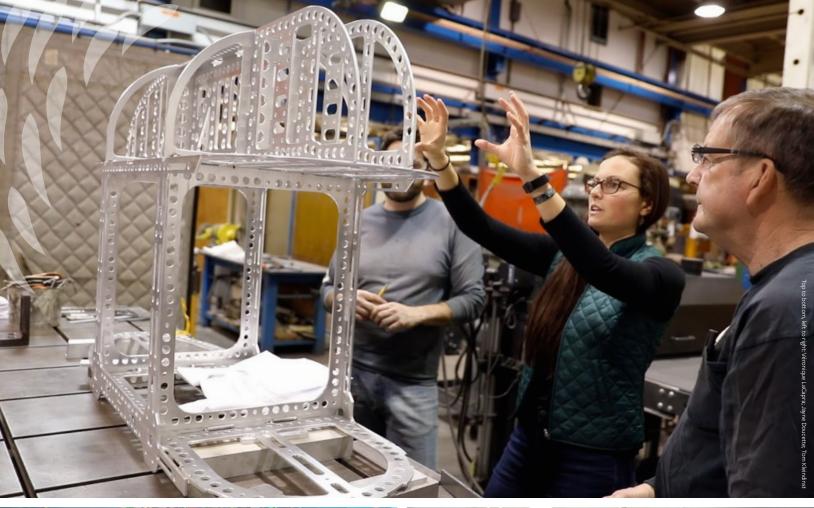
Identifying animals in this way requires a comprehensive reference library that links DNA sequences to individual species. Because the ocean

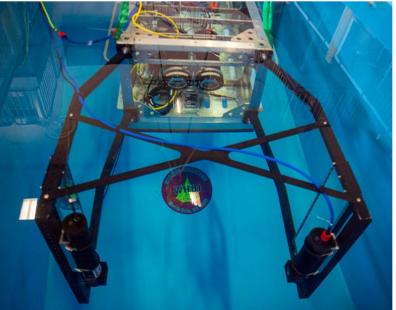
#### eDNA

Environmental DNA, or eDNA, can identify animals in the ocean twilight zone without needing to see or collect them, just by analyzing the genetic information they leave behind in the water. twilight zone is remarkably understudied, reference sequences are not available for many animals, so WHOI researchers are using the animals they identify from net tows to build this library. This will eventually become a key component of the project's Open Data Platform and will help researchers around the world advance their own work to better understand even more about life in the twilight zone.











# Technology

Technologies developed for the OTZ project stand to fundamentally reshape human knowledge of the twilight zone. In the first year alone, we've seen new instruments and vehicle systems come on-line, and more appear on the drawing board, all with the singular purpose of accelerating our knowledge of a place that presents significant technical challenges to exploration and understanding. In addition, WHOI scientists and engineers, together with academic and commercial partners, are developing low-cost, distributed solutions that permit data to come from many different sources across a wide area and for long periods. Because if we're going to do things differently this time and protect what we're discovering in the twilight zone, we're going to need more information, faster. And that requires innovative solutions to questions we haven't even asked.

- In its first expedition, Deep-See returned over 20TB of data that gave scientists fundamental new insights into the twilight zone.
- Mesobot's cameras, lights, and tracking software were tested in April.

- Development and testing of MINIONS—small, inexpensive floats that track carbon through the twilight zone—is progressing toward first tests of seagoing prototypes as early as the summer of 2019.
- A new generation of low-cost, easy-to-use radiometers under development will enable virtually any underwater vehicle or instrument to become an ultrasensitive light sensor.

### THE Most Advanced Twilight Zone Vehicle IN THE World

#### DEEP-SEE

What sets *Deep-See* apart from other vehicles is its combination of broadband acoustic sensors that allow it to peer deeper and with greater clarity into the twilight zone and its dual camera systems that capture images of twilight zone creatures, from large fish down to microscopic zooplankton. Its unique combination of sonars, cameras, and water sampling provides researchers with a powerful tool for studying a wide range of questions about the diversity, abundance, and nature of life in the ocean

twilight zone. On its first cruise in August 2018, *Deep-See* gave scientists fundamental new insights into life inhabiting the depths. Over the past year, the vehicle has had a complete makeover, including new cameras, a new electrical system, an improved harness, and more advanced acoustic sensors.



### A Smart, Stealthy New Robot TO TRACK LIFE IN THE TWILIGHT ZONE

#### **MESOBOT**

Mesobot is designed to let scientists observe the twilight zone by autonomously tracking individual animals for hours or even days without disturbing the environment or disrupting their behavior, making it possible to follow individual animals as they take part in the great migration from the twilight zone to the surface and back each day. *Mesobot* is also equipped with samplers that will allow it to capture traces of environmental DNA (eDNA) from seawater while on a dive. The engineering team held a very successful test of its cameras, lights, and sophisticated tracking software in April, and the rest of the vehicle is currently in its build phase. If all goes as planned, *Mesobot*'s first mission will be in September 2019.

### Many Eyes in the Twilight Zone

NEW LOW-COST SENSORS WILL PROVIDE DISTRIBUTED ACCESS TO THE TWILIGHT ZONE IN UNPRECEDENTED WAYS

#### **ROAM TAGS**

Sharks and other large fish like swordfish and tuna are among the most iconic animals of the open ocean. We suspect that they are also surprisingly active hunters in the twilight zone, but little is known about how often, how long, or where they dive to find food. These new satellite tags will allow researchers to track sharks and other large predators in three dimensions over months or years as they move through the twilight zone. (RAFOS Ocean Acoustic Monitoring) tags are both smaller and provide significantly more accurate positions than tags in current use. They will also transmit data back to shore via satellite at the end of tag deployment, giving researchers a first look at where these predators are in relation to physical, chemical, and biological processes that create hot spots of activity in the twilight zone.

#### MINION

If there's anything we've learned about the twilight zone in the past year, it's that the more eyes we have in it, the better. MINION (MINiature IsOpycNal) floats are small, inexpensive devices ballasted to be neutrally buoyant at a preselected depth in the twilight zone in order to photograph particles of "marine snow" as they fall from above. Each float drifts with the currents so that it does not need propulsion and is programmed to surface at a specific time. Members of the Buesseler Lab expect to test the first prototypes as early as the summer of 2019.



#### **TWILIGHT ZONE EXPLORER**

The movement of carbon in and through the twilight zone is a critical but poorly understood part of Earth's climate system. To get our arms around how much gets through and is removed from the atmosphere, the Buesseler Lab is designing a new camera system to add to a recently developed autonomous profiling float that also collects "marine snow" as it sinks through the twilight zone. The new system, known as the Twilight Zone Explorer, will give researchers new insight into the movement of organic carbon marine snow. These new floats should make their first appearance in the twilight zone in spring of 2020 as part of the combined OTZ-NASA EXPORTS mission in the Northwest Atlantic.

#### RADIOMETER

Even the small amount of light that reaches the twilight zone plays an important role in governing the rhythms and pulses of life. Light cues animals when to migrate, helps them hide, and much more. But the instruments capable of measuring such minute fluctuations and barely discernible amounts of light reaching the twilight zone are notoriously expensive and difficult to handle. As a result, there are very few direct measurements of light levels in the twilight zone. The new generation of low-cost, easy-to-use radiometers we are developing will change this and enable virtually any underwater vehicle or instrument to become an ultrasensitive light sensor.



# Engagement

In our first year, we have built significant awareness and excitement surrounding the ocean twilight zone and its role as a critical part of the ocean ecosystem and Earth's climate engine. Since April 2018, we have helped place stories in such high-profile outlets as *The New York Times, The Washington Post, The Boston Globe*, and *Quartz* with a potential reach of hundreds of millions. We also have laid the foundation for inclusion of the twilight zone in upcoming international policy discussions and we've taken advantage of high-profile opportunities such as an immersive video exhibit at the TED2019 conference in Vancouver, Canada, all of which allowed us to increase awareness of the twilight zone with key stakeholders and build broad partnerships. But we are just getting started, ultimately the Ocean Twilight Zone project will achieve much more than scientific discovery—we aim to foster more informed ocean stewardship and sustainable human interactions with the ocean and our planet.

- Earned more than 300 media mentions with over 130 million potential reach worldwide
- Improved awareness among international policy makers of the twilight zone at the UN's Biodiversity Beyond National Jurisdiction negotiations
- Partnered with OceanX, BBC, and the Avatar Alliance Foundation to build a video exhibit featuring the twilight zone at the TED2019 conference in Vancouver
- Published a dedicated twilight zone edition of Oceanus magazine with a distribution of 12,000 print copies and over 15,000 digital views

ENGAGEMENT



#### LETTER FROM SAM HARP

Humanity has a poor record when it comes to sustainable use of marine resources. With commercial interests waking up to the extraordinary abundance of life that exists in this remarkable and largely hidden region of the ocean, it has become clear we need to stretch beyond the standard methods of scientific communication to spread our message of urgency and hope as widely as possible. The stakes embodied in the Ocean Twilight Zone (OTZ) project demand that we reach a broader public, raise awareness to new heights, and engage in more meaningful ways with influencers and policy makers worldwide.

The philanthropic support awarded through The Audacious Project to explore and study the ocean twilight zone represents both a critical investment in ocean science and a powerful mandate to go beyond business as usual as humanity faces a crucial turning point in our relationship with the ocean and we tailor our engagement efforts to this unique task.

So we have approached engagement for the OTZ project with every bit as much urgency as the science and engineering. An early focus on developing our narrative of exploration and discovery helped lay a solid foundation from which to ramp up visual storytelling, social engagement, and public relations efforts. We have made key hires who will help accelerate our development of video and other forms of content. And we have a well-elaborated, three-pronged engagement strategy that is strongly backed at all levels of the institution.

Playing to WHOI's traditional strengths, our academic engagement and collaboration program will help drive discovery, advance the science, and form networks that act as force multipliers throughout the scientific community and beyond. Our marine policy influence and agenda-setting program will work to promote evidence-based policies and inform international negotiations regarding sustainable use of twilight zone and other shared ocean resources. And a robust audience-building and awareness program will help build a broad constituency that knows about, cares about, and is motivated to protect the twilight zone. In addition, the development of an Open Data Platform as well as programs to promote publication, build partnerships, recruit ambassadors, and engage with a variety of audiences through largeand small-scale events will further accelerate engagement in academic, policy, and public spheres.

This spring, for the second year in a row, members of WHOI's OTZ team had the opportunity to share the twilight zone story with a global audience of innovation leaders at the annual TED conference in Vancouver. The immersive, multimedia *Mission: Ocean* exhibit grew out of a unique collaboration among leaders in ocean discovery, innovation, exploration, and storytelling: WHOI, OceanX, and the BBC, with funding and design support from the Avatar Alliance Foundation. I believe this kind of collaboration is just what is needed to raise awareness and motivate action to sustain the ocean ecosystems we admire, play in, study—and depend upon for life and livelihood.

In year two of the OTZ project, we look forward to building on our early successes to effect real change in marine policy and spark global enthusiasm for the ocean twilight zone and its role in the health of our planet and people everywhere.

Samuel Harp, Vice President for Advancement and Chief Marketing Officer\_

## Policy INFLUENCING DECISION-MAKING AND GOVERNANCE

A central theme of our engagement efforts is to ensure that the twilight zone is a part of international negotiations on a future treaty establishing equitable and sustainable use of marine resources that fall outside national jurisdictions.

#### **OTZ ON THE HIGH SEAS OF POLICY**

Much of the twilight zone lies in the "high seas"—waters beyond national jurisdiction where relatively few laws or international agreements apply. With exploratory fishing activities by several nations already underway, ensuring that the twilight zone is included in all ocean policy discussions is one of the OTZ project's highest priorities.

From March 20 to April 5, marine policy experts Porter Hoagland and Aria Ritz Finkelstein attended the second session of the Intergovernmental Conference on the conservation and sustainable use of marine biodiversity of areas beyond national jurisdiction (BBNJ) at the United Nations in New York City. While there, they laid the groundwork for emerging twilight zone science to inform the treaty negotiations focused on the governance of marine biodiversity outside of any nation's exclusive economic zone. In addition to one-on-one meetings introducing the twilight zone to delegates, Finkelstein gave a statement to the entire BBNJ plenary about the importance of the twilight zone.

#### THE COST OF CARBON

The ocean sequesters between 4 and 12 billion metric tons of carbon per year, much of which originated as greenhouse gases such as atmospheric carbon dioxide from industrial emissions that was converted to organic carbon by photosynthesizing marine plants. Marine chemist Ken Buesseler is working with Hoagland and Di Jin at WHOI's Marine Policy Center on a study that focuses on quantifying the social value of improving predictions regarding how much carbon the ocean is taking up—predictions that would, in turn, lead to better decision-making on emission controls and climate change response strategies. It's still a work in progress, but initial estimates put the value in the tens of billions of dollars.



# Raising Awareness

#### BRINGING OUR MESSAGE TO THE WIDEST POSSIBLE AUDIENCE

By emphasizing visual storytelling to capture the public's interest and imagination, we aim to inspire a movement raising awareness about the importance of the twilight zone ahead of widespread exploitation.

#### **EVENTS**

WHOI staff participated in over 125 meetings, conferences, expeditions, and other events to engage with the academic and policy communities and to raise the profile of the twilight zone among the general public.

#### WHOI Dives Deeper at TED

After Heidi Sosik's successful TED Talk last year, we wanted to make sure attendees to the 2019 conference kept the ocean as a whole, and the twilight zone in particular, front of mind. With support from the Avatar Alliance Foundation and the Dalio Foundation, WHOI teamed up with OceanX and the BBC to create an immersive video experience, *Mission: Ocean*, at the conference in Vancouver April 14–19. The installation included a massive video wall consisting of five 14-foot pillars showcasing stunning underwater footage, as well as items that represented the breadth and depth of WHOI's effort to expand human knowledge about the ocean.

The exhibit reached thousands of conferencegoers, with hundreds stopping to explore and engage with participating OTZ team members—Heidi Sosik, Andy Bowen, Sam Harp, and David Scully. Building strategic partnerships like this is a key OTZ engagement goal, and the contacts we established at TED2019 will considerably broaden our reach.





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What happens to life on the seafloor when ancient corals are damaged or destroyed?

B B C BLUE PLANET ||

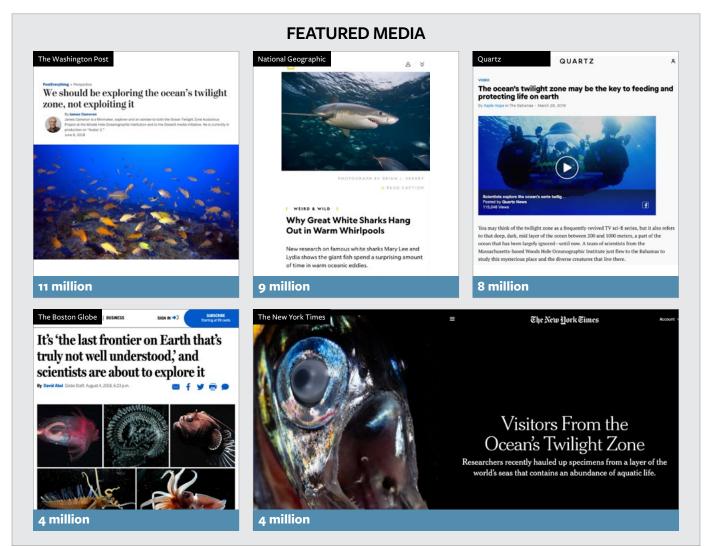
OPENROV

#### EARNED MEDIA

>300

STORIES IN THE UNITED STATES ALONE

#### >130,000,000 POTENTIAL REACH



#### SOCIAL MEDIA

#### 175

POSTS

50,750 ENGAGEMENT

>2,000,000 REACH



120,213 FACEBOOK REACH

32,635 TWITTER REACH

1.25 million

#### **WEB**

#### 39 STORIES

#### 27,000

OTZ WEBSITE PAGE VIEWS

#### 33,300

PRINT

10,313 INSTAGRAM REACH

VIEWS OF OTHER OTZ CONTENT (OCEANUS, TOPIC PAGE, IMAGE OF THE DAY, ETC.)

#### 2018 OTZ TED TALK

16

LANGUAGES

OTZ SPECIAL ISSUES PRINTED



12,000

1,600 OTZ CALENDARS DISTRIBUTED





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# In the Field

Time on a research vessel is a rare and valuable commodity, so when we had the chance to go to sea over the past year, we jumped. WHOI's long tradition of seagoing science also ensured that we used each opportunity to its fullest to push the boundaries of even the most basic knowledge about the twilight zone. All these opportunities and the gains we made as a result further underscored the fact that WHOI's far-reaching partnerships with other academic institutions and organizations act as force multipliers that enable us to gather more data and samples, test new ideas, and help the entire ocean research community make greater strides than anyone would be able to alone.

- Completed inaugural expedition with Deep-See in the Northwest Atlantic just months after receiving Audacious funding
- Established partnership with NASA- and NSF-funded EXPORTS program by participating in a multiship expedition in the North Pacific
- Seized a last-minute opportunity to organize a mission aboard M/V Alucia with only 10 days' notice

## Ocean Twilight Zone Project Sets Sail

#### **KICKING OFF OTZ, AUGUST 2018**

With the start of the Ocean Twilight Zone project in April 2018, we immediately set our sights on summer and the chance to kick off our research program aboard the NOAA research ship *Henry B. Bigelow*. The Audacious Award enabled Andone Lavery to accelerate development of *Deep-See* and make its first deployment from the ship a success. Upon returning to Woods Hole, Lavery gave a debrief on the cruise that began with her saying, "We have to completely rethink what we know about the twilight zone." In oceanography, that depth of revelatory insight comes from only one thing: taking knowledgeable scientists and experienced engineers to sea.

#### PARTNERING WITH NASA, AUG-SEPT 2018

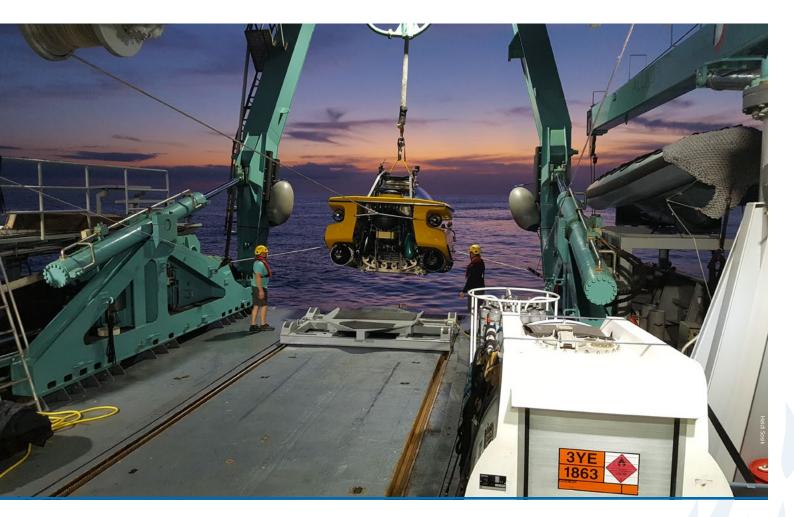
At the same time an OTZ team was out in the Atlantic on the *Henry B. Bigelow*, a group from WHOI was in the Pacific split between two ships operated by the Scripps Institution of Oceanography: R/V Roger Revelle and R/V Sally Ride. The expedition had been long in the works as part of the \$40 million NASAand NSF-funded EXPORTS (EXport Processes in the Ocean from Remote Sensing) program. The ongoing partnership with EXPORTS strengthens the OTZ project's ability to study how the twilight zone influences Earth's climate.



#### **SEIZING AN OPPORTUNITY, MARCH 2019**

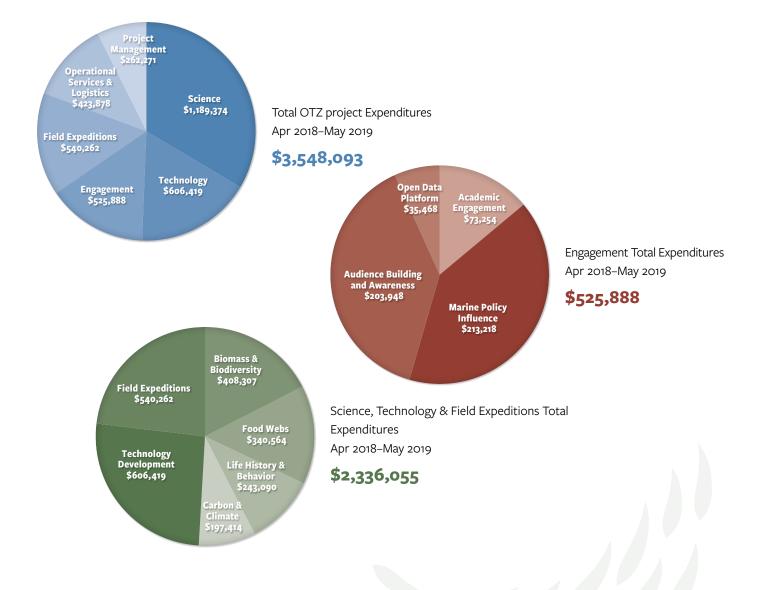
To close out the first year of the OTZ project, this past March the team had an appropriately audacious 10 days to mobilize a research expedition on the OceanX research vessel M/V *Alucia* off the coast of the Bahamas. Efforts were already running in high gear, but somehow everyone took it to another level entirely, completing in less than two weeks what normally requires months to accomplish. It helped that WHOI has experienced personnel in our Marine Operations department and Shipboard Scientific

Services Group, all of whom said, "Let's make it happen." The result was a 10-day expedition during which Joel Llopiz, Heidi Sosik, and several other OTZ team members made their first submersible dives to explore the twilight zone in person. It also provided a critical opportunity to partner with Quartz Media to get the story out and to gather video footage to produce highquality content for future engagement activities.





# ocean twilight zone project Financial Report



Thanks to our generous donors, the total pledged amount for the six-year, three-phased OTZ project currently stands at: \$35,100,000

#### RECEIVED

#### ANTICIPATED

#### SPENT

#### \$7,800,000

Amount the project has received from inception (April 2018)

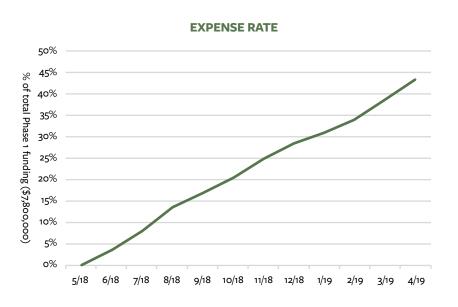
#### **\$5,450,000** Funds anticipated to be

received in July 2019

Phase I (April 2018–June 2020) expenditures at 1 May 2019\*

\$3,548,093

#### \* Phase I Expense Rate to date = 45% (on track with one year remaining)



#### **PROJECT LEADERSHIP**

#### LEADERSHIP COMMITTEE

Mark Abbott President & Director of WHOI (Chair) David Scully Chairman of the Board of Trustees Larry Madin Vice President for Research **Rob Munier** Vice President for Marine Facilities & Operations Heidi Sosik Senior Scientist Andy Bowen Director of National Deep Submergence Facility Sam Harp Vice President for Advancement Peter Wiebe Scientist Emeritus

#### **STEERING COMMITTEE**

Heidi Sosik, *Lead* Andy Bowen, *Lead* Ken Buesseler Annette Govindarajan Porter Hoagland Jon Howland Di Jin Andone Lavery Joel Llopiz Larry Madin Simon Thorrold Peter Wiebe Dana Yoerger

#### **PROGRAM OFFICE**

Phil Renaud, Program Manager Kathryn Baltes, Project Manager

# On the Horizon

#### WHAT'S NEXT FOR THE OCEAN TWILIGHT ZONE?

- This summer, the OTZ team will take an upgraded Deep-See out for its second mission aboard the NOAA ship Henry B.
  Bigelow on an expedition that will include net tows, eDNA sampling, and carbon flux measurements.
- In June, the Mesobot autonomous underwater vehicle will see its first test deployments aboard the Monterey Bay Aquarium Research Institute's vessel Rachel Carson. If all goes well, its first science deployment will take place later in the year.
- In spring 2020, the EXPORTS program moves to the Atlantic with the two large WHOI-operated ships, R/V Atlantis and R/V Neil Armstrong, along with an additional OTZ-staffed and -funded ship to provide a broader look at the inner workings of the twilight zone.

- Efforts will continue to ensure that the twilight zone is included in policy discussions and international negotiations regarding the governance of marine resources on the high seas, particularly at the third session of the UN's Intergovernmental Conference on Biodiversity Beyond National Jurisdiction in August.
- Plans continue for an Open Data Platform that will democratize discovery by enabling stakeholders to quickly and easily interact with OTZ project data to contribute to the research process and to extract value from the knowledge gained.
- We will continue to produce a stream of engagement assets distributed across a wide range of media channels, from academic journals to the popular press to social media to WHOI's own website and Oceanus magazine.

- Alliances to help us drive awareness, scientific collaboration, and global action in support of sustainable use of the twilight zone will remain a focus, particularly those with conservation organizations, universities, and other global academic partners, as well as public-facing institutions such as museums and aquariums.
- An influencer program will help us recruit high-profile figures willing to serve as spokespeople and thought leaders for the OTZ project worldwide.

#### **OCEAN TWILIGHT ZONE**

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

Questions or feedback? Contact: Phil Renaud, OTZ Program Manager prenaud@whoi.edu or (508) 289-2216.

twilightzone.whoi.edu

