MARINE TECHNOLOGY REPORTER

March/April 2021

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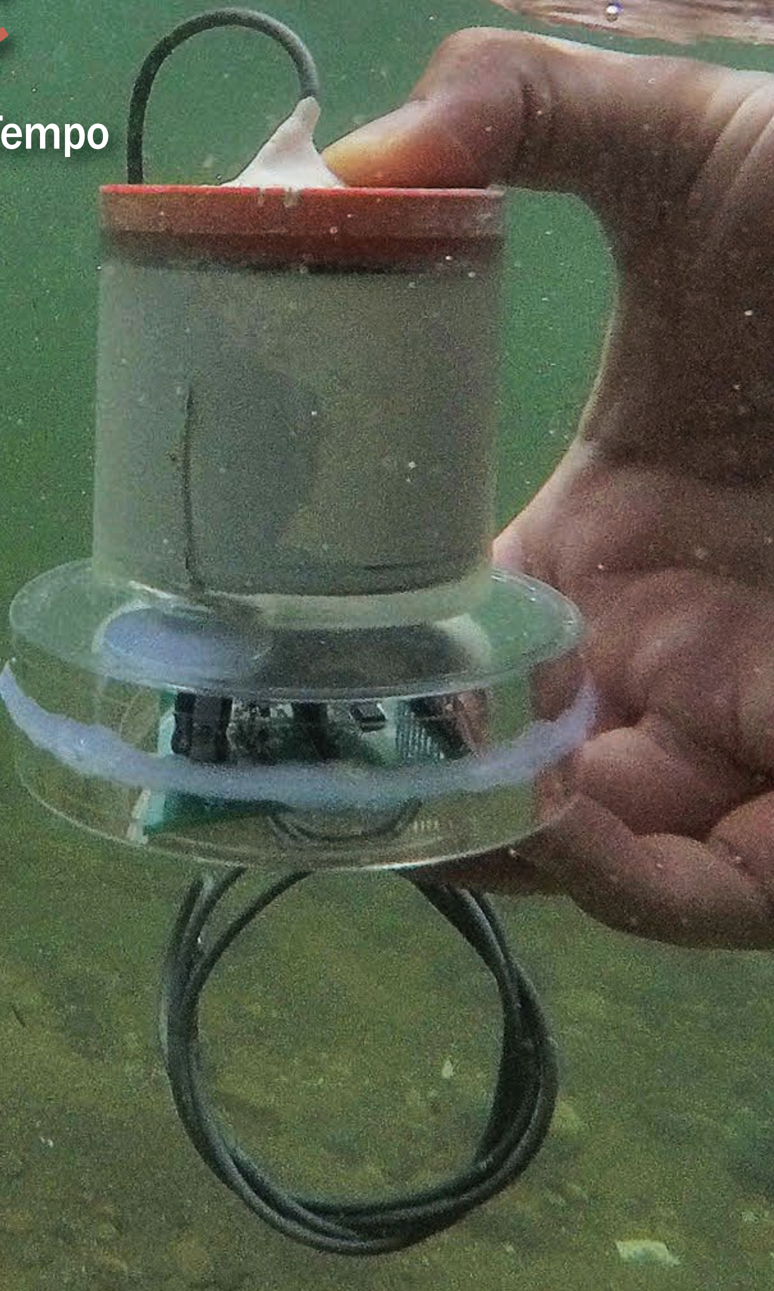
Noise

Underwater Acoustics Picks up the Tempo



Instrumentation

Fiber Optic Sensing Opens New Potential

AUV Docking

ISE & Autonomous Docking with its Explorer Class AUV

Renewable Energy

Sustainable Marine Energy Takes on Bay of Fundy

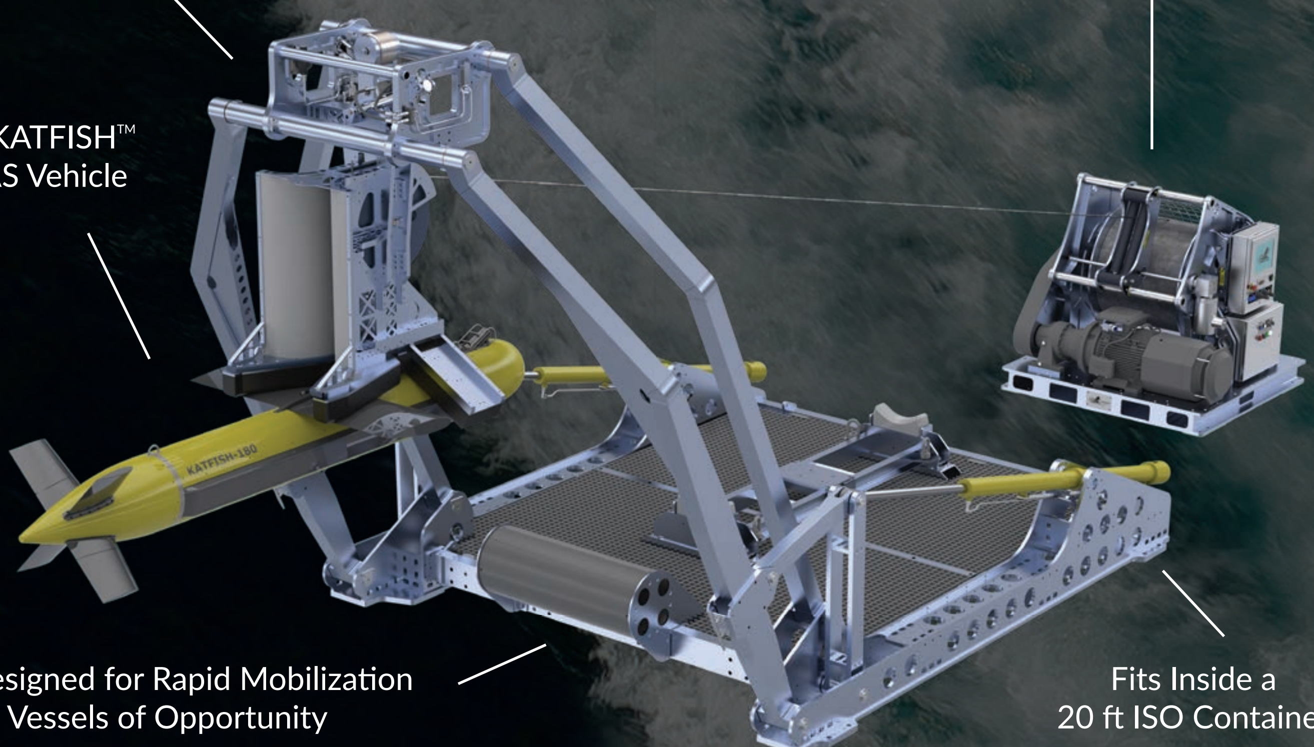
Volume 64 Number 3


DEFENDER

KRAKEN

ALARS

Autonomous Launch and Recovery System



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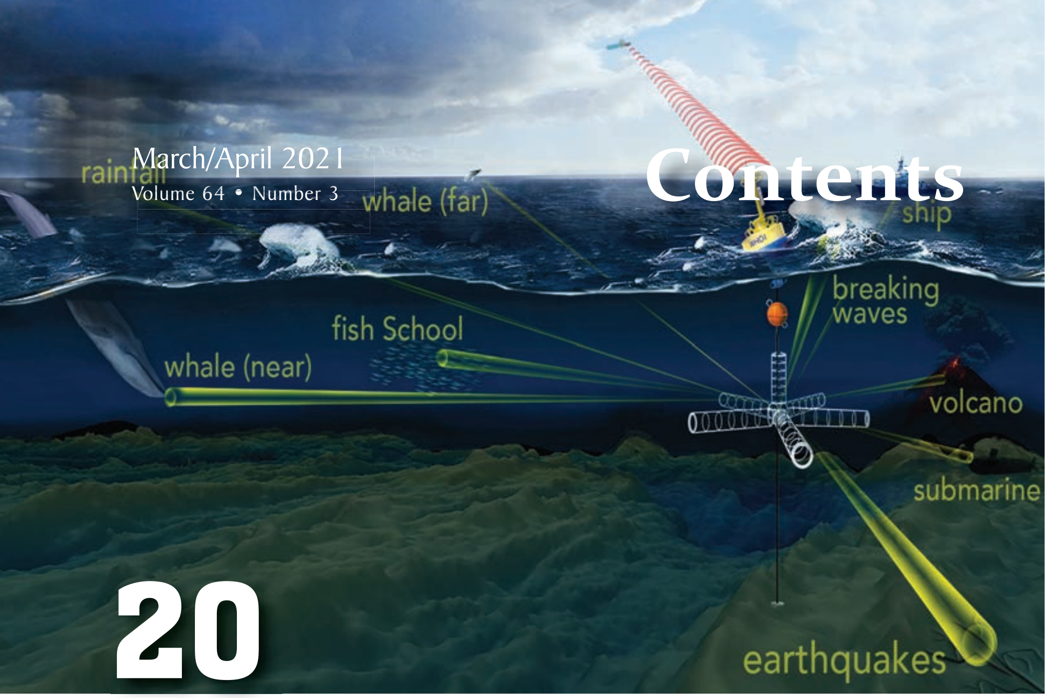
Contents



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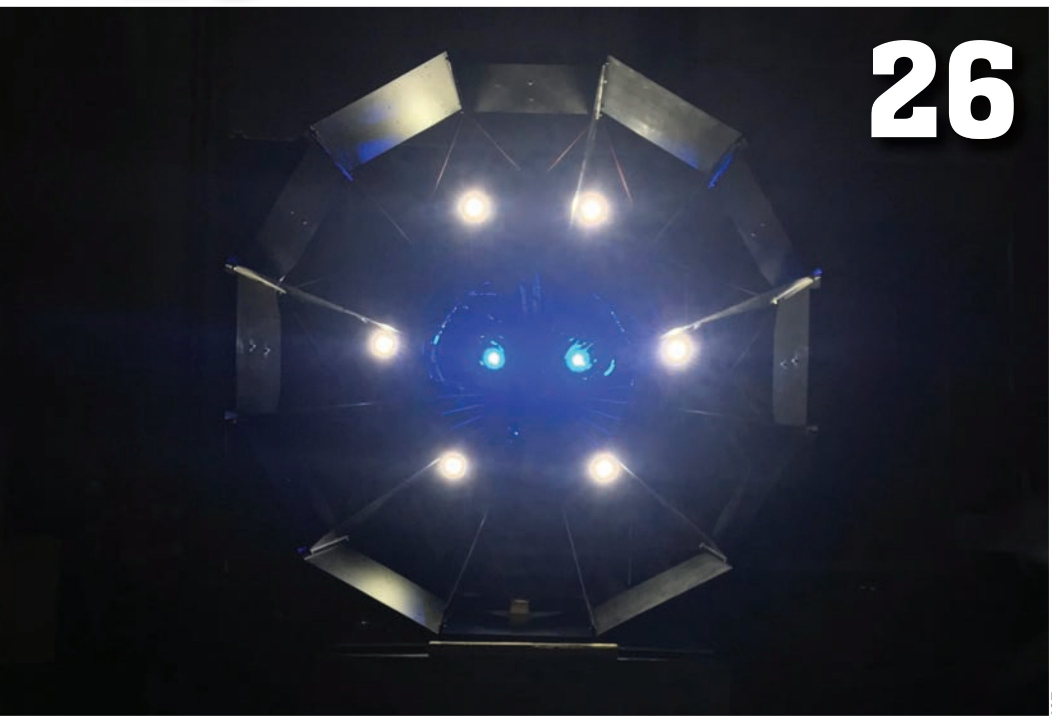

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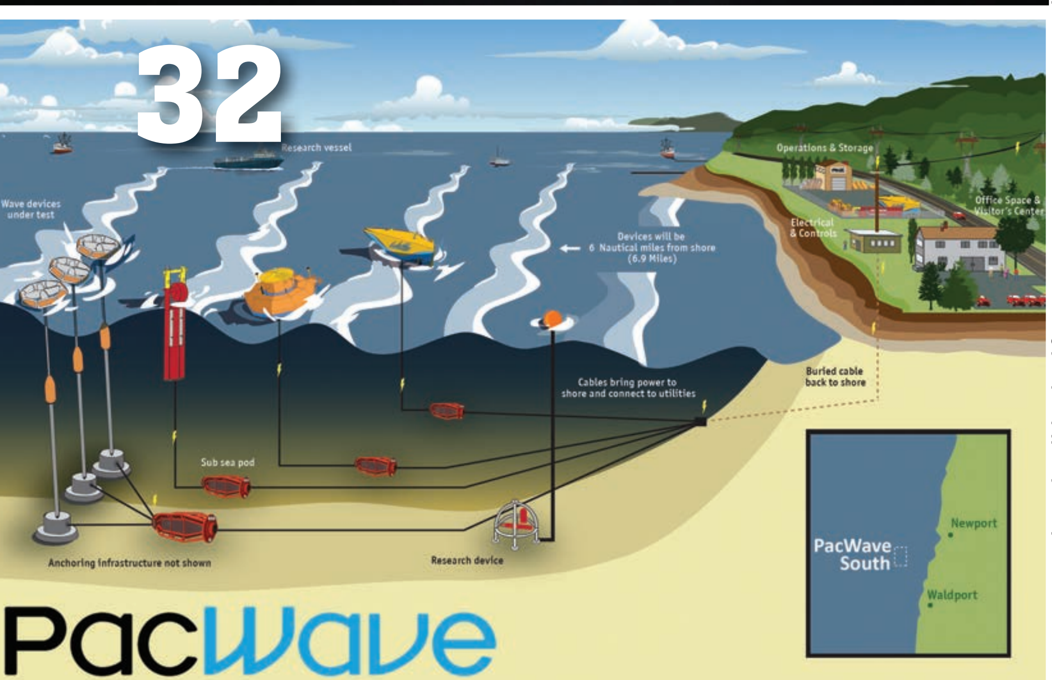
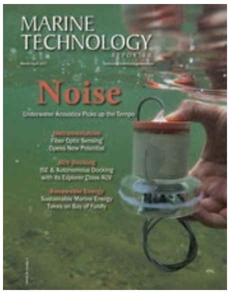


Image from University of Oregon

On the Cover

Researchers at MIT have developed a battery-free pinpointing system called Underwater Backscatter Localization (UBL).

(Photo © Fadel Adib (MIT)



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Editorial

It seems that 2021 begins as 2020 has ended, with varying states of lockdown globally presenting a number of challenges to conducting business efficiently and effectively. But while there are challenges aplenty, if you haven't noticed, the world and business carries on. I, like you, find myself on a dozen or more video calls/meetings/webinars weekly, and invariably the discussion turns to COVID-19 and its various impact on business and life. Trust when I say I cannot wait for the day that "COVID-19" is erased from my daily vernacular, but nonetheless I find it a fascinating study of human and business resilience to learn how these many challenges are being hurdled.

One feature focus this month is the burgeoning renewable offshore energy market, and here with checked in with **Jason Hayman**, CEO of Sustainable Marine Energy for an update on his organization's efforts to more forward on its tidal energy system, an innovative trimaran system in tandem with Schottel. It's next-generation system was, at the time of our interview in February, literally on the slipway at A.F. Theriault and ready for its first commercial project at FORCE. While Hayman's team is globally dispersed and the challenges have been numerous with COVID-19, the Sustainable Marine Energy team is on schedule for its first commercial project, as you'll read starting on page 38.

Generating power under water is one, but hardly the only challenge when working in the world's oceans and waterways. As we watched with amazement when NASA's Perseverance ("Percy") rover safely landed on Mars and sent over its first images of its Jezero Crater landing site, I could not help but thing back to the popular axiom that "we know more about the surface of Mars than we do our own oceans," and to date, about 80% of the world's oceans remain unexplored and only 7% are designated marine protected areas (MPAs). In the efforts to explore and understand our oceans, the use of sound has always been particularly tricky, but **Celia Konowe** found a number of researchers that are working to better harness, and understand, the sounds of the deep sea. Her story, this month's cover feature, starts on page 20.

Gregory R. Trauthwein
Associate Publisher & Editor

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Maslin

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Luke Alden BSc Mechanical Designer at International Submarine Engineering Ltd. Luke has 10+ years experience in engineering. During his time at ISE he has been involved in many design projects including integrating cameras on AUVs.

Konowe

Celia Konowe is a college senior from Reston, Virginia, majoring in environmental studies at the University of Rochester with minors in French and theatre. This past semester, prior to the COVID-19 lockdown, she studied abroad in Ecuador through the Universidad de San Francisco Quito as part of its GAIAS (Galápagos Institute for the Arts and Sciences) program.

Lundquist

Edward Lundquist is a retired naval officer who writes on naval, maritime, defense and security issues. He is a regular contributor to Maritime Reporter and MTR.

Maslin

Elaine Maslin is an offshore upstream and renewables focused journalist, based in Scotland, covering technologies, from well intervention to subsea robotics.

"Quotable"

"In developing a floating system, the real challenge is dealing with the huge loads through the mooring system. To give you an idea, **two of our turbines produce the same thrust as an F-35 fighter jet on full afterburner.** *So you take our new six-turbine platform, and that's like taking three F-35s, telling the pilots hit full throttle, and putting that on a leash."*

. . . . .

Jason Hayman, CEO, Sustainable Marine Energy

Photo courtesy Sustainable Marine Energy

20

"Soundscapes will play an important role in managing marine-related affairs as the techniques to recognize various biological, environmental, and anthropogenic sounds become more mature."

Dr. Tzu-Hao Lin
Assistant research fellow at Biodiversity Research Center, Academia Sinica in Taiwan

Purdue University photo/Jared Pike

"This is a totally unique approach. Most underwater gliders can only operate in deep oceans and are not agile for confined spaces. ROUGHIE has a turning radius of only about 10 feet."

. . . . .

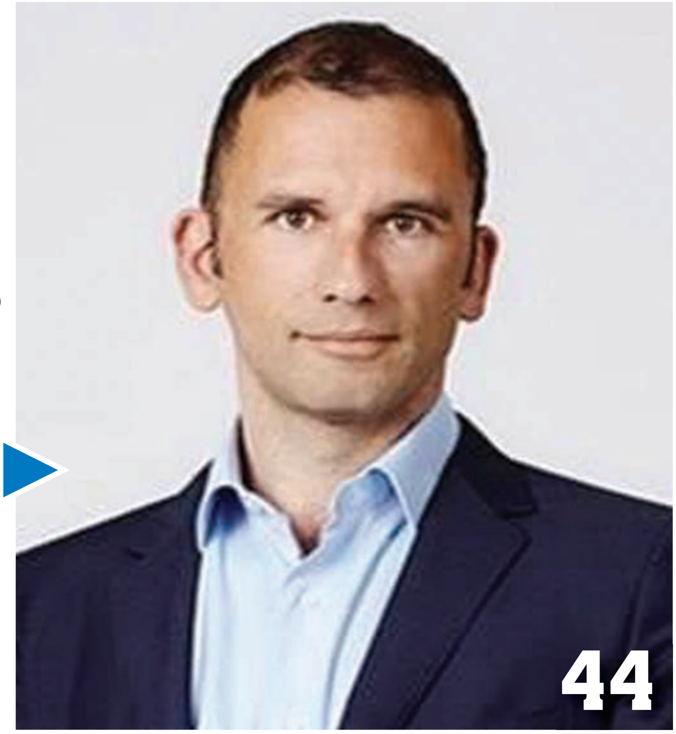
Nina Mahmoudian, associate professor, mechanical engineering, Purdue University

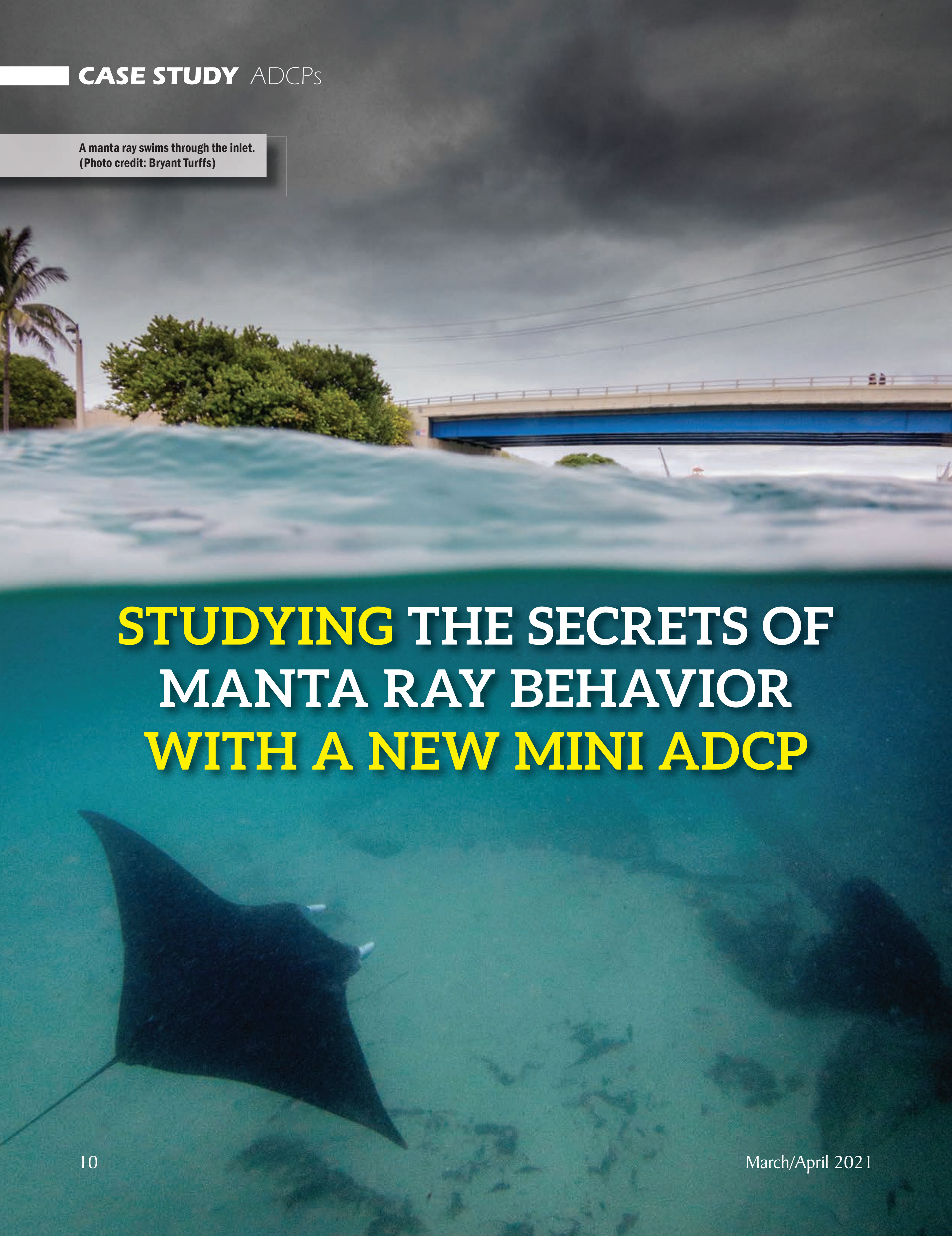
"Quotable"

"They have a vision of installing a huge wave energy park in the bay area to electrify most of the city. So far it's only one (Smart Power Buoy installed) so there's still some way to go, but that has a great potential. They're not in it for the real time data, they're in it for the wave energy, for the electricity."

• • • • •

Roland Boysen, CCO, Resen Waves





A manta ray swims through the inlet.
(Photo credit: Bryant Turffs)

STUDYING THE SECRETS OF MANTA RAY BEHAVIOR WITH A NEW MINI ADCP

Understanding why marine animals are using some places and not others is crucial to minimizing our impact on them. Recently, the new Eco ADCP has been helping one marine biologist, with no previous experience in using oceanographic instruments, characterize current flows in one of the manta ray's more unusual shallow-water coastal habitats with simplicity and ease.

Powerful yet graceful, manta rays top almost everyone's list of must-see marine animals. While people flock to places like Indonesia or the Maldives to watch these gentle giants, one location has gone relatively unnoticed – South Florida.

"I lived in Florida working as a sea turtle biologist, and a lot of data collection involved being on the beach all day," recounts Jessica Pate, a marine biologist with the Marine Megafauna Foundation. "Sometimes I would notice these big, black shapes swimming right next to shore in less than a meter of water."

Surprised to see manta rays, Pate searched for more information but found very little. "I know hundreds of people researching sea turtles, and I couldn't believe that no one was studying manta rays [in South Florida]," she says.

Manta rays favor shallow water with strong currents

With Florida's coast so highly developed, it is a surprising location for a nursery area. What's more, these particular "urban manta rays" are also singling out some particularly hazardous locations.

"There's this man-made inlet [Boynton Beach Inlet] that's known for being one of the most dangerous inlets because it's very skinny with seawalls, and boats come flying through. I try to avoid it at all costs," Pate says.

Despite the risks, and the shallow water (Pate estimates Boynton Beach Inlet's maximum depth to be around 10 m), the inlet seems to be a popular location for the manta rays. "They will come around and face into the current, which is really strong, and just sit," says Pate, who sees groups of up to six manta rays sitting in the inlet for hours at a time.

Exchanging floating oranges for slightly more accurate technology

Pate knew that currents in the inlet are fast, but to properly characterize the flow she needed to be able to measure them. However, the costs of purchasing an ADCP quickly became a major roadblock. In search of alternatives, Pate started to consider other, much less accurate, options.

"I did an experiment with the drone, where I tossed oranges into the water with the hope of measuring the surface current," Pate says. Fortunately, when the Eco came along, Pate did not have to resort to oranges any more.

The Eco is designed with users like Pate in mind – those who are interested in understanding the physical nature of shallow-water environments but lack in-depth training or experience in using oceanographic instruments. Fitted with a transducer with a maximum profiling range of 20 m, plus sensors for temperature, pressure, tilt, and heading, the Eco offers such users a simpler, low-cost and user-friendly alternative to its larger, more heavily equipped sibling ADCPs.

"It was so easy to set up – all you do is go onto the online portal, input the time and date you want it to start recording, and deploy it," says Pate.

Being just the size of a large coffee cup, the Eco is a natural fit for the shallows and is extremely portable – a feature which proved particularly useful when Covid-19 restrictions 2020 blocked access to the marina containing the boat Pate could use. Instead of using a boat, Pate's boyfriend deployed the instrument using his stand-up paddleboard.

Effortless processing of current measurement data

Data collection is one thing, but for those like Pate who do not regularly work with oceanographic instruments, extracting the data and translating it into something meaningful can be a challenge.

For Pate, the deployment reports generated by the Eco were a boon.

"It was pretty idiot-proof," she says, explaining that generating the reports simply requires connecting the Eco wirelessly to a website and waiting for the report (and the raw data) to be produced.

"When I got the reports, I was very excited that [the software] put everything together for me instead of sending me a spreadsheet with a bunch of data that I didn't understand," says Pate, who was quickly able to identify some interesting patterns from the visualizations provided.

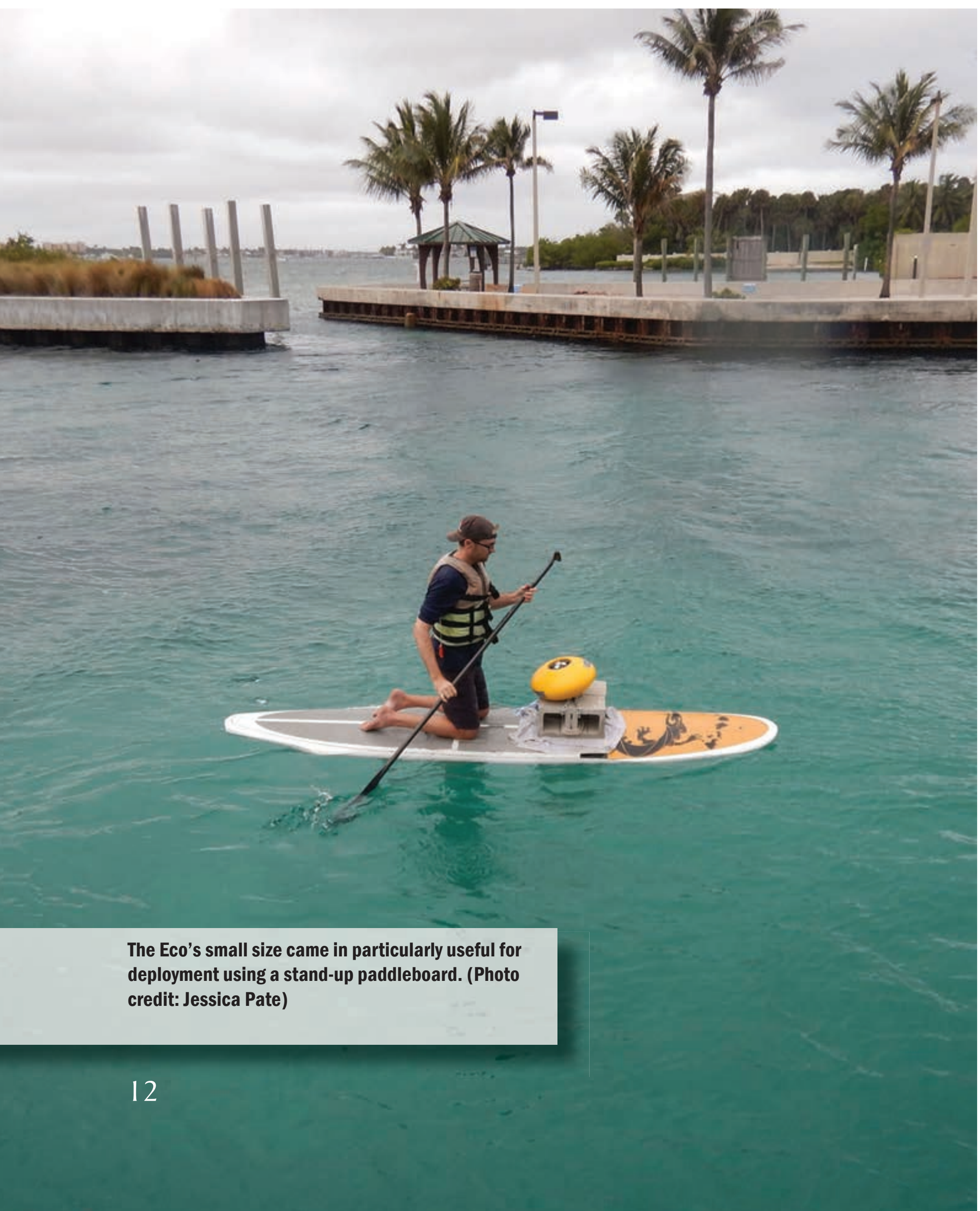
"I learned that the surface current and the bottom current are not the same," Pate recounts, noting that the bottom current is stronger than the surface, on incoming tides, and with the full moon.

For any at-risk species, protecting juveniles and their nursery areas is generally considered a must-do.

For manta rays, which are listed as vulnerable to extinction by the International Union for Conservation of Nature, it is arguably vital. South Florida appears to be home to one of just three known manta ray nurseries in the world. "The manta rays are very young, so this is really important habitat for them to safely develop into adulthood," Pate explains.

With the Florida coast so highly developed and its coastal waters brimming with human activity, it is not surprising that accidents happen. "We see a lot of fishing line entanglement and vessel strike on the manta rays and other species," says Pate.

Key to designing measures to reduce our impact on the young rays is understanding why they are using the places they are. "For NOAA, the federal government, to designate critical habitat, you have to identify the physical and biological characteristics of that habitat to be able to say why are they here, and not here," Pate explains.

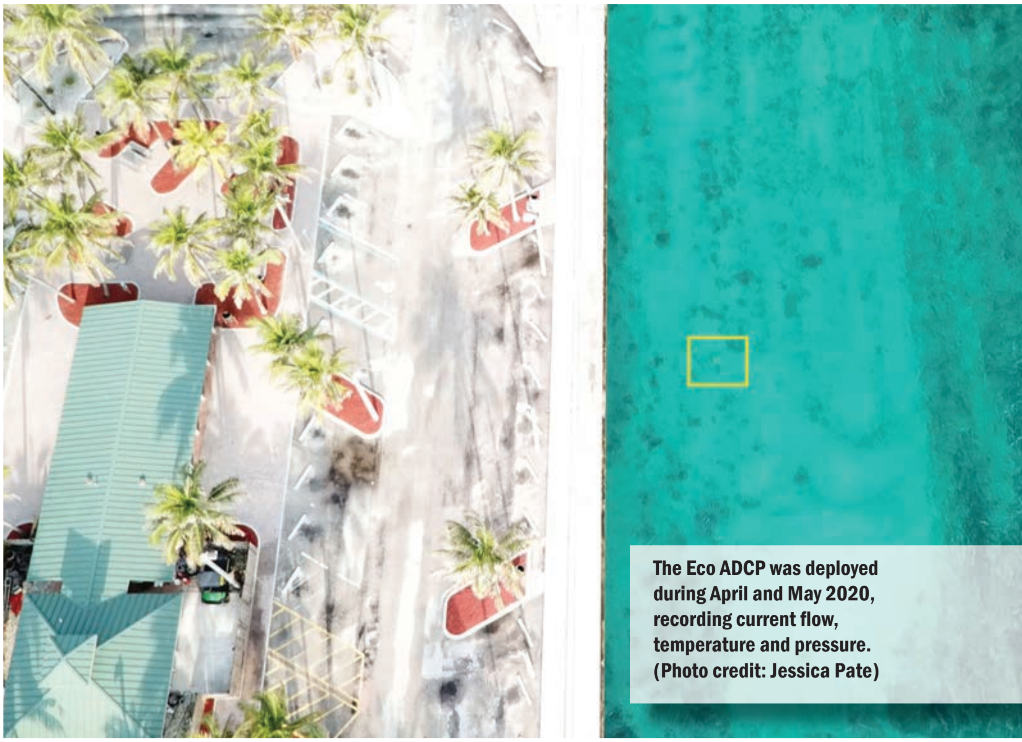


The Eco's small size came in particularly useful for deployment using a stand-up paddleboard. (Photo credit: Jessica Pate)

Pate's work with the Eco on the inlet has revealed some of the secrets to the manta rays' particularly hazardous habitat choice. Not only did she quantify the speed of the fast-moving current, but she also uncovered how the current varies throughout the inlet's shallow water column, with tide, and with the lunar cycle.

To build up a complete picture of the manta rays' habitat preferences, Pate would like to monitor other inlets to see if and when manta rays are using those, and measure current conditions in them just as she has done with the Eco in the Boynton Beach Inlet. Armed with such information, Pate hopes to raise awareness about the manta rays and work with the community to ensure that these urban manta rays will be with us for a long time to come.

(Story courtesy Nortek)



The Eco ADCP was deployed during April and May 2020, recording current flow, temperature and pressure. (Photo credit: Jessica Pate)

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KONGSBERG
AUTONOMOUS SOLUTIONS FOR ECOSYSTEM MONITORING

Kongsberg Maritime is to deliver two Sounder USVs and two AUVs for the Institute of Marine Research. The delivery includes an innovative new system for onboard classification and remote sensor operation.

Photo courtesyKongsberg

Kongsberg Maritime reached an agreement to supply Norway's Institute of Marine Research (IMR) with four autonomous vessels: two Kongsberg Maritime Sounder USVs and two Kongsberg AUVs. The four vehicles will form the practical basis of the institute's long-term strategy to develop the monitoring and management of marine environments and resources.

The vessels will be equipped with Kongsberg's new Blue Insight, a cloud-based ecosystem designed to facilitate remote instrument operation, data visualization and smart management of oceanographic and meteorological data. Infrastructure for automated classification of fish through machine learning is a key feature of the delivery, consolidating the long-running partnership between Kongsberg and the IMR towards the goal of implementing seagoing drones for ecosystem management.

The Kongsberg AUVs are scheduled for delivery this year, with the USVs following in the late summer/early autumn of 2022. The AUVs are depth-rated to 1,500m and are equipped with a payload for environmental monitoring and seabed mapping. The IMR USVs will be equipped with a full EK80 wideband system accommodating ADCP functionality, similar to the setup on their existing research vessels. Control and navigation of both AUVs and the Sounder USVs can be handled just by a single interface.

"As we embark on the next stage in this project, we are happy to do so alongside Kongsberg Maritime," said Sissel Rogne, CEO, IMR. "We are seeing a wide range of changes in our coastal and ocean ecosystems – and these changes happen fast. In response to this, we must streamline and increase our management efforts. (Kongsberg's) USVs and AUVs will initially work alongside our traditional research vessels in an 'armada strategy,' but will subsequently operate more independently as we expand."

Purdue University photo/Jared Pike

Nina Mahmoudian (center) and her students have developed an underwater glider that can operate silently and in confined spaces, ideal for conducting biology or climate studies without disturbing wildlife.

MEET ROUGHIE:

TEAM AT PURDUE ADVANCES WORK ON NEW GLIDER

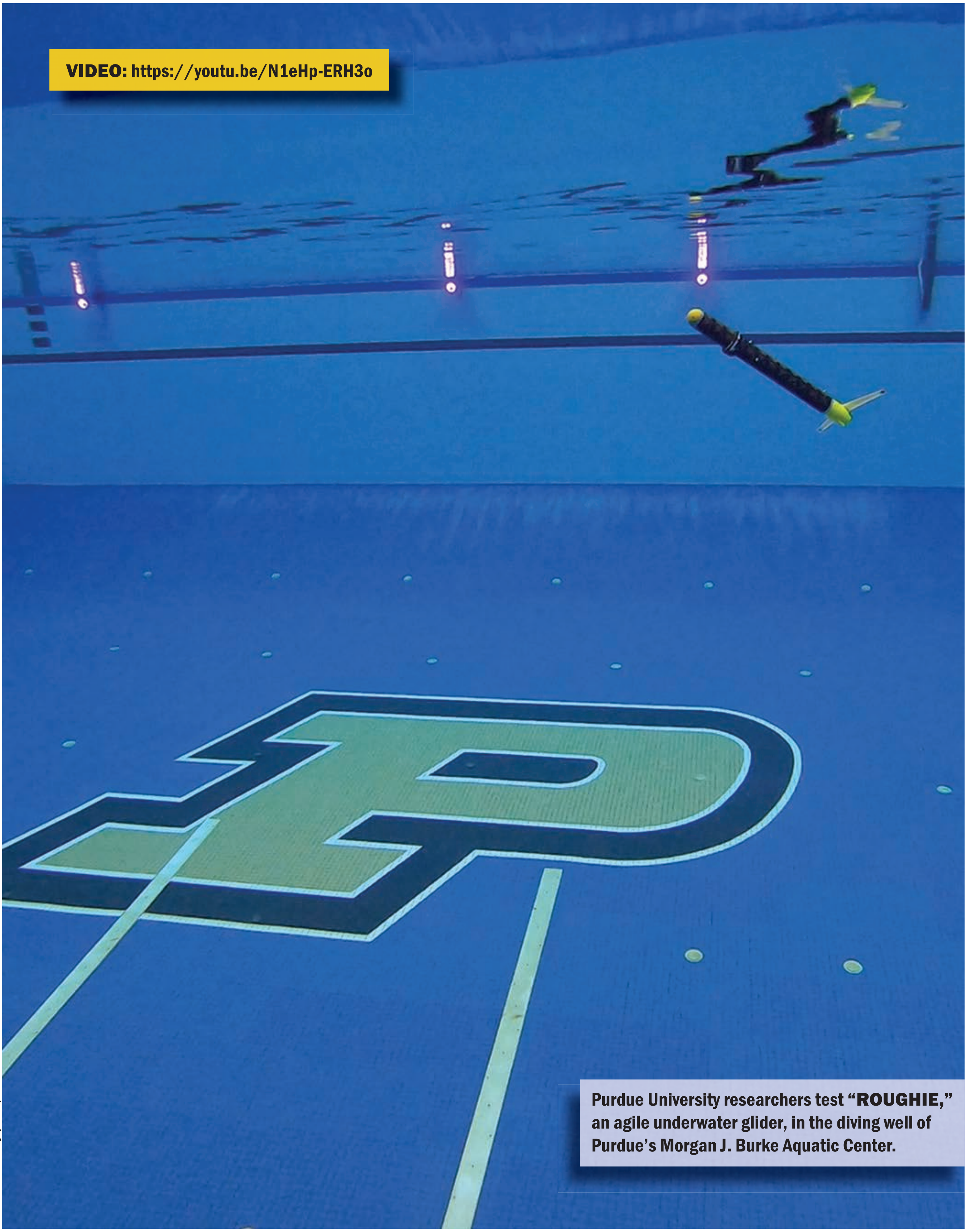
Autonomous underwater vehicles have become versatile tools for exploring the seas. Purdue University researchers are studying means to optimize the design, aiming to deliver a highly maneuverable, low-cost underwater glider that operates silently, with components and sensors that can be easily swapped out or added according to a wide range of mission specifications.

"Our goal is persistent operation of mobile robots in challenging environments," said Nina Mahmoudian, associate professor of mechanical engineering. "Most underwater robots have limited battery life and must return back after just a few hours. For long-endurance operations, an underwater glider can travel for weeks or months between charges but could benefit from increased deployment opportunities in high-risk areas."

An underwater glider differs from other marine robots because it has no propeller or active propulsion system. It changes its own buoyancy to sink down and rise up, and to propel itself forward. Although this up-and-down approach enables very energy-efficient vehicles, it presents problems: the vehicles are slow and not maneuverable, especially in shallow water.

When deployed from shore or from a boat, ROUGHIE pumps water into its ballast tanks to change its buoyancy and provide initial glide path angle. To control its pitch, the vehicle's battery subtly shifts its weight forward and backward, acting as its own control mechanism. To steer, the entire suite of inner components are mounted on a rail that rotates, precisely controlling the vehicle's roll. The design is modular and adaptable for a variety of applications.

"This is a totally unique approach," Mahmoudian said. "Most underwater gliders can only operate in deep oceans and are not agile for confined spaces. ROUGHIE has a turning radius of only about 10 feet, compared to an approximately 33-foot turn radius of other gliders."



VIDEO: https://youtu.be/N1eHp-ERH3o

Purdue University researchers test "**ROUGHIE,**" an agile underwater glider, in the diving well of Purdue's Morgan J. Burke Aquatic Center.

Purdue University photo/Jared Pike

ROUGHIE is so maneuverable that Mahmoudian's team has been testing it in the diving well at Purdue's Morgan J. Burke Aquatic Center. By installing a motion capture system of infrared cameras below the water, they can track the vehicle's movements and characterize its maneuvering behavior in three dimensions with millimeter accuracy.

"We program ROUGHIE with flight patterns ahead of time, and it performs those patterns autonomously," Mahmoudian said. "It can do standard sawtooth up-and-down movements to travel in a straight line, but it can also travel in circular patterns or S-shaped patterns, which it would use when patrolling at sea. The fact that it can perform these tasks within the confined environment of a swimming pool using nothing but internal actuation is incredibly impressive."

This maneuverability means that ROUGHIE is able to follow complex paths and can explore real-world areas other underwater gliders can't.

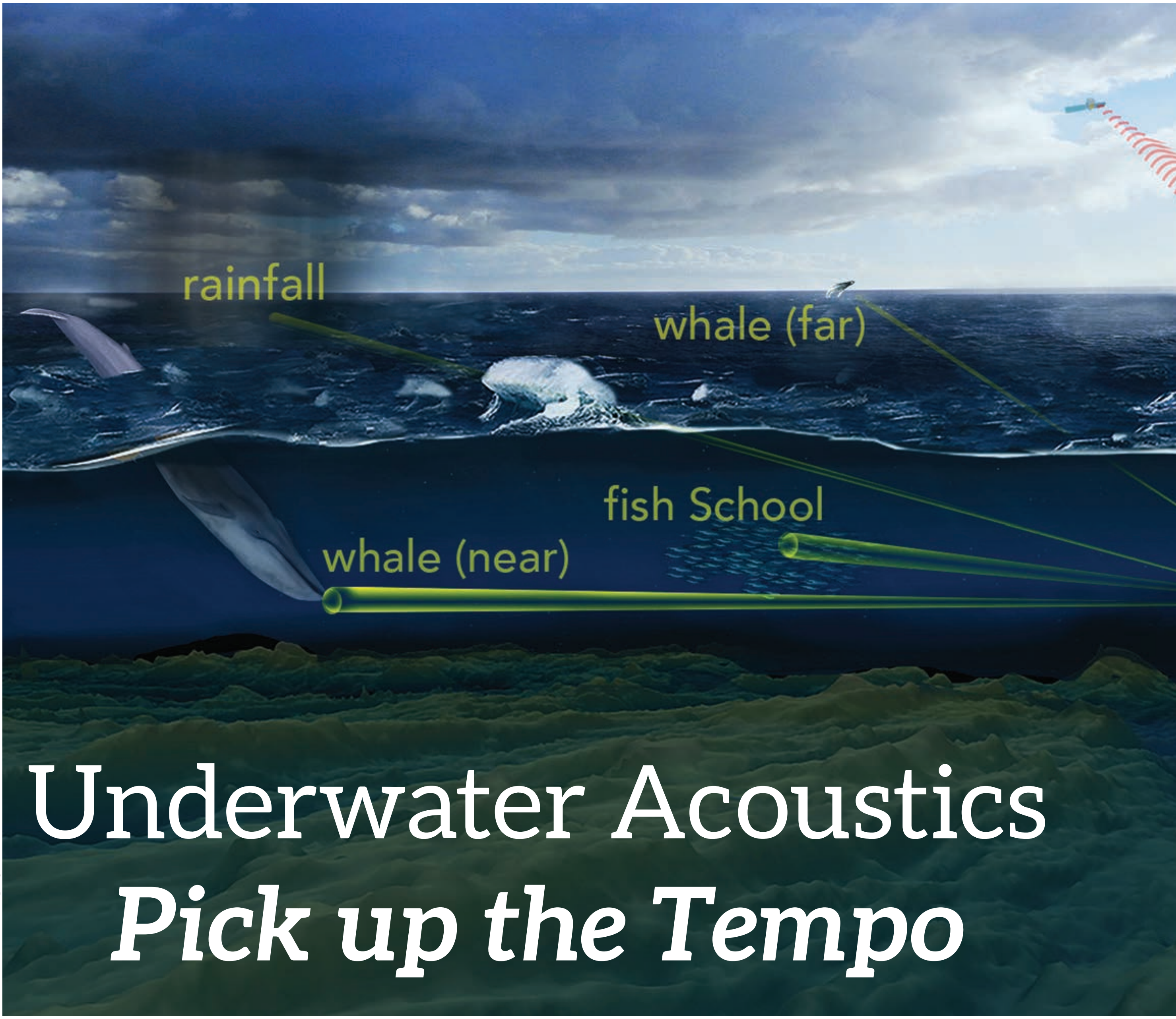
"It can operate in shallow seas and coastal areas, which is so important for biology or climate studies," Mahmoudian said. "And because it's totally quiet, it won't disturb wildlife or disrupt water currents like motorized vehicles do."

ROUGHIE can be fitted with a variety of sensors, gathering temperature, pressure and conductivity data vital to oceanographers. Mahmoudian's team has sent ROUGHIE into small ponds and lakes with a fluorimeter to measure algae bloom. The team also outfitted the vehicle with compact magnetometers, capable of detecting anomalies like shipwrecks and underwater munitions. This research has been published recently in the journal Sensors.

Mahmoudian and her students have been developing ROUGHIE since 2012 when she began the project at Michigan Technological University.

"My students designed and built it from scratch, and they developed the control and navigational algorithms in parallel," Mahmoudian said. "For the price of a current commercial vehicle, we can put 10 of these in the water, monitoring conditions for months at a time. We believe this vehicle has great value to any local community."

This work is supported by the National Science Foundation (grant 1921060), Office of Naval Research (grant N00014-20-1-2085) and the Naval Sea Systems Command Small Business Technology Transfer program N68335-19-C-0086.



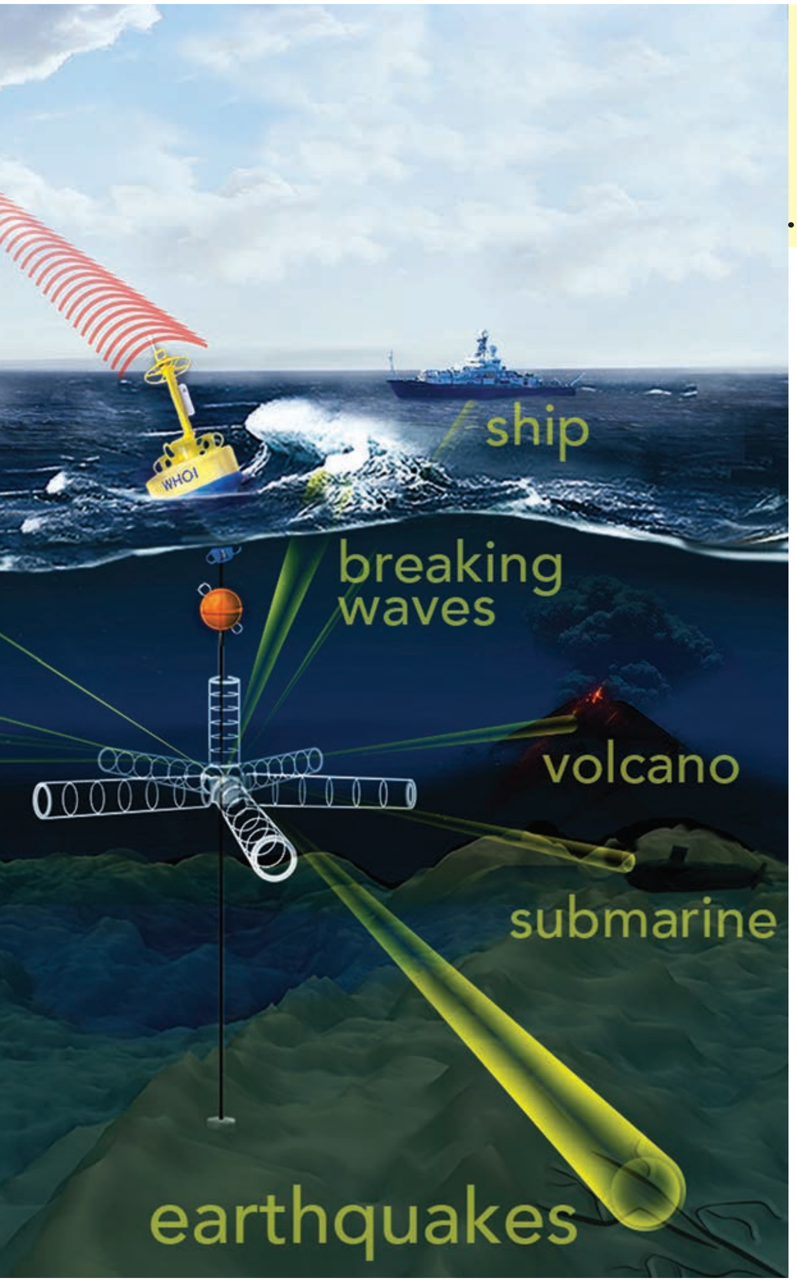
Woods Hole Oceanographic Institution, N. Renier

Underwater Acoustics *Pick up the Tempo*

By Celia Konowe

Humans have always been intrigued by what we do not know, especially that which we can't see. At the time of writing, NASA's Perseverance rover, fondly nicknamed Percy, has safely landed on Mars and sent over its first images of its Jezero Crater landing site. Percy, among many other technological creations, demonstrates the curiosity and capacity of our exploratory efforts. While our achievements in outer space exploration pile up, there is still much work to be done here on Earth—particularly in our oceans. To date, about 80% of the world's oceans remain unexplored and only 7% are designated marine protected areas (MPAs). The depth of our oceans comes with many setbacks to "seeing" the deep sea in a traditional sense—zero visibility, freezing temperatures and crushing levels of pressure. But what about creating an auditory image?

During recent decades, progress in subsea exploration has increased significantly, especially with the advancement of underwater vehicles, whether autonomous, remotely oper-



To probe the ocean's opaque interior, sound is one of the most efficient tools available. WHOI scientists have developed an "acoustic telescope" to "see" into a noisy ocean and pick out unique sounds produced by distant acoustic phenomena, such as whale calls and fish schooling, as well as the rumble of earthquakes, volcanoes, and storms.

ated, manned or otherwise. Sound has moved to the forefront of ocean exploration in past years thanks to its speed underwater—it travels almost five times faster than in the air. Audio samples can be caught with hydrophones that can pick up sounds from hundreds of miles away, whether they come from marine life, human interference or movement within the Earth's surface. The information we gather from underwater acoustics can tell us much about the patterns and health of marine life, geological and physical characteristics of the seafloor, the impact of anthropogenic activities, future climatic conditions, and even play a role in GPS and navigation. The key to better understanding the deep sea, it seems, is sound.

While significant work has already been done to greatly advance our understanding of the ocean and marine ecosystems, there is still a desperate need for survey methods to monitor overall ecosystem health, believes Dr. Tzu-Hao Lin, assistant research fellow at Biodiversity Research Center, Academia Sinica in Taiwan. The cost of deploying autonomous sound recorders is significantly lower than visual-based systems. Dr. Lin, who is also in charge of the Marine Ecoacoustics and Informatics Lab, stated, "Soundscapes will play an important role in managing marine-related affairs as the techniques to recognize various biological, environmental, and anthropogenic sounds become more mature."

Dr. Lin's recent projects focus on the use of underwater sounds in remote sensing of marine ecosystem dynamics. The first investigated coral reef soundscapes in Okinawa, Japan, by deploying three autonomous sound recorders at depths ranging from 1.5m to 40m to cover shallow-water and mesophotic reefs. By using a computational approach that integrates machine learning and audio source separation, the researchers were able to unmix biological and anthropogenic sound sources and to visualize spatial and temporal occurrences of crustaceans and fish, as well as some shipping activities. "Our results reveal that although shallow-water coral reefs have high intensities of snapping shrimp sounds, mesophotic coral reefs contain a higher diversity of fish choruses than shallow-water coral reefs. In the meantime, they are more susceptible to noise generated from ferry and fishery activities," Dr. Lin said.

The second project investigated acoustic diversity at the twilight zone by analyzing two and a half years of underwater recordings transmitted from a cabled seafloor observatory at a depth of 277m off the coast of northeastern Taiwan. The team's computational approach allowed for the separation of single-channel audio into multiple channels that encode the behaviors of marine mammals, sound-producing fish, shipping activities and any mutual interactions. "The results," Dr. Lin explained, "revealed that the studied continental shelf environment hosts a diverse array of sound-producing animals and that the community structure changes with diurnal, lunar and seasonal cycles."

Techno Rhythm

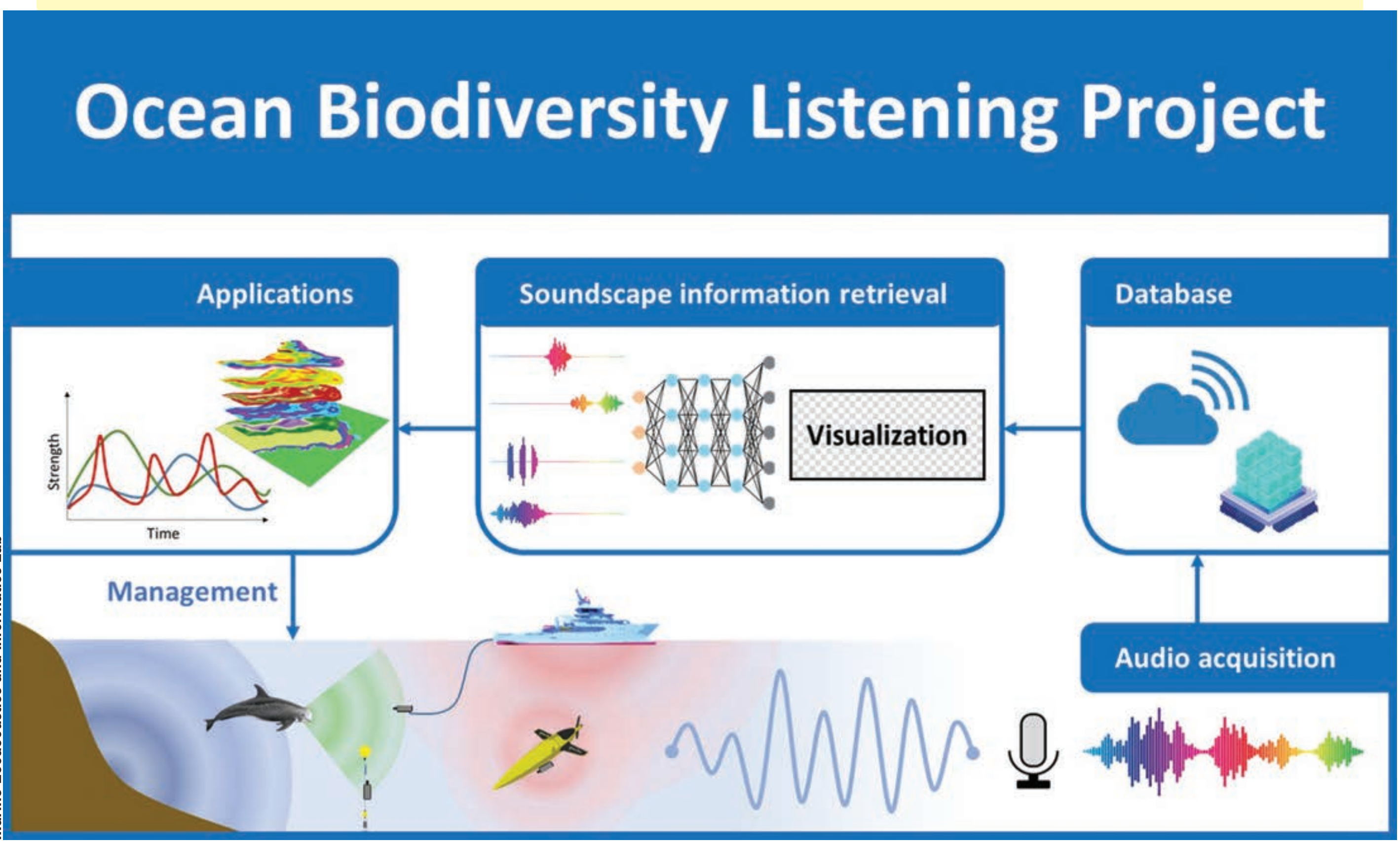
Dr. Lin's work is among many that highlights the importance of underwater acoustic research for better understanding the depths of our oceans and that would not be possible without technological advances. In some cases, for his work, the team gathers audio data from cabled observatories, like the one off the northeastern coast of Taiwan, which are designed to monitor deep-sea environments. Otherwise, Dr. Lin shared, they use standalone autonomous recorders like the SoundTrap 300, designed by New Zealand-based Ocean Instruments. When it comes to analysis, Dr. Lin's computational approach automatically separates "anthropogenic noise from biological sounds, thus improving the diversity assessment of sound-producing animals and noise-generating activities."

For some, the main goal is making it easier to distinguish between individual sounds in noisy underwater soundscapes from the outset. Woods Hole Oceanographic Institute scientist Dr. Ying-Tsong Lin and his team are building the first ever underwater 3D "acoustic telescope," a 30-foot diameter, six-armed array of hydrophones. The star-shaped "telescope" will be capable of tuning in sounds from thousands of miles away and isolating them from other background acoustic sources. In addition, the instrument will be equipped with satellite communication for real-time data transmission. This technology will enable scientists to gain a more nuanced and holistic view of the underwater soundscape, taking the complexity of ocean sound sources into account. Once fully constructed, the "telescope" will be deployed at the edge of the continental shelf off the Northeast coast of the United States; the ultimate goal is an array of "acoustic telescopes" to capture the 3D soundscape of entire ocean basins.

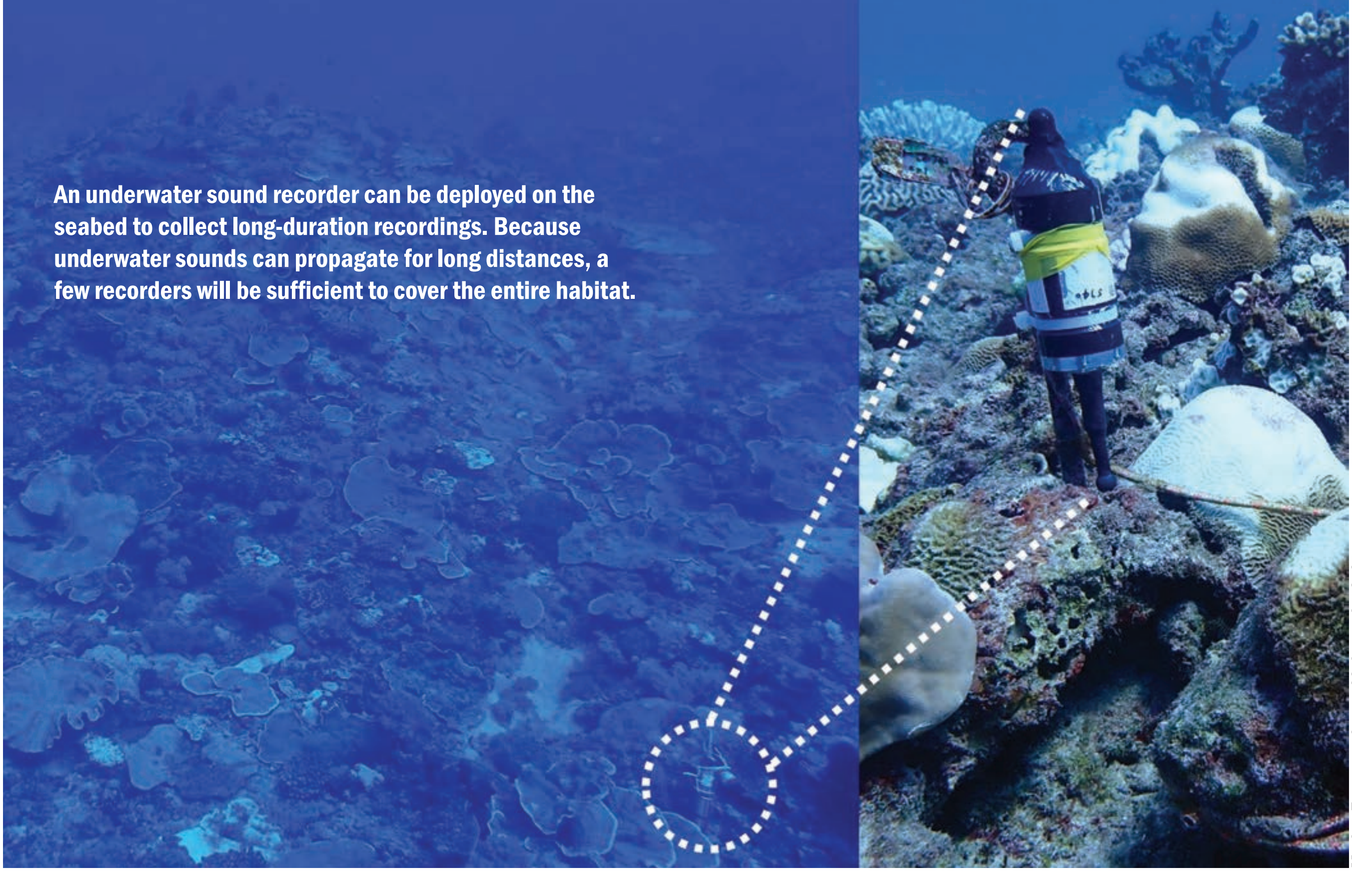
Marine Theme Songs

Unsurprisingly, as with any success story, there are still challenges to face and surmount. For Dr. Lin of Academia Sinica, insufficient information on the acoustic behavior of marine animals is a major hindrance. In his second project, mentioned previously, two new types of fish choruses were discovered in the continental shelf environment; however, the team still cannot identify the species despite knowing their diurnal and seasonal occurrence patterns. The solution? "An audio library for various sound-producing marine organisms," Dr. Lin said. Such a library is critical for promoting the use of soundscape

A conceptual figure illustrates the use of soundscapes in monitoring marine ecosystems. Underwater sounds will be digitally archived and available for the public use. Users can connect to the database and apply techniques of soundscape information retrieval to detect and classify various acoustic events.

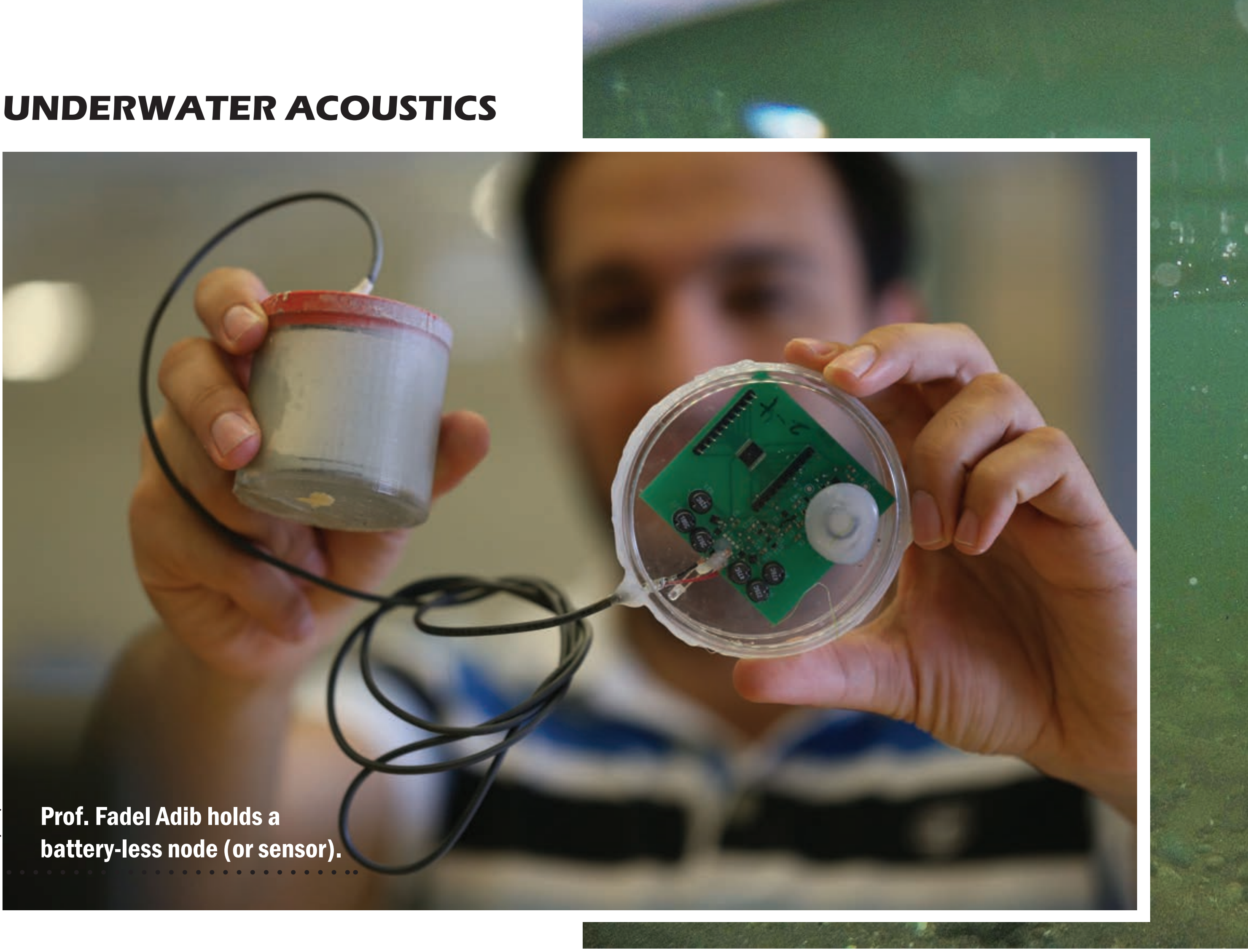


Marine Ecoacoustics and Informatics Lab



An underwater sound recorder can be deployed on the seabed to collect long-duration recordings. Because underwater sounds can propagate for long distances, a few recorders will be sufficient to cover the entire habitat.

Marine Ecoacoustics and Informatics Lab



Fadel Adib (MIT)

Prof. Fadel Adib holds a battery-less node (or sensor).

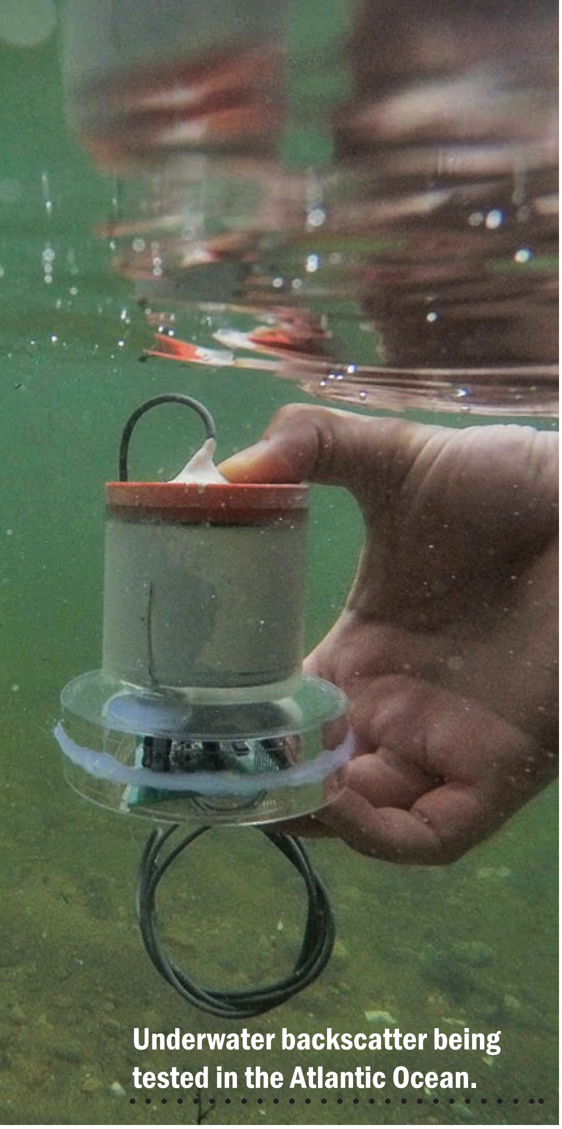
analysis in ecosystem assessment, as well as for developing sound recognition software that can recognize species and their unique behaviors.

This idea is already being pursued via The Ocean Biodiversity Listening Project (OBLP), which "aims to establish a large-scale soundscape monitoring network (using autonomous sound recorders or cabled observatories) to cover various marine ecosystems." The goal, Dr. Lin explained, "is to identify sounds of geophonic, biological and anthropogenic sources from soundscapes so that we can transform acoustic data into metrics that describe the ecosystem health, biodiversity, human activities, as well as their mutual interactions." He believes that OBLP will allow managers and stakeholders to efficiently monitor marine ecosystem trends and perform data-driven decision making in conservation management.

Sound Mapping

Underwater acoustics, while excellent at painting an auditory map of the deep sea, can also paint a spatial one. Since GPS doesn't work well underwater, as radio waves break down in liquids, scientists rely on acoustic signaling for locating undersea objects like drones or animals. Motivated by the massive amount of oceanic territory that remains unexplored, researchers at MIT have developed a battery-free pinpointing system called Underwater Backscatter Localization (UBL). When asked to explain the technology, the scientists used the example of an underwater drone trying to determine its location to navigate. With UBL, the drone generates an acoustic signal or some sort of underwater sound, which "then travels and hits one of our battery-free beacons, reflects and comes back. The drone can measure the time it takes the signal to go, reflect and come back to measure the distance."

Underwater acoustics play another important role, aside from helping determine distance. The battery-free beacons, which employ piezoelectric materials, power up by harvesting energy from sound. To do so, the researchers explained, "Our node leverages a piezoceramic unit that is efficiently designed to convert the acoustic energy to electricity." Piezoelectric materials, which are used to both harvest energy and reflect acoustic signals, are key in overcoming the previous challenge of power-hungry tracking devices and deploying underwater GPS. With the ability to easily navigate underwater, scientists can boost ocean exploration. "We can furthermore use this technology for various other applications such as climatographic studies, underwater mining and asset management among others," MIT's research team said.



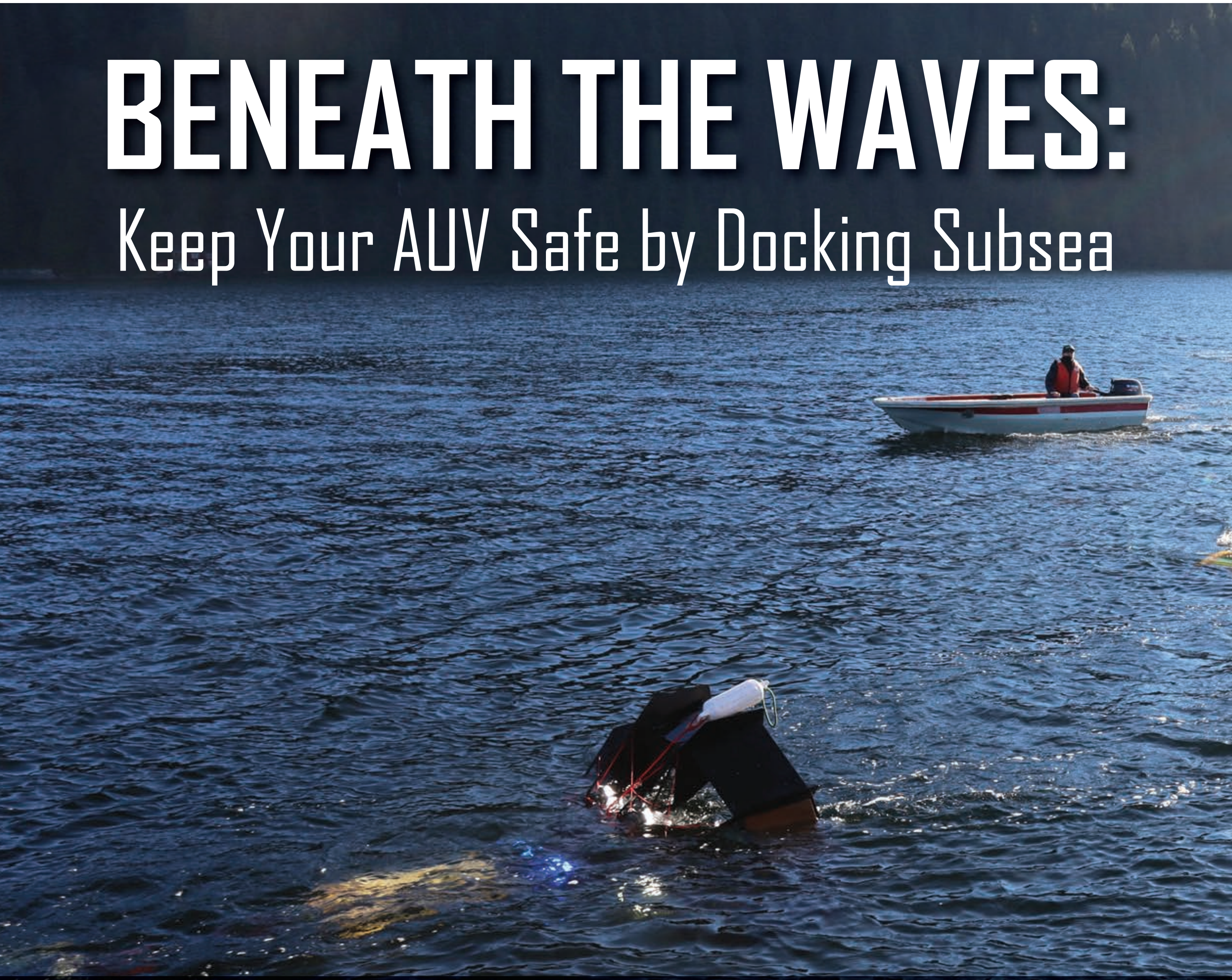
Underwater backscatter being tested in the Atlantic Ocean.

Fadel Adib (MIT)

The Beat Goes On

The future of underwater acoustics is an important one, as Dr. Lin expressed: "Since soundscapes can tell us so many things from the recording site, I believe that underwater acoustics will be an indispensable component for the future development of marine monitoring networks." The implications are plentiful and crucial to ecosystem management, whether through analyzing acoustic soundscapes to identify marine life patterns or safely and confidently deploying underwater drones to collect samples. Technological advancements, coupled with our natural curiosity and drive to explore the unknown, will give way to wonderful discoveries in the coming years.

If Percy's recent success represents humanity's latest interplanetary achievement, the exploration potential achieved on Earth with underwater acoustics is as bottomless as the deep seafloor.



BENEATH THE WAVES:

Keep Your AUV Safe by Docking Subsea

Find out about ISEs experiences with getting its Explorer class AUV to dock autonomously during it's recent sea trials.

By Luke Alden, Mechanical Designer,
International Submarine Engineering Limited

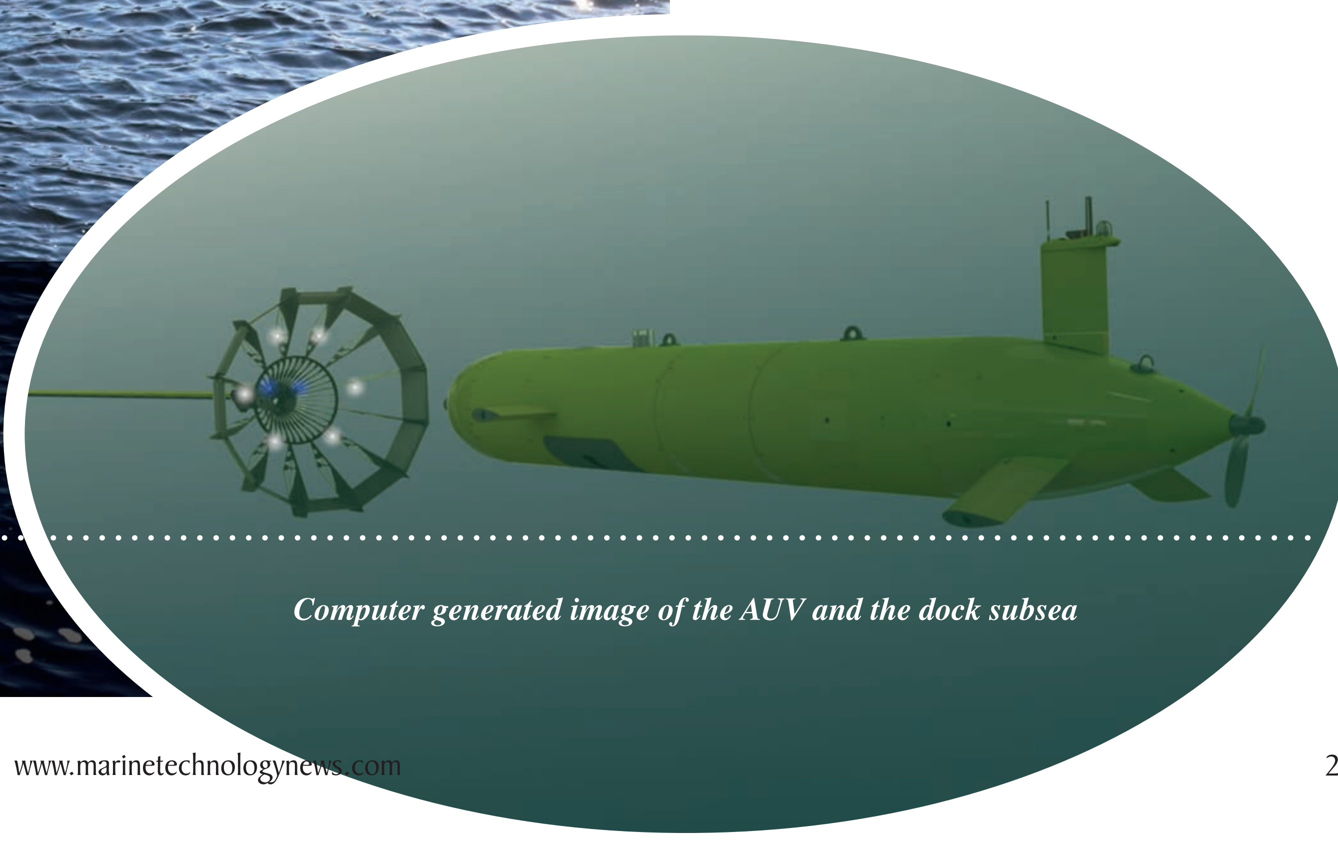
All images courtesy International Submarine Engineering

The atmosphere on the bridge of ISE's vessel Researcher is tense. All mission checks are complete; conditions are optimum for docking; everything looks good. The vehicle, a 5-meter-long Autonomous Underwater Vehicle (or AUV), is on mission underwater. Updates from the AUV are now limited to acoustic chirps every 30 seconds and everyone is waiting anxiously. Will it succeed?

Whenever an AUV is sent underwater to test new systems it is an exciting time, and for the ISE team onboard Researcher this feeling is nothing new. On this occasion, they were testing the results of their year-long autonomous docking development. The project, funded by Canadian Innovation for Defence Excellence and Security (IDEaS), used both vision and acoustic-based systems to locate, track, and home in on a towed docking station. In this article we will explain the benefits and challenges and how ISE overcame them, as well as looking at the next steps for this project.

THE BENEFITS

AUVs are incredible platforms for collecting subsea data without human intervention. One of their drawbacks, however, is that they still need a support ship to recover them for data download and battery charging. AUVs, like ISE's Explorer, are on the larger side to allow for longer duration and the integration of higher quality and power-hungry sonar systems. This can make the proposition of recovery even more daunting in heavy seas. It is an added risk for the operators, the operation and the AUV itself. With the ability to dock subsea, mission duration can be increased by allowing operators to recharge and retask the AUV without having to risk potentially dangerous recoveries.



Computer generated image of the AUV and the dock subsea

ISE's prototype dock being towed on the surface

All images courtesy International Submarine Engineering

Typically, the AUV deploys a float and line that is used by the operators to bring the AUV closer to the ship. This can be very challenging in harsh seas and there is a risk of the line fouling with the AUV control planes and thruster. Once close enough, the AUV has to mate with a ship that is often pitching and rolling. This stage is extremely dangerous as the recovery infrastructure can easily end up impacting the AUV. As the waves get bigger, so do the dangers.

With subsea docking that AUV can make the connection with the ship infrastructure beneath the waves. This increases mission endurance by allowing operators to recharge and re-task the vehicle without having to risk these potentially dangerous recoveries.

There is also an additional benefit: if the docking can be autonomous it can be solely supported by a large Uncrewed Surface Vessel (USV). This radically changes the AUV's mission capability and by removing a crewed surface ship, the costs are significantly reduced. With the AUV and USV paired like this their mission endurance can be measured in weeks - not hours - and they can both be launched from shore.

IDEaS has a keen interest in persistent maritime surveillance; the Department of National Defense want to know what is entering their waters. As there is such a vast Canadian coastline needing to be monitored, new thinking is required to find the best solution. Having a USV and AUV working together could be it.

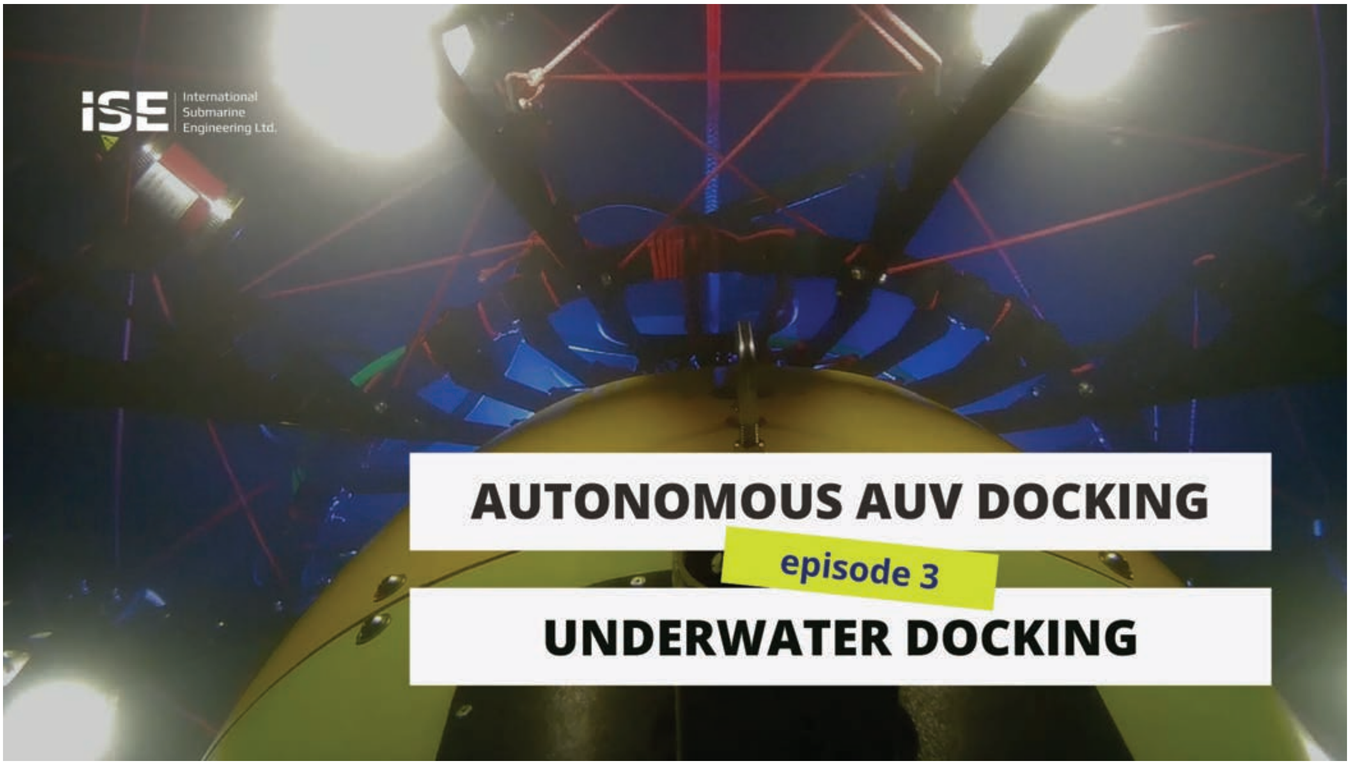
ACOUSTIC AND VISUAL TRACKING

"Range 26 meters. On acoustics." Jason, one of ISE's electrical engineers, breaks the silence on the bridge of Researcher. He has just received the first data packet from the AUV. It has successfully acquired the dock's acoustic signature using its forward looking multibeam echosounder. This is nothing new for the project, and at this point the AUV has repeatedly completed this stage of its mission at ranges up to 100 meters as part of ISE's testing plan. That said, it is still a big milestone. It means that the AUV has filtered out the strong acoustic returns in its field of view and has identified one that meets the criteria and has adjusted its heading to approach. It must be able to do this on its own as communication with the surface is so limited.

"Range 8 meters. It's switched to visual tracking." Jason again reads data from the AUV at the next important milestone. The AUV has assessed that the quality of visual tracking is good enough to switch away from acoustic tracking. It can now see the light array on the dock and is using it to calculate the dock relative position, speed, and attitude. This capability took months to develop using techniques such as computational neural networks to train the vehicle to recognise the LEDs and array being used.

When deciding on the dock design, ISE opted to make it as simple and as passive as possible, taking a similar approach to aircraft in-flight refueling. The reason being that the AUV is already a very capable and maneuverable vehicle. Designing a complex system that required a pilot to aid the docking process wasn't in the spirit of what they were trying to achieve.

The resulting dock was designed to be a stable platform with a half meter target cone. As long as the AUV impacts within this cone, the dock will self-align and aid the process. It was also designed with a two-part tow cable to help decouple the dock movement from the surface waves.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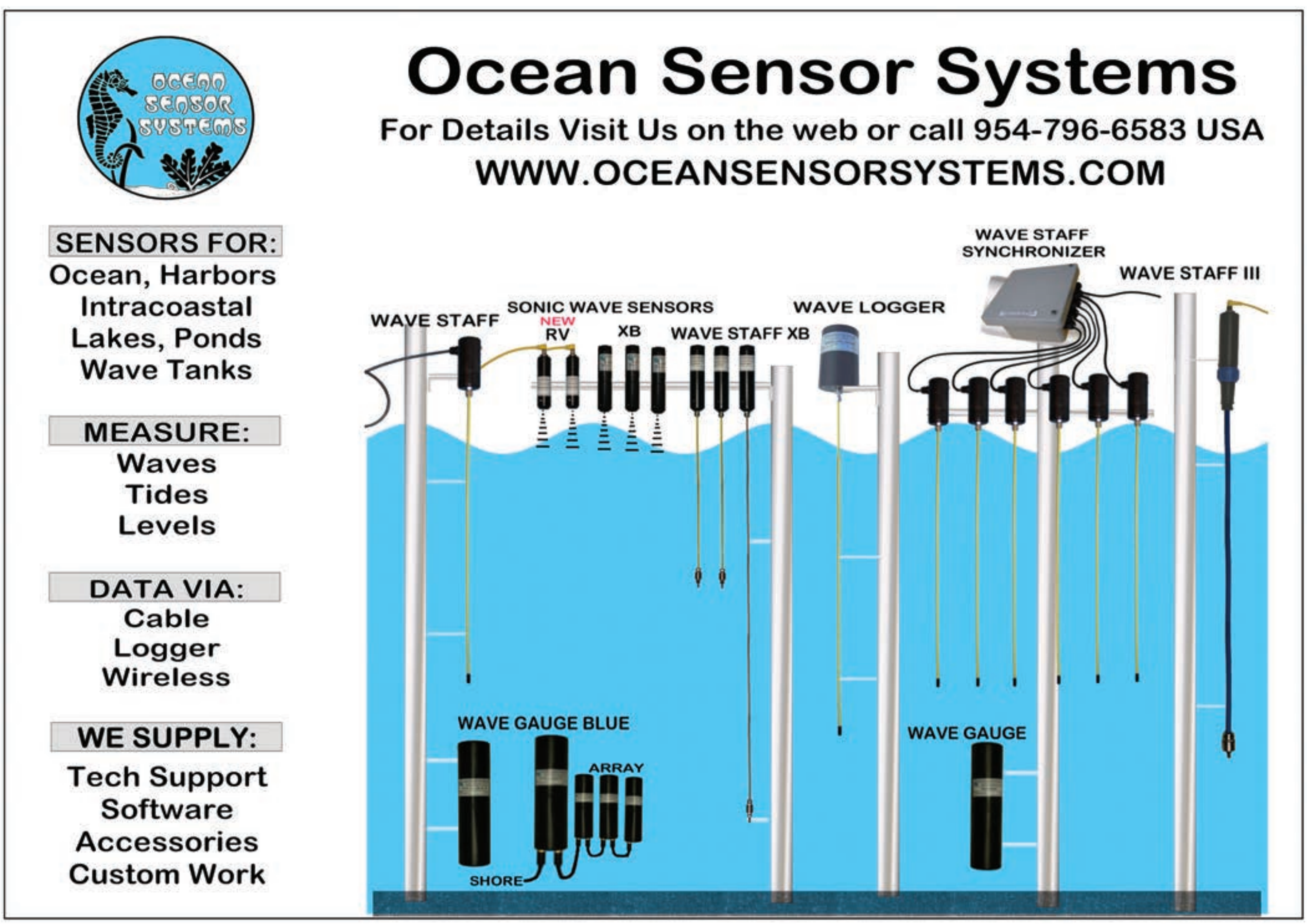
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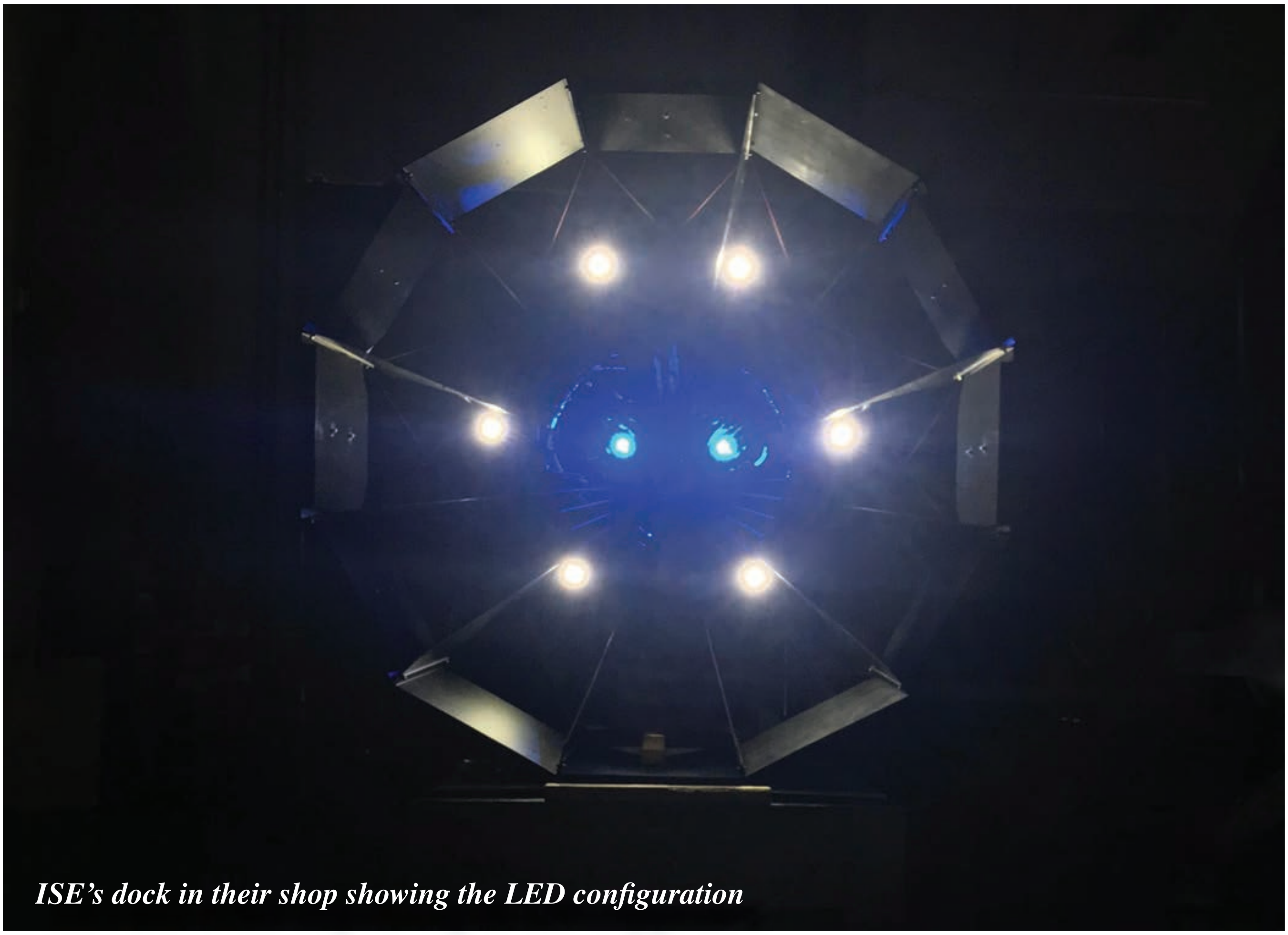


ISE's dock in their shop showing the LED configuration

All images courtesy International Submarine Engineering

DOCKING

"Range 3.5 meters. We're on 380." Back on Researcher, Jason breaks the building tension yet again with the next big event. '380' is the name for the section of the mission where the AUV attempts its final closing stage. It has evaluated that the conditions are good and switched to the next stage. In this phase there are several safety features designed to minimise risk of damage to the AUV and dock. If the vehicle has not received a signal that it has latched within a certain time frame, if it travels over a certain distance, or loses tracking on the LEDs, it will automatically switch to the abort phase of the mission so that it can back away and try again later. These abort conditions were considered at great length by the team at ISE, as trying to hit something with the AUV is the opposite of what they normally intend to do.

Everyone on the bridge is now anxiously waiting for the next update. They've double and triple-checked everything. On previous days, the AUV had completed every part of the mission except this final one, will it succeed? The next update arrives: "We have telemetry, and we're docked!" It made it!

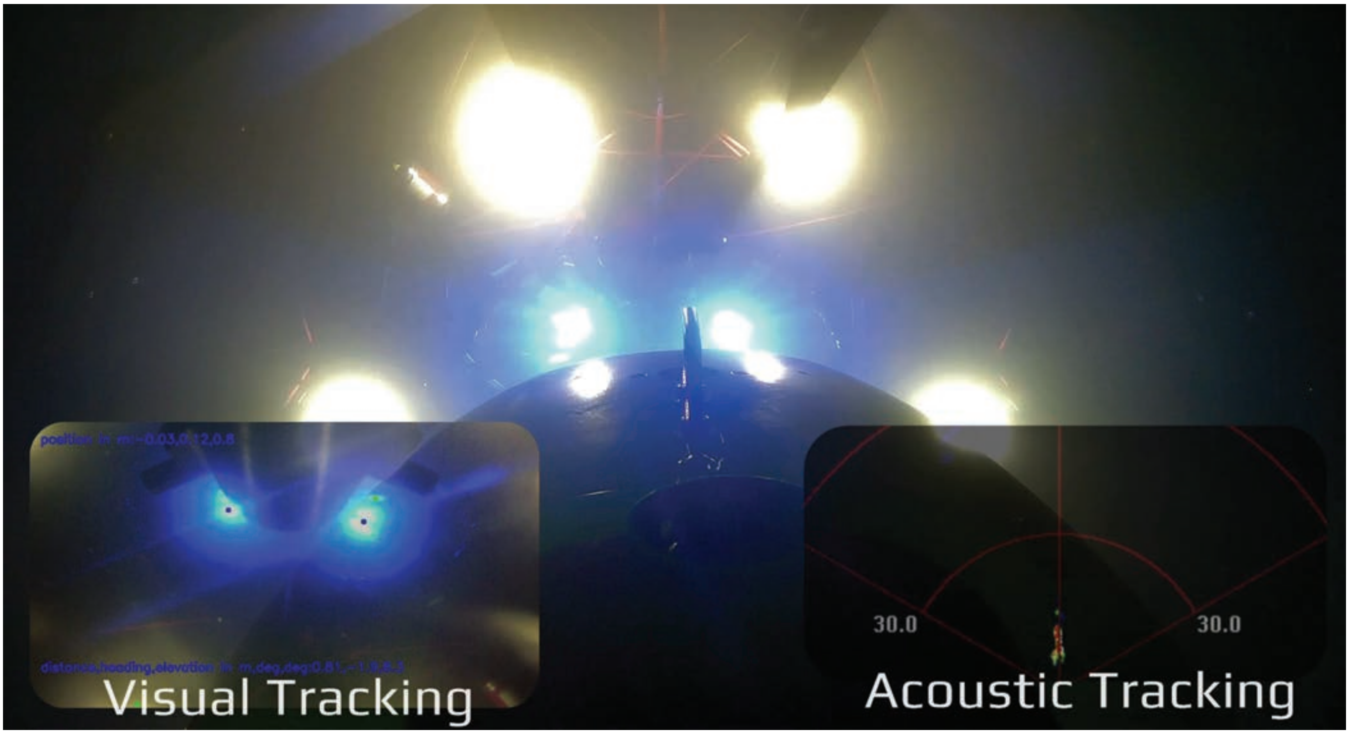
Although the sense of achievement was felt by the whole ISE team, they weren't content with docking just once. They wanted to accomplish this repeatedly over several days and gather data on the system performance. This feedback would not only help to inform the next stage design decisions but would prove that the first success wasn't just luck. Over the next few days, the AUV successfully docked five more times, giving the team plenty of data to work with.

THE NEXT STEPS

Now ISE has completed this stage of the project there are many options for continued development. Various lessons were learned during these sea trials - as is always the case with prototypes. For example, the dock can be made smaller and simpler to launch and the tracking algorithms can be improved to make them more robust.

For this project ISE focused solely on docking as this was what they identified as the gap in the market. This capability has many benefits and possibilities as previously mentioned. However, if the system were also able to recover the AUV that would open up even more possibilities, especially as more offshore work moves to utilising robotic systems operated from shore.

Whatever the final system looks like, its clear that there is a lot of potential to improve our current subsea survey operations.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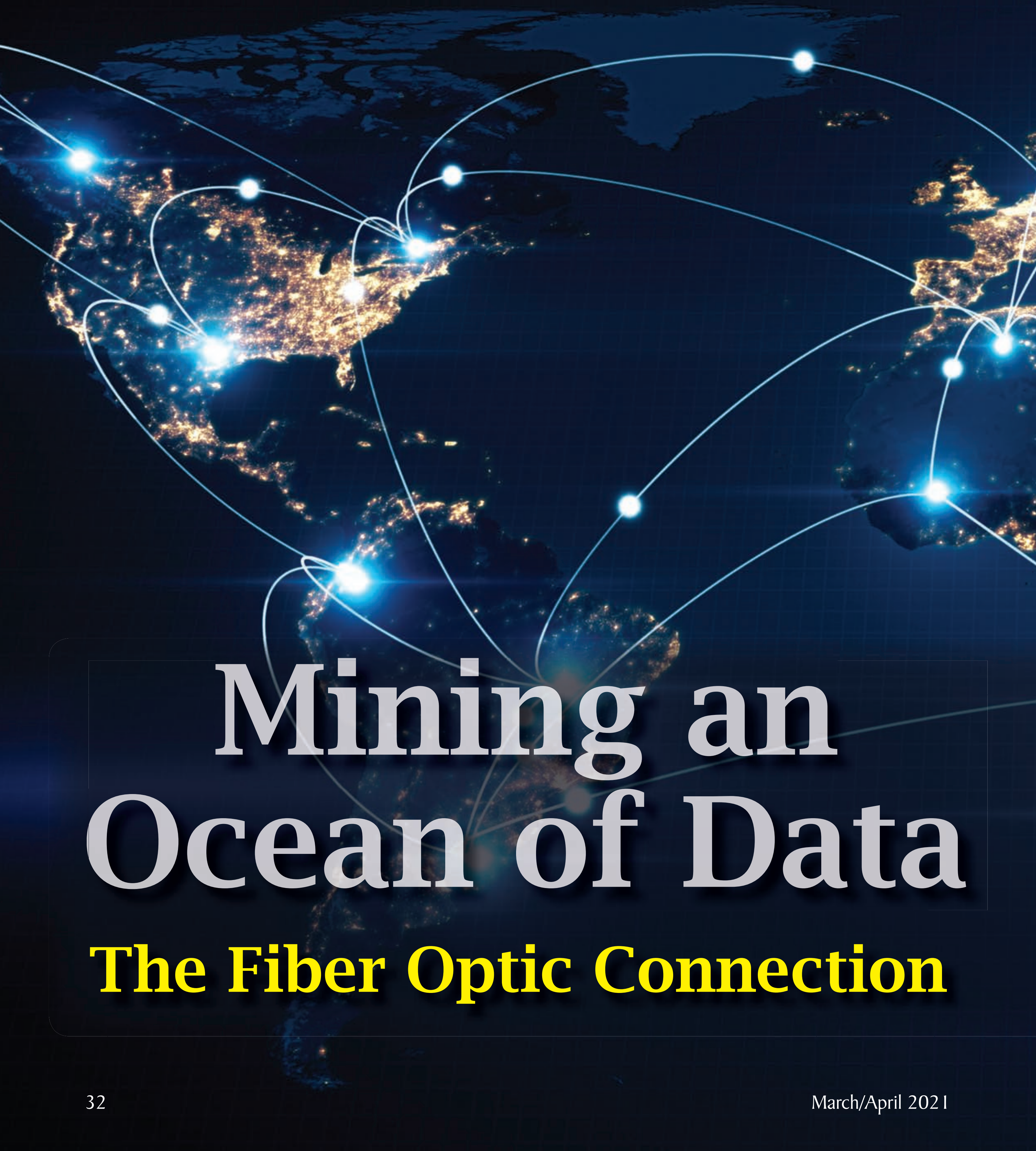


Mining an Ocean of Data

The Fiber Optic Connection

Adobe Stock © flashmovie

Fiber optic sensing is opening up vast new areas of research and data gathering potential, not least across our oceans, where existing cables could offer a new global sensing network.
Elaine Maslin ***reports.***

Criss crossing between our nations, across channels and between continents are a multitude of cables – some 120 million km of them. Some are pretty old (the first international submarine cable was laid across the Channel, between the UK and France, in 1850). But many laid since the 1980s contain fiber optics and provide the conduits for everything from those YouTube cat videos to stock market data.

An increasing number of researchers are now hoping that they can also use these cables to create a global sensing network that could tell us a lot more about the earth – and much else besides – using distributed acoustic sensing (DAS).

DAS involves using a photonic device that sends short pulses of laser light down an optical fiber and detects the backscattering created by strain in the cable that is caused by stretching. With interferometry, they can measure the backscatter every 2 m (6 ft), effectively turning a 20-km cable into 10,000 individual motion sensors. This capability could plug a huge gap in ocean sensing.

"For geophysicists, there's a big gap in instrumentation below the ocean," says Dr. Diane Rivet, Seismologist Professor Assistant - Head of OCA Seismological Observatory, Observatoire de la Côté d'Azur - Univ. Côte d'Azur. "The ocean covers 70% of the earth's surface, so it's a blind spot for us and there's no way to measure what's happening on the seafloor using remote sensing. For seismologists, this is very important for understanding seismicity, volcanic activity and natural hazards that take place below water."

It's been something of a journey but there's a small but growing band of researchers and now commercial operations looking at it. One is Dr. Nate Lindsey, Lead Scientist at FiberSense, a young company providing digitally inter-connected fiber-based sensing solutions. "When I first started looking at DAS we were working on permafrost thaw detection with the Cold Regions Research and Environmental Lab in Fairbanks, Alaska," he says. "Installing cables ourselves in a field took weeks, so it was difficult to understand how this technology would grow to any significant scale. But during that experiment we started seeing earthquakes across the world on our Alaskan DAS array." Seeing the potential, but also how long it took to lay new cable, led to the idea to use already installed fiber. And, from there, it was a short leap to thinking about using offshore cables, where it was even harder to deploy sensors, especially high resolution systems.

Seismic waves generated by a 1.9 magnitude earthquake located north of Fréjus (Var), recorded along the 41 km-long fibre optic cable deployed on the seafloor off Toulon.

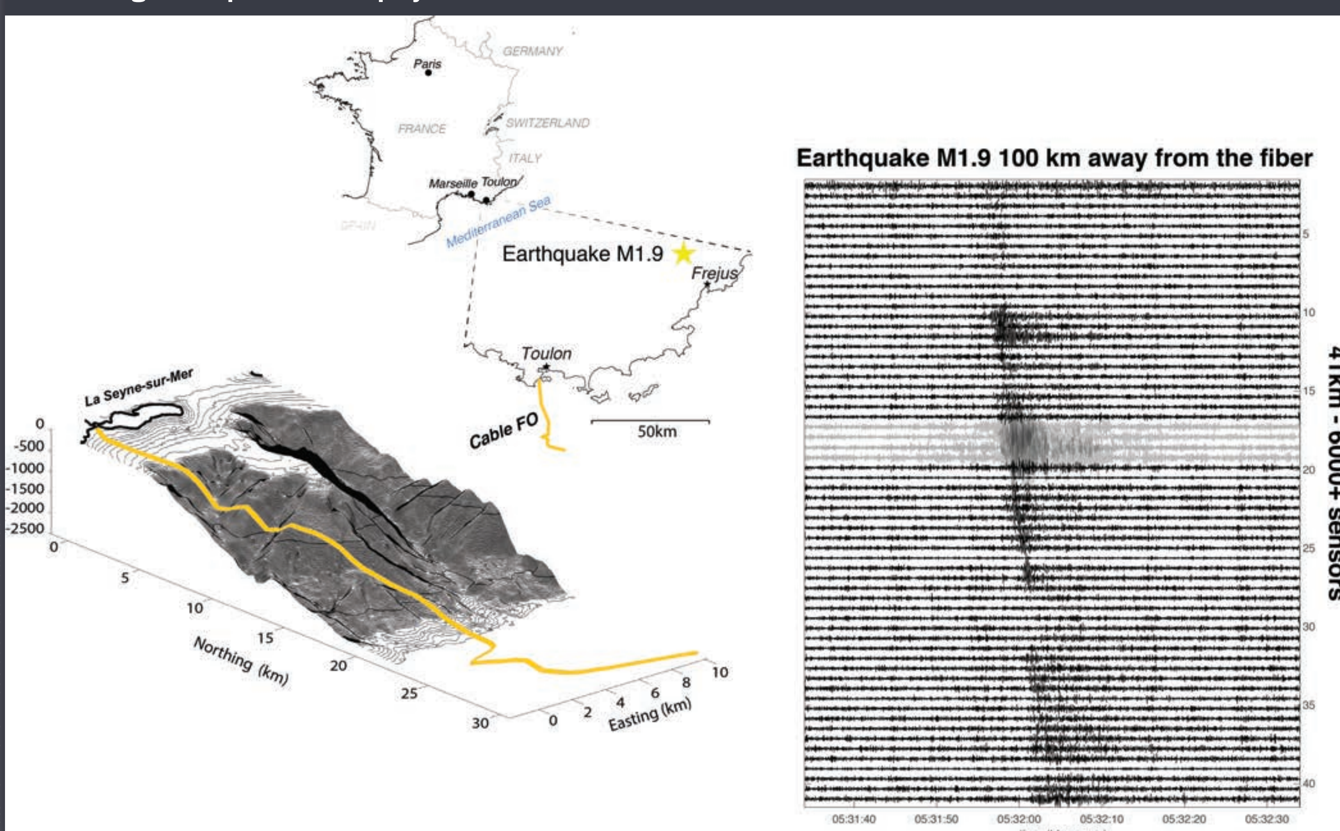


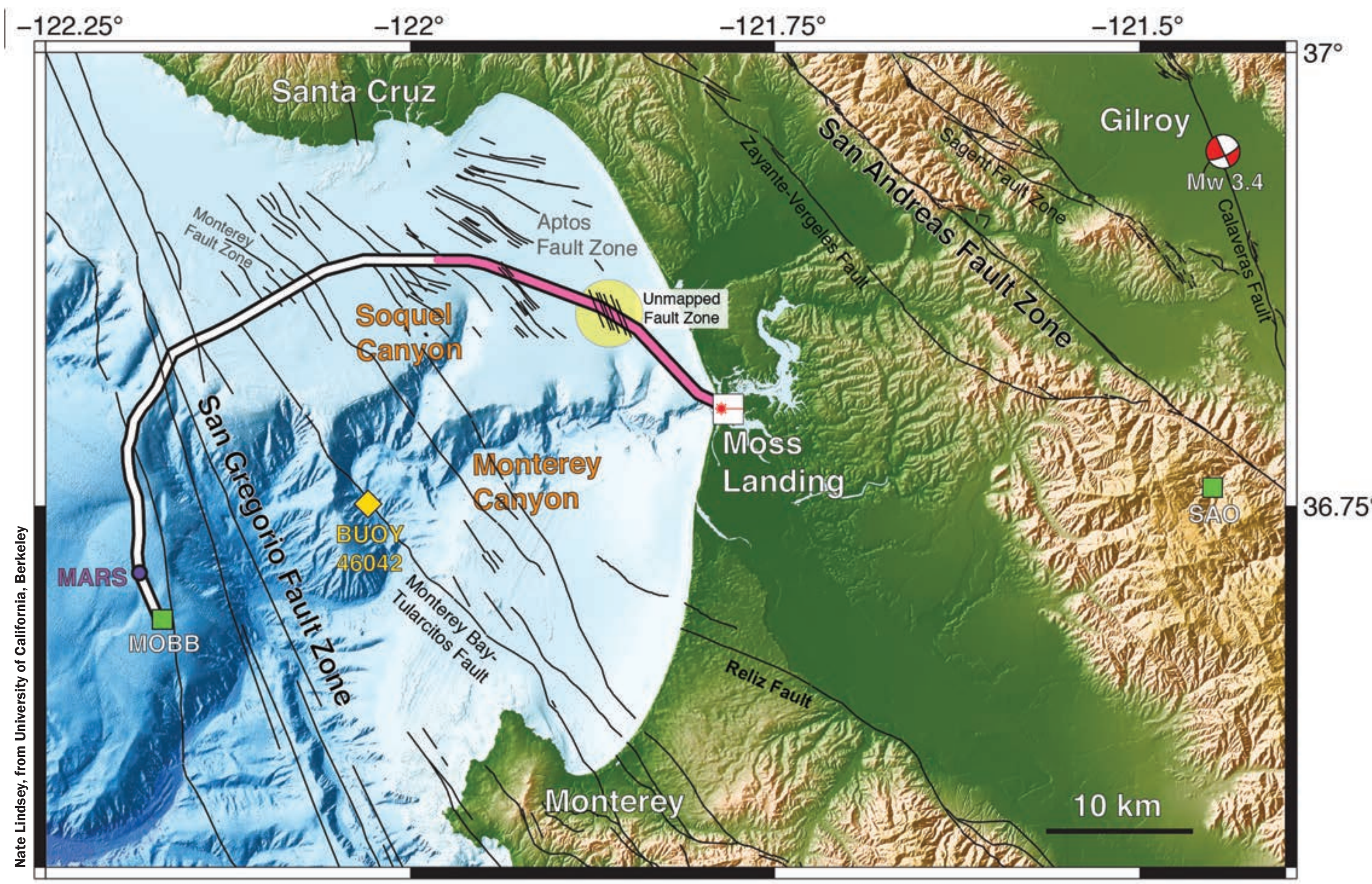
Photo from Diane Rivet Sladen et al. nature com. 2019.

That project led to an experiment, in March 2018, involving the University of California, Berkeley (where Lindsey was a graduate student), Lawrence Berkeley National Laboratory, Monterey Bay Aquarium Research Institute (MBARI) and Rice University. The idea was to use a 20 km-long section of the 51 km MARS fiber optic cable used to communicate with seabed instruments to gather oceanographic or seismic signals. The cable was going to be "dark", i.e. not in use, for a few days for maintenance. That made it available for the DAS experiments.

The experiment delivered even more information than expected – from a magnitude 3.4 earthquake that occurred 45 km inland to the drumbeat of shoaling ocean waves, called microseisms. Multiple known and previously unmapped submarine fault zones were also mapped. For example, the team were able to use seismic scattering to map out the local San Andreas Fault System and detect previously unknown faults within it. "DAS can focus our picture of earthquake hazards in the coastal oceans providing new information about fault orientations and seafloor structure," says Lindsey.

At around the same time, other groups in Belgium and France

Researchers used 20 km (pink) of a 51-km undersea fiber-optic cable, normally used to communicate with the Monterey Accelerated Research System, as a seismic array to study the fault zones under Monterey Bay.



Nate Lindsey, from University of California, Berkeley were also trying out the same idea. In Belgium, a group from California Institute of Technology (Caltech) tried out DAS on the first 42 km of a dark fiber connected to an offshore wind farm. It was originally installed to monitor a power cable for the Belwind Offshore Wind Farm. It had channel spacing of 10 m, creating 4192 simultaneously recording seismic sensors. During the study, in August 2018, it recorded an earthquake of magnitude 8.2 near Fiji.

At the Université Côte d'Azur in France, three cables, one in France and two in Greece, were used to help test this new concept and assess its capabilities. Measurements along a 41.5 km-long telecom cable that is deployed offshore Toulon included a magnitude 1.9 microearthquake some 100 km away.

"It was completely new, recording data on this cable looking for earthquakes," says Rivet. "But we also observed other phenomena, like the interaction between ocean waves and the seafloor. If we can see this, maybe we can also see acoustic signals in the water column and listen to what's happening. We see a lot of very interesting signals.

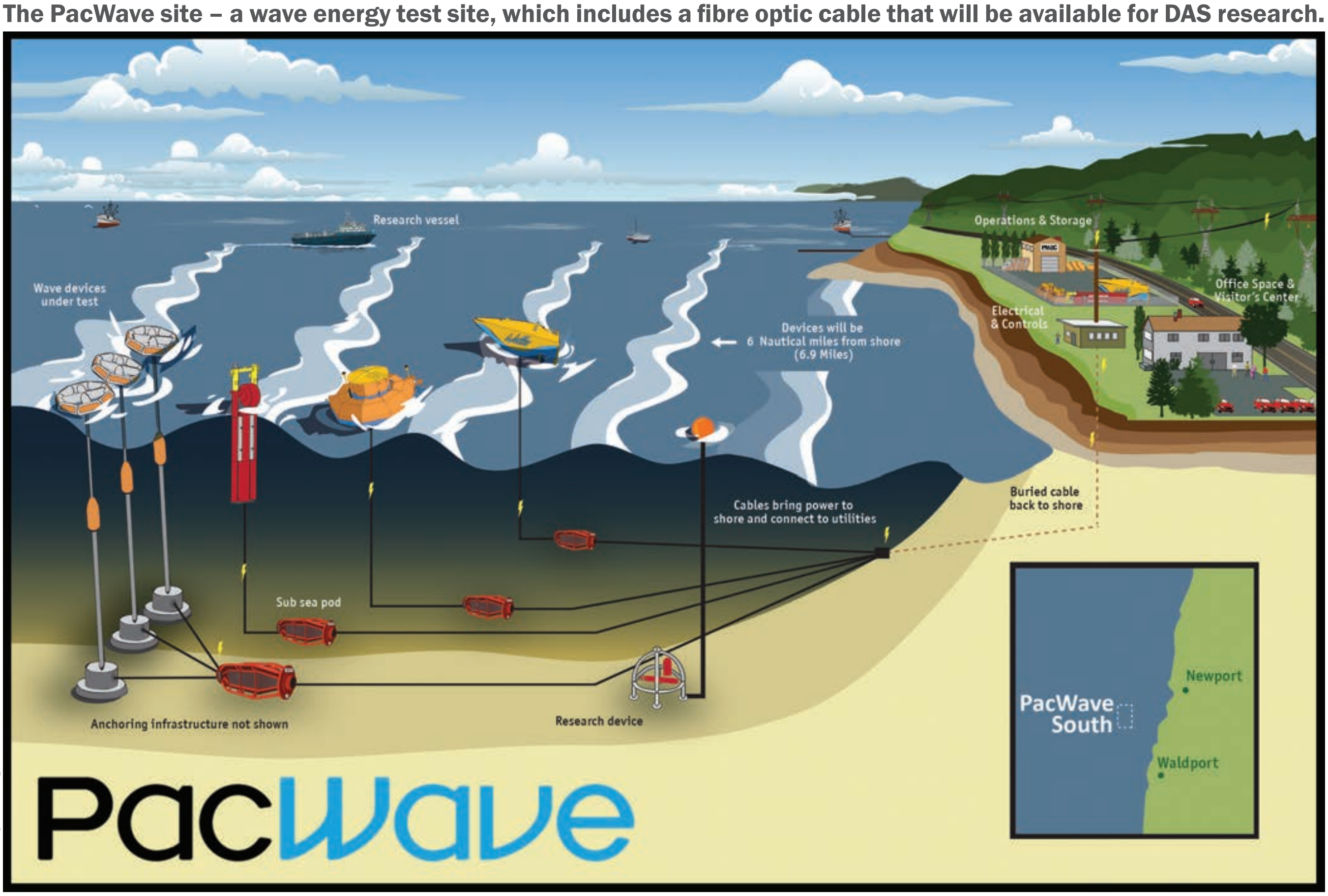
"What's important is that this is an opportunistic instrument," she adds. "We're using cables that were installed for something else." All the researchers need to do is plug in their interrogator. "It is also real-time. With a seafloor instrument or a floating device, it's difficult to have real time transmission of the data. We can do this with DAS."

One challenge is that it can only see lower frequencies with current DAS instruments, such as below 1kHz, but while that's low frequency for acoustics, it's high for seismologists and enough to detect boat signals – from as deep as 2,000 m. she says. "What's also nice is that it's an array, so even if you have low sensitivity at each sensing point, by using all the points together you can enhance the signal and assess information, such as vessel position and velocity," adds Rivet. The team is also looking at whether mammals such as whales could be detected and tracked.

Other challenges are not knowing exactly where the cable is – sometimes the uncertainty is up to 10m. As seabed bathymetry can affect the signals, influencing what DAS senses. But characterisation of these acoustic and seismic signals could enable analysts to understand the bathymetry the cable is on, if the cable moved or even the soil condition, says Rivet. It's also currently only possible to use the first 50-100 km of a cable (even 200 km with some technology), but that's already encompass numerous areas of focus for the scientific community and this limited distance would be extended over time, she says.

For Rivet, the goal is to better understand the interaction

The PacWave site – a wave energy test site, which includes a fibre optic cable that will be available for DAS research.



University of Oregon

between the ocean and seafloor as part of understanding the earth's crust and how it's structured and changes. That includes looking at active faults that it's not been possible to look at before. "It's a very new field and we're learning new things every day," she says. "It's all new data we've acquired, that we've never seen before."

This area has been aided by advances in photonic and signal processing. "There have been a couple of step changes that make what we are doing today possible; for example, the quality of the laser light, the way we recover strain data from random Rayleigh scattering down the fibre, how we handle and process terabytes-per-day, and how we make sense of this information."

It's opened the field up. Many others are now getting involved, across the US, Canada, Japan and Europe. A challenge is that dark fibers can be limited offshore. But this may change in the future as the technology could evolve to share spectrum with in-use fibers, enabling DAS to run in a cable without disrupting its main use, i.e. data transfer.

Still there is hope. The new Fly-Lion3 submarine fiber optic cable is being laid to provide internet connectivity to the Indian Ocean island of Mayotte, northwest of Madagascar. It's also been agreed that scientists will be able to use it to detect earthquakes related to a newborn submarine volcano near the island.

Oregon State University has also got funding to install fiber that can be used for DAS work. It's due to be installed off North Carolina next fall and will extend 1-2km out to sea. Another cable is being installed in Oregon that will stretch 20km out to a wave energy test site. This will also be available for DAS measurements.

Meagan Wengrove, Civil and Construction Engineering Assistant Professor at Oregon State University, is looking to use DAS for coastal hydrodynamic and sediment transportation studies, where traditional instruments are limited. "DAS is a sensor that can measure over potentially 100km with a really fine resolution down to 10m and that range makes it really unique for nearshore ocean monitoring," she says. "The models we currently use to predict coastal changes after big storms are only accurate 50% of the time – there's still a lot of room for improvement. DAS technology can give us the ability to monitor over longer periods of time and ranges, and over storm events and constrain how the sediment is moving." In turn, this will help coastal communities better understand how vulnerable they are and to then do something about it. "Data from the new fiber arrays will be able to feed into the DUNEX – During Nearshore Event Experiment – project, an academic, federal agency and non-governmental collaborative experiment to help understand how hurricanes impact the coast," adds Wengrove.

There are lots of other ideas of how these cables could be used and efforts to get access to existing cables. The SMART Cables Joint Task Force is an international effort to get sensors incorporated into commercial trans-ocean submarine communication cables for ocean and climate monitoring and disaster warning, for example.

"There are many potential uses. As DAS creates an array, a single cable can be used for monitoring anthropic noise such as marine traffic that impacts marine lives," says Rivet. Work is being using machine learning to identify useful signals, which could have obvious uses in submarine detection. Cable could also be deployed for subsurface imaging, if paired with a source, like traditional seismic data acquisition. Being able to spot where noise is coming from could be used for many applications from deep sea mining surveillance to wind farm monitoring, suggests Lindsey.

It's just the start for this technology. To help spur it on, there's also a National Science Foundation funded DAS Research Coordination Network that's linked researchers globally to help spur innovation and understanding. It's a fast-evolving space. You could say it's moving at light speed… (sorry!).

All photos Sustainable Marine Energy

Jason Hayman

CEO, Sustainable Marine Energy

Harnessing the power of the tides is not for the squeamish, with the roster of trials and failures long and distinguished. Jason Hayman and his Sustainable Marine Energy crew are putting their tech to the test in one of the harshest spots on the planet, the Bay of Fundy, as his discussed with Marine Technology TV.

By Greg Trauthwein

Jason, to start, how did you come to a career in the offshore renewable energy field?

I suppose my interest got piqued back in about 2003. I went to a lecture at the University of Newcastle and they had a wave energy crowd there and a tidal energy developer. It was pretty cool tech, and at the time I was working on a FPSO topside installation in a shipyard in Newcastle. So I was working for "the dark side" and I had my eyes opened. I think I had a moment where I thought "this is where the next 30 years is going to be," which is figuring out how to (extract energy from the marine environment) renewably.

We understand that your company has developed a platform for floating tidal energy. Can you give us a brief on the technology and specifically how does it work, and is it scalable?

Our technology is basically a trimaran. It's on a big swinging mooring and it's got some outboards off the back, outboards not propelling it forward, instead basically the hydro generators, which are capturing the energy in the flow going past the platform. So the loads are fairly big and the thing is pretty beamy because those turbines are fairly large.

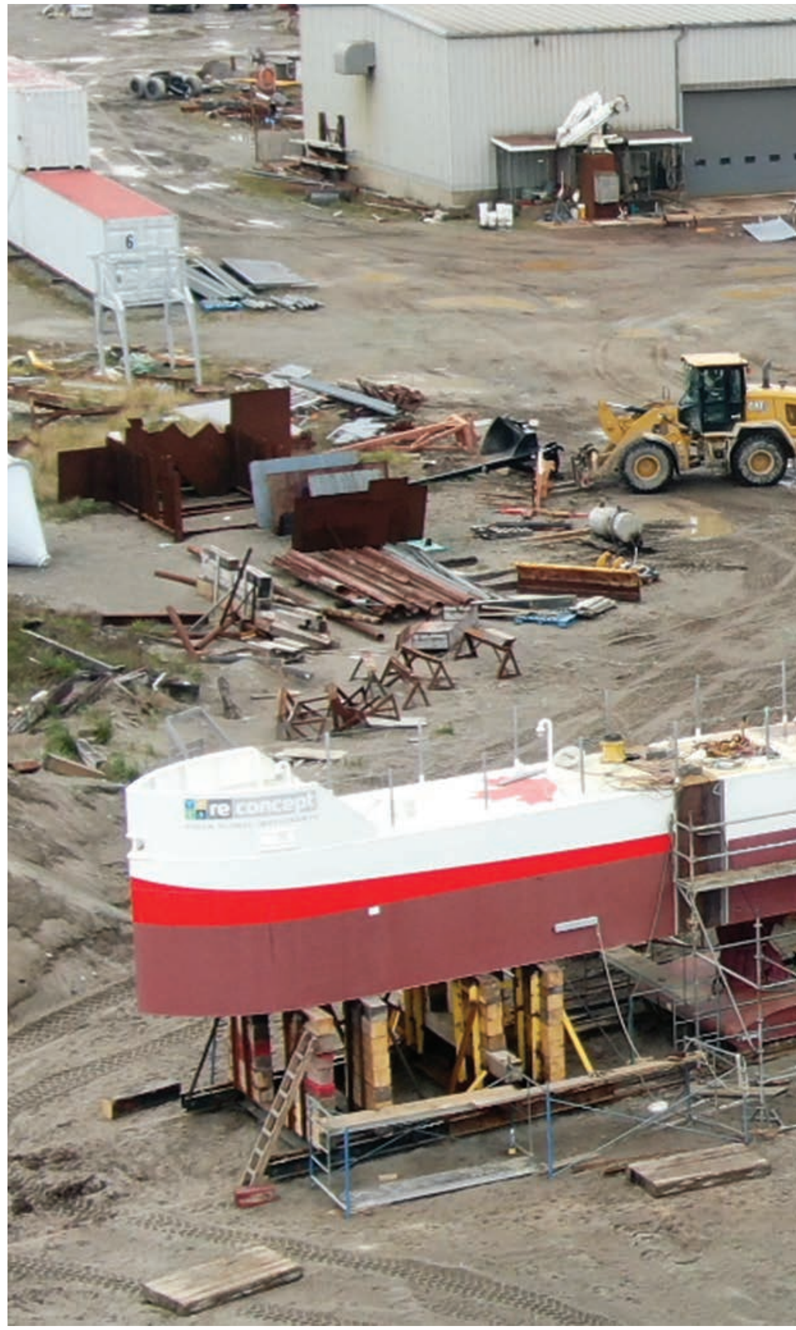
We've settled on a drivetrain, which is about 70 kW, but we can scale the rotor diameter to the turbines, depending on the site characteristics. Whether it's a moderate resource, like six, seven knots, or a fierce site like FORCE, which is more like 10 knots. And then we can vary the number of turbines that we put on the platform: we can do two, four or six at the moment. That means we can get anywhere from 70 to 420 kW at one platform.

What do you consider to be the key technical points of your system?

The first project I was involved in with Voith Hydro out in Korea, installing a first-generation gravity-mounted turbine, was a fantastic project. But the heavy lift gear and everything that was needed to put it on the seabed was huge and expensive. And if you just had something go wrong, one little component on the auxiliary system failure, you'd have to lift this whole system up with hundreds of tons to be able to do it.

That's what drove us towards thinking about a floating system, and in developing a floating system, the real challenge is dealing with the huge loads through the mooring system.

To give you an idea, two of our turbines produce the same thrust as an F-35 fighter jet on full afterburner. You take our new six-turbine platform, and that's like taking three F-35s, telling the pilots hit full throttle, and putting that on a leash. We had to really think about it literally from the bottom up, and we developed an innovative rock anchoring system where we lower a remotely-operated tool onto the seabed, we drill and install a rock anchor in one hit. And we've got to do that within an hour, deck to deck, because we've got to do it at slack tide. That's really challenging.

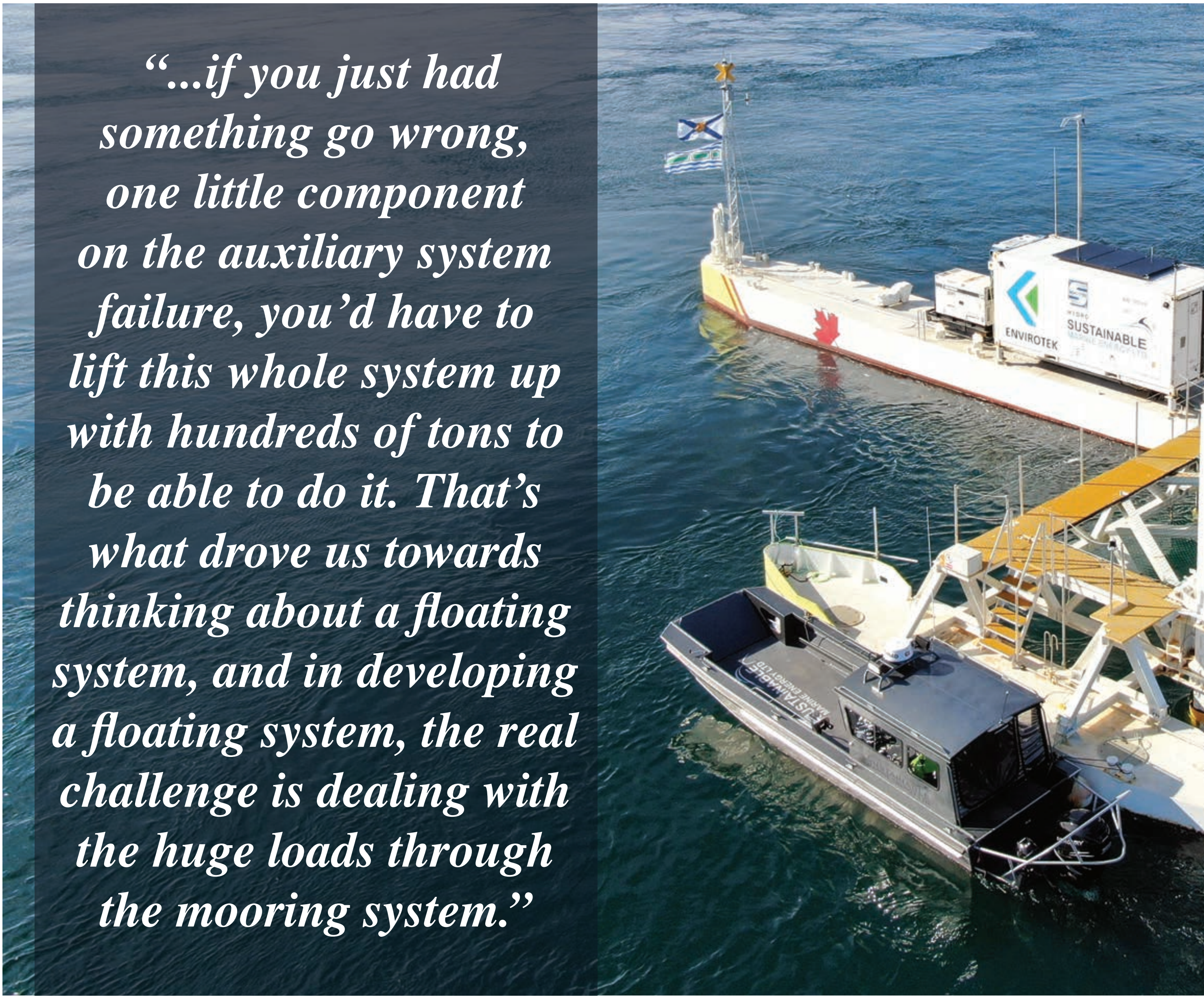


Then we've got to think about the mooring side of it, which it's not just a simple chain, all one size all the way up, because we've got to think about how the different parts of the mooring system work. Why … because we've also got to deal with rise and falls of the tide of up to 15 meters at FORCE. And then we've got a mooring turret, it's on the platform itself, which is what we connect the mooring into. That's got to allow the power export cable to come up through the center of it, through the geostationary portion, and then it's got to react all that thrust that's coming through the structure.

Well, it sounds like there's a lot going on there for sure. Jason, we understand that the system has been put to the test in the field. Can you give us some specifics on that? And also, can you discuss the activities that you have planned for this year in the Bay of Fundy?

The first test deployment was on the west coast of Scotland from the winter of 2017 through to the summer 2018. And then we pulled it out and took it over to Canada, to Grande Passage, in the mouth of the Bay of Fundy, and that's where we've been testing it since we installed it there in September 2018. We've had some brief ins and outs to fix things, but we've had a pretty steady run for a bit more than a year there.

Then we have our next generation platform, which is going to be going into our first commercial project at FORCE and is literally sitting on the slipway at A.F. Theriault (at the time of the interview in February 2021). Then in the summer we'll be commencing the installation of all of our balance of plants. That's all the cabling, anchors and moorings. That first platform will be followed, hopefully, by two more by the end of the year.



"...if you just had something go wrong, one little component on the auxiliary system failure, you'd have to lift this whole system up with hundreds of tons to be able to do it. That's what drove us towards thinking about a floating system, and in developing a floating system, the real challenge is dealing with the huge loads through the mooring system."

Among you strategic partners, can you discuss your relationship with Schottel Hydro?

Schottel has been in the marine sector for a long, long time with its propulsion units. About 10 years ago now, they started an initiative to start to (leverage their know-how from the propulsion units) and turn that into a tidal turbine. They have done some work for other tidal turbine technology developers, supplying drivetrain components and subsystems. And in the meantime, they've been developing this small drivetrain themselves. We were partnering with them for a while using their drivetrain in our early prototypes, then we reached a point where we said, "Okay, well, you guys have got part of the system, we've got part of the solution. And ultimately all people want is one package." So we teamed with them, and they've actually now become the largest shareholder in our business.

Excellent. So how are you investing in the coming 12 to 24 months?

The main investment that we're making this year is in the team and the infrastructure required to deliver our first 9-MW commercial project at FORCE, which we're going to be delivering here in phases over the next three to four years. So this is about ramping it up; this is about moving from R&D and prototyping into commercial delivery mode. And that, of course, requires some pretty substantial investments in equipment. We just bought a couple of small support vessels. We're developing a new rig for anchoring at FORCE because it's a pretty brutal environment.

What do you see as the key hurdles to bring tidal power to utility scale?

I think first is the public acceptance, the social license, especially within the Bay of Fundy. Hopefully we can bring long-lasting economic benefit back to that area. It's not like what's happening in the North Sea, where the (oil and gas) resources are going to one day run out and then the industry is going to wind down and people are going to be looking for jobs. I think people have got to understand it's a long-term play, but it's hard yards to get there. It's going to require support and once you start deploying at scale, costs are going to come down. We've seen that with offshore wind. But you've got to get to deployment at scale and make it meaningful.

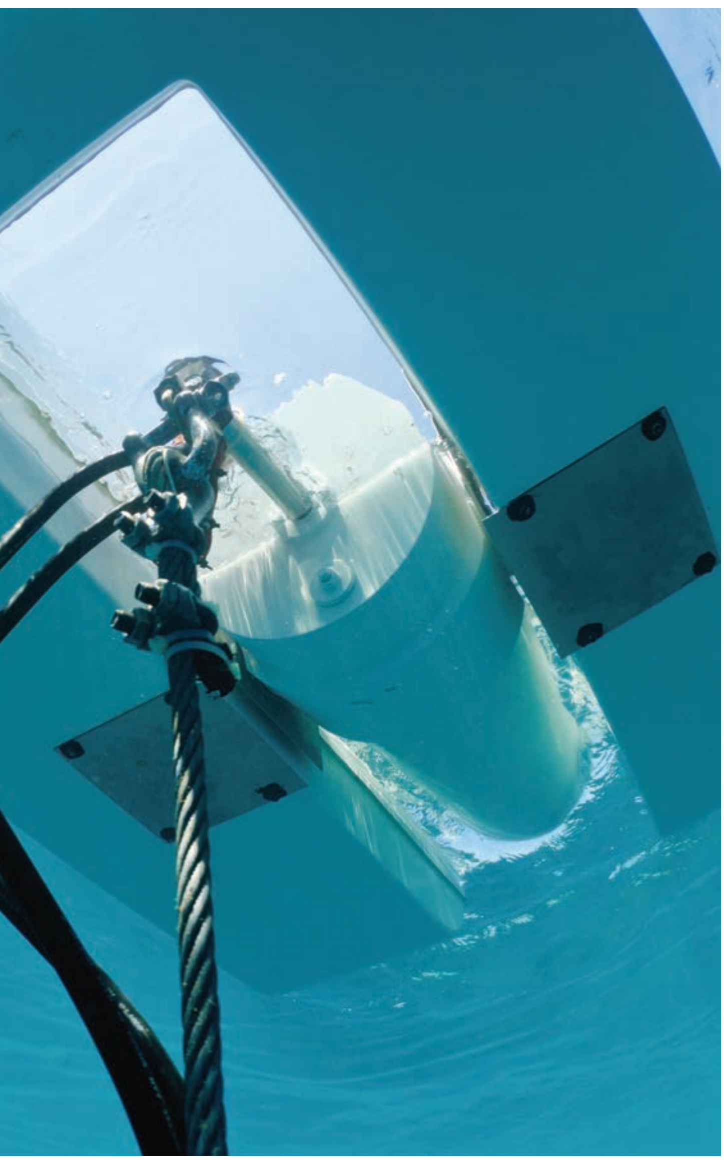
Smart Power Buoy:

Wave Power Expands Recharge at Sea Possibilities

*From powering sensor systems to recharging autonomous vehicles to feeding the power grid, Resen Waves is making step changes in the renewable wave power market. **Roland Boysen, CCO**, discussed the technology and the potential with MTR.*

By Greg Trauthwein

Three images on spreaed: Photographer Matthew Oldfield



While generations of innovators have attempted, to varying degrees of success, to harness the tremendous renewable power potential of waves, the Danish company Resen Waves contends it is able to do just that, in a scale to remotely power sea-based instruments and vehicles, and eventually all the way up to entire cities.

The Resen Waves Smart Power Buoy is designed to harness the constant movement of waves to power autonomous machinery (AUVs) and instruments in the sea with clean, renewable, continuous energy while facilitating real-time, uninterrupted data communications.

Resen Waves' Smart Power Buoy sits at the crux of an important crossroads and that's renewable energy and the emerging need to provide power at sea. While working in the sea is never simple, Roland Boysen, CCO, contends that his company is cracking the code on generating power from waves safely, efficiently, and yes, simply.

The Resen Waves Power Buoy powers a battery pack on the seabed through the mooring line.

That battery pack can then feed power to various instruments and machinery in the sea. In addition, the buoy can log data from connected instruments. These instruments are connected through a fiber optic connection. This data will be transmitted from the buoy to shore per satellite, 3G or 4G connection.

"We have the floater which carries the weight of the whole mechanical package," said Boysen. "The floater is basically foam and glass fiber, to keep it simple. Then there's a shaft where you have the center drum. If you look at it, you see kind of yo-yo shaped design, which is working as a more or less as a pulley." The small-scale buoy for powering instruments in the sea and providing real-time data access the instruments in the sea uses the center drum in the buoy, a drum which turns back and forth with the wave action, and activates the generator inside the drum and produces electric power.

"We have a unidirectional gear and that makes the generator rotate only one direction," said Boysen. "This way it won't lose momentum." The mooring line can vary in length depending on location, it is 'Kevlar armored' and inside this armoring is the power cable and, if applicable, a fiber optic cable.

"On the seabed, you have an anchor that could be a concrete block, it could be a sand screw, but you also have a large battery package, which is powered or charged through the power cable," said Boysen.

Born to live and work at sea, Resen Waves' Smart Power Buoy is naturally designed to withstand the elements, including a feature that lets it submerge – automatically or via remote control – in the event of excessively big storms that otherwise might destroy the system.

"You can tell the device to dive just below the surface because of this tensioning mechanism we have built into the cylinder," said Boysen

WORKING IN THE FIELD

While the possibilities for its use are broad, Boysen said it has generated ample interest from those running ADCPs. In addition, as the autonomous with persistence trend continues to unfold, there will be countless numbers of AUVs, USVs and even airborne drones that constantly need repowering. As anyone working in the industry can

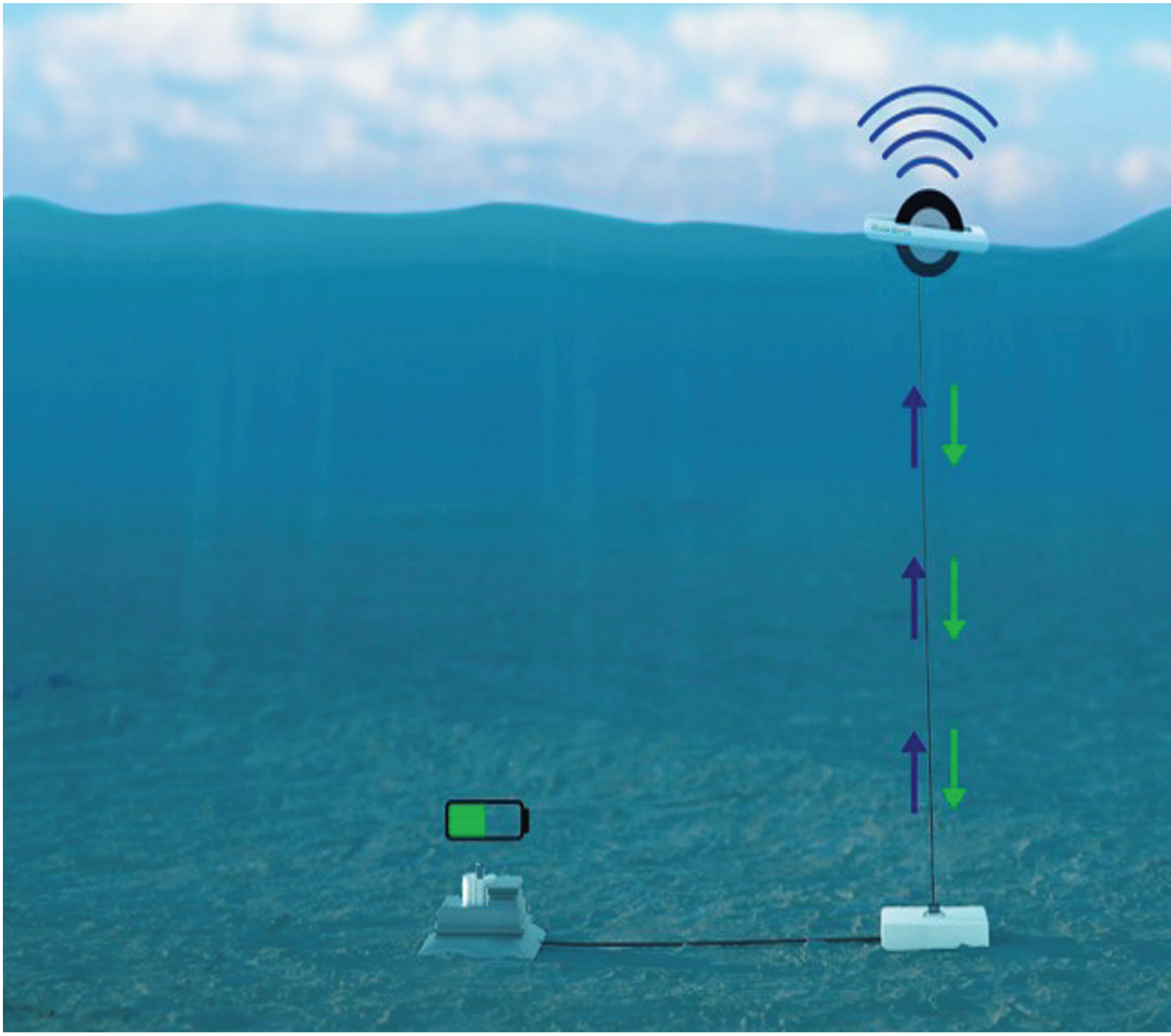
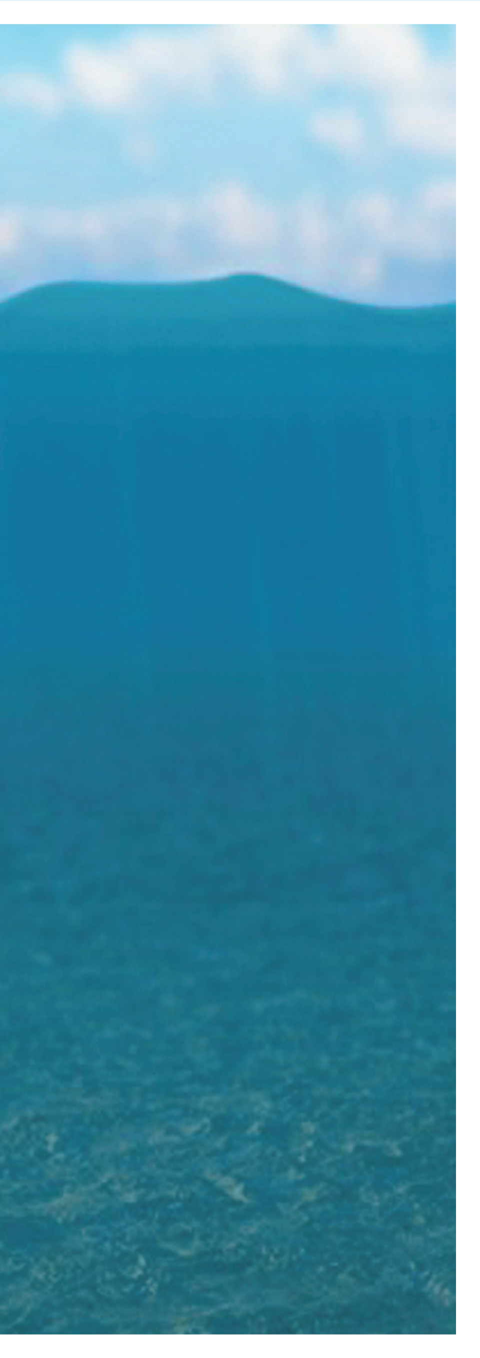


Photo couresy ResenWaves

attest, talking about new technology is one thing, proving its value in real-world circumstances even more powerful. “One I can mention is coral reef restoration project in Bali,” said Boysen, a project that is using the BioRock reef restoration technique, a technique designed to make the reef more survivable. “It needs power to grow, and they have one of our Smart Power Buoys in Bali.”

In Hong Kong the company has another installation working to boost the renewable energy signature of this historic city. “They have a vision of installing a huge wave energy park in the bay area to electrify most of the city,” said Boysen. “So far it’s only one (Smart Power Buoy installed) so there’s still some way to go, but that has a great potential. They’re not in it for the real time data, they’re in it for the wave energy, for the electricity.” Finally, another case study Boysen mentions is a trial with the Malaysian national oil company, Petronas, which is using a Smart Power Buoy to power a subsea instrument suite.



Roland Boysen, CCO, Resen Waves on renewable energy in Hong Kong:

"They have a vision of installing a huge wave energy park in the bay area to electrify most of the city. So far it's only one (Smart Power Buoy installed) so there's still some way to go, but that has a great potential. They're not in it for the real time data, they're in it for the wave energy, for the electricity."

MARINE TECHNOLOGY REPORTER

2021 Editorial Calendar

January 2021

Underwater Vehicle Annual

- Underwater Defense
- Manipulator Arms and Tools
- Autonomous Navigation GNSS MEMS
- Unmanned Vehicle Propulsion
- Hydrophones

Event Distribution:

Subsea Expo
February 23-25 Aberdeen, Scotland
Underwater Defense and Security
March 2-4 Southampton, UK
Ocean Business 2021
April 13-15 Southampton, UK

Digital Edition

MTR E-Magazine Edition: Oceanographic

March 2021

Oceanographic Instrumentation & Sensors

- Offshore Energy: O&G and Renewables
- Fiber Optic Cables, Connectors & Slip Rings
- Buoyancy Technology
- Scientific Deck Machinery / LARS

Event Distribution:

OTC
May 3-6 Houston, TX
Oceans Europe
May 17-21 Porto, Portugal
Underwater Technology Conference
June 2021 Bergen, Norway

May 2021

Hydrographic Survey Sonar

- Comms, Telemetry & Data Processing Software
- USV Platforms
- Magnetometers & Streamers
- GPS, Gyro Compasses & MEMS Motion Tracking

Event Distribution:

Seawork:
Jun 15-17, Southampton, UK

Digital Edition

MTR E-Magazine Edition: Hydrographic

July 2021

Autonomous Vehicle Operations

- Subsea Electrification & Residency
- ROV Technology: Work Class to Micro Systems
- Thruster Tech: Underwater Propulsion
- Underwater Tools & Manipulators
- Beacons, Flashers & Tracking Systems

Event Distribution:

Offshore Europe:
September 7-10 Aberdeen, Scotland
Oceans
September 20-23, San Diego

September 2021

MTR100: Focus on 100 Leading Companies, People and Innovations in the Subsea Space

- Interconnect: Underwater Cables & Connectors
- Offshore Inspection, Maintenance & Repair (IMR)
- Underwater Imaging: Lights, Cameras, Lasers & Multibeam Sonars

Event Distribution:

Europort:
Nov 2-5 Rotterdam, Netherlands

November 2021

Ocean Observation: Gliders, Buoys & Sub-Surface Networks

- Acoustic Doppler Sonar Technologies ADCPs and DVLs
- Instrumentation: Profilers, Samplers & Sediment Corers
- Fresh Water Monitoring & Sensors
- Seafloor Mapping
- Geospatial Software Systems for Hydrography

Digital Edition

MTR E-Magazine Edition: Subsea Vehicles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BAE Systems to Power University of Vermont Research Vessel with Emission-Reducing Electric Power and Propulsion System

BAE Systems was selected by Chartwell Marine to supply the electric hybrid power and propulsion system for a new maritime research vessel for the University of Vermont. As part of the contract, BAE Systems will supply and integrate the hybrid system, working with the vessel's builder, Derecktor Shipyard.

BAE Systems' HybriGen Power and Propulsion system will help reduce both carbon emissions and the use of fuel by the vessel, which will serve as a floating classroom and lab for students of the Rubenstein School of Environment and Natural Resources conducting research on Lake Champlain.

"Using green energy to power transportation in the water is an essential part of establishing cleaner waterways and harbors in places where we live, work, and visit," said Steve Trichka, vice president and general manager of Power & Propulsion Solutions at BAE Systems. "This proven and reliable technology will create a new and sustainable way for the University of Vermont to conduct its critical research."

The fully integrated HybriGen Power and Propulsion system includes electric motors, variable speed generators, battery-based energy storage system, and vessel auxiliary power with shore power charging. The technology creates a clean form of power and propulsion for the vessel and its auxiliary power needs such as heat, air conditioning, lighting, and working deck gear. The electric-powered components not only provide emission-reducing benefits to the environment, but also create a smooth ride for passengers and help operators save on maintenance costs.

Those systems power more than 13,000 transit buses around the globe, including cities such as Boston, New York, and San Francisco.

The new system leverages that core technology for the water with controls and components that have passed certification and inspection by the U.S. Coast Guard.

BAE Systems will supply the electric hybrid power and propulsion system for a new maritime research vessel for the University of Vermont on Lake Champlain.

BAE Systems

Kongsberg Maritime Launches New HiPAP 602

Kongsberg Maritime (KM) has announced the launch of its HiPAP 602 Ultra Deepwater SSBL (Super Short Base Line) Positioning Tool. The newest addition to Kongsberg's established portfolio of acoustic positioning systems, the HiPAP 602 has been designed specifically to provide extreme range (up to 7,000m+) and accuracy for positioning ROVs and AUVs, and to operate as a DP reference.

To achieve this performance, the HiPAP 602 replaces the spherical transducer used by the HiPAP 502 with a large-diameter, multi-element planar array combined with electronic beam forming and unique signal processing techniques. This enables narrow transmitter and receiver beams to be generated in all directions within the lower half of the transducer, giving the HiPAP 602 high accuracy and long-range capabilities in a cone directly below the unit. This makes it well suited for deep water operation, especially seabed mining.

HiPAP SSBL systems need only a single hull-mounted transducer and a cNODE transponder on the subsea vehicle to calculate position in three dimensions, by measuring the range from the ship's transducer to the transponder as well as the horizontal and vertical angles. The HiPAP 602 system's enhanced angular measurement accuracy increases the depth that SSBL positioning can be relied upon for survey operations before switching to long baseline positioning techniques (LBL), thereby reducing operational cost. The system is fully compatible with the entire range of existing medium frequency cNODE transponders and modems, with depth ratings available from 100m to 7,000m.

The HiPAP 602 shares its modular construction principles with its sister product, the HiPAP 502 acoustic underwater positioning and navigation system, allowing the 502 to be easily converted to a 602 by swapping transducers. For long range towfish tracking the transducer can be fitted with a 30° tilt adapter. The HiPAP 602 is fully compatible with the latest HAIN Subsea 7000 inertial navigation system, which allows for fast calibration of sparse LBL arrays using the ROV box-in technique. Robust high speed modem capabilities permit third-party control and data transfer to and from subsea sensors, AUVs and Hybrid ROVs.

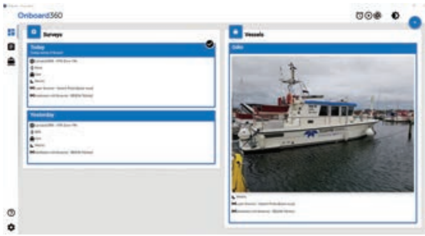
"The HiPAP 602 should not be seen as an upgrade of the 502," says Jan Erik Faugstadmo, Product Line Manager, Kongsberg Maritime. "The two complement one another: the HiPAP 602 is ideally suited to high accuracy operation at extreme depths in a conical zone below the transducer. Outside of those circumstances, the 502 will still be the system of choice. The 602 will be of particular use in contexts such as deep-water drilling, research, deep water AUV positioning and deep-sea mining, adding even more versatility to the HiPAP range which has already proven indispensable in a broad variety of subsea applications."

Kongsberg Maritime's new HiPAP 602 Positioning Tool will facilitate accurate operations at extreme depths.

Kongsberg Maritime

Tech File

Innovative new products, technologies and concepts



Teledyne CARIS Announces Onboard360

Teledyne CARIS released Onboard360 with CARIS Collect, designed to deliver a seamless flow of data into the Ping-to-Chart workflow. When combined with the Onboard360 Process module, logged data is imported and processed automatically allowing near real-time and remote quality monitoring of in-progress surveys. “We are pleased to offer our customers the ability to collect with confidence using CARIS Onboard360,” said Andy Hoggarth, VP Sales and Marketing. “Our Ping-to-Chart solution is now complete with the inclusion of the simplest acquisition software available for hydrographic survey operations whilst providing significant reductions in ship to shore turnaround times.”

Sercel, Kappa Offshore Launch PIKSEL

Sercel and Kappa Offshore Solutions offer PIKSEL, a ‘compact’ marine seismic solution specially designed for acquiring the seismic data for high-resolution 3D imaging of targeted offshore areas.

Using Sercel’s Sentinel streamer technology and Kappa Offshore Solutions’ experience in equipment integration and hydrodynamic modeling, PIKSEL is designed to acquire high- and ultra-high-precision seismic data, drawing on the low noise performance of its Sentinel streamer’s hydrophone design as well as an optimized rigging and handling system that minimizes vibration. For enhanced broadband imaging,

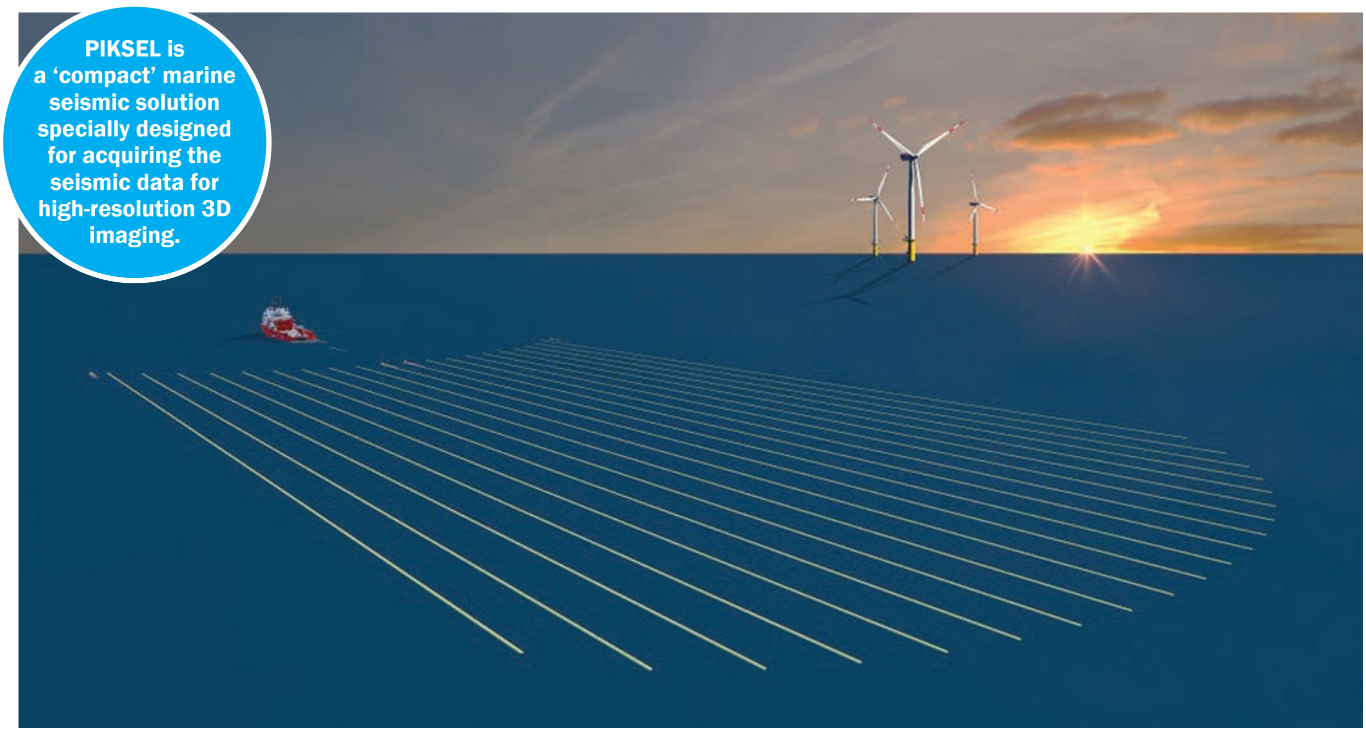
PIKSEL can be containerized to enable quick installation onboard a range of vessel types, and it is compatible with QuietSea, Sercel’s Passive Acoustic Monitoring system, Nautilus, Sercel’s streamer positioning solution, and SeaProNav Suite, Sercel’s navigation platform.

SiNAPS 2: Upgraded Acoustic Positioning

EvoLogics released SiNAPS 2, an upgraded underwater acoustic positioning software. Rebuilt from scratch, it comes with a more powerful and efficient data engine with improved positioning accuracy.

SiNAPS 2 supports USBL, LBL, and advanced hybrid positioning methods, and comes with built-in system calibration tools. With SiNAPS, it is possible to manage multiple databases and maintain separate data sets. Automation options and advanced data fusion strategies are available for demanding application tasks. Real-time multiple target tracking is combined with data input from multiple sensors. SiNAPS is capable of real-time output of positioning and sensor data for custom forwarding and processing.

Its web-based user interface allows using SiNAPS on any device in the local computer network; the extensive display tools include the new option to visualize acoustic communication, as well as adding online and offline background maps.



PIKSEL is a ‘compact’ marine seismic solution specially designed for acquiring the seismic data for high-resolution 3D imaging.

Sercel and Kappa Offshore Solutions

EvoLogics releases SiNAPS 2, the upgraded acoustic positioning software

EvoLogics

Sonardyne Delivers Fusion 2 Remote Operations First

Sonardyne reports successfully providing remote Fusion 2 survey operations capability on a live subsea construction campaign in the U.S. Gulf of Mexico.

Using its new Remote Operations Access Module (ROAM), Sonardyne surveyors based in the UK were able to remotely access and operate the Fusion 2 survey and construction software onboard Subsea 7 vessels in the Gulf of Mexico, significant from the Sonardyne perspective as it de-risks the upgrade to Fusion 2, mitigating international travel restrictions road blocks.

Fusion 2 is designed to streamline offshore field development operations by reducing the time and capital expenditure needed to undertake survey and construction tasks, combining traditional Long BaseLine (LBL) and inertial navigation system (INS) techniques in one, enabling the ability to perform real-time simultaneous location and mapping (SLAM) calibration of sparse seabed transponder arrays.

ROAM is a portable communications link in a box which can operate over satellite or any other available network, such as 4G/5G and vessel Wi-Fi, providing secure access between Sonardyne engineers and any vessel needing remote expert assistance.

The remote operations service was provided last summer during a deepwater campaign on the Mad Dog Phase 2 project in the U.S. Gulf of Mexico, where Subsea 7 onboard surveyors were able to undertake remote training in Fusion 2 prior to deployment. Using ROAM, Sonardyne surveyors working onshore in the UK were able to work shifts alongside their counterparts onboard the vessel in Fusion 2, supporting live positioning operations and taking secure control if required.

Subsea7

Sonardyne Fusion 2:
Structures being installed during the Mad Dog construction campaign.

Innovative new products, technologies and concepts

ECOncrete Installs Cable Protection in Long Island Sound

December 2020 marked the deployment of fifty 150-square-foot nature-inclusive ECOncrete Marine Mattresses, providing large-scale armoring and protection for the Cross-Sound Cable, a 24 mile underwater electrical transmission cable under contract by Eversource and the Long Island Power Authority. Operated by PSEG Long Island, as agent to LIPA, the cable runs along the bed of the Long Island Sound allowing electricity to be transmitted between Long Island and Connecticut.

The 6,250 square feet of mattresses were developed by ECOncrete in partnership with Besser Company under the BIRD Foundation funding framework in 2016.

This project is the first full-scale deployment of ECOncrete's ecological Marine Mattresses after completed pilot projects in Fort Lauderdale, Florida and Neptune, New Jersey, having undergone comprehensive multi-year monitoring efforts to provide field validation. The ECOncrete Marine Mattresses will provide ecosystem regeneration, serving as a habitat for Long Island Sound's marine life, in addition to fulfilling the structural purpose of protecting the underwater cable. This project is a major step to reduce the ecological footprint of offshore construction, such as changes to native seabed ecosystems that can result in the dominance of invasive and nuisance species.

This structural and ecological installation will also serve to improve accountability to an increasingly environmentally conscious public. ECOncrete's Marine Mattresses provide the means to minimize structural-environmental conflicts, changing the way we build in water, so our infrastructure is made stronger by enabling ecosystems to thrive.

"The use of ECOncrete's Mattresses for an offshore installation such as this will be a crucial case study for future offshore works, especially at a time when offshore wind energy is gearing up for full-scale deployment in the tri-state area," said Dr. Andrew Rella, Global Director of Engineering, ECOncrete.

"For more than 50 years Eversource has operated high-voltage electric cables under the Long Island Sound, supporting the reliability needs of our customers in southwest Connecticut with an additional power source," said Eversource Vice President of Electric Field Operations Don Boudreau. "It's critical to protect those cables to ensure the safe delivery of power and the health and wellbeing of the Sound."

"PSEG Long Island is pleased to be part of this innovative technology," said John O'Connell, vice president of Transmission & Distribution at PSEG Long Island. "Providing our customers with safe and reliable power is very important to us. The new ECOncrete's Mattresses will not only protect the cables, it will help to provide a safe environment for our local marine life."

Images courtesy ECOncrete

Boxfish Research Debuts Underwater Filmmaking Tech

The Boxfish cinematography drone delivers full-frame, 8K video from 1,000m depth.

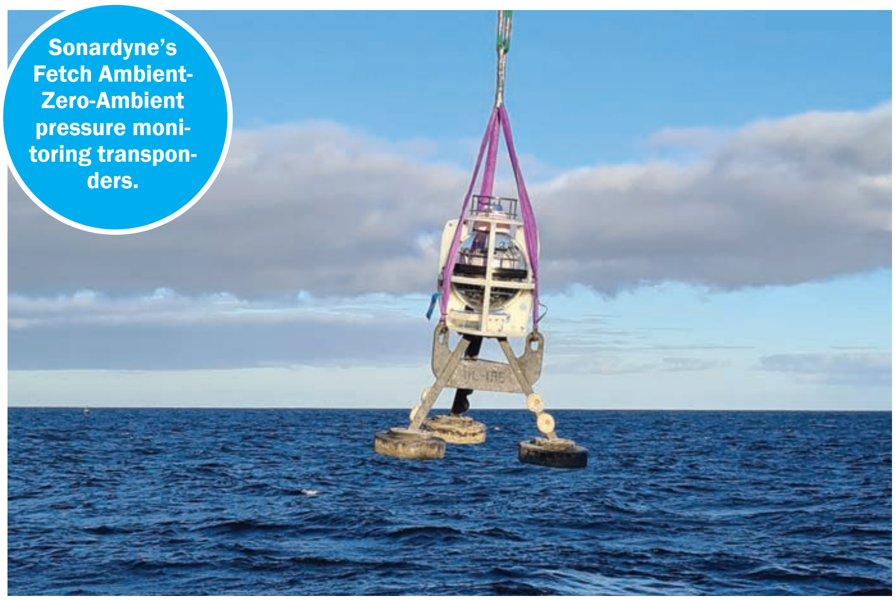
Images courtesy Boxfish Research

Boxfish Research, New Zealand manufacturer of underwater remotely operated vehicles, announced the launch of its next-generation cinematography drone, the Boxfish Luna, for professional underwater videographers and photographers. Using imaging from Sony and a new 200mm precision optical dome, the Boxfish Luna has been completely redesigned to allow filmmakers to capture underwater environments with clarity and ease of use.

The Boxfish Luna allows professional cinematographers to capture crisp and clear imagery up to 1000 meters underwater. And with the latest Sony camera integration, filmmakers can record in full-frame up to 8K 10-bit video with precision zoom control — as well as shutter speed, aperture, focus, white balance, ISO and exposure mode directly from the control station.

The Boxfish Luna is available now, serving various industries worldwide, including cinematography and natural history filmmakers.

Self-calibrating Fetch AZA Subsidence Monitor Sensors



Sonardyne's Fetch Ambient-Zero-Ambient pressure monitoring transponders.

Images courtesy Sonardyne

A new breed of underwater sensor that is able to self-calibrate, designed to enable precise, long-duration subsidence monitoring at all depths, has been deployed at scale. The 20-plus Fetch Ambient-Zero-Ambient (AZA) pressure monitoring transponders (PMTs), developed by Sonardyne will support an ongoing long-term, large-scale seabed monitoring project at Ormen Lange for A/S Norske Shell.

The AZA technology autonomously re-calibrates in situ. A unique control system periodically cycles the pressure sensor from ambient seabed pressure to near-zero, enabling comparison to a highly accurate low-pressure reference sensor for calibration.

The reference sensor is never subjected to ambient pressure and is accurate to changes of less than a millibar, or about 1cm of head of water.

In-situ calibration unlocks the ability to be able to monitor seafloor subsidence with centimetric accuracy for up to 10 years, without a loss of precision or any need for retrieval and recalibration of the sensors.

This is the latest deployment of Fetch PMTs at the Ormen Lange field, 120 km offshore, in 800 – 1,100 m water depth. Each sensor collects pressure, temperature and inclination data at the seafloor, at pre-programmed intervals.

The data is then periodically harvested, from an integrated high speed acoustic modem contained within each Fetch PMT or Fetch AZA PMT, using a choice of Sonardyne's acoustic systems deployed from an unmanned surface vehicle (USV) or conventional ship. The data is then used to calculate any vertical displacement of the seabed at the Ormen Lange field.

Who’s News?

Latest People & Company News

Andres Nicola

Dick Duin

Daniel Esser

New Name in Survey: Nicola Offshore Opens for Business

Nicola Offshore GmbH, a new company specializing in turnkey services for the most challenging marine survey campaigns and on-demand missions in and around Europe started operations from its HQ in Hamburg on March 15, 2021.

Working from an agile logistics and technology platform, Nicola Offshore was established to service the more complex and specialist aspects of marine surveying, including underwater object detection, unexploded ordinance (UXO), and subsea cable investigations, as well as pre- and post-dredging reports.

The company is a joint venture between Nicola Engineering GmbH, a German marine survey provider with over 40 years’ experience and ProMarine BV, a well-known and highly regarded Dutch workboat manufacturer.

Fulfilling its laser-sharp focus of providing fast-turnaround surveys for offshore oil & gas, and renewable energy clients, Nicola Offshore has developed an advanced marine data acquisition platform based on ProMarine fast workboats fitted with the unique integrated Hydrographic Survey System (iHSS) from marine data acquisition specialist, Subsea Europe Services GmbH.

www.nicola-offshore.com

Ocean Infinity Acquires MMT

Ocean Infinity acquired MMT. The combined force is envisioned to maximize the potential of Ocean Infinity’s fleet of Autonomous Underwater Vehicles (AUVs), and the soon to be launched Armada fleet of uncrewed, low-emission, robotic ships. The company will be uniquely placed to support its international clients’ data acquisition requirements, working across multiple sectors including, energy, subsea cables, government and defence.

Following the acquisition by Ocean Infinity, MMT will continue to operate under the MMT brand. The enlarged group will have a headcount of over 300.

ClassNK Guidelines for ROV/AUVs

ClassNK produced “Guidelines for ROV/AUV” which summarize the performance and safety requirements for ROVs and AUVs. To date, ROVs and AUVs have been mainly used for oceanographic surveys and offshore oil and gas field development, but in recent years their utilization as a means for maintaining offshore wind power generation facilities and pipelines has been steadily increasing. Although the use of ROVs and AUVs is increasing worldwide, no international standardization has been implemented. With this in mind, in order to contribute to the safe and effective use of ROVs/AUVs, ClassNK developed the guidelines which establish requirements related to the equipment and basic items that are generally required for the operation of these vehicles, as well as precautions and safety measures.

The guidelines also explain related terms, classifications, and utilization examples so that they can be used as introductory material on ROVs/AUVs. For implementing specific application cases of ROVs, they include the requirement for ROVs service suppliers as well as the procedures in using at ship surveys such as in-water surveys, internal hull surveys of flooded compartments, and damage verification.

Who's News?

Latest People & Company News

ROVCO

Brian Allen

Rovco Launches Spin-Off "Vaarst"

Rovco announced an executive shift focus within the company. Simon Miller will take over as new Managing Director of Rovco, while newly appointed CFO and Director, Nick Boorman will lead the group alongside CEO, Brian Allen, who turns his attention to the development of a new start-up technology company, Vaarst. The news marks the continued expansion of the company during a period of sustained growth, as the number of Rovco employees reaches 57. Allen said, "Vaarst has so much potential and will now also be targeting new markets in the industrial robotics sectors with tech that was born from the offshore world."

FET Appoints Brazilian partner

Forum Energy Technologies (FET) entered into a partnership with Deepsea Technologies Equipamentos Industriais Ltda (Deepsea Technologies) to represent its operations in Brazil as part of the business' long-term growth strategy in South America. Deepsea Technologies provides engineered products and services to the oil and gas industry globally. It has a key focus in delivering solutions for subsea and topside production systems and subsea intervention systems. The partnership will see Deepsea Technologies provide business development and engineering support on behalf of FET in Brazil. It will also deliver full servicing, repair, calibration, upgrades and modifications for FET remotely operated vehicles (ROVs) and associated tooling. Deepsea Technologies will also have responsibility for the repair and calibration of FET torque machines.

FET

Film-Ocean Invests in ROV System

FET

Film-Ocean Ltd., based in Aberdeenshire, has invested a six-figure sum in a Schilling Heavy Duty Work Class ROV (Remote Operated Vehicle) and plans to grow its workforce to support the company's ambitious growth plans.

The Schilling Heavy Duty Work Class ROV is capable of operating at depths of up to 4000m and is supported by an Active Heave Compensation Launch and Recovery Systems (AHC LARS). As part of its five-year growth plan, Film-Ocean has expanded its workforce by more than 50 percent in the past two years. Recent appointments have seen several new positions being created, that have included an ROV Technical Support Engineer, Stores Person and Crewing Team Lead.

Strohm

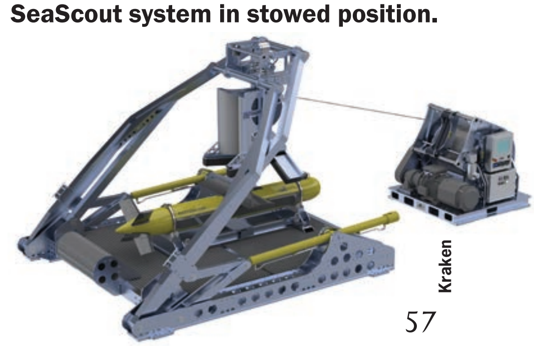
Deepsea Mining First for Strohm

A composite jumper designed and manufactured by Strohm (formerly known as Airborne Oil & Gas) will feature in deepsea mining technology being developed by offshore contractor Allseas to responsibly recover polymetallic nodules from the seabed at depths of 4,000 - 6,500m. This is the first time Strohm's Thermoplastic Composite Pipe (TCP) solution will be used in a deepsea mining application. Under the agreement, the world's leading manufacturer of this technology will provide Allseas with a spoolable TCP Jumper to connect the seabed vehicle to the vertical transport system.

Ultra Sonar Systems, Kraken Robotic Systems Team

Ultra Sonar Systems has joined forces with Kraken Robotic Systems Inc. (Kraken) to support the supply of their SeaScout system to the Royal Danish Navy. The SeaScout is comprised of Kraken's KATFISH towed Synthetic Aperture Sonar vehicle, Tentacle Winch

SeaScout system in stowed position.



Kraken

ly unmanned surface vessels in support of their mine countermeasure activities.

Ultra's Integrated Logistic Support (ILS) engineering team will provide expert support to Kraken throughout the delivery phase in the production of ILS documentation, as well as supporting Kraken's installation and commissioning teams in the field, with an option to continue to support the complete Sea-Scout system throughout the lifecycle once it is in service with the Danish Navy.

OneOcean Appoints Pang CCO

OneOcean appointed Adam Pang as the company's new Chief Commercial Officer. Pang has an extensive background in disruptive technology and holds specialist knowledge in complex software as a service (SaaS) solutions.

UKHO Launches New Innovation Challenge

The UK Hydrographic Office (UKHO) has launched a new marine innovation challenge, focused on identifying the causes and risks of coastal inundation and mitigating its effects. As part of the ADMIRALTY Marine Innovation Program, the latest challenge invites participants to develop solutions that provide disaster relief agencies with a clear view of coastal inundation situations, and support other groups to identify vulnerable areas and put in place mitigation measures before an inundation event occurs.

Participants will have access to world-leading geospatial and scientific ADMIRALTY data throughout the challenge - including Anguilla data sets - and will also get the chance to work with leading experts and receive support from

UKHO

UKHO staff as they develop a prototype product.

The winning team will receive hands-on support and marine geospatial information, in addition to a cash prize of $10,000 Singapore dollars to develop an alpha product that could help to protect the lives and livelihoods of millions of people around the world.

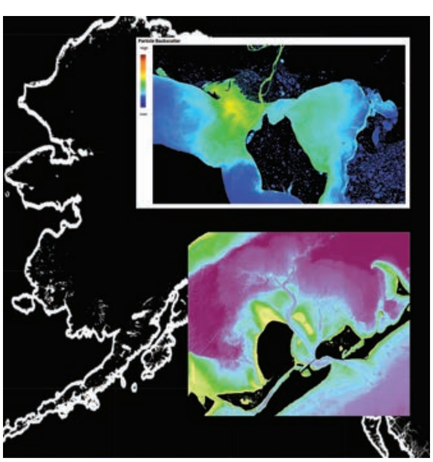
To participate in this challenge, applications must be submitted by Friday, 2

TCarta Wins NOAA Grant to Enhance Satellite Derived Bathymetry Tech

TCarta Marine won a Small Business Innovation Research (SBIR) Phase II grant from the National Oceanic and Atmospheric Administration (NOAA). The research focuses on enhancing Satellite Derived Bathymetry technology for application in the coastal waters of Alaska.

Begun in 2020, the NOAA SBIR Phase I research expanded the potential sources of satellite imagery for the Alaskan coast. Winter darkness, floating sea ice, turbulent spring runoff, plankton blooms, and unpredictable tidal variations make it difficult to capture images with the quality necessary for SDB processing. Just a small window of acquisition time exists during the summer, and it varies for different areas along Alaska's 32,000 miles of coastline. An important Phase I result was the development of automated tools to assess water clarity in daily satellite images to monitor water clarity for suitable conditions for SDB image tasking or planning airborne LiDAR surveying, Goodrich added.

In Phase II of the NOAA program, TCarta has shifted focus to SDB data processing and hydrographic analysis by developing new ways to improve confidence in the seafloor depth measurements derived from Alaskan imagery. The Colorado firm is creating workflows involving Artificial Intelligence to identify and minimize errors in SDB measurements, predict uncertainty and to integrate established hydrographic standards, thereby enhancing interoperability of SDB with other technologies.



32,000 miles of Alaskan coastline pose a challenge and an opportunity for Satellite Derived Bathymetry. Technologies developed to survey water clarity in daily satellite imagery (upper right inset) can be used as a tool to determine precise collection of high-resolution imagery for Satellite Derived Bathymetry surveying (lower right inset).

(Image Courtesy TCarta)

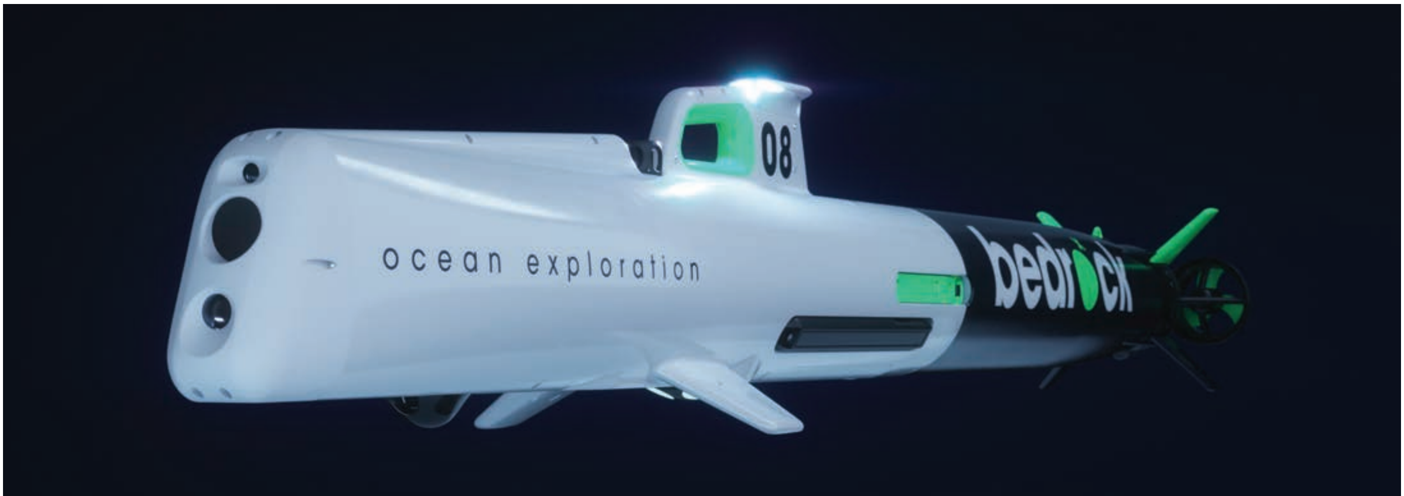


Image Courtesy Bedrock Ocean Exploration

Bedrock Scores $8M in Funding to Fast Track Ocean Data Initiatives

Bedrock Ocean Exploration, which was created to make the business of gathering, processing and disseminating accurate information on the world's oceans to key stakeholders, has raised an $8M seed round from Eniac Ventures, Primary Venture Partners, Quiet Capital and R7. The funding is targeted to help Bedrock scale their robotics and cloud software to map the ocean floor more efficiently than ever, effectively removing people & ship-centric acquisition operations. Bedrock's goal is to ultimately provide centralized access to the first complete map and database of our oceans at the highest possible resolution. "For more than three years, we explored ocean tech as a category of interest," said Vic Singh, General Partner at Eniac Ventures. "We believe it is a deeply underinvested sector and ripe for opportunity given the vast amount of data."

Bedrock's founders, Anthony DiMare, CEO and Charles Chiau, CTO, have almost three decades of experience at the intersection of maritime and technology. DiMare previously founded Nautilus Labs, a maritime technology company aiming to advance the efficiency of ocean commerce through artificial intelligence.

Chiau was previously at SpaceX where he helped design the avionics systems for Crew Dragon. He also was a system engineer at Reliable Robotics working on their autonomous aviation system, and was the CTO of DeepFlight where he developed manned submersibles.

While opportunities abound throughout the sector, at the outset Bedrock is aiming to support the explosion of offshore wind projects in the U.S. and abroad. Everything from site exploration to export and array cable laying and operations and maintenance (O&M) work rely on geophysical surveys. Bedrock is doing this more safely, quickly, and efficiently through a new breed of marine surveying enabled by their proprietary Autonomous Underwater Vehicle (AUV)-based data acquisition platform and software ecosystem they're building around the collected data.

April 2021. You can find out more about the challenge and access the application form here: https://www.admiralty.co.uk/innovation-programme/coastal-inundation-challenge

Blue Logic Launches Subsea USB

Blue Logic created a new company, Subsea USB AS, to provide its underwater inductive connectors. The product rights, technology and patents of Subsea USB's connectors were previously jointly owned with the Kristiansand-based Wireless Power and Communication (WPC AS). All assets within the product area have been transferred to Subsea USB.

CGG Extends Northern Viking Graben Dual-Azimuth Survey

CGG announced phase two of its multi-client 3D survey in the Northern North Sea, which will expand on the phase one acquisition initiated in 2020 to add a second azimuth over CGG's existing Northern Viking Graben (NVG) multi-client 3D survey and extend coverage into the UKCS. In the 2021 phase two acquisition will add approximately 8,000 sq km of new data in an E-W direction. Similar to the 2020 phase one, multi-component technology will be used for the acquisition, and this new data will be processed with the existing N-S data, using CGG's latest velocity modeling and imaging technology, to produce a dual-azimuth volume. Fast-track data from the phase two acquisition are expected to be available by the end of 2021.

BOOK REVIEW

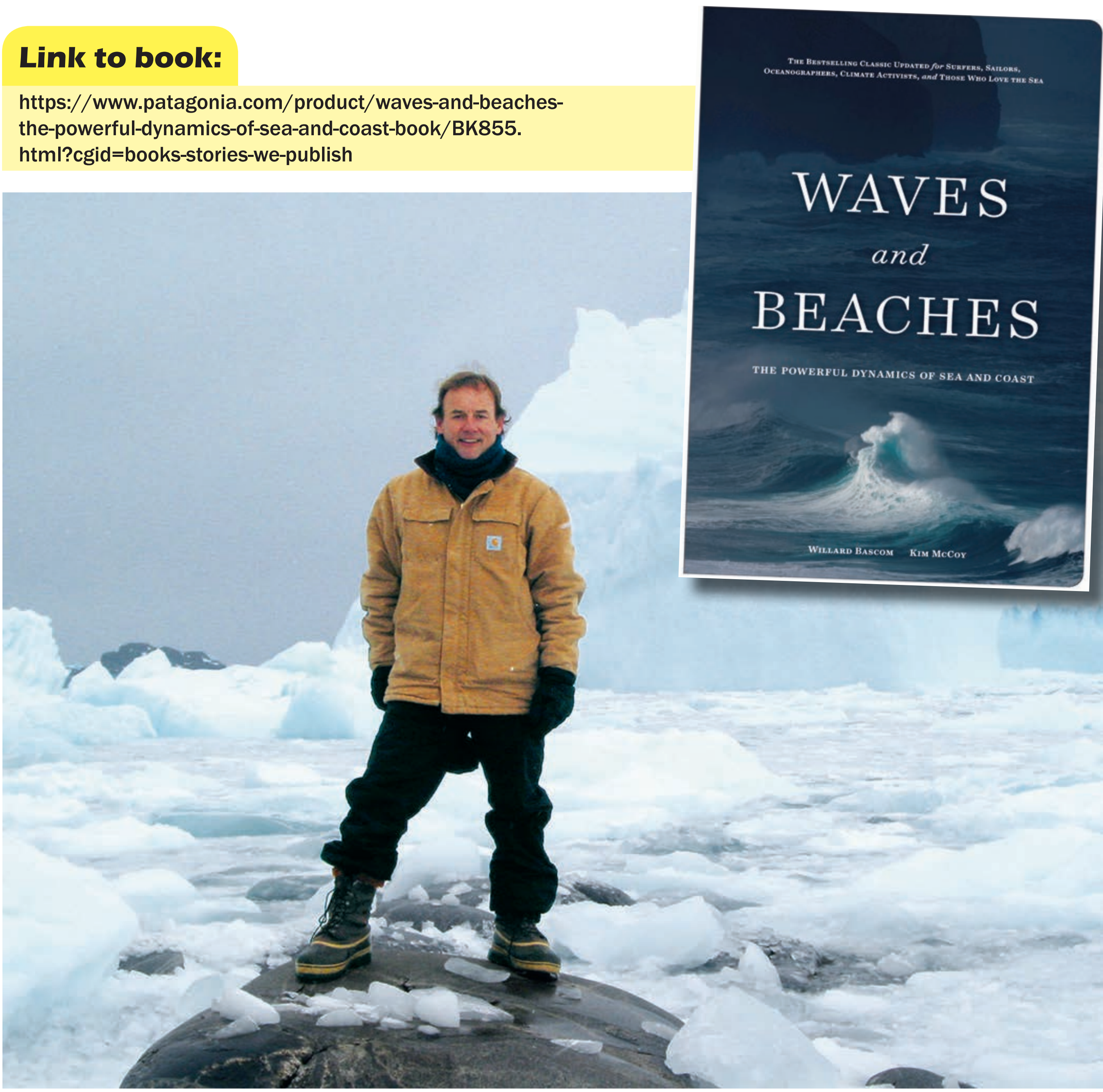
Waves of Change

By Kim McCoy, Oceanographer and Author of ***Waves and Beaches*****:** The Powerful Dynamics of Sea and Coast

(an updated classic by Willard Bascom published by Patagonia)

Link to book:

https://www.patagonia.com/product/waves-and-beaches-the-powerful-dynamics-of-sea-and-coast-book/BK855.html?cgid=books-stories-we-publish



Throughout history, explorers, engineers and empires have challenged the sea. Success, punctuated by failure and sea sickness has been the norm. Yet, since the industrial age began, a change in nature's dynamics has slowly crept upon us. Our warming oceans are sending stronger hurricanes and more powerful waves to shifting shores.

Today our horizons are filled with opportunity, immense ships, offshore structures and wind farms. Yet nature's waves will continue to sink ships, damage dock facilities, pillage containers as rising sea level inundates many coastal cities. Although unseen by most, waves and tides influence every vessel's fuel consumption, sea-going integrity and determines the useful lifetime of structures.

The Role of Waves

What knowledge do we need and which measures must be taken to defend from such losses? Future impacts can be mitigated by understanding the nature of ocean waves and their persistent interactions with vessels, structures and sediments.

Most waves begin as small ripples, driven by the wind on the surface of the sea, some will grow into towering ocean swells. There are many other types of ocean waves: capillary, chop, internal, seiches, tides and tsunamis. Some varieties of waves are visible only at the coast while others appear only on the high seas. Beneath the surface, the constant effects of waves reposition the sediments, fill navigational channels, undermine pipelines and sever submarine cables.

From above and below, waves are measured using arrays of oceanographic instruments, shore-based sensors and spaceborne satellites. These measurements are fed into weather models which produce ship routing and crew scheduling. This immense web of information enables our globalized commerce.

The prediction of waves and ocean currents has become vitally important, from delivering goods on time, to letting surfers know when to paddle out.

Waves and Ships

A steep wave can bury the bow of a ship while other waves may pass harmlessly. Why?

Some ships are long enough to bridge several wave crests. Each passing wave can contort the hull with a twist, then a sag and a hog. Steeper waves jar a vessel, compress bulkheads, flexing shafts and propellers. When running parallel to an ocean swell, a vessel may become unstable when the wave period matches its natural roll period. When it does, each roll is reinforced by the next wave (as when pushing a swing at just the right time).

A smaller vessel may have it easier structurally because it is too small to span between wave crests and its roll period infrequently matches the swell. However, as it heaves and rotates like a cork, it is impacted by steep waves - small and large. Such unpleasant movements result from a vessel's design (length, beam, metacentric height), but may be minimized by altering its speed and heading, relative to the waves. During its lifetime a vessel will be stressed and creak from millions of ocean waves and a few rogue waves.

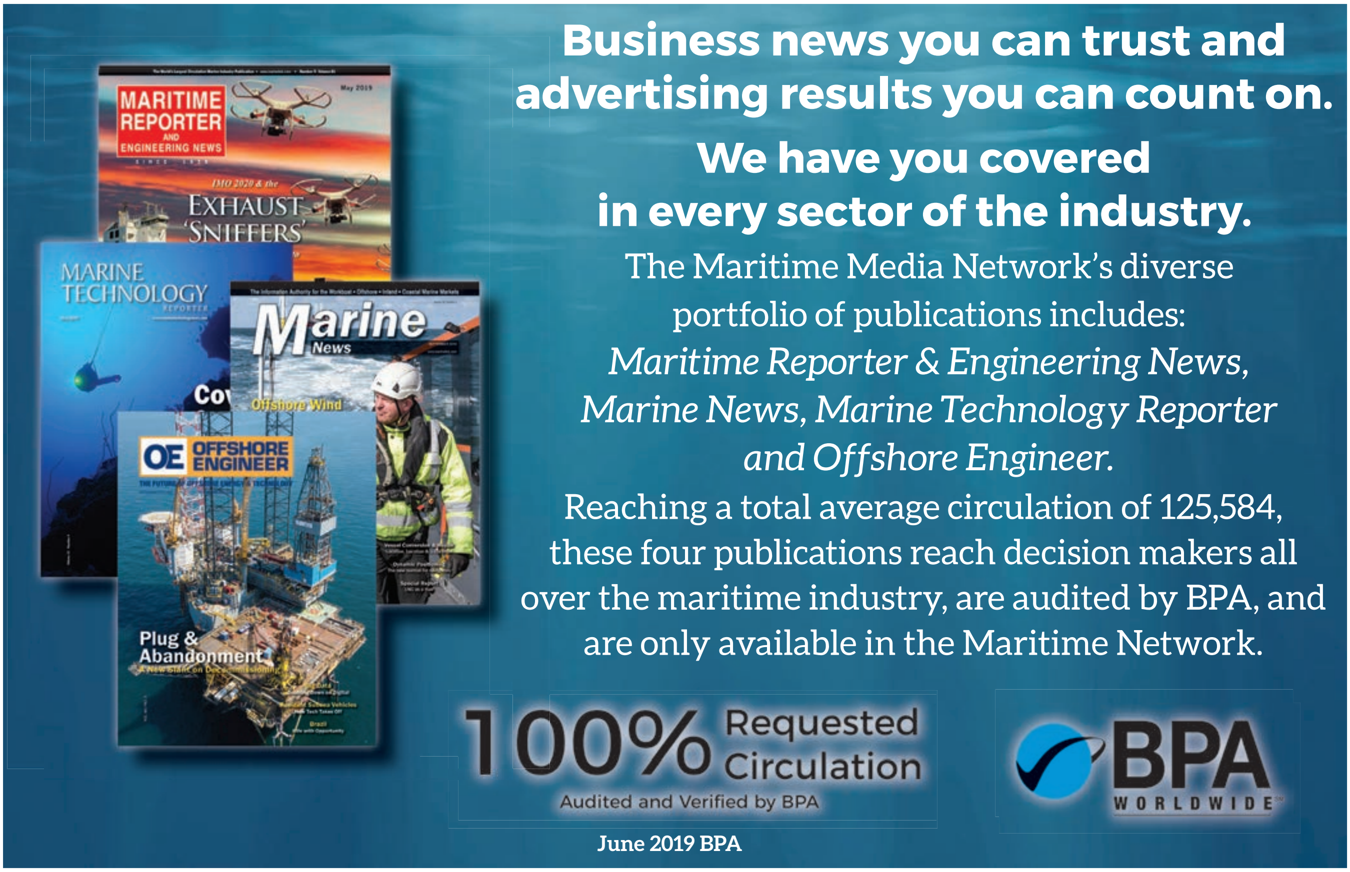
When Size Matters - From Deep to Shallow Waters

When does water depth become significant? A deep water wave with a 10-second period has a wave length of about 156 meters. (The equation: L = 1.56T2 in meters, or 5.12T2 in feet, is used to calculate deep water wave length, L, and T is the period in seconds). As a wave reaches shallow water (defined as less than 1/2 of its wave length) it begins to transform. This means that a 10-second period wave is influenced by the seabed in waters less than 75 meters in depth. However, more intense storm winds can create more powerful and longer period waves which influence the deeper sediments.

Storm waves disrupt everything in their path including offshore structures, drill pipes and moorings. As a wave moves into shallower water, its direction will change (refract), its wave length will shorten causing the wave to become steeper and more dangerous (an example is the North Sea's Dogger Bank area). Near the limit of wave steepness (about 120 degrees) a wave will begin to break. When storms, steep waves and high tides coincide, storm surges can inundate the land, destroy dock structures and make fresh water aquifers more saline. A shift of sediments can make a beach whither or a harbor fill. In some harbors, if the beat of the waves is just right, water will slosh (seiche) back and forth causing ships to tug at their mooring lines.

The waves of change are everywhere you look. Waves from hurricanes, typhoons and tsunamis continue to change insurance rates, construction methods, municipal planning and geopolitics. These events have provided the rationale for many governments and businesses to develop mitigation plans. Leadership and corporations which educate the public, recognize our changing climate and implement plans will be better prepared to endure episodic events and avoid future catastrophic losses ashore and at sea.

It's not just science, it's good business. And as we know, surfers will always pray for surf.



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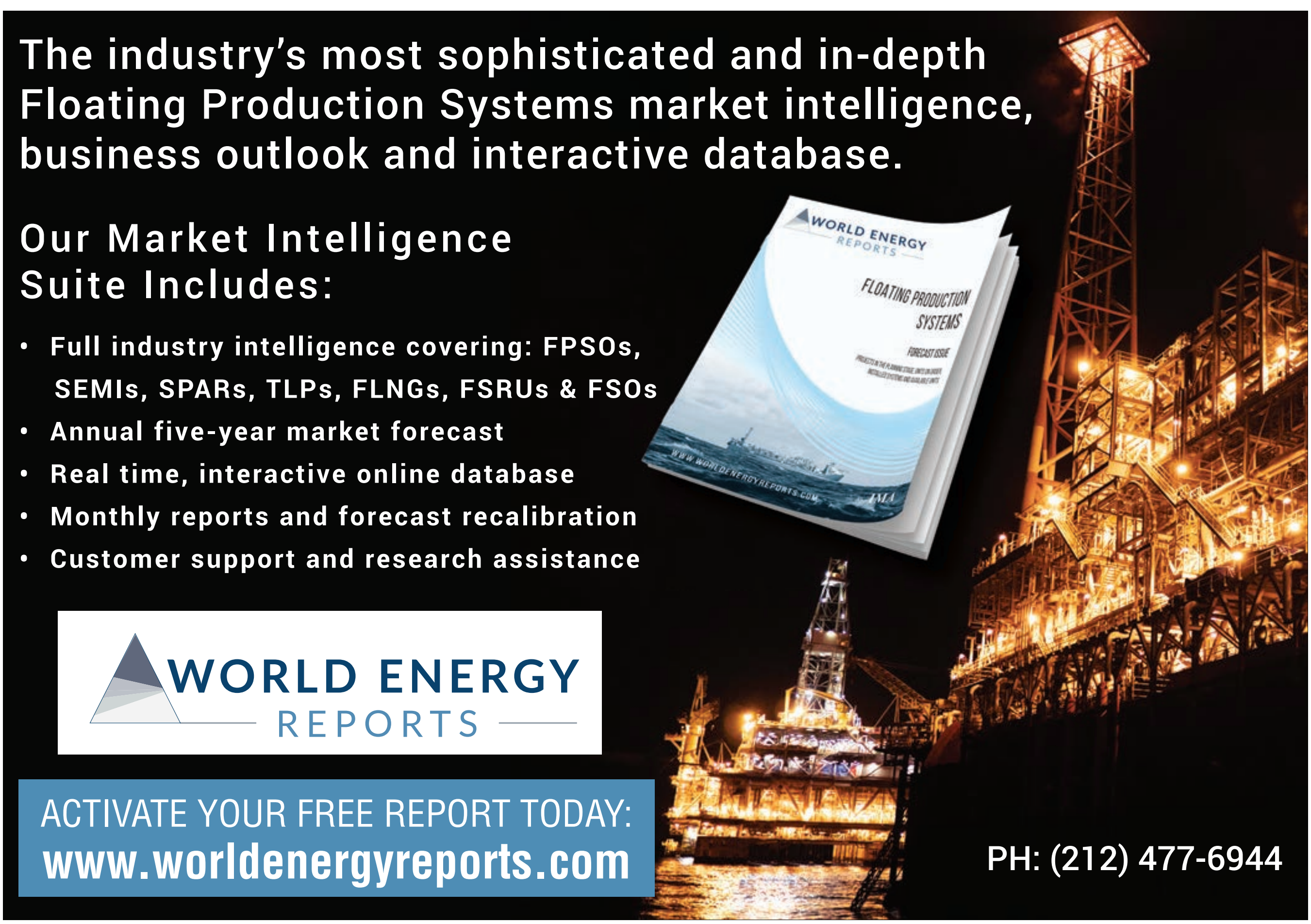

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