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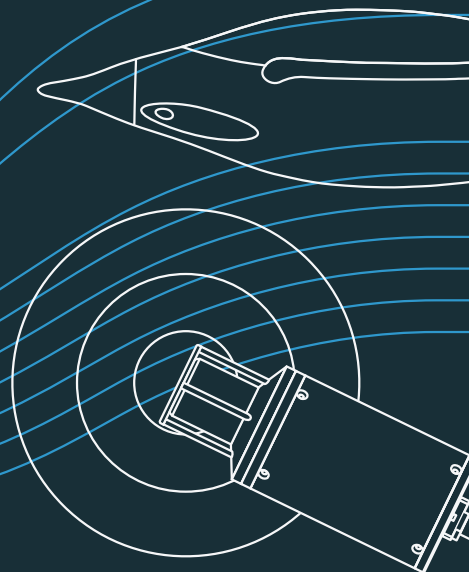
**OCEAN RESOURCES
DEVELOPMENT &
COASTAL ZONE MANAGEMENT**

FEATURING:

Combo Method for Hydrographic Survey

Carbon Tracing for CCUS

Q&A: Don Walsh



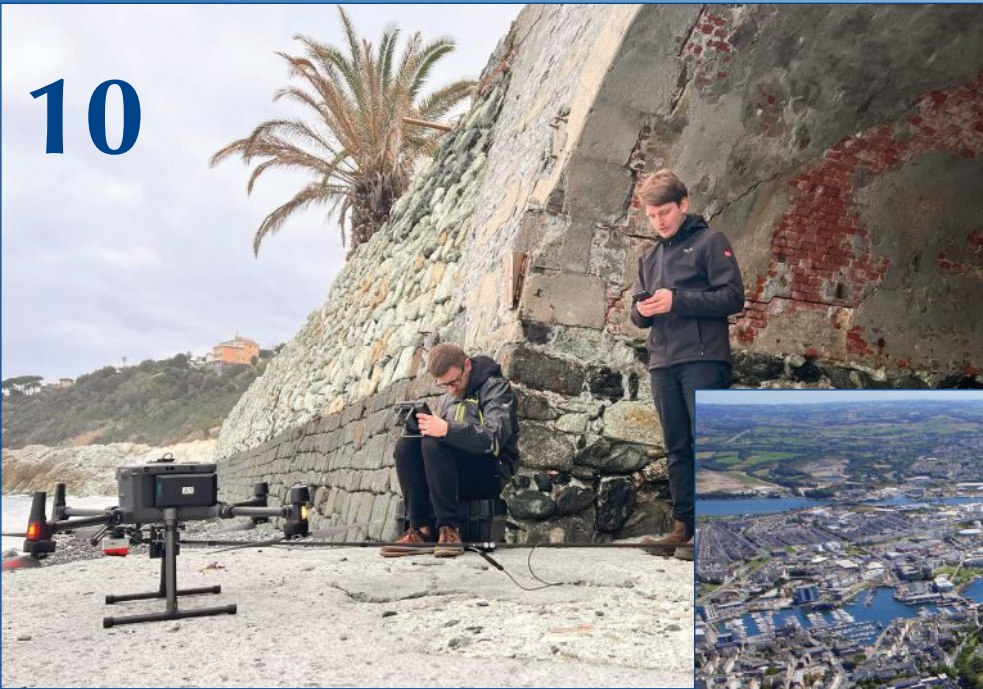
SMART SUBSEA SOLUTIONS

- Delivering data in most adverse conditions: underwater acoustic modems with advanced communication technology and networking
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- Quadroin - the novel bionic AUV for surveys and monitoring



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COVER IMAGE

The Norwegian Public Roads Administration's Ferry-free E39 project assesses floating bridge construction for fjord crossings in April 2024. The area is well known for heavy seas, and evaluation of the mooring required reliable data on wave and wind impact. A Miros Wave & Current radar was installed to monitor the conditions. (Credit: Ørjan Kleppe, Miros)

NEXT MONTH

Autonomous sailboat to gather geophysical data ... ROV launch from USV platform for offshore subsea inspection ... Industry uses NASA tech to map seafloor for resources and conservation ... Weather intelligence supports offshore wind installation safety ... USVs for geophysical survey.

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)) Report on US Marine Economy. The U.S. marine economy in 2022 increased in sales and jobs, according to the most recent statistics from the annual Marine Economy Satellite Account (MESA) released by two Department of Commerce agencies, NOAA and the Bureau of Economic Analysis. The marine economy contributed a total of \$476 billion in economic impact in 2022, making up nearly 2 percent of the nation's gross domestic product (GDP). It generated \$777 billion in sales, and supported 2.4 million jobs in 2022. The largest contributors to GDP are tourism and recreation, with \$163 billion; national defense and public administration, with \$149 billion; and offshore minerals, with \$62 billion. The sales sectors that showed the most growth for 2022 include: ship and boat building, up 14.6 percent; coastal tourism and recreation, up 8.1 percent; and marine transportation and warehousing, up 7 percent. For the first time, MESA includes information on wind energy and alternative power generation, allowing for a greater understanding of the offshore wind industry's importance to the nation's economy. Wind farm construction totaled \$161 million in sales, and alternative power generation totaled \$10 million in sales.

)) Cap-and-Trade Proposal for 30x30. Thirty-by-thirty (30x30) is a global agreement that aims to protect 30 percent of the planet by 2030. Three researchers at UC Santa Barbara have proposed a market-based approach to achieving the 30x30 targets in the ocean. They tested whether a system that allowed countries to trade conservation credits could reduce costs, incentivizing nations to actually meet their goals. Allowing voluntary trade always reduced the cost of conservation, sometimes by more than 90 percent, according to the study, published in *Science*. This is the first study to draft and analyze a conservation market for achieving 30x30 targets in the ocean. The 30x30 initiative is one aspect of the Convention on Biological Diversity, a multilateral treaty developed in the early 1990s; its target No. 3 of the larger Global Biodiversity Framework (GBF) adopted by the 196 countries that convened for the UN Biodiversity Conference in 2022. The goal of the effective protection and management of 30 percent of the world's terrestrial, freshwater, coastal and marine areas by the year 2030 is one that many scientists say humanity must achieve to secure our planet's long-term health. While the GBF requires countries to commit to conservation targets, it does not outline which areas should be protected, how to do so inclusively, or how to pay for it. Environmental economists and scientists at UC Santa Barbara's Environmental Markets Lab (emLab) propose a conservation credit system could help meet 30x30 targets in the ocean by allowing nations to trade their conservation obligation with each other through a "transferable conservation market" policy built around ecological principles.

)) Onboard Carbon Capture Potential. Onboard carbon capture (OCC) is attracting interest within the shipping industry, providing shipowners with the opportunity to continue operating on conventional fuels while reducing emissions. However, according to DNV's latest whitepaper, "The potential of onboard carbon capture in shipping," its success depends on collaboration between regulators, policymakers, industry stakeholders, class and suppliers. With decarbonization target deadlines rapidly approaching, demand for cost-efficient solutions for emission reduction is increasing. DNV's latest whitepaper explores OCC as a decarbonization solution for shipping by looking at its technical, economic, operational and regulatory challenges, as well as its integration into the carbon capture, utilization and storage (CCUS) value chain. CCUS is the process of capturing CO₂ and recycling it for future use or permanently storing it in deep underground geological formations (see story in this issue). The maritime industry is exploring its application on board ships, which will require an onboard system to capture, process and store the CO₂, and a network of offloading that is integrated into wider CCUS infrastructure. The EU ETS is the only regulatory framework currently providing commercial incentives for OCC. To encourage shipowners to adopt the technology, future environmental and greenhouse gas (GHG) emissions regulations must also provide credit for captured CO₂.

)) Meiofauna Database. Through the Meiodysea project, scientists from Ifremer, in collaboration with teams from JAMSTEC in Japan, Naturalis Biodiversity Center in the Netherlands and Senckenberg Natural History Museum in Germany, are taking on the challenge of describing 125 to 200 new species of meiofauna, small organisms measuring less than a millimeter that nest in sediments in the five oceans. Combining high-resolution 3D imaging and artificial intelligence, this project, funded by the Sasakawa Peace Foundation, aims to fill the knowledge gap on the diversity, ecology and evolutionary history of invisible marine fauna to facilitate the conservation of vulnerable marine ecosystems. The project, coordinated by Ifremer, will be based on samples from 1,437 sites around the world. This new database will cover all marine environments, from the coast to the open sea, including abyssal plains and hadal trenches, from depths of a few centimeters to over 6,000 m, in the heart of polar waters and tropical seas. Of the 2 million species currently described, only 250,000 are marine animals. From thousands of samples, millions of organisms will be extracted, sorted and selected in order to detect hitherto unknown species. They will be identified, annotated, measured, and imaged in 3D to visualize all their external and internal morphological structures with unprecedented precision. Their genetic, proteomic and functional characteristics will also be examined using sequencers. AI software will detect, measure, and describe the morphological and morphometric characteristics of new species. From 2025, the massive image and data bank will be freely accessible on a virtual platform. **ST**

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Law Enforcement Should Add AUVs to Their Toolkit

The recent collapse of Baltimore's Francis Scott Key bridge highlights the need for county and state law enforcement agencies to have access to advanced underwater technology for search, rescue, and salvage. It's equally important to know how to use them. For example, the Maryland State Police used a Coda Octopus high-resolution sonar and divers in the wake of the bridge collapse.

I've spent most of my life working in the subsea business with these technologies. I began my career in 1974, building ship fenders and oil skimmers for Ocean Systems Inc. (OSI) in Virginia. From there, I graduated to building deep saturation diving systems. After attending the Commercial Diving Center in Wilmington, California, in 1977, I was offered a job to work with OSI's first ROV team. OSI took a bold step at the time by purchasing three tethered ROVs and two tethered remotely operated camera vehicles from International Submarine Engineering in Canada. Becoming proficient with these vehicles was a steep learning curve. I then spent decades working with ROVs, from the oilfield to submarine cable work to deep ocean salvage for the U.S. Navy.

Fortunately for law enforcement, operating advanced underwater systems is far more accessible than when I started my career. Now, most of the gear can be maintained at the board level with interchangeable components. In addition, the processing of acoustic images makes it possible for a layman to identify submerged targets.

I recommend that law enforcement agencies add AUVs to their toolkit. These systems are still expensive and require some experience to create missions and conduct surveys, but if these challenges could be overcome, AUVs would enable officials to investigate more thoroughly.

Most of my experience with AUVs was the result of my role as the procurement manager for the U.S. Navy's Hugin 54 vehicle (Trondheim) and getting the system ready for issue. I also spent several years operating an L3Harris Iver3-580 AUV in rivers and harbors. I helped conduct surveys in the Anacostia River to make sure there was sufficient water depth to allow for the removal of a Vietnam-era destroyer docked as a museum ship at the Washington Navy Yard. We also used the Iver as a platform to develop an autonomous pinger locator payload. These tests were conducted in the Chesapeake Bay, the lower Potomac River, and Buzzards Bay in Massachusetts, where the Iver successfully identified the location of a simulated flight data recorder.

Another mission we did with the Iver was a harbor survey in Alexandroupolis, Greece, to look for leftover wreckage from the dredge barge *Oлга*, which was over 150 ft. long and weighed 800 metric tons. It was salvaged previously by NAVSEA so that NATO assets could use the port. I wrote missions to fly the Iver along the side of the pier underwater, outboard of the barge using side scan sonar on several range scales. The sonar showed no remaining wreckage.

A follow-on task in Greece was to survey the channel entering the harbor to make sure there was sufficient water depth to allow the USNS *Carson City*, a *Spearhead*-class expeditionary fast transport, to enter the port and dock. We ran lines on the water surface with the Iver's DVL to measure depth. The *Carson City* made it into port, and the captain gave us a Bravo Zulu for our efforts.

Prior to operating the Iver, I had zero experience with AUVs. Of course, I had deep experience with underwater operations and decent computer skills, but the challenge should not deter law enforcement agencies and personnel. Adding an AUV to their toolkit and skill set would enable them to better execute their missions. **ST**

SEA TECHNOLOGY® 2024

JANUARY

Annual Review & Forecast

****EUROMARITIME 2024**, January 30-February 1, Marseille, France

FEBRUARY

Instrumentation: Measurement, Processing & Analysis

****Oceanology International 2024**, March 12-14, ExCel, London, U.K.

MARCH

Electronic Charting/Vessel Management/ Ports & Harbors/Dredging/Homeland Security

****UDT 2024**, April 9-11, ExCel, London, U.K.

****OCEANS 2024 Singapore**, April 14-18, Singapore

****XPONENTIAL 2024**, April 22-25, San Diego, CA

APRIL

Offshore Technology/Alternative Energy & Ocean Engineering

****Offshore Technology Conference**, May 6-9, Houston, TX

MAY

Communications, Telemetry, Data Processing

JUNE

Seafloor Mapping/Sonar Systems/Vessels

****Sea Technology supports these shows**

BONUS INFORMATION

- | | | |
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| • Company Profiles | • Marine Resources | • Ocean Research |
| • Contracts | • Meetings | • People |
| • Environmental Monitoring | • Navy Currents | • Product Development |
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4 EDITORIAL CALENDAR

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JULY

Deck Gear, Cable, Connectors, Power Systems & Salvage

****IMAGE 2024**, August 25-30, Houston, TX

AUGUST

Ocean Resources Development & Coastal Zone Management

****OCEANS 2024 Halifax**, September 23-26, Halifax, Canada

SEPTEMBER

Geophysical Exploration/Seafloor Engineering

OCTOBER

Environmental Monitoring, Remote Sensing & Pollution Control

****EURONAVAL 2024**, November 4-7, Paris, France

****CLEAN GULF**, November 18-20, San Antonio, TX

****MAST Australia 2024**, November 19-21, Adelaide, Australia

NOVEMBER

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DECEMBER

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Topobathymetry from the Air

Combo Surveying Approach for Hydrographic Data

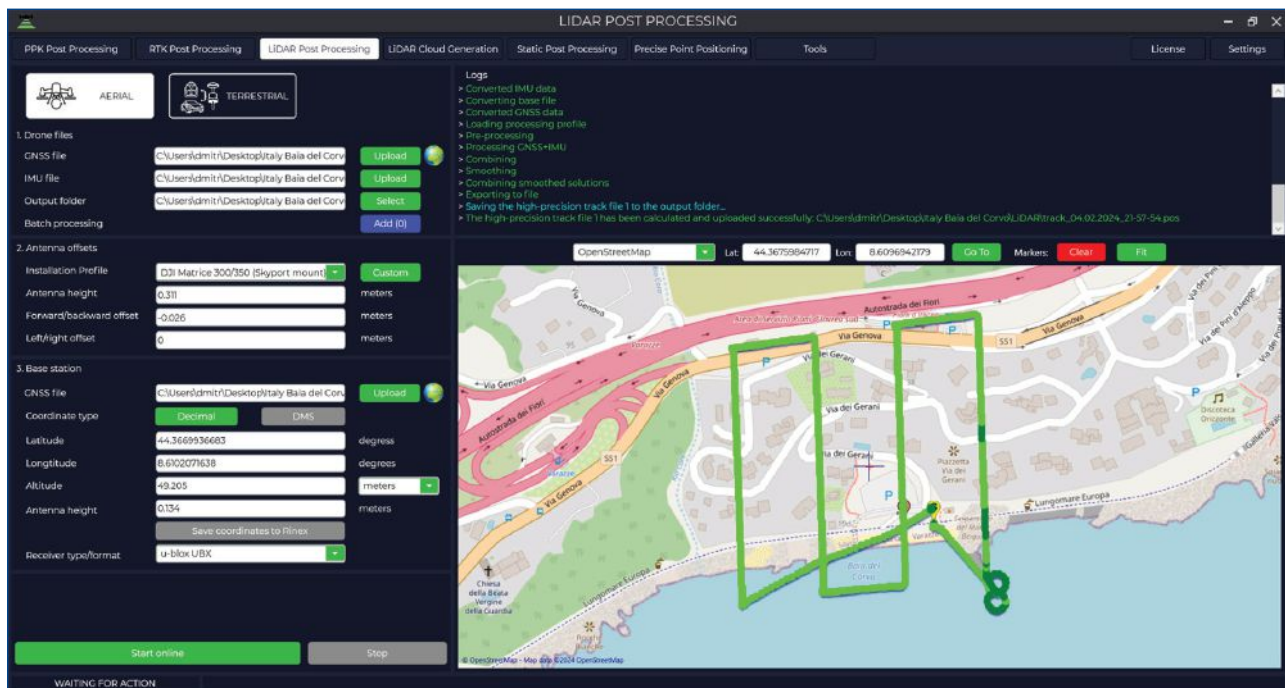
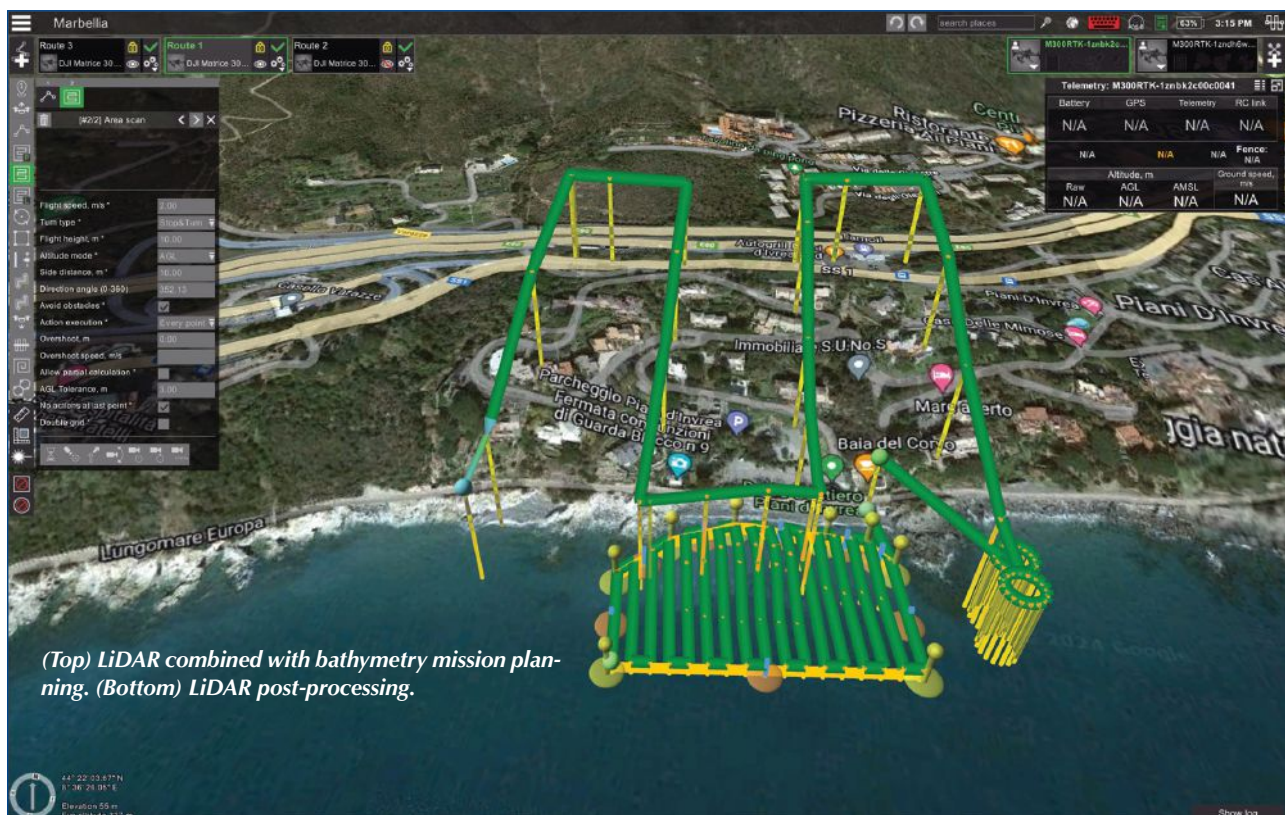
By Ilya Shikov

Coastal zone management and ocean resources development are dependent on hydrographic data from surveying, and there is a trend toward optimizing the quantity of hardware and software. The rise of airborne surveying solutions has enabled an increase in the scale, speed, and accuracy of data collection to facilitate coastal flood risk assessments, seabed predictions, and environmental monitoring. Technologies such as UAV LiDAR

bathymetry accompanied with airborne photogrammetry and echosounders can help to map areas that are hazardous and/or difficult to survey with vessels.

Airborne technologies are having a transformative impact on hydrographic surveying practices. A very competitive market is quickly developing for airborne bathymetric LiDAR systems. Such systems are typically hefty and require heavy-lift multirotor drones to carry them.





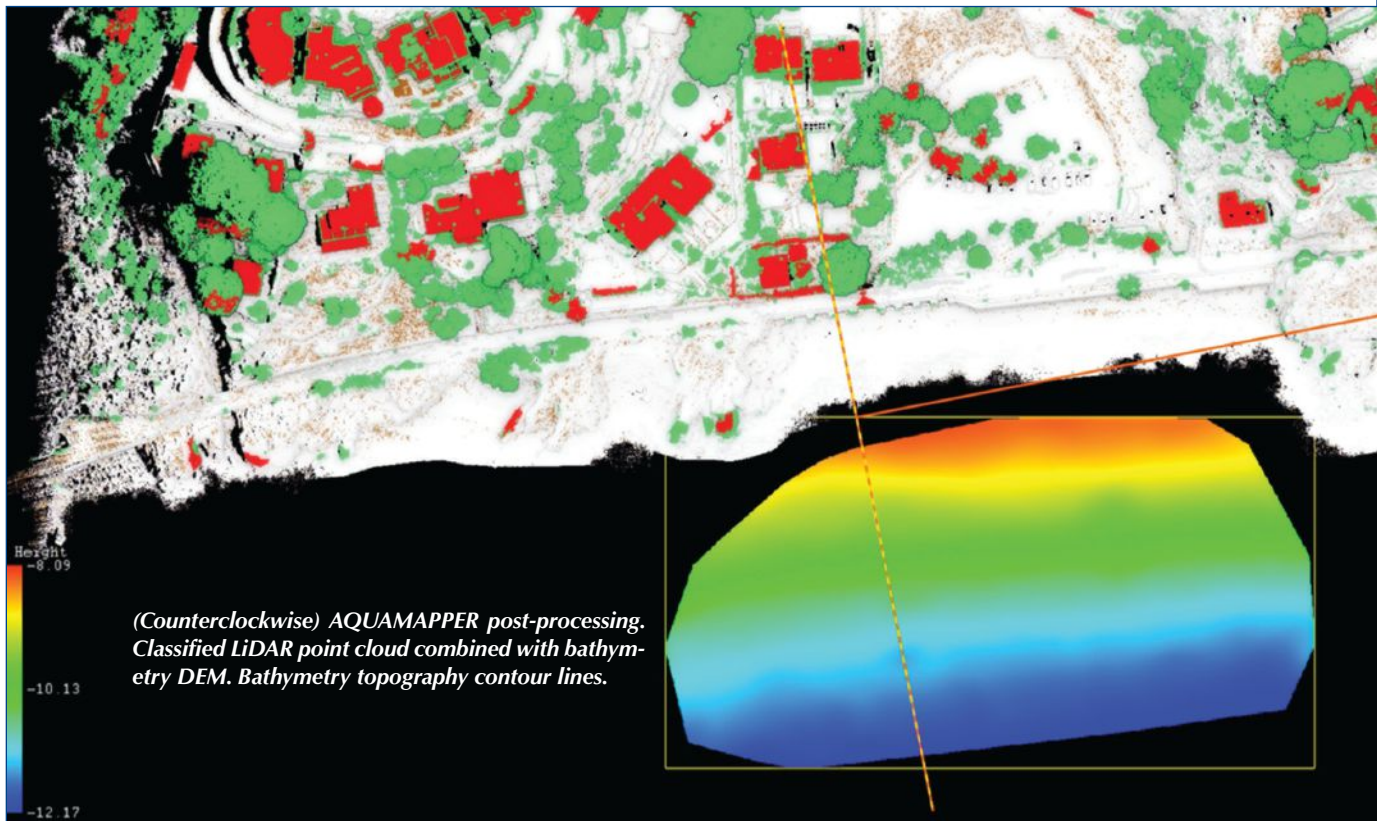
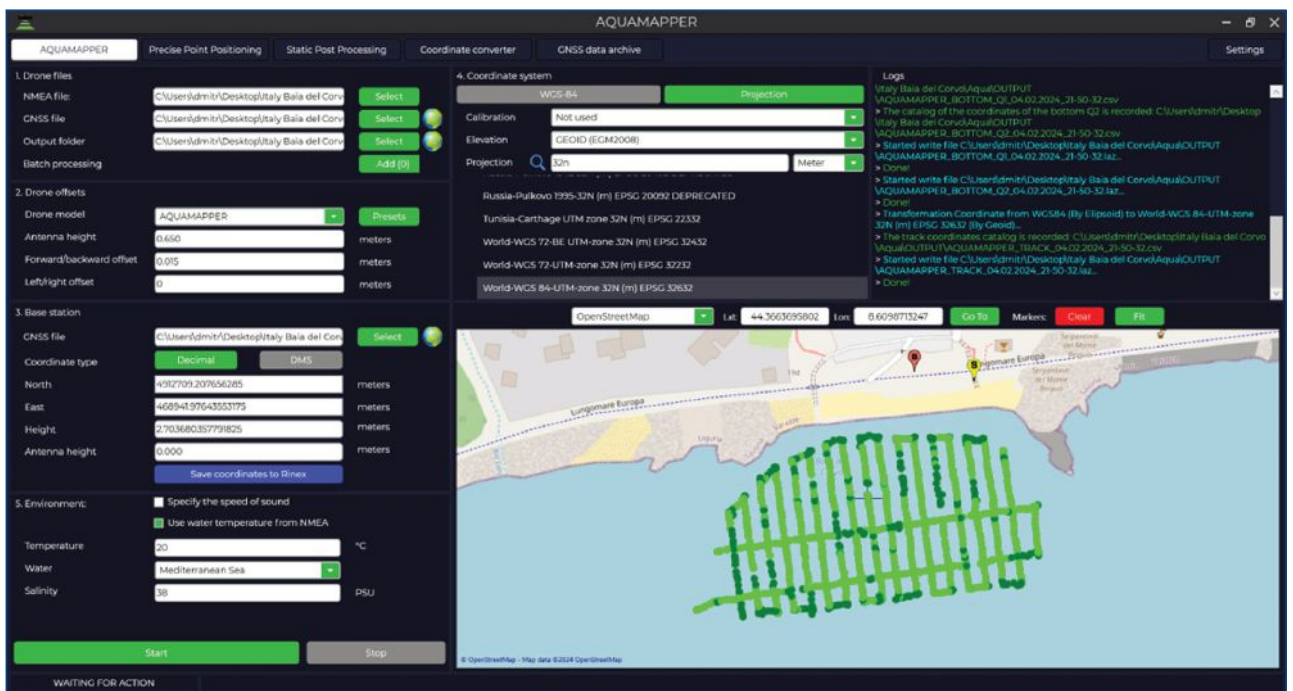
There are lighter weight systems available, however, and they combine multiple airborne surveying practices using a photogrammetry camera, LiDAR and bathymetric equipment (echosounder).

Proof of Concept

In 2023, TOPODRONE started to implement its combo solution for coastal mapping services. TOPODRONE's versatile design philosophy makes it possible to integrate the company's AQUAMAPPER bathymetric equipment

with LiDAR and photogrammetric cameras installed as a payload on one drone using a centralized mission planning and data processing software. With this hardware and software combo, survey teams can remain small and agile.

For example, a survey was conducted in February 2024 in Genova, Italy, by a team of three people within one day. For hardware, the team used the DJI Matrice 350 RTK drone integrated with TOPODRONE AQUAMAPPER, a single-frequency solution that measures

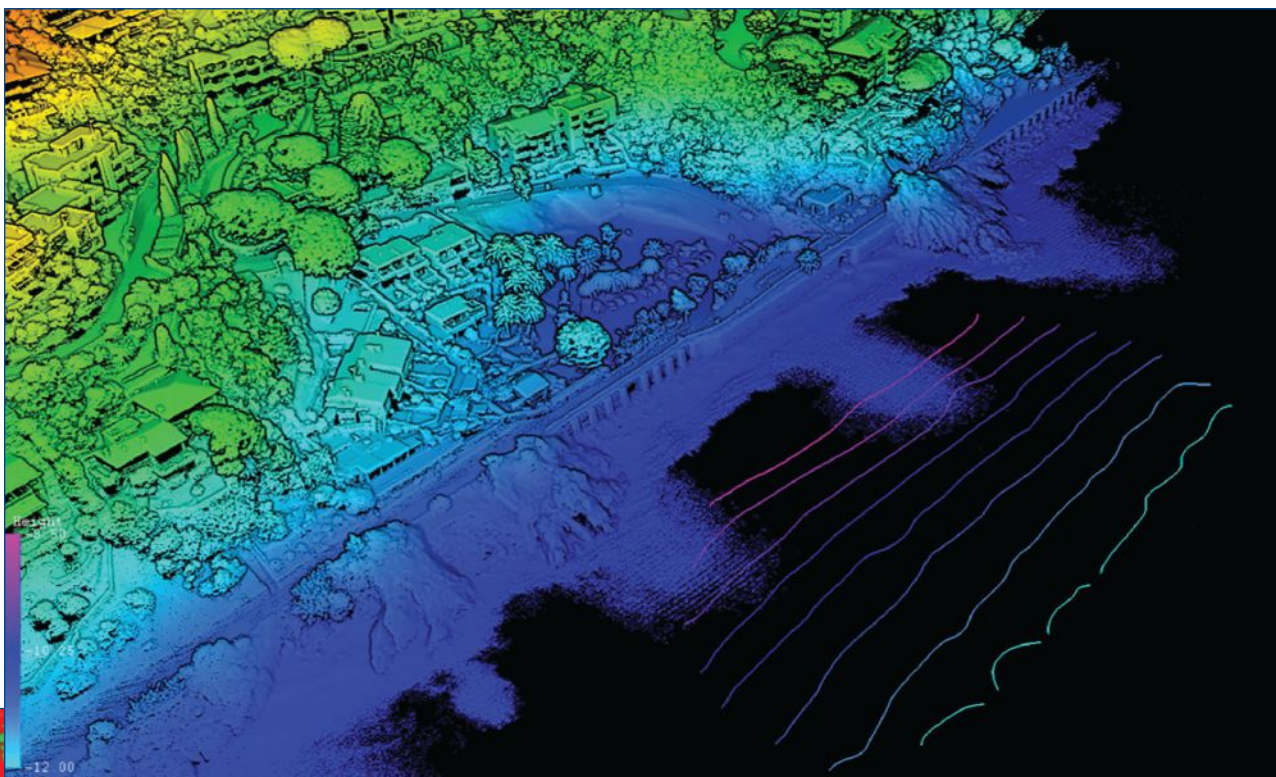


bathymetry to achieve a profile of the seabed with data that can be used for any other projects and designs, and TOPODRONE LiDAR 200+. The UgCS software by SPH Engineering was used for mission planning, and TOPODRONE and LiDAR 360 software were used for data processing.

The goal of the survey in Italy was comprehensive coastal mapping of a total of 6.82 hectares, including both land and sea aspects of the shoreline. The challenge of this project was the wave height. At 1 m, the wave

height was higher than expected and beyond the TOPODRONE team's recommended use for clients. Yet, the team used the tools it had and began to survey.

The survey started with TOPODRONE AQUAMAPPER hardware preparation. The carbon pole was assembled, comprising a couple of cables: a power supply and the connection of the SkyHub device from SPH Engineering. After that, the flight mission was prepared, and the mission was implemented at the speed of 2 m/sec. The total flight time was 24 min., a little above the lim-



its of recommended use for TOPODRONE AQUAMAPPER.

Despite exceeding the recommended product limitations, the mission resulted in a successful flight. The mission was created by one member of the team as the other two members were assembling the equipment. It took about 5 min. to prepare everything for the flight, and the mission was accomplished directly on site with no advance preparation in the office.

During the LiDAR preparation, there was nothing to assemble. The LiDAR simply required two cables to connect: an antenna cable and the power supply. This means that when you turn on the drone, the recording starts automatically. Unnecessary data can be cut at the post-processing step. For LiDAR mission planning, the only thing that is necessary to remember before creating the main survey pattern is to locate the calibration infinity sign to initialize the IMU. There is no recalibration of the IMU during the flight. You calibrate it once, and

you're good to go.

All the flights were performed in fully automatic mode. We planned our missions (one for bathymetry and one for LiDAR survey) with the goal of having a good overlap of data to ensure a full picture of the area being surveyed.

You can directly see AQUAMAPPER's streaming data through the DJI Pilot 2 software, including the bathymetry profile, the unit angles during the flight at speed, and GNSS data.

During the flights, we monitored the radar data and the movement of the drone using the UgCS EXPERT software from SPH Engineering, which allows us to see all of the telemetry, the GPS data, the flight pattern and the altimeter.

Data Processing

Once the fieldwork was done and the data gathered, the TOPODRONE team started the processing stage at a café by the sea to check on the data so that, in case something had gone wrong, we could conduct the survey again. We also had the chance to charge the batteries at the café in case we needed more power.

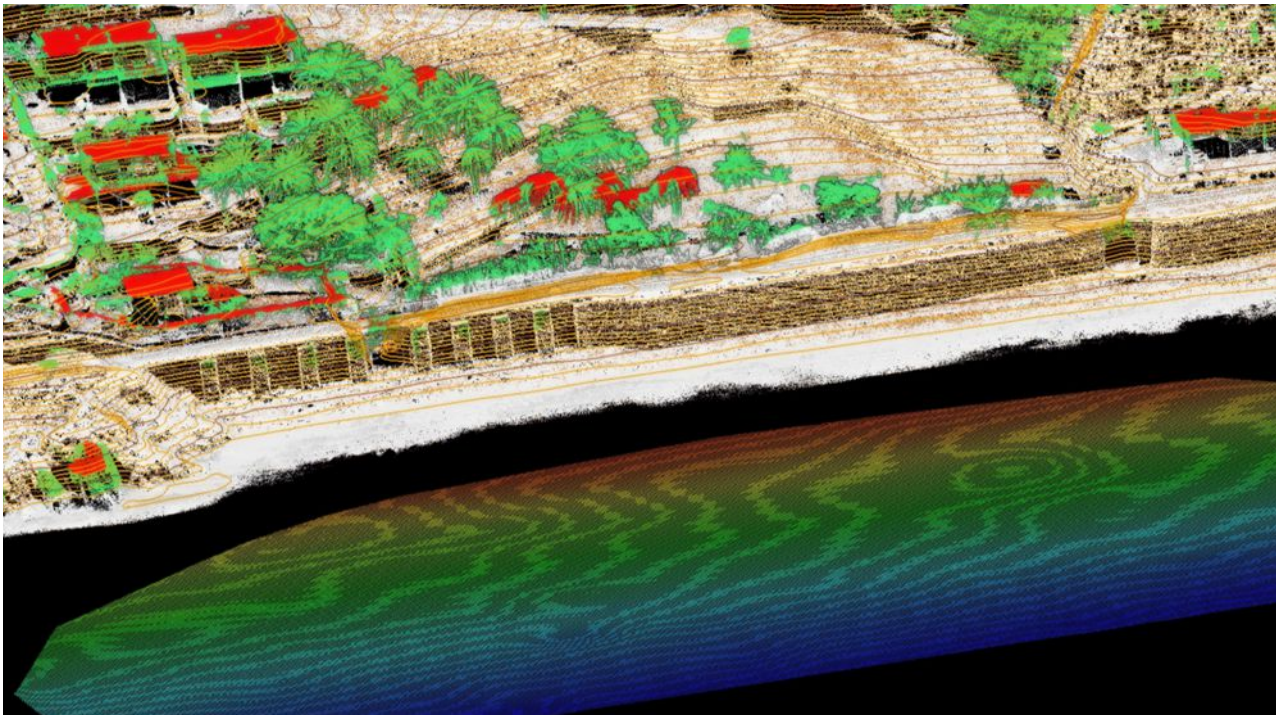
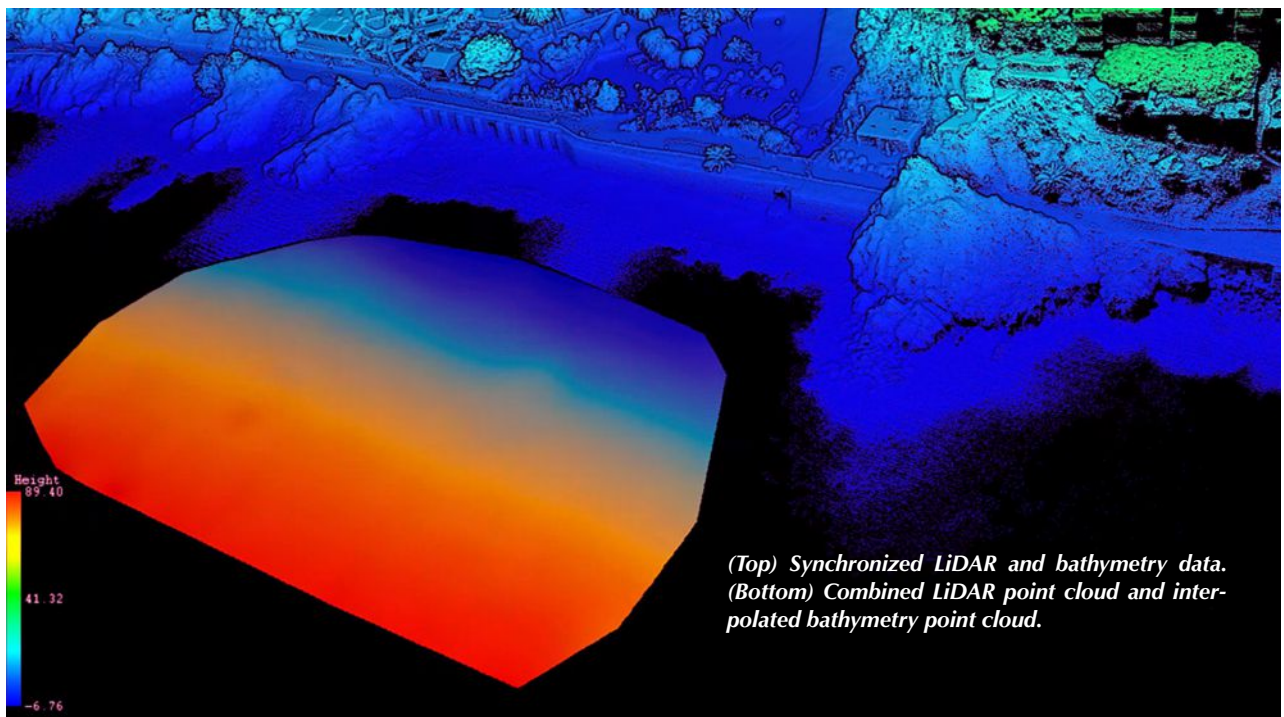
First, we calculated the raw data for TOPODRONE AQUAMAPPER. Then, we post-processed the LiDAR data. For the AQUAMAPPER, we simply needed to upload all of the data to the software and press "start." The files comprise one NMEA file, with depth measurements from the AQUAMAPPER sensor, and one UBX file, which is the GNSS file from the PPK receiver.

The data also included the drone offsets, or the GNSS antenna offsets (the distance between the PPK receiver and the center of the GNSS antenna and the base station).

Water salinity was also part of the data, as a pre-installed parameter.

Basically, the process runs from beginning to end with a simple press of the "start" button. After gathering data from the missions, we are able to generate a digital elevation model (DEM) with horizontal contour lines using the interpolation method, with a grid size of 10 by 10 cm.

The AQUAMAPPER data post-processing results in a LAS/LAZ file, which is a point cloud. We used the local coordinate system, which we chose from a pre-installed list of projections to generate the point cloud. We could



monitor the process of point cloud generation in a preview window. The point cloud was also generated from the LiDAR data, which were already strip aligned and adjusted, and the noise points removed. The thickness of the point cloud is 4 cm.

The combo surveying approach enabled us to provide bathymetry and LiDAR data. The DEM from the AQUA-MAPPER in TIFF format combined with the LiDAR data so that we could deliver the interpolated bathymetry data as a point cloud after raster to point conversion. So, it is possible to combine the ground layer from both survey methods.

This coastal management survey project in Italy showcased that a single-carrier solution coupled with centralized data-processing software for multiple data collection equipment can achieve high-accuracy data for real-time analysis with less resources.

The data from the Genova survey has potential applications for coastal construction and management of erosion. **ST**

Ilya Shikov is the CTO at TOPODRONE.

Sustainable Use of the Ocean

How to Balance Resource Demand with Coastal Management

By Dr. Ana Queirós • Kelly Davidson

The global ocean plays a crucial role in regulating the planet's climate, supporting biodiversity, and providing invaluable resources and other services to humanity. However, the increasing demands of a growing global population, coupled with the impacts of climate change, pose significant challenges to the sustainable management of ocean resources and coastal zones. This article delves into the complexities of ocean resource use

and coastal zone management, exploring balanced approaches to ecological preservation, economic growth and societal values.

Ocean Resources: A Wealth of Opportunities

The ocean is rich in resources that hold immense economic potential. Fisheries, for instance, provide a vital source of protein for billions of people worldwide and



A view of Plymouth Sound. Coastal areas will see a continuing increase in population, which will put greater pressure on marine resources. (Credit: Trevor Burrows)



affect the sustainability of human activities within the marine space, including industrial sectors, as well as conservation.

To this end, PML has been leading research into the development of climate-smart marine plans. One such project is the Marine Spatial Planning Addressing Climate Effects (MSPACE) project (www.pml.ac.uk/science/projects/MSPACE-Marine-Spatial-Planning-Addressing-Climate), funded by the Sustainable Management of UK Marine Resources Strategic Priorities Fund, which was designed to advance the capability of the four U.K. nations in designing and implementing climate-smart marine spatial plans.

The first-of-its-kind project involves a wide range of policy and industry partners and stakeholders, bringing marine climate scientists, modelers, social scientists and economists together to help manage the U.K.'s marine environment sustainably in a changing climate.

support the livelihoods of millions in the fishing industry. However, overfishing, illegal fishing practices, habitat destruction and environmental changes have led to the depletion of fish stocks and the degradation of marine ecosystems. Sustainable fisheries management strategies, such as implementing quotas, enforcing regulations and promoting ecosystem-based approaches, are essential to ensure the long-term provision and viability of marine resources.

Beyond fisheries, the ocean also offers a plethora of other valuable resources, including minerals, aggregates (sand and gravel), and access to oil and gas deposits and renewable energy sources, such as wind, waves and tidal. Such industries, while providing significant economic benefits, can also pose environmental risks, such as habitat damage, pollution and disturbance to marine wildlife. Sustainable development practices, stringent environmental regulations, and technological innovations can help mitigate these impacts and ensure responsible resource use.

Climate-Smart Marine Planning

Plymouth Marine Laboratory (PML) in the U.K. has been researching ways in which society can make the most of the marine environment and its resources in a sustainable way through comprehensive, targeted and adaptive marine plans. These new-generation marine plans document and set priorities about how the marine space is managed and shared while incorporating the impact of current and future climate change.

Climate change is already affecting species and habitats around the world, and these effects are set to increase if greenhouse gas emissions continue to rise, further accelerating climate change and its consequences. These changes



(Top left) A PML study predicts that the rate of sea level rise will affect the region's MPA status. (Credit: Alan Le Sommer, Unsplash)

MSPACE recently published the report “Early-warning system - Climate-smart spatial management of UK fisheries, aquaculture and conservation” (<https://indd.ado.be.com/view/4fdcf0d-fd86-4365-8fcb-fed57e978f3a>), a state-of-the-art modeling analysis showing where, and for how long, marine conservation, fisheries and aquaculture could be best supported across U.K. seas. This report is already helping inform the development of climate-smart plans in the U.K. (www.youtube.com/watch?v=vKLq68HzFwE).

The data uncovered in the MSPACE illustrates how, despite the growing pressure of climate change on our marine ecosystems, human activities and conservation can be managed to build on areas where lower sensitivity to climate change is observed within a planning area. Such nature-based solutions promote climate change adaptation for nature and people.

Social value assessments and economic modeling are now being used to translate this climate change evidence into indicators that are tangible to stakeholders in consultations inherent to marine plan development to ensure plans are not only climate-smart but also economically viable and socially acceptable.

Protecting Marine Ecosystems: An Ascension Island Study

Another recent modeling study by PML scientists has highlighted policy delivery challenges in light of climate change (www.pml.ac.uk/News/Marine-Protected-Area-%e2%80%98not-safe%e2%80%99-from-climate-change). The modeled projections showed that the waters around the U.K. overseas territory Ascension Island, situated in the equatorial Atlantic Ocean, could have a concerning future if the rate of climate change continues. Ascension Island’s marine environment has been protected from fishing and deep-sea mining since 2019, and it is the eighth largest marine protected area (MPA) in the world.

Despite efforts to safeguard this MPA, climate simulations project that over the next century, this MPA region will become warmer, more saline and more acidic, with less nutrients, less chlorophyll and less primary production in the surface waters. Even in the low-emission scenarios, the models project significant ecological change within the MPA. The main current of the region, the Atlantic equatorial undercurrent, is also projected to weaken in all scenarios. These changes will likely negatively impact the capacity of the area to provide ecosystem services, such as the removal of carbon dioxide from the air, tourism and fish stocks.

Creating new, climate-smart management strategies that protect vulnerable areas while sustainably optimizing opportunities in more climate resilient areas is vital for effective marine conservation and economic growth in the long term.

Coastal Zone Management: Protecting Vulnerable Ecosystems

Coastal zones are dynamic environments often encompassing a diverse array of ecosystems, such as mangroves, coral reefs and salt marshes. These ecosystems provide essential services, including nursery habitats for wildlife, coastal protection, biodiversity conservation and carbon sequestration. However, coastal areas are also under increasing pressure from human activities, such as urbanization, industrialization and tourism development.

It is estimated that 2.15 billion people live in the near-coastal zone and 898 million in the low-elevation coastal zone globally, with these numbers expected to rise rapidly in the coming years. Unchecked coastal infrastructure development can lead to increased habitat and biodiversity loss, pollution, and coastal erosion, adding additional pressures to an already stressed environment.

Effective and targeted coastal zone management strategies are essential to mitigate these threats and promote sustainable development along coastlines. Integrated coastal zone management (ICZM) approaches, which involve stakeholder engagement, marine spatial planning and adaptive management, can help bal-

*predicts a vulnerable future for Ascension
of climate change continues, despite the
lit: Ben Tullis) (Bottom) Artificial light at
own to have harmful effects on marine
ways to mitigate these issues. (Credit:
h)*



ance competing interests in a particular area and help safeguard coastal ecosystems and industries.

We Need to Talk About ALAN

Another area that PML has been investigating that is very much related to coastal zone management is the issue of artificial light at night, also known as ALAN [www.pml.ac.uk/Videos/Artificial-Light-At-Night-(ALAN)]. As coastal areas become increasingly developed, concerns are growing about the levels of artificial light at night and its potential impacts on the marine environment (Sea Technology, April 2023).

Light pollution is well-studied in terms of its effects on the night sky and astronomy, and on terrestrial ecosystems, but effects on the ocean have been understudied. Our research, alongside colleagues from the University of Plymouth, has found that up to 1.9 million km² of the world's coastal waters are being exposed to biologically significant levels of ALAN. Impacts upon marine life include: altering the bodily processes and function of animals; changes to ecological communities; reducing reproductive success in fish and turtles; delaying the production of gametes in corals; disruption of migration in zooplankton, sandhoppers and highly photosensitive species; changes to cross-species interactions; altered phytoplankton quantity; and decreased effectiveness of camouflage at night for prey species.

Due to the extent and wide-ranging effects of ALAN, it should be recognized as a major 21st century global human impact issue, alongside climate change, chemical pollutants, overexploitation, wastewater discharge and plastics, to name just a few.

A complete ban or significant reduction of coastal lighting is unfeasible as suitable lighting in built-up areas is vital for night visibility, safety, security, aesthetics and reducing criminal behavior. However, there are a number of options that can be explored by marine developers and planners to help reduce the impact of ALAN on marine life, which include: reducing the blue element of the light spectrum in coastal lighting (there is evidence that LED lighting, with a peak in the blue end of the spectrum, is more harmful to biological rhythms than traditional sodium lighting and passes deeper into water than red photons); reducing spotlights and floodlights near the coast; using directional fixtures; lowering and/or shielding lights to illuminate only areas essential for safety; installing motion sensitive lights; limiting the illumination of civic buildings and offices near the coast; instituting "dark hours" with increased surveillance; directing lighting away from the coast; performing regular light pollution surveys on land and marine light sources; including a light pollution assessment in all new coastal development plans; and planting native vegetation to act as a buffer between the light source and marine environment.

Challenges and Opportunities

Numerous challenges remain as we move toward the goals of sustainable ocean resource development and coastal zone management. Climate change exacerbates

existing threats, such as sea level rise, ocean acidification and extreme weather events, putting additional pressure on marine and coastal ecosystems. Inadequate governance, lack of capacity and competing interests among stakeholders further complicate efforts to achieve sustainable management outcomes.

Many marine plans and licensing regulations, as well as governance for MPAs, currently do not effectively support the conservation of ecologically and commercially important species in light of climate change. This is also true for the effects of climate change on wild capture and aquaculture regulatory policies, and highlights the urgent need for climate-adaptive marine spatial management strategies.

However, amid these challenges lie opportunities for innovation, collaboration and transformative change. Advances in technology, such as remote sensing, artificial intelligence and biotechnology, offer new tools for monitoring, managing and conserving ocean resources. In addition, international cooperation and multilateral agreements, such as the Paris Agreement, provide frameworks for addressing transboundary issues and promoting sustainable development.

The use of nature-based solutions, such as mangrove restoration, beach nourishment, wetland regeneration and green infrastructure, is a rapidly growing approach and can offer cost-effective and sustainable alternatives to traditional engineering approaches to provide or enhance biodiversity, coastal protection, nursery grounds for wildlife, and carbon sequestration. These are important and potentially powerful tools in the marine management toolbox.

Conclusion

Sustainable ocean resource development and coastal zone management are critical components of global efforts to achieve ecological resilience, social equity, and economic prosperity. By adopting integrated approaches that balance conservation and development objectives, we can harness the immense potential of the oceans while safeguarding their ecological integrity for future generations. Through collaboration, innovation and concerted action, a more sustainable and resilient future for the oceans and the people who rely on them can be achieved worldwide. **ST**

Dr. Ana Queirós is a marine and climate change ecologist at Plymouth Marine Laboratory and has been awarded an honorary professorship from the University of Exeter. She is an internationally recognized expert in climate change ecology, with expertise in field, laboratory and modeling approaches. Queirós has an extensive track record in the co-development of nature-based solutions for ocean management. She leads research to help practitioners build climate resilience into marine conservation and marine spatial planning.

Kelly Davidson is an environmental communicator at Plymouth Marine Laboratory. She has worked as an environmental communicator for over 18 years and has contributed to or led the communication packages for international environmental research projects. Davidson obtained an M.S. in science communication in 2015, focusing on science writing, stakeholder engagement and changes in science journalism since the advent of social media.

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Carbon Tracing

Tracer Tech Can Enhance Offshore CCUS Monitoring

By Roy Greig • Charles McConnell

Offshore carbon capture, utilization, and storage (CCUS) is a promising solution for reducing carbon emissions and mitigating climate change, providing a secure and environmentally sound method for long-term carbon dioxide (CO₂) storage while leveraging existing offshore infrastructure and the vast capacity of offshore geologic repositories. The long-term impact of offshore CCUS storage will be required globally and has the unique potential to lower anthropogenic carbon dioxide emissions and thus enable the essential utilization of fossil fuels in an environmentally transformative manner.

Offshore geologic fields have long served as repositories for oil and gas. These formations have existed for centuries and provide a natural advantage for CO₂ storage and can now be repurposed for carbon storage. Offshore CCUS offers several benefits, including safe and secure storage, extremely large and long-term capacity, reduced environmental footprint, increased location flexibility (not in anyone's back yard), and enhanced oil recovery (EOR) potential.

Today, a considerable portion of the world's CO₂ storage capacity resides offshore, with many regions lacking onshore storage facilities. Certain regions, such as Western Europe, heavily rely on underwater reserves due to geological positioning and data availability. Offshore geological formations, such as depleted oil and gas reservoirs or deep saline aquifers, can provide secure and stable storage for CO₂ over long periods. These formations that have held oil and gas for a very long time are typically well-sealed by impermeable rock layers, effectively eliminating the risk of CO₂ leakage into the atmosphere.

There are several benefits of storing CO₂ offshore. It helps mitigate the environmental impact of carbon emissions by preventing them from entering the atmosphere and contributing to global warming. Offshore storage sites can be located near CO₂ emission sources, such as industrial facilities or power plants, reducing the need for

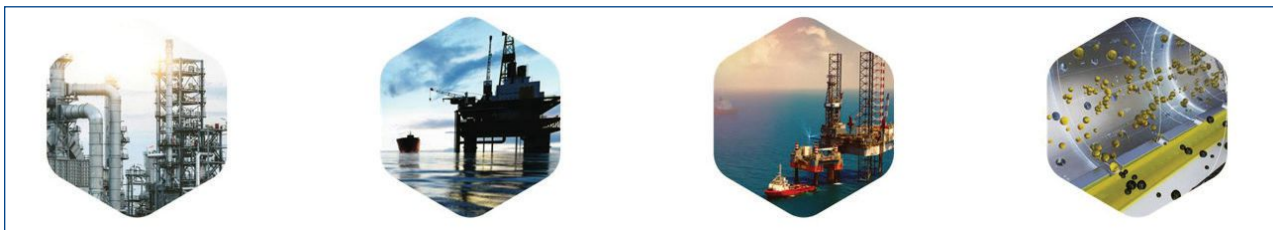
long-distance transportation of CO₂ and helping to lower the costs of CCUS projects. CO₂ captured from industrial processes or power plants can also be used for enhanced oil recovery in depleted oil reservoirs, which can help increase oil production while simultaneously storing CO₂ underground.

CCUS Offshore Deployment Cases

The North Sea, and Norway in particular, leads ongoing offshore CCUS endeavors. The Sleipnir project, initiated in 1996, remains the world's longest-running CO₂ storage project, capturing and storing around 1 million tons of CO₂ annually from natural gas. Newer ventures include the Northern Lights and Acorn in Scotland that aim to advance low-carbon technologies, with the Greensand Project in Denmark recently commencing injection test operations as a consortium of 23 Danish and international partners. As the world's first cross-border offshore CO₂ storage intended to mitigate climate change, the Greensand Project plans to store up to 1.5 million tons of CO₂ annually from 2025/2026, potentially rising to 8 million tons by 2030. This project has demonstrated the value of offshore CO₂ storage across the full value chain, from capture to transport and storage.

In the U.S., several companies are collaborating to develop Bayou Bend, an offshore CCUS facility in Texas that boasts a storage capacity of 600 million metric tons. Bayou Bend is designed as a 10 million metric tons per annum (MMTPA) CO₂ capture, transport and storage facility. Its primary goal is to sequester CO₂ emissions from industrial operations in Port Arthur and the surrounding area.

In other markets, Australia leads in anticipated projects, primarily in the study stage. Southeast Asia boasts numerous brownfield projects, such as the Kasawari project offshore Sarawak in east Malaysia. It is expected to be the world's largest offshore CCUS facility, with ca-



Tracer technology offers precision for CCS monitoring.

capacity to reduce CO₂ emissions by 3.3 million tons per annum (MTPA). Additional offshore projects have been announced in Thailand and Saudi Arabia.

STEMM-CCS

The STEMM-CCS project is situated within the offshore waters of Scotland's Outer Moray Firth in the U.K. sector of the central North Sea (56 to 60° N). The project, led by Shell, sought to test these technologies and validate them for offshore CCUS. This involved deliberately injecting different tracers into the seabed, where gas bubble releases were expected. The bubbles were then carefully gathered and sent to different labs for detailed examination.

While the results yielded valuable insights, they also underscored inherent challenges. Discrepancies emerged among the results obtained from different laboratories, prompting questions about the reliability of tracer utilization in isolation, ruling out some tracers and techniques and suggesting that a full-scale and complex geochemical survey and study are required to get value from the results. However, even then, variability persists due to the differing analytical capabilities of laboratories, as they differ in capabilities as they try to detect tracers among the masking geochemistry at parts per million (PPM) or parts per billion (PPB) levels.

Offshore CCUS Challenges

According to the Global CCS Institute, to meet the Paris Agreement climate goals, more than 2,000 large-scale CCUS facilities must be deployed by 2025, 100 times more than those in operation today. Nonetheless, CCUS projects have encountered numerous challenges. Offshore, there are concerns over the safety of utilizing subsea formations, particularly when it comes to the selection of wells—should we repurpose existing ones or drill new ones?

There are several challenges with CCUS offshore, including subsea conditions, detection accuracy, scale and depth, cost, and environmental impact. For example, carbon dioxide sequestered can migrate through geological layers, utilizing existing pathways created by older oil and gas wells. Also, operating in deep-sea environments introduces logistical complexities, requiring specialized equipment for monitoring and maintenance.

Notably, public opposition challenges are driven by fears of CO₂ leakage, further underscoring the need for

robust monitoring and mitigation measures to detect, locate, and quantify CO₂ leaks underwater. Ensuring accurate detection and measurement of CO₂ movement in underwater environments is challenging due to water currents, temperature, and dissolved gases. Offshore storage sites are often vast and located at considerable depths, making comprehensive monitoring challenging and requiring sophisticated monitoring technologies. Implementing and maintaining monitoring systems in offshore environments can be costly due to the need for remote operation, specialized equipment, and frequent inspections.

Regulatory Challenges

In the U.S., the regulatory framework for offshore CCUS is still in its infancy, facing significant challenges related to long-term liability of related projects and the adaptation of existing regulations. Unlike onshore CCUS, which utilizes Class VI wells designed for the safe injection of CO₂ into deep underground rock formations, offshore CCUS lacks a well-established regulatory structure. This nascent status means that comprehensive guidelines and standards specifically tailored for the unique conditions of offshore environments are not yet fully developed. The complexities of offshore operations, such as deep-sea pressures, corrosion issues and the ecological sensitivity of marine environments, require stringent regulatory approaches that ensure both safety and environmental protection over extended periods.

The current regulatory reliance on Class VI wells, primarily intended for onshore injection, highlights the gap in addressing offshore-specific challenges. Despite the stringent and robust monitoring plans mandated by the U.S. Environmental Protection Agency for onshore Class VI wells, these wells have limited applicability to offshore scenarios, necessitating the development of new standards through demonstrations and pilot projects.

The evolution of offshore CCUS regulations will involve substantial efforts to refine and adapt these frameworks to ensure they adequately address long-term liability concerns, including monitoring and remediation responsibilities. This process is crucial to build stakeholder confidence and establish a robust regulatory environment that supports the scaling up of offshore CCUS. Furthermore, the regulatory process for obtaining a Class VI permit is lengthy and rigorous, involving extensive public and stakeholder engagement.

Long-Term Monitoring Challenges

Long-term monitoring presents one of the key challenges with offshore CCUS. Assessing the environmental impact of CO₂ leakage in marine ecosystems requires

thorough monitoring and understanding of marine biology and ecology. Meeting regulatory requirements for monitoring and reporting CO₂ storage activities in offshore areas adds complexity and necessitates robust monitoring systems. To instill confidence in regulatory agencies and the public regarding the integrity of CO₂ storage and to obtain a social license to operate, it's imperative to showcase the implementation of resilient offshore monitoring systems to detect any potential leakage or migration of CO₂. The imperative to swiftly and accurately detect and effectively manage any unintentional release of injected CO₂ is a key challenge hindering the widespread adoption of large-scale CCUS projects.

Currently, in the maritime industry, AUVs are strategically deployed at intervals to monitor the seabed above CO₂ storage sites for potential leaks. AUVs can also be outfitted with gas bubble collectors upon detection, facilitating subsequent detailed analysis of any identified bubbles. However, while conventional methods, such as the use of cameras on AUVs, can detect anomalies, distinguishing CO₂ emissions from natural seepages remains a challenge.

The Role of Tracer Technology

This is where tracer monitoring fits in as a cutting-edge solution that offers unparalleled insights into the origins of underwater gas emissions. Chemical tracers emerge as an effective tool for identifying, attributing and measuring any surface-bound CO₂ leaks originating from geological storage sites—a pivotal aspect of CCUS technology. Chemical tracers are used for tracking large-scale subsurface flow patterns, serving as unique fingerprints to enable the identification of CO₂ leakage. Leveraging chemical tracers effectively could yield invaluable insights into the movement and destiny of CO₂. By introducing unique, non-naturally occurring tracers into the storage reservoir, researchers can track the movement of CO₂ and differentiate it from ambient gases. Even in instances where direct sampling from wells isn't feasible, tracers enable researchers to pinpoint the source of gas bubbles with remarkable precision.

While traditional monitoring methods yield inconclusive results at PPB levels, advanced tracer technology pushes the boundaries further, operating at parts per trillion (PPT). This unparalleled sensitivity allows for the detection of even the slightest traces of CO₂ leakage, ensuring the integrity of offshore storage sites.

The process is sophisticated yet straightforward. Gas bubbles are collected using specialized collectors deployed alongside AUVs or ROVs. These samples are then subjected to laboratory analysis, where tracers are identified and quantified. By correlating tracer signatures with specific storage reservoirs, researchers can conclusively determine the origin of underwater gas emissions.

The use of tracers is not only scientifically robust but also environmentally friendly. These tracers are non-toxic, non-radioactive and have a minimal carbon footprint, ensuring environmental safety and operator well-being. They pose no risk to marine ecosystems and can be tailored to meet specific monitoring requirements. With

advancements in analytical techniques, we can detect tracers in minuscule concentrations, further enhancing the accuracy of monitoring efforts.

RESMAN's low-toxicity, organically derived tracers, for example, offer a unique and highly detectable solution for monitoring CO₂ in CCUS projects. This cutting-edge approach to gas bubble collection thrives on the meticulous selection and consistent detection of the most suitable tracers for each environment. Once seabed samples are obtained, tracer analysis can swiftly pinpoint the origin of CO₂ leaks. The methodology allows for extreme detectability with minimal tracer amounts, reaching even PPT detection levels and offering a reliable means of validating potential leak paths from reservoirs. These tracers play a vital role in confirming or debunking leak sources without the need for extensive geochemical surveys or studies, thus saving on cost and eliminating ambiguity. RESMAN's tracers are used in projects worldwide, including those in Algeria, the Netherlands and Norway, providing assurance that CO₂ remains contained underground.

Offshore CO₂ storage holds immense potential as a climate mitigation strategy. By demystifying the monitoring process and providing unequivocal evidence of CO₂ origins, tracer technology can pave the way for the widespread acceptance of offshore CCUS initiatives. A comprehensive measurement, monitoring, and verification plan can enable safe, efficient, and transparent CO₂ storage, as well as cost optimization. **ST**

Roy Greig is the senior vice president of RESMAN Energy Technology, with 30 years of experience in technology and subsurface consultancy for oil and gas and energy industries. He leads RESMAN's strategy for growing its business and technology portfolio in line with global energy transition needs and requirements. Previously, Greig held senior roles at Baker Hughes and ION Geophysical. Specializing in geoscience and petrophysics, he has driven key subsurface technology innovations and business turnarounds. Roy has also contributed to numerous award-winning scientific papers. He holds a B.S. in earth sciences from Durham University and a finance qualification from Harvard Business School.



Charles McConnell is the executive director of the Center for Carbon Management in Energy at the University of Houston (UH), where he leads executive CCUS education programs and CCUS commercialization consortia of industry and public/private experts to promote CCUS deployment in the U.S. and globally. McConnell has more than 35 years of energy experience. He ran the global H₂ business at Praxair and the carbon management business at Battelle, where he was in charge of CCUS R&D in the U.S. Midwest. Prior to joining UH Energy, McConnell served as assistant secretary at the U.S. Department of Energy (2011 to 2013). He holds a bachelor's degree in chemical engineering from Carnegie-Mellon University and an MBA in finance from Cleveland State University.



Technology Aids Marine Conservation

Spotlight on Five Pew Marine Fellows

By Nathan Fedrizzi

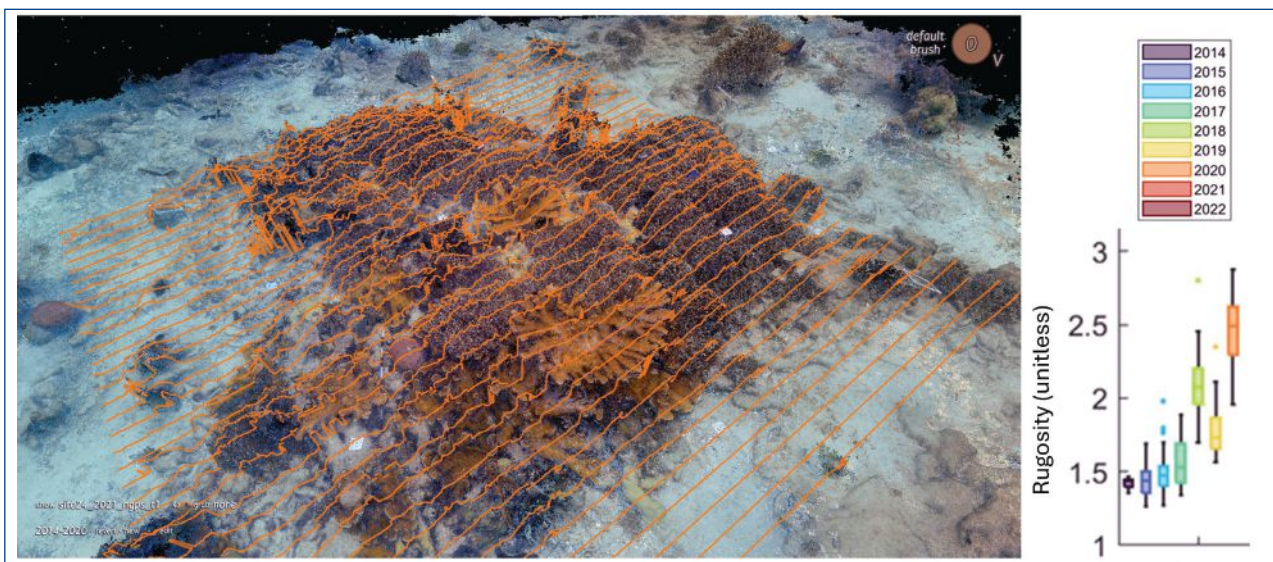
Technological innovation is critical to advancing marine conservation and sustainable resource management. The development of new high-tech tools can improve ocean monitoring, data collection and scientific analyses, efforts that aid in the protection of marine ecosystems through better surveillance, enforcement and

restoration. These advancements can also enhance public engagement and awareness, contributing to better informed and more proactive conservation practices.

Throughout the world, scientists supported by the Pew Fellows Program in Marine Conservation are leveraging groundbreaking technologies to address pressing envi-

A full-page photograph showing a diver in a dark wetsuit and fins swimming horizontally over a vast, textured coral reef. The water is clear and blue, with sunlight filtering down from the surface. The diver is holding a camera, and a small pink buoy is visible in the distance.

Arthur Gleason demonstrates photo acquisition during his underwater photomosaic training class in Belize. (Credit: Ana Giro)



Digital 3D models allow for improved measurements of the seabed. For example, divers traditionally measure rugosity, or roughness, on centimeter-to-meter scales using chain transects or profile gauges. This slow process is time consuming and hard to replicate year to year. With digital models like the one shown here from a coral reef restoration site in Belize, measurements can be precisely replicated over time and spread out over space, thereby estimating not only rugosity but the variance in rugosity across a site. (Credit: Arthur Gleason)

ronmental challenges, from coastal habitat restoration in East Asia to coral reef conservation in the Caribbean to European aquaculture sustainability. With support from this prestigious program, which seeks to improve ocean health through high-quality research, scientists Juan Patino-Martinez, Arthur Gleason, Emi Uchida, Marine Cusa, and James Kar-Hei Fang use cutting-edge tools to drive marine conservation initiatives and address urgent problems plaguing the world's oceans.

Satellite Telemetry and Marine Megafauna Tracking

Cape Verde is home to one of the largest nesting colonies of endangered loggerhead sea turtles. These majestic animals face numerous threats to their survival, including fisheries bycatch, habitat loss and pollution. Tracking the turtles is essential to understanding their migratory patterns, foraging behavior and habitat preferences. It's also important in helping scientists identify areas where the turtles are most likely to face threats from human activities. However, current tracking technologies, such as biologging telemetry instruments that are typically attached to the turtles' shells, remain costly and, as such, are often inaccessible.

Juan Patino-Martinez, a 2023 Pew marine fellow and scientific coordinator at the Maio Biodiversity Foundation in Cape Verde, works to redefine the landscape of marine megafauna tracking through the development of affordable, open-source satellite telemetry devices. With a primary focus on sea turtles, Patino-Martinez's innova-

tive approach uses satellite technology to meticulously monitor the movements and behaviors of these highly mobile marine creatures.

In a 2023 study in the *African Journal of Sea Turtle Biology and Conservation*, Patino-Martinez and fellow researchers explain the advances in technology that have enhanced our understanding of loggerhead turtles. The researchers use small temperature data devices to investigate the effect of temperature variation on turtle eggs in nesting beaches. Infrared night-vision cameras are used to assess the natural behavior of predators, such as ghost crabs. The team also uses drones to monitor turtle nesting activities in remote regions.

These methods are coupled with the scientists' own technological innovations, including integrating video technology with tracking equipment to enhance research on sea turtle habitat use while overlaying turtle movement tracks with data collected from fishing vessels to help determine and reduce the risk of harmful interaction with sea turtles.

"[T]hrough the progressive integration of technological innovations, we have facilitated data acquisition and enhanced data quality, ultimately improving research efficiency and accuracy," Patino-Martinez and his co-researchers wrote in the study. "We have developed more accessible and efficient technological tools for tracking and observing marine migratory species."

"The design, implementation, and widespread dissemination of technological innovations applied to conservation will enable global efforts, promoting collaboration within information networks and effective synergy between conservation and technology experts," the researchers added.

Underwater Landscape Mosaics For Coral Reef Conservation

Caribbean coral reef ecosystems face unprecedented threats, including climate change, overfishing and pollution. Monitoring the health of coral reefs is critical for effective conservation. However, traditional methods, such as line transect surveys—in which divers assess coral

“The underwater landscape mosaics of Arthur Gleason, a 2020 Pew marine fellow and research associate professor at the University of Miami, are a paradigm shift in coral reef monitoring.”

cover along lines across the substrate—lack the precision and scalability needed for comprehensive monitoring.

The underwater landscape mosaics of Arthur Gleason, a 2020 Pew marine fellow and research associate professor at the University of Miami, are a paradigm shift in coral reef monitoring. This emerging technology can measure—in stunning detail—how well various methods to conserve and restore the Caribbean coral reefs are working. The approach uses software and cameras to assemble and analyze large-scale composite images of reefs, enabling scientists to efficiently track the fate of individual coral colonies over time and the composition of entire communities on the ocean floor.

"A major goal of coral reef restoration is the resumption of critical ecosystem services, including shoreline protection, creation of fish habitat and biodiversity maintenance. Hard coral coverage and rugosity [or, roughness] are two key drivers of these ecosystem services," Gleason explained. "The underwater photogrammetric

models that I've been making are wonderful tools for quantifying and monitoring both of these values, among other things."

By precisely monitoring coral reef health, biodiversity and structural integrity, Gleason's research provides crucial data for evidence-based decision making and the formulation of targeted conservation strategies. Scientists who participate in Gleason's training workshops on the use of underwater photogrammetry will also be able to send their images to a digital archive. This collaborative effort will help determine how to best scale active reef restoration initiatives and create conditions favorable for natural coral reef rehabilitation.

Predicting Changes in Coastal Habitats And Designing Proactive Restoration Solutions

Coastal habitats, such as mangroves and seagrasses, in the western Pacific Ocean's Coral Triangle provide numerous ecological and socioeconomic benefits, includ-

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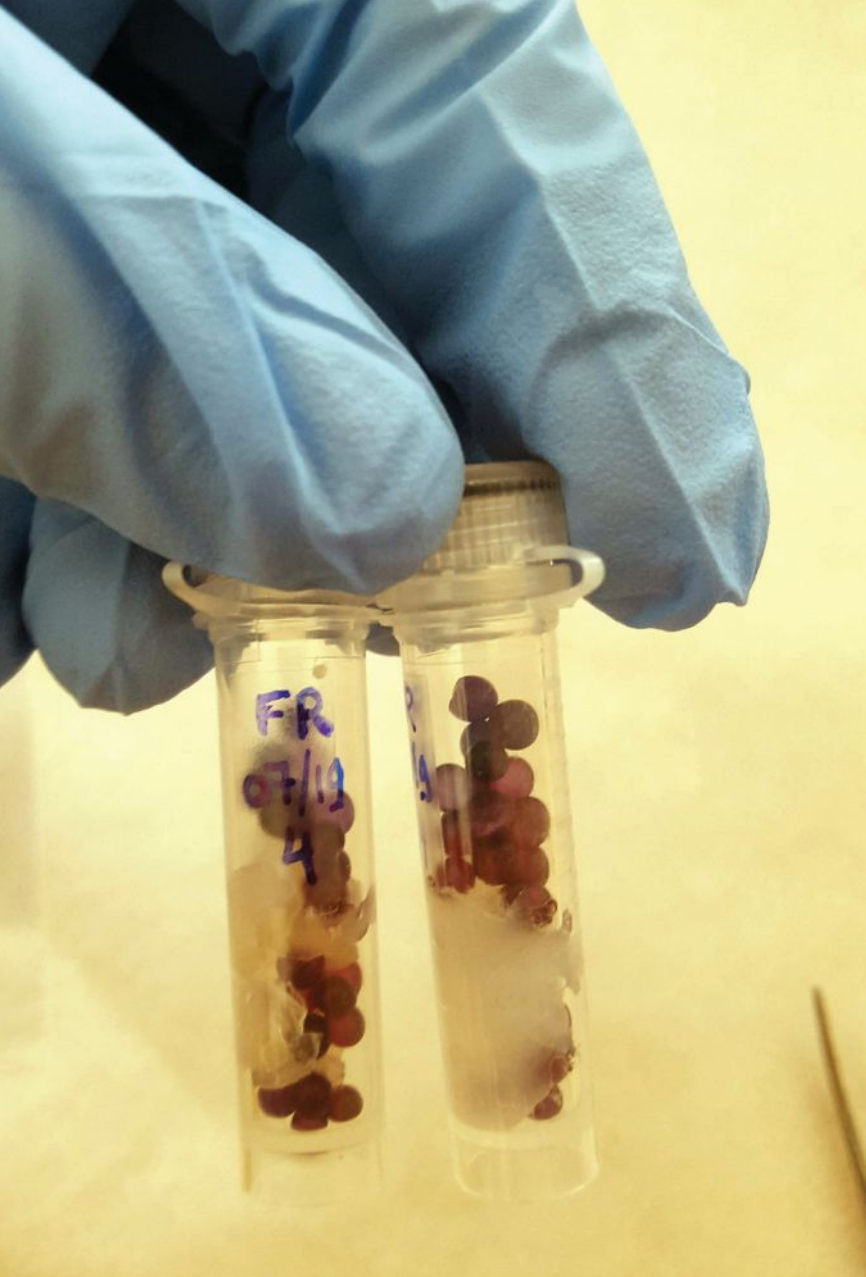
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ing coastal protection and carbon sequestration. However, these vital ecosystems are threatened by habitat loss, pollution and climate change.

“To reverse the losses effectively and efficiently, decision makers need reliable predictions of future threats and defensible evidence on the cost effectiveness of management practices,” said 2024 Pew marine fellow Emi Uchida, a professor of environmental and natural resource economics at the University of Rhode Island.

Uchida’s research is a pioneering effort in the application of remote sensing and social experiments to rigorously assess the effectiveness of conservation interventions. She employs remote sensing technologies, coupled with machine learning and econometrics, to identify degradation hotspots and the impact of local policies, and to predict future at-risk areas. Uchida aims to develop models that can forecast future changes in coastal habitats. These predictive models can then be used to design and assess proactive management strategies for the purpose

of reducing the risk of man-made environmental stressors while promoting ecosystem resilience.

Collaborating with local communities when addressing the problem of mangrove and seagrass loss is key to success, Uchida says, since many of the ecosystem services these coastal habitats provide directly affect people’s livelihoods—from fisheries and coastal protection services to beekeeping and other conservation endeavors. Through this approach, Uchida hopes to give local stakeholders and policymakers the knowledge and tools they need to ensure the long-term sustainability of coastal habitats.

“By working with the communities,” Uchida said, “we can better understand the values of these ecosystem services and their variation across and within communities. And by quantifying these values, we can get a [fuller] picture of the benefits of conservation and restoration—and better justify the efforts to reverse the losses of mangrove forests and seagrass meadows.”



(Left to right) Dried fish samples to be analyzed using genetic tools. (Credit: Marine Cusa) Marine Cusa uses genetic tools to evaluate seafood fraud on the European market. (Credit: Charles Baillie) Marine Cusa uses genetic tools to investigate the shark trade in Indonesia. (Credit: Bruno Cusa)

Enhancing Transparency in Aquaculture Through Genetic Tools

The aquaculture industry plays a significant role in global food production but also poses challenges for ocean sustainability. In Europe, most of the finfish aquaculture sector—in which fish are raised in closed pens or other contained areas—is devoted to farming carnivorous fish such as salmon, which are typically fed diets that include some amount of fish meal often from other small wild-caught fish. These small species are the primary prey for many larger marine animals and play a key role in ocean food webs. As such, ensuring the responsible sourcing of these fish feed products and the conservation of forage fish populations is important for ocean health and essential for the long-term sustainability of aquaculture operations.

Marine Cusa, a 2024 Pew marine fellow and policy adviser at Oceana in Denmark, aims to enhance transparency and sustainability in European aquaculture

through the integration of advanced genetic tools. With a specific focus on forage fish populations and the sourcing of fish feed products, Cusa employs state-of-the-art genetic techniques to trace the origins of forage fish used in aquaculture feeds and promote accountability within the sector.

By leveraging DNA-based tools, Cusa works to develop streamlined methods for species identification and traceability, thereby encouraging the responsible management and conservation of marine resources. Through collaborative partnerships with industry stakeholders, regulatory agencies and conservation organizations, Cusa's research seeks to foster a culture of transparency and stewardship in the aquaculture industry.

"I hope this research will provide transparency on the origin of aquafeed products, informing decision making and preventing the entry of unethically sourced fish into the market," Cusa said. "I aim to empower individuals, influence policies and hold the aquafeed industry ac-

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“Advanced technologies are transforming marine conservation by enabling more precise and effective ways to protect the world’s oceans.”

countable, driving a positive change in its complex trade landscape.”

3D Imaging Technologies for Pearl Oyster Restoration

Pearl oyster reefs, once abundant in Hong Kong waters, have declined significantly due to overexploitation and coastal development. The loss of these habitats not only impacts biodiversity, but also undermines the ecological and economic resilience of coastal communities.

James Kar-Hei Fang, a 2024 Pew marine fellow and associate professor at Hong Kong Polytechnic University, focuses on spearheading pearl oyster restoration efforts in Hong Kong, with a dual emphasis on ecological revitalization and economic resilience. Recognizing the ecological significance of pearl oyster reefs as critical habitat for marine biodiversity, Fang employs innovative culture methodologies and advanced 3D imaging to aid in restoring degraded habitats and to help assess how the oysters contribute to ecosystem health by acting as a substrate for other organisms. By engaging with local communities, fishers, students and policymakers, he aims to develop sustainable aquaculture practices that promote the recovery of pearl oyster populations while enhancing ecosystem services and supporting local livelihoods.

“Knowing that this project can provide additional income to local fishermen and inspire conservation awareness among students brings a sense of purpose to my research,” Fang said.

Through his interdisciplinary approach and commitment to conservation-driven innovation, Fang seeks to establish a model for sustainable aquaculture and coastal resource management that can be replicated in other regions facing similar challenges.

Advanced technologies are transforming marine conservation by enabling more precise and effective ways to protect the world’s oceans. Scientists supported by the Pew Fellows Program in Marine Conservation are spearheading this technological innovation, helping to better predict, monitor and address environmental issues, and ensuring that marine ecosystems remain resilient and sustainable for future generations. Through their groundbreaking research and collaborative efforts, these experts are at the forefront of new approaches to ocean conservation, instilling hope for a brighter, more sustainable future for the oceans—and the communities that depend on them. **ST**

Nathan Fedrizzi is a principal associate at the Pew Charitable Trusts. He implements the Pew Fellows Program in Marine Conservation.

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Q&A: Don Walsh

By David Helvarg



On November 12, 2023, Capt. Don Walsh (U.S. Navy, retired) died at the age of 92. As a Navy lieutenant in 1960, he and Swiss engineer Jacques Piccard dove to the deepest point in the ocean, almost 7 mi. down into the Pacific's Challenger Deep in the bathyscaphe Trieste. In the following decades, Walsh continued to push the boundaries of ocean science, policy, safety and marine exploration. In a final interview on Blue Frontier's podcast, he talked about his historic dive and the current state of ocean resources and the need to protect ocean health. The following is an edited version of the interview.

How were you selected for the Challenger Deep dive?

I always wanted to be a sailor. By the time I got out of high school in 1949, there weren't any jobs in the Merchant Marine, so the only way I could get to sea was to join the Navy.

I went to Annapolis [the U.S. Naval Academy], but the year I was to graduate, I found out my eyes weren't good enough to fly, so I went in another direction, submarines. And from submarines, I accessed the Trieste [bathysphere] program. I was the first volunteer. I passed the Navy's high standards by being the only volunteer.



They were developing a plan to hit the lowest point on Earth, the Challenger Deep.

I made my first dive in the Trieste to 4,000 feet because that's as deep as we could get off San Diego, operating out of the Navy lab. Then, it was revealed to me that we're trying to prepare the bathyscaphe to dive to the deepest place in the world ocean. The Office of Naval Research bought the Trieste to use it as a research platform to be able to take the trained mind to the deepest places in the ocean. Our job initially at the Navy Lab was to test it to the extreme to make sure it was a safe, productive platform for civilian oceanographers to use. Picard and myself, as a couple of engineers, we were test pilots to see if the thing could exist at the deepest possible depth. We tested it by doing it.

The Trieste, when it's floating on the surface, the cabin, the sphere, is hanging underneath the flotation, or the float, which is filled with aviation gasoline because that's how we get our buoyancy. It's an underwater balloon. We use a fraction of gas to adjust buoyancy on a dive. Somebody had 54,000 gallons of it, and it kept us afloat.

The cabin where we lived hangs beneath that float. There's a tube that comes down through the float. That's the gas tank. Just a cylinder tube with a ladder. At the bottom is the hatch to get into the cabin. At the back of that tube, where it comes down beneath the float, there was a curved plastic window that allowed us to look through a viewport in the entrance hatch to look aft. It was not for piloting or making scientific observations, it was just an operational convenience.

When they built this window, they didn't elongate the holes for the bolts that hold it to the metal frame. They were circular holes rather than oval. When plastic is under pressure on both sides, if it's not free to move on the

edges [along an oval hole], this stores up a lot of energy. When we get to 30,000 feet, there's this great bang. There's a crack in that window. I figured out what it was.

That was a nine-hour dive. It was five hours and some change going down. We stayed 20 minutes on the bottom, and then the rest of the time was coming back up. We went down very slowly because no one had any really good seafloor charts or topography. We don't want to get spiked on a seam as we're going down, or hit something because we're not aligned with the trench. We had no machines to measure the depths. No one had bottom scan sonar systems that map out the seafloor in great detail. Those were decades away.

Why didn't this become the first of a major exploration program for the deep ocean like the Mercury capsule that led us into space?

We were slightly ahead of, but not that far ahead of, NASA being formed. And we were always in the umbra of the National Space Program. It's, you know, sexy. A lot of talk about *son et lumière*, the idea that these guys are wearing these really nice pajamas and the American flag here and their funny hats, and there was huge noise with the rocket going up. We couldn't do that.

All we did is get in the thing, and when we dove, you see the swirl of bubbles where the sub went under. No noise, no fancy clothing. So, we weren't as sexy as space.

And with all due credit to them—in another life, I did apply for the Apollo program because I did my doctoral dissertation in remote sensing oceanography—so, I respect the space program. I'm just saying parity would have been nice in terms of budgets and policy. And we have a blue world that we still haven't explored at the

levels we've explored the moon and Mars. It would be fifty-four years before another person went to the deepest point on our planet.

And you were there on his mothership when Jim Cameron did that in 2012.

Yeah, 'cause I had worked a little bit as a technical adviser on 'The Abyss.' I was on the faculty at USC, and the Navy motion picture office in Hollywood would call me up. So, Jim and I were acquainted, and he asked me to come down to Malibu to visit his office. He said, 'I had this dream that I want to build a couple of one-man submersibles to go to the deepest place in the world ocean.' With one man, we can really reduce the engineering complexity and do an effective job. And he said, 'Do you want to go along?' I said, 'Sure.' Eventually, he only built one sub. I was involved a bit toward the end when he was completing the construction in Australia.

I was actually on board the mothership with Jim when he made his dive. I was the last person to talk to him and the first person to greet him when he came back up. That was nice. I never thought anybody would get back there fifty-two years later. I never thought I'd live to see all of this.

And then, I was on Victor Vescovo's expedition in 2019, when he dove his sub, his two-man sub, to the Challenger Deep. Victor's done that fourteen times, so you want to talk about a reliable, repeatable system, that's what you're talking about.

And your son got to go down with him in 2020?

Yeah, I would have never asked Victor for that because I know what they cost. He's in for about \$50 million to build a sub, and I think the burn rate is about a million dollars a month. Each of those seats is precious.

What are your thoughts on deep-sea mining, extracting minerals from the bottom of the sea?

I wholly agree with the people who hold a negative opinion of it right now. On land, we don't hesitate to do environmental impact studies before we undertake most major activities that will have an effect on the environment, and I don't understand why that's not considered to be the same rule when you're in the oceans. They haven't done that kind of work, and the International Seabed Authority [ISA], which is a UN agency located in Kingston, Jamaica, that governs the allocation of mining sites, I think that they're moving too quickly. They have not had the budgets they need to really invoke a full-grown environmental study program of various mining sites.

It is an activity that doesn't differentiate between the ore and the things that live with that ore on the seafloor. You're going to scrape them up, and these are organisms that take thousands of years to populate an area. They're not going to repopulate quickly.

I think that there has to be a convincing amount of study being done on types of potential mining sites, and

it would be nice if it was site specific. In other words, you get a license to mine, it's two steps, just like offshore petroleum. You get an exploration permit, and you can go test an area to see if there's anything there. Just like you drill test wells in offshore oil and gas development, you get a lot of dry holes, so you're not going to move a whole production operation into that area until you've done that exploratory drilling. And so, exploratory mining, I think is okay.

I would, first of all, check out an area. Is there anything there of value? The impact of test mining is pretty minimal compared to full-on commercial mining. I can't support awarding mining permissions or licenses to areas that have not been carefully studied.

I think the ISA needs to look in the mirror. They seem to be more governed by the potential users [mining companies] than the overall consideration of the health of the oceans, and that's got to stop. Overall, I would hope that ISA would get some backbone and become truly independent and responsible for stewardship of these deep ocean resources.

As to fisheries, that's just greed, isn't it? And it's gotten worse. The only thing we don't need in global fisheries is better technology because right now they can vacuum up everything, and we know that some top species are under severe pressure, if not extinct. And you've got these motherships, you get slavery at sea. There are ways of limiting this abuse—AIS on ships—but they turn them off. I think what you need to do is go for port sanctions, so these ships can't refuel. You've got to go back to your flag country [to refuel], and then, through our diplomacy, we lean hard on these flag states that have pirate fishing boats.

If it's not that, then we can worry about the ocean becoming more acidic, so fewer fish are being produced by nature.

There's a lot of competing things, and all is not good news. I'm wondering whether or not the world can really act in time to save a great deal of what's happening to the oceans. I remember talking about this with Jacques Cousteau many years ago, when he was first sounding the call that the oceans are dying. I thought, well, that's good press, and it's good for your visibility, kind of doing 'the sky is falling' thing. But now I'm thinking he was a real pioneer in seeing the trouble with the health of the oceans because everything I look at is not very positive.

Well, I guess one piece of good news is that, now, I think the general population is getting information about the challenges, and there's more engagement, more cross-collaboration, and the word is getting out. Having this precautionary principle [do no harm] for deep ocean mining and being aware of how nations can actually work with their communities to solve these problems is a little bit of good news. **ST**

David Helvarg is a writer and the executive director of Blue Frontier, an ocean media and policy group. He is the co-host of "Rising Tide – The Ocean Podcast." You can listen to the full Don Walsh interview at: <https://bluefront.org/podcast/rising-tide-96-the-late-don-walsh-in-his-own-words>.

international

Defense Tech Collaboration

Forcys and SH Defence have signed a memorandum of understanding to explore the integration of Forcys's advanced solutions into SH Defence's Cube Modular Mission Capability system. The system can turn almost any platform into a future-proof multi-mission capability using interchangeable modules.

This agreement follows the successful recent delivery of a containerized ROTV (remotely operated towed vehicle) to a NATO navy. For that project, Forcys's sister company EIVA A/S delivered a ScanFish L ROTV, which was seamlessly integrated into an SH Defence Cube.

First Hybrid LNG Tug

The first LNG tugboat with a hybrid system has begun operating in Singapore, with mtu gas engines from Rolls-Royce. Seatrium Ltd. is the designer, builder and operator of the new 29-m, 65-tonne bollard pull tug, *JMS Sunshine*.

The Port of Singapore has committed to the Maritime R&D Roadmap 2030 to make the port environmentally friendly and reduce energy consumption.

Dual-Fuel Hydrogen Tugs

CMB.TECH and Damen have collaborated on four hydrogen-powered ASD tugs. Built by Damen, these vessels use CMB.TECH's dual-fuel hydrogen technology that will significantly reduce emissions.

While these tugs will primarily run on hydrogen, they're equipped to switch to traditional fuel if hydrogen isn't available, and they can operate on 100 percent traditional fuel if needed.

Greensea Expands into Israel

Greensea IQ, has appointed DpeR Consulting to represent Bayonet autonomous underwater ground vehicles (AUGVs) in Israel.

This partnership marks another milestone in Greensea IQ's ongoing global expansion efforts, which will increase the accessibility of its advanced surf zone robotics solutions.

Tototheo Rebrands

Tototheo Maritime has rebranded to Tototheo Global. The company will focus on connectivity, IoT, AI-driven analytics and custom software development. Operating from strategic hubs in Cyprus, Greece, Germany and Turkey, and with an extensive network that spans across Europe, the U.S., the Middle East and the Far East, Tototheo Global combines global reach with local expertise.

Company Launch for ROV, Survey Services

FreeStar Subsea Services is a new company born from the merger of Vriezoo ROV Services and Mark Offshore. The collaboration offers a unique combination of ROV and survey support services with FreeStar's SSV *Navicula Star*, which was acquired from the Royal Netherlands Institute for Sea Research (NIOZ).

While most mid-size subsea companies specialize in either vessel or ROV services, FreeStar's owners believe that the combination will give the new offshore service provider a competitive edge. FreeStar aims to offer a comprehensive suite of subsea services, including bathymetric and geotechnical surveys, cable protection, and burial operations. It has a fleet of five offshore and four inshore ROV systems, in addition to the *Navicula Star*.

SRV Pilot Achievement

JFD, part of James Fisher and Sons plc, has announced that rescue service technician Tony Tang Kok Yong has qualified as the first Singaporean Submarine Rescue Vehicle (SRV) Pilot 1.

This achievement demonstrates James Fisher's commitment to developing the local community and its home market capability in Singapore. Yong has become the first Singaporean SRV pilot to complete the intensive training program and pursue this specialist career. With this qualification, he will join James Fisher's pool of SRV pilots and further strengthen its ability to respond to a submarine emergency globally, especially across the Indo-Pacific region.

Larger Base for AutoNaut

To accommodate more orders for the wave-propelled AutoNaut USV, the company has moved from its base in West Sussex to Okehampton in Devon, U.K. AutoNaut now shares larger premises and resources with the



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Seiche Water Technology Group of companies (SWTG). Recruitment is ongoing for workshop, sales, software and systems engineers.

The AutoNaut USV can carry a wide range of sensors into the most extreme ocean environments and can remain at sea for months, covering thousands of miles without requiring a mothership.

Twin Disc Acquires Katsa

Twin Disc, Inc., specializing in power transmission technology, has completed the €21 million acquisition of Katsa Oy, a Finland-based designer and manufacturer of gearboxes and power transmission components for industrial and marine end-markets.

The acquisition will broaden Twin Disc's reach into growing European markets; add complementary products in the industrial, marine and hybrid/electrification space; and strengthen Twin Disc's global sales and service network.

PLEUGER Nears a Century in Business

PLEUGER, a pioneer in the manufacture of submersible motors and pumps, is celebrating its 95th anniversary. Founded in Berlin in 1929, PLEUGER has been based in Hamburg, Germany, since 1945 and in Hamburg Wandsbek since 1951. It has more than 200 employees.

PLEUGER's clients are from the fields of conventional and renewable energy, mining, water management, and industrial processing. At the beginning of 2024, PLEUGER acquired AVI International in the U.S., a company specializing in pump service, to optimize service for customers in the U.S. and Canada.

After several years of unsuccessful previous owners, the company was taken over by U.S. investor Michael Flacks in 2018, who handed over the management to Anton Schneerson. Instead of just manufacturing pumps, PLEUGER has since developed, built and marketed complete solutions, including accessories, from sensors to control cabinets.

Poor Report Card for Worldwide Basic Energy

A new report by the International Energy Agency, the International Renewable Energy Agency, the United Nations Statistics Division, the World Bank and the World Health Organization has found that the world remains off course to achieve the UN Sustainable Development Goal (SDG) 7 for energy by 2030. SDG 7 is to ensure access to affordable, reliable, sustainable and modern energy. The goal includes reaching universal access to electricity and clean cooking, doubling historic levels of efficiency improvements, and substantially increasing the share of renewables in the global energy mix.

Side Scan Sonar Detects Missing Plane

EdgeTech's 4125i side scan sonar was used in May to help find an aircraft that has been missing for over 50 years.

In 1971 a plane departed from Burlington International Airport bound for Providence, Rhode Island, but crashed en route, presumably in Lake Champlain. Searches were

carried out at the time of the crash, but weather made the operations difficult and searches in subsequent years were unsuccessful. A detailed narrative surrounding the events of the 1971 plane crash and the ensuing years of search is forthcoming.

DriX O-16 Demo

Exail's DriX O-16 has been put to sea for the first time in its home port of La Ciotat, France, for initial sea trials, after which it was showcased in action to selected partners and customers.

Twice the length and five times the displacement of the legacy DriX H-8, the DriX O-16 is designed for long-duration operations of up to 30 days and 3,500 nautical mi. It can deploy multiple payloads and subsea assets, including multibeam echosounders, sub-bottom profilers and USBL. Additionally, the USV features a launch and recovery system to deploy ROTVs, inspection-class ROVs and AUVs. The USV is particularly suited for full ocean depth scientific and hydrographic surveys, geophysical and UXO surveys, and subsea infrastructure inspections that could require deploying multiple robots.

Changes at Klein

Klein Marine Systems, part of General Oceans, is phasing out legacy product lines to focus on mine countermeasures via its high-resolution, high-speed 5900 side scan sonar and the 5000V2 and UUV3500 for AUV applications. Klein is also moving to a new facility. **ST**

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Energy Containment



Compatible with all valve actuator types, the Survitec Gauntlet is a protective sleeve constructed from lightweight para-aramid armoring, 10 times as strong as steel, and designed to contain the unpredictable forces of failure. Technically qualified by Lloyd's Register, the Survitec Gauntlet is of minimal weight, placing no additional stress on the actuator, and it protects the workings of the actuator from further corrosion and component degradation. Survitec Group Ltd.

Ballast Water Management

PureBallast 3 Ultra brings new advantages to the UV treatment solution, from enhanced performance in challenging waters to more power savings and simpler installation. A new filter design reduces the risk of clogging. The BWMS runs at just 50% of its potential operating power in many conditions and can ramp up to full power to maintain flow in challenging waters. Alfa Laval AB.

Nautical Chart Production

CARIS AutoChart is an alternative to the traditional production of nautical paper charts that has been fraught with challenges related to manual data entry, complex chart formatting, and the integration of various data sources. The comprehensive software solution is tailored specifically to the needs of nautical chart producers. Teledyne Geospatial.

Versatile Lubricant

High-performance Marine Grease offers a multitude of applications

above and below the waterline, reducing friction and wear. Water repellent and saltwater resistant, it's ideal for lubricating moving parts that are exposed to submersion or briny air. Below decks, it serves as a long-lasting substitute for oil when eliminating squeaky hinges and sticky drawer slides. Marine Grease is resistant to cold and hot water and offers excellent sealing properties. LIQUI MOLY USA Inc.

Updated Analytics Platform

A completely revised version of the Metis platform includes additional information layers, advanced filtering, intuitive navigation and enhanced user experience to help clients better manage their ship and fleet performance. KPIs provide improved overviews, including of ship emissions, vessel performance, optimized operations and machinery condition, useful for benchmarking within the fleet and between sister ships. METIS.

Fuel-Flexible Tug



ASD Tug 2812 FF supports less energy dense fuels to accommodate future vessel energy needs. The tug has volume to support the fuel preparation space and alternative tanks for fuels such as methanol. Closed spaces are filled with nitrogen to mitigate explosion risk and avoid creation of permanent hazardous areas. Storage tanks can handle all likely pressure fluctuations that can occur during normal operation, so there is no unexpected emergency release of toxic,

flammable vapors. Damen Shipyards Group.

Fleet Management

Version 18 of Oceanly Performance introduces innovative features, including advanced time charter party management and an intuitive itinerary planner designed to optimize fleet performance and operational efficiency. Oceanly Performance offers a seamless pathway for shipping companies to comply with the EU Emissions Trading System (EU-ETS). Oceanly S.r.l.

Garmin Support for Heat Monitor



Garmin has added support for the FLIR Maritime Thermal Monitoring System (MTMS), a powerful tool for monitoring and protecting vital machinery and equipment from catastrophic breakdown, in its April 2024 (v35) software release. Supported features include: live display of the video feed from the

FLIR MTMS camera system; audible alarms and visual alerts from the FLIR MTMS on the Garmin chart plotter; full support for thermal, visible and MSX thermal/visible blending; and thermal color palette selection. FLIR, a Teledyne Technologies company.

Inland Waterway Engine

QSK38 Stage V is a power solution for vessels operating on European inland waterways. The Stage V-certified QSK38 propulsion engine delivers 1,400 hp (1,044 kW) at 1,800 rpm. QSK38 is a proven engine in both propulsion and auxiliary marine applications, designed to operate in the most challenging conditions while minimizing exhaust emissions. Cummins Inc.

Remote Piloting Station

This collaborative solution allows vessel data to be sent to the cloud and displayed in near real time ashore. By giving DanPilot access to the data, a pilot can see the same as they if aboard ship. This saves the time and cost of a pilot joining a vessel and reduces the risk of accidents during transfer. Danelec and DanPilot.

Wireless Winch Charging

A wireless charging and data transfer system has been developed for OSIL's Micro Profiling Winches, designed to be used seamlessly with an AML-3 LGR instrument.

The compact and programmable winches are designed to equip USV systems with the ability to collect SVP or CTD profiles from user-specified depths during live operations. Wireless data transfer is accomplished simultaneously using the instruments integrated Wi-Fi transmitter. OSIL.

Autonomous Speed Control

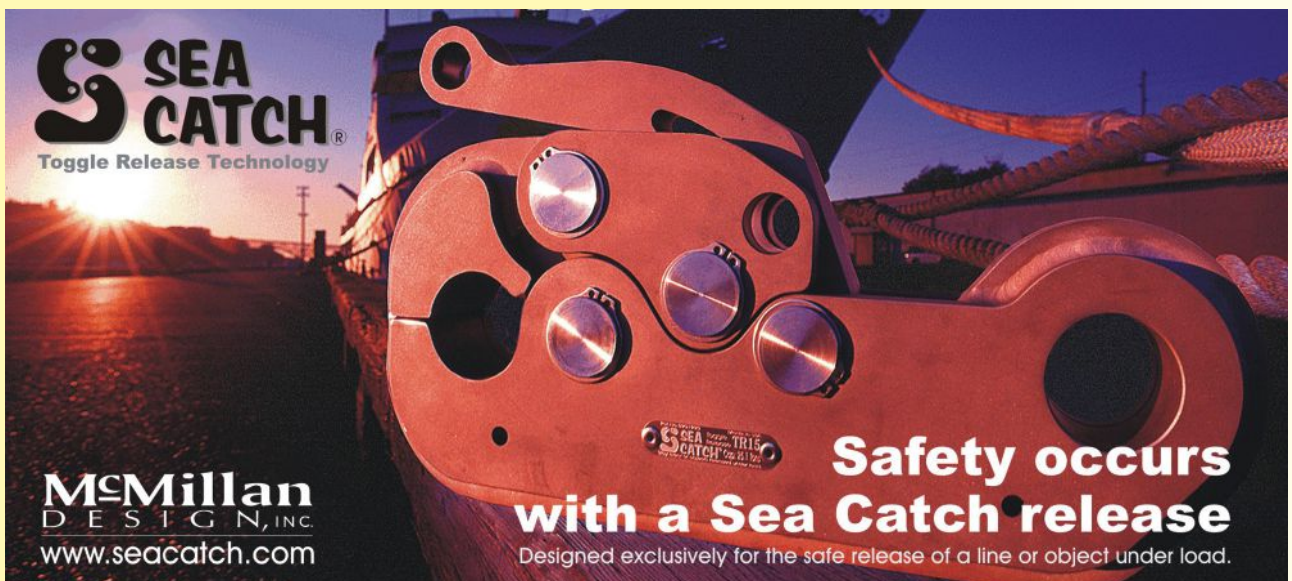
DNV type-approved HyperPilot automatically and precisely controls the change of speeds across a voyage to achieve fuel savings. An easily retrofittable control device, HyperPilot dynamically retrieves the speed command corresponding to the vessel's location and automatically feeds it to the propulsion control system. DeepSea Technologies.

Hydrophobic Rope

WarpSpeed 3D incorporates SamsonDry hydrophobic technology. The SamsonDry absorbs less than 5% of its weight in water, providing a lighter, faster, easier-to-handle rope. It is spliceable, works well with hardware, and has an elastic elongation of only 1.1% at 10% of its breaking strength load. Samson Rope Technologies.

Compact Generator

Piccolo 6 is a small, quiet and powerful generator with an electronic PMG inverter output. It delivers power for onboard equipment. WhisperPower. **ST**



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Wind Farm Survey

UTEC, a brand in marine energy and infrastructure services company Acteon, has been awarded an offshore survey and positioning contract for the Taiwan Power Co. (TPC) Phase 2 wind farm project offshore Taiwan.

The contract further reinforces UTEC's foothold in Taiwan, building on its initial entry in 2019. As part of the geo services scope of work, UTEC will deliver onshore dimensional control, bathymetric survey, positioning support during offshore pin pile installation, and as-built survey of foundation jackets.

The services will be provided on board three offshore installation vessels and several onshore fabrication facilities. The fieldwork was to start in the second quarter this year and could extend into 2025.

Validation of WindWings

The performance of BAR Technologies' WindWings has been validated by DNV. In an interim report, DNV found that, when sailing in favorable conditions, the two WindWings installed on the MV *Pyxis Ocean*, a Kamsarmax bulk carrier under management of MC Shipping Singapore Branch and chartered by Cargill, reduced energy consumption of the main engine by 32 percent per nautical mile.

The MV *Pyxis Ocean* is the world's first ship to be equipped with BAR Technologies' WindWings technology. It embarked on open waters in August 2023. During testing, between August 2023 and March 2024, the vessel traversed the Indian Ocean, Pacific Ocean, and North and South Atlantic, and navigated Cape Horn and the Cape of Good Hope. So far, the ship has visited six ports, completing eight successful loading and unloading operations.

Atlantic Shores EIS

The U.S. Bureau of Ocean Energy Management (BOEM) has made available the final environmental impact statement (EIS) for two wind

energy projects offshore New Jersey. If approved, the two projects could generate about 2,800 MW of electricity, enough to power almost 1 million homes.

Atlantic Shores Offshore Wind submitted a combined construction and operations plan for two wind energy facilities and associated export cables on the Outer Continental Shelf offshore New Jersey: Atlantic Shores Offshore Wind Project 1 and 2, collectively referred to as the Atlantic Shores South Wind Project. The combined proposal includes up to 200 total wind turbines and up to 10 offshore substations, with subsea transmission cables potentially making landfall in Atlantic City and Sea Girt. The lease area covers approximately 102,124 acres and is approximately 8.7 mi. offshore New Jersey at its closest point.

Offshore Wind CTVs

Singapore-based boat builder Strategic Marine has completed deliveries of two new crew transfer vessels (CTVs) for U.K.-based Mainprize Offshore Ltd. These two vessels are part of the leading U.K.-based CTV owner and operator's ongoing fleet expansion and will add to its current fleet of 11 vessels.

Scheduled for operations in European waters from July 2024 onward, both vessels will conduct crew transfers in Europe, often in higher waves, resulting in less down time, increased efficiency, increased power generation and increased profits.

Dry-Mate Connections For PacWave South

MacArtney's GreenLink terminations will connect innovative technology at PacWave South (PWS). This cutting-edge platform, run by Oregon State University (OSU), is for testing and optimizing marine energy devices in open-ocean environments, driving the application of wave energy as a reliable power source.

Through PWS, a full-scale test facility featuring four offshore test

berths, OSU, provides the necessary infrastructure for U.S. and international wave energy innovators to feed the electricity grid with alternative power sources. The project received significant investment from the U.S. Department of Energy to support the development of carbon-free wave energy conversion (WEC) technologies. PWS covers an area of 2 sq. nautical mi. and is licensed to support testing of up to 20 commercial-scale WECs.

To ensure reliable grid connectivity from each berth to the shore-based facility, OSU and its selected prime marine contractor for the system manufacture, delivery, and installation, RT Casey, collaborated with MacArtney to choose the GreenLink dry-mate solution. It will terminate the four dedicated PWS subsea power and fiber-optic cables and connect client-supplied dynamic cables or umbilicals.

Offshore Wind Alliance Adds Member

The Offshore Wind O&M Partnership (OWOP), an alliance between RES, GEV Wind Power, Outreach Offshore and Rix Renewables, has welcomed Rovco, a U.K.-based provider of offshore wind solutions, to complement its package of long-term operations and maintenance (O&M) services to offshore wind asset owners internationally.

As a specialist in the creation and deployment of advanced technologies for offshore wind services, particularly subsea, Rovco was a natural candidate to join OWOP to further enhance its capabilities as a Tier 1 contractor for offshore wind asset owners. Through automated hydrographic survey and ROV operations, Rovco's highly technical offering includes O&M services, construction support and marine site characterization.

Based in the U.K., OWOP offers a coordinated, agile approach: Through a single contract, offshore wind asset owners have access to all typical turbine, blade, substation and balance-of-plant O&M services, plus workboats, advanced digital tools and comprehensive subsea O&M capabilities. **ST**

Hybrid Tugboats for Panama Canal

The Panama Canal Authority has ordered 10 hybrid tractor tugboats from European shipbuilder Astilleros Armón, with options for another 10 similar vessels. Corvus Energy will supply the battery systems. Each 30-m tugboat will have 70-tonnes bollard pull.

The tugboats will be equipped with hybrid propulsion systems to reduce emissions during ship towage through the Panama Canal and while docking in Panamanian ports. Corvus Energy's Orca ESS battery energy storage systems will provide these tugboats with 450 kWh of power per vessel.

Partnership for Zero-Emission Ferry

Incat has a new partnership with European shipping company Brittany Ferries and technology company Wärtsilä to explore design and technical requirements for a 137-m, zero-emission ferry. Wärtsilä will power Incat Hull 096, the world's largest battery electric ferry, with its battery electric propulsion system and waterjets.

Battery electric propulsion coupled with lightweight aluminum vessels is a proven method to eliminate emissions. This project will support Brittany Ferries' goal of achieving net zero by 2050, as all-electric power is a solution best suited to shorter ferry routes.

Autonomous Navigation Demo

The Indian Register of Shipping (IRS) has successfully collaborated with Mazagon Dock Shipbuilders Ltd. (MDL) on a technology demonstration of an autonomous navigation system with dual navigation capabilities on MDL's tug MT *Andaman*.

IRS conducted a thorough review of the autonomy concept, system documentation, software quality documentation and a detailed risk assessment in accordance with IRS Guidelines for ROVs and ASVs. IRS rigorously tested the autonomous

navigation system software at the manufacturer's development center through simulation.

The autonomous configuration also includes a remote control center (RCC), specifically designed to control and or monitor the vessel from a remote location. Remote control of propulsion and steering systems from the RCC, as well as the monitoring of key machinery, navigation parameters and situational awareness system at the RCC, were also verified.

The trials successfully demonstrated collision avoidance in accordance with COLREGs, alongside various emergency response measures, such as handling the loss of primary controls and communication with the RCC.

The Indian Navy provided support by deploying an interceptor boat, contributing to the safety and success of the testing process.

As demand for autonomous vessels grows in mission-critical operations, the development of such systems presents significant opportunities within the defense sector.

Research on Data-Driven Vessel Maintenance

Joint research from Lloyd's Register (LR), Nippon Yusen Kabushiki Kaisha (NYK Line) and MTI Co. Ltd. has identified that the adoption of data-driven condition-based maintenance (DCBM) can have a significant impact on vessel efficiency and reliability. The whitepaper shows how DCBM processes that utilize the latest analytical models can deliver considerable benefits to the maritime industry. The whitepaper also outlines the potential pathways and obstacles to successful implementation.

The four challenges that shipowners must address to maximize the benefits of DCBM are: a lack of precision in maintenance and inspection checklists; deviations from scheduled maintenance and inspections; vague or undefined criteria when identifying hazardous operating conditions; and ensuring

an effective strategic response when faced with system failures.

By overcoming these challenges, owners and operators can benefit from increased equipment availability, reduced downtime, and lower total maintenance costs. This could collectively contribute to a higher return on investment from their assets and significantly lower operational expenditure while reducing crew workload and improving safety standards.

The research indicates that by embracing a data-driven future and prioritizing analytic-driven maintenance, owners and operators can secure a competitive advantage, reduce overheads, and deliver excellence in maritime operations.

XOCEAN Secures More Funds

XOCEAN, the ocean data company, has successfully raised €30 million in its latest Series B funding round. The oversubscribed funding was led by Venturewave Capital, with co-investors including Endeavor Catalyst and Enterprise Ireland, facilitated through the Venturebeam platform. Notably, XOCEAN achieved an AA+ rating for impact by the new platform. This funding will accelerate the company's international growth and drive further technical innovation. As part of this round, XOCEAN secured €20 million in venture-debt funding from the European Investment Bank.

XOCEAN's mission is to deliver data that supports the sustainable development of the oceans by using low-impact robotics to collect large volumes of ocean data to the highest industry standards.

The global blue economy is growing substantially, driven by industries such as offshore wind, but the data to support this growth are difficult to acquire. XOCEAN has developed a fleet of USVs that can remain offshore for extended periods, collecting large volumes of ocean data. Operators and data analysts remain safely located onshore, connected to the vessels via satellite link. XOCEAN's carbon-neutral technology will prevent the emission of 1 million tons of carbon over the next five years. **ST**

Vessel Financing

Damen Financial Services (DFS) and Siemens Financial Services (SFS) have joined forces to establish a new facility for vessel financing solutions: Damen Ship Lease (DSL).

The DSL facility is now one of the funds of Damen Ship Lease Cooperation, which is managed by DFS. It is designed to provide current and prospective shipowners with the ability to expand their fleets by enabling them to acquire state-of-the-art vessels using flexible financing options.

This strategic alliance combines Damen's extensive expertise in maritime solutions with Siemens Financial Services' experience in financing the maritime industry. The two organizations also share a commitment to advancing the maritime sector through sustainable and client-focused services.

The lease options offered allow operators in the highly competitive maritime industry to acquire vessels with the latest technology on board, enabling them to renew their fleets to become more sustainable and efficient.

Financing is specifically available for workboats such as tugs, fast crew suppliers, Multi Cats, tenders, small ferries and waterbuses.

How to Improve Conservation for Reef Sharks

Marine protected areas (MPAs) often have more reef sharks compared to non-protected areas, but, according to a new study in *Nature Ecology & Evolution* by researchers of Curtin University, Mote Marine Laboratory and others, when MPAs are established in nations that also limit shark fishing through catch limits or gear restrictions, conservation benefits are doubled.

Based on the world's largest reef shark and ray survey, Global Fin-Print, a project funded by The Paul G. Allen Family Foundation, these findings emphasize that nations should use both MPAs and effective fisheries management to rebuild reef shark populations, which have

declined on average by 63 percent globally.

Mangroves at High Risk

More than half of the world's mangrove ecosystems are at risk of collapse, according to the first global mangrove assessment for the International Union for Conservation of Nature (IUCN) Red List of Ecosystems.

This is the first time an ecosystem group has been assessed entirely across the planet using the IUCN Red List of Ecosystems, a global standard for measuring the health of ecosystems.

The findings show that 50 percent of the mangrove ecosystems assessed are at risk of collapse: classed as vulnerable, endangered or critically endangered. Nearly 20 percent of the assessed mangroves are classed as the latter two.

Mangroves are threatened by deforestation, development, pollution and dam construction, and the risk to these ecosystems is increasing due to sea level rise and the increased frequency of severe storms associated with climate change. Climate change threatens one-third of the mangrove ecosystems assessed.

This study classified the world's mangrove ecosystems in 36 regions and assessed the threats and risk of collapse in each region. This work has been led by IUCN, with active involvement of more than 250 experts based in 44 countries.

Sponge to Soak Up Oil Spills

Oil spills, if not cleaned up quickly and effectively, can cause lasting damage to marine and coastal environments. That's why a team of North American researchers are developing a new sponge-like material that is not only effective at grabbing and holding oil on its surface (adsorption), but it can be re-used again and again—even in icy Canadian waters.

The special material, called CNF-SP aerogel, combines a biodegradable cellulose-based material with a substance called spiropyran,

a light-sensitive material. Spiropyran has a unique "switchable" property that enables the aerogel to go between being oil-sorbent and oil-repellent, just like a kitchen sponge that can be used to soak up and squeeze out water.

"Once spiropyran has been added to the aerogel, after each usage, we just switch the light condition," explained Dr. Baiyu Helen Zhang, professor and Canada research chair at Memorial University, Newfoundland. "We used the aerogel as an oil sorbent under visible light. After oil adsorption, we switched the light condition to UV light. This switch helped the sponge to release the oil."

The material continues soaking up and releasing oil, even when the water temperature drops.

The researchers used the CLS's Mid-IR beamline to examine the characteristics of the aerogel before and after exposing it to visible and UV light. The researchers are looking to scale up their research with large pilot studies and testing the material in the field.

CCS Certification in Malaysia

DNV and PETRONAS's wholly owned subsidiary, PETRONAS CCS Ventures Sdn Bhd, have signed a master price agreement for the certification of carbon dioxide storage sites and associated facilities for carbon capture and storage (CCS) projects in Malaysia.

PETRONAS is committed to achieving net-zero carbon emissions by 2050 and has established growth targets for cleaner energy solutions, including CCS. Substantial progress has already been made, with the Kasawari CCS project currently in construction, several CCS hubs in development, and major international agreements having been announced.

DNV is ideally positioned to help PETRONAS ensure that the emerging Malaysian CCS industry adheres to international standards and best practices. DNV has been involved in the development of CCS facilities globally for more than 20 years, delivering specialist services spanning the entire CCS value chain. **ST**

MPAs Need Better Design, Management

An international collaboration that includes two Oregon State University (OSU) scientists says the world's largest marine protected areas (MPAs) aren't collectively delivering the biodiversity benefits they could be because of slow implementation of management strategies and a failure to restrict the most impactful human activities. Their analysis of the 100 biggest MPAs, which account for nearly 90 percent of the Earth's protected ocean areas, was published in *Conservation Letters*.

The research evaluated key indicators for biodiversity success based on criteria established by "The MPA Guide: A framework to achieve global goals for the ocean," published in *Science* in 2021.

As the world aims to protect at least 30 percent of the ocean by 2030, a target set by a United Nations international agreement, the assessment provides a reminder that achieving that goal requires both increased quantity and improved quality of MPAs.

The report's findings also raise questions about the effectiveness of current conservation efforts in achieving the declared goals of marine protection. The intended outcomes of MPAs are closely linked to the MPAs' design and management.

For example, some MPAs allow oil and gas exploration, industrial fishing and aquaculture, while others are highly protected. One-quarter of the areas lack management plan implementation. Without regulations or management, these areas are no different from surrounding unprotected waters and cannot deliver conservation benefits.

New Fisheries RV for Australia

Built for Australia's Department of Primary Industries and Regional Development (DPIRD) by Dongara Marine, the new 18.6-m fisheries research vessel has been named "Djildjit Kaartadjiny" in consultation with Noongar (indigenous) elders. "Djildjit Kaartadjiny" means

knowledge and understanding of aquamarine fish or fisheries research.

Acquired to undertake fisheries research and science activities throughout Western Australian waters, the new vessel replaced DPIRD's RV *George Cassels*. Compared to that craft, the new research vessel is an aluminum monohull providing a larger multipurpose platform to perform a broad range of research, stock assessment and science monitoring tasks. It can manage a variety of specialized research equipment, including fish traps and crustacean pots, baited remote underwater video, ROVs, and towed underwater survey cameras.

DTU Aqua Arctic RV

KNUD E. HANSEN has designed a 70-m Arctic research vessel (KEH ARV-70) for the Danish National Institute of Aquatic Resources (DTU Aqua). Over the past year, the Dansk Dana Konsortium, a partnership between KNUD E. HANSEN and Odense Maritime Technology, has transformed the initial 68-m concept into an extensive 70-m tender design.

The design encompasses comprehensive engineering; propeller design; model testing (ice, maneuvering, seakeeping, cavitation and self-propulsion tests); underwater noise analysis; and innovative measures to minimize bubble sweep down, culminating in a state-of-the-art *Polar*-class research vessel.

DTU Aqua has now released a public tender for the construction and delivery of the vessel, named "DANA V."

Challenger 150 Partners with Seabed 2030

Challenger 150, which coordinates a global effort to map life in the deep sea, has signed a memorandum of understanding with The Nippon Foundation-GEBCO Seabed 2030 Project, a global initiative to map the entire ocean floor by the end of the decade. Consolidating the physical and biological ocean

data being identified and produced by the two separate initiatives will greatly advance our understanding of the ocean.

Seabed 2030 is a flagship program of the UN Decade of Ocean Science for Sustainable Development (2021 to 2030), with its mission of actively supporting UN Sustainable Development Goal 14: to conserve and sustainably use the ocean, seas, and marine resources for sustainable development.

Challenger 150 is a global scientific cooperative under the Deep Ocean Stewardship Initiative for the Ocean Decade. It will: build capacity for global deep-sea research, expand biological observations and the understanding of deep-sea ecosystems, and support their sustainable management.

\$45 Million for Ocean Science

Five global science and technology projects have been selected to join the Ocean Biogeochemistry Virtual Institute (OBVI), addressing gaps in ocean data and modeling efforts by improving the breadth of research in the field and expanding capacity to understand ocean resources.

Schmidt Sciences, started by Eric and Wendy Schmidt, will bring together 60 scientists from 11 countries. The research will provide clarity on how much carbon dioxide the ocean can hold and the resilience of marine ecosystems in a rapidly warming world.

The five selected teams will make up a global research network and receive financial support from Schmidt Sciences and access to Schmidt Ocean Institute's RV *Falkor (too)*. They will receive expert shipboard assistance to tackle the challenges associated with collecting large amounts of biological, chemical, geological and physical oceanography data.

Through this research, the teams will develop accurate modeling across ocean systems to address ocean processes in climate projections and mitigation. The inaugural membership of OBVI will receive \$45 million in funding over the next five years. **ST**

contracts

Eastern Pacific Shipping, Singapore, will implement a comprehensive, fleet-wide deployment of the Cassandra Performance Monitoring platform. This comes after an extensive trial process on the accuracy of high-frequency AI performance models. DeepSea Technologies.

DNV, Høvik, Norway, will collaborate on fully electric foiling vessels to ensure safety requirements under the relevant international regulations and DNV rules are met or exceeded. Artemis Technologies Ltd.

Korean Register (KR), Busan, South Korea, will collaborate on the pilot project of a cloud-based next-generation smart ship solution (ISS 2.0) developed by HD Hyundai. KR will conduct technical reviews based on classification rules, as well as domestic and international regulations. HD Hyundai.

Wärtsilä, Helsinki, Finland, will supply the engines, fuel gas supply system and thrusters for two new Ropax ferries being built for a subsidiary of CMA CGM. The vessels, designed to minimize emissions, will operate between Marseille and Corsica. La Méridionale.

Auramarine Ltd., Lieto, Finland, has won an order from a shipyard for a methanol fuel supply system and associated equipment for the luxury Mein Schiff 7 cruise vessel owned by TUI Cruises. Meyer Turku.

Tototheo Global, Limassol, Cyprus, will deploy Neuron's AI-powered quality of experience (QoE) management platform to vessels contracted to Tototheo. This partnership will enable increased transparency and technologies to help vessels switch seamlessly among satellite service deliveries. Neuron.

Maritime Craft Services Clyde Ltd., Fairlie, U.K., has partnered to upgrade the propulsion plant of the SWATH 2 vessel, focusing on decarbonization and operational effi-

ciency. This retrofit includes modifications to improve machinery space accessibility and reduce greenhouse gas emissions. BMT. **ST**

meetings

SEPTEMBER

September 11-12—Maritime Salvage & Casualty Response, London, U.K. www.wplgroup.com/aci/event/maritime-salvage-casualty-response.

September 11-12—Oil Spill India, New Delhi, India. <https://oilspillindia.org>.

September 16-19—Fleet Maintenance & Modernization Symposium, Virginia Beach, Virginia. www.navalengineers.org/Symposia/FMMS2024.

September 16-20—Marine Electronics Conference & Expo, Providence, Rhode Island. <https://expo.nmea.org>.

September 17-19—South America Offshore Wind, Rio de Janeiro, Brazil.

September 23-26—OCEANS 2024 Halifax, Halifax, Canada. <https://halifax24.oceansconference.org>.

OCTOBER

October 2-3—Sustainable Marine Fuel Fest, Porto, Portugal. <https://ship.energy/events/smf-fest-2024>.

October 7-10—Marine Imaging Workshop, Monterey, California. <https://miw2024.org>.

October 9-10—Water, Wastewater and Environmental Monitoring (WWEM), Birmingham, U.K. www.ilmexhibitions.com/wwem.

October 9-11—NOIA Fall Meeting, Colorado Springs, Colorado. www.noia.org/event/2024-noia-fall-meeting.

October 9-11—WISTA Inter-

national AGM and Conference, Limassol, Cyprus. <https://wistainternational.com/event/wista-international-agm-and-conference-2024>.

October 27-30—AAPA Annual Convention, Boston, Massachusetts. <https://aapa.getregistered.net/2024-annual-convention-and-expo>.

NOVEMBER

November 4-7—EURONAVAL, Paris-Nord Villepinte, France. www.euronaval.fr.

November 5-7—Deepwater Operations and Topsides, Platforms & Hulls Conference and Exhibition, Galveston, Texas. offshore-event.com.

November 7-10—Europort, Rotterdam, Netherlands. www.europort.nl.

November 12-14—International WorkBoat Show, New Orleans, Louisiana. www.workboatshow.com.

November 18-20—CLEAN GULF, Houston, Texas. www.cleangulf.org.

November 18-21—BlueTech Week, San Diego, California. bluetechweek.org.

November 19-21—Marine Renewables Canada Conference, Halifax, Canada. <https://marinerenewablesconference.ca>.

November 19-21—MAST Australia, Adelaide, Australia. [Mastconfex.org](http://mastconfex.org).

November 20-21—Decarbonisation in Shipping Europe, Hamburg, Germany. www.wplgroup.com/aci/event/decarbonisation-shipping-europe.

November 26-27—Offshore Energy, Amsterdam, Netherlands. www.offshore-energy.biz.

For more industry meetings, visit sea-technology.com/meetings. **ST**

people

NOAA Commissioned Officer Corps **RAdm. Nancy A. Hann** has been selected for promotion to the rank of vice admiral and will begin serving as NOAA's deputy undersecretary for operations in August. Since 2021, Hann has served as director of the NOAA Corps and NOAA Office of Marine and Aviation Operations.



In her new role, Hann is responsible for the day-to-day management of the agency's national and international operations for oceanic and atmospheric services, research, and coastal and marine stewardship.



Anemoi Marine Technologies Ltd., specializing in wind-assisted propulsion technology for commercial vessels, has appointed **Claes Horn-dahl** as commercial director. With a career spanning more than 20 years supporting gas carriers and tankers, he brings a wealth of expertise in maritime consultancy, commercial

strategy, and operational efficiency to Anemoi as the company ramps up production of its Rotor Sail systems. He is a strong advocate for sustainable maritime practices.

Dr. Ioseba "Joe" Tena has been appointed managing director and **Peter Hodgkinson** has been appointed as nonexecutive director of Forcys. Tena has served as commercial director since the company's formation in 2022. Prior to that, he was head of defense at Sonardyne International Ltd., a sister company within the Covelya Group. Hodgkinson is a senior consultant in maritime defense, with experience as a both a user and provider of cutting-edge maritime defense systems.

Matthew Peck has joined Teledyne Interconnect Solutions as outside sales manager. Based primarily in Houston, Texas, he will lead the sales team in serving customers in a wide range of industrial and marine markets. Peck has experience in subsea oil and gas and offshore wind in sales, engineering, and project management roles.

Hendrik Veder Group, specializing in steel wire and fiber rope products and services, has appointed **Anne Raangs** as a sustainability and circularity specialist, a new position in the company. She will utilize her expertise to design detailed strategies for customers in the North Sea triangle (U.K., Netherlands and Norway) while establishing partnerships with operators to implement new approaches.

The Maritime Authority of Jamaica has appointed **Bertrand "Bert" Smith** as director general. His expertise in

maritime law led to his engagement by the International Maritime Organization (IMO) and in the Caribbean region on matters related to implementation of IMO treaties and merchant shipping legislation.

JFD Ltd., part of James Fisher & Sons PLC, has welcomed **Peter Loughton** as the head of military diving to support the company's continued growth in the U.K. and international defense markets. He has over 32 years of extensive operational experience in the Royal Navy.

Mauricio Morre has joined ABS Group as vice president of finance and chief financial officer. Morre's expertise spans financial leadership roles at companies such as Schlumberger, GE Oil & Gas and Lufkin Industries. **Kamal Patel** has assumed the newly established role of vice president of strategic development for ABS Group. Patel has experience in engineering, environmental services and technical consulting.

Auramarine Ltd. has appointed **Tuomas Häkkinen** as director of business line projects. He has more than 10 years of experience in services, sales, account management and business development.

Lee Billingham is the International Marine Contractors Association's (IMCA) new director of strategy and energy transition. He has over 20 years' experience in the energy sector. **ST**

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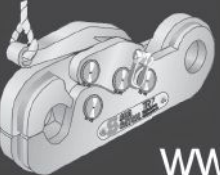
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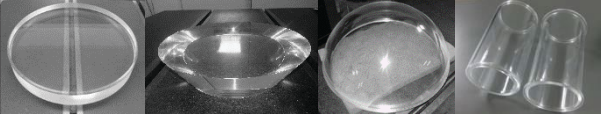
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Ports are Making Decarbonization Progress but Need More Support—*Ian Gansler*

Ian Gansler is the manager of energy, resilience and sustainability policy for the American Association of Port Authorities (AAPA), America's trade association representing public seaports, based in Washington, D.C. He advocates for the port industry's environmental and energy resilience goals. Gansler has a master of public policy degree from the Georgetown McCourt School of Public Policy.



Unless the maritime industry takes preventative action, greenhouse gas (GHG) emissions could grow to 130 percent of 2008 levels by 2050, according to the International Maritime Organization (IMO). As the central nodes where vessels, trucks and rail all meet, ports have been directing their attention to emission mitigation and are making astounding progress.

The American Association of Port Authorities (AAPA) and the American Bureau of Shipping (ABS) has released a report, titled "Port Decarbonization Survey: Trends and Lessons Learned," that aims to provide insight into the current landscape of port decarbonization and makes recommendations to help the industry achieve its goals.

The report synthesizes a 25-question survey conducted with responses from 27 unique ports and two terminal operators, representing a wide variety of vessel and cargo types. Most ports have already set formal decarbonization goals. Ninety percent of ports cited financial constraints as the biggest hurdle to decarbonizing, followed by low technology readiness and equipment performance constraints, implying that work needs to be done along the whole supply chain to reach emissions goals. Notably, 54 percent of ports reported facing space constraints in installing charging stations and fueling

systems for shoreside equipment, which is a significant challenge because reconfiguring a terminal is incredibly costly.

Trends suggest ports have ambitious decarbonization goals, despite the current roadblocks. Although only one port has shore power available for bulk vessels, 54 percent of ports plan to develop future shore power connections for bulk cargo ships. This indicates a need to standardize shore power systems for bulk vessels, as has already been done for container ships, passenger ships and harbor crafts.

In addition to electrified port technology, alternative fuels are crucial to decarbonizing the industry. The report draws on a 2023 AAPA survey of ports on alternative fuels. LNG is the most popular, with most ports either planning to or currently offering LNG bunkering. Although LNG will not meet GHG targets alone, it has massive potential as a sustainable bridge solution if combined with other technologies. For land-side equipment, propane is a common solution, with many ports planning to provide hydrogen in the future. Hydrogen presents a few challenges, including its volatility and wide flammability range, so applications and safety regulations will have to be carefully crafted.

AAPA and ABS's report recognizes the crucial role of the relationship between ports and utilities. Although some have already established formal relationships, formal committees or boards across the industry will streamline communication. Since many ports plan on local power generation, utilities should draft official policies governing ports' power sales back to the grid, reducing barriers to local power generation. The report suggests that utilities should plan future transmission projects in advance to align with ports' goals.

Electrification planning requires a holistic approach that acknowl-

edges the complicated nature of port infrastructure projects. To accommodate heavier electric port equipment, older support infrastructure will need updates. Improving efficiency by increasing rail and barge capacity will reduce congestion without new technology. During project construction, planning should be optimized so that multiple systems can be improved at once.

Reaching decarbonization goals requires cooperation from multiple stakeholders, and the report recommends a comprehensive system of emissions inventories to compare levels across ports. AAPA also recommends standardizing charging infrastructure to cut costs and optimal cable management systems for ease of shore power access.

Due to financial constraints, ports are taking full advantage of federal and state grant opportunities, although most require even more support to reach their goals. Federal funding is needed beyond the expiration of the Bipartisan Infrastructure Law (BIL) and Inflation Reduction Act (IRA).

Additionally, comprehensive permitting reform at every level of government will likely improve the pace of decarbonization. Ports face extreme difficulties decarbonizing under Build America, Buy America (BABA) rules, so waivers should be predictable and efficient.

Finally, with the current market of zero-emission equipment, federal grants should allow the purchase of hybrid equipment to stimulate progress toward decarbonization today.

This report from AAPA and ABS highlights the need for ports to work with all their stakeholders, including vessel operators. With ample funding being made available by the federal government, now is the time to look at past successes and plan for the future in the move toward port decarbonization. **ST**

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