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JANUARY 2022

ANNUAL REVIEW & FORECAST

FEATURING:

US Government

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NGOs



TOTAL OCEAN MARKET COVERAGE

2022

JANUARY

Annual Review & Forecast

**EUROMARITIME, February 1-3, Marseille, France

**OCEANS 2022 Chennai, February 21-24, Chennai, India

FEBRUARY

Instrumentation: Measurement, Processing & Analysis

**Oceanology International, March 15-17, London, Excel, U.K.

MARCH

Electronic Charting/Vessel Management/

Ports & Harbors/Dredging/Homeland Security

**AUVSI XPONENTIAL 2022, April 25-28, Orlando, FL

APRIL

Offshore Technology/Alternative Energy & Ocean Engineering

**Offshore Technology Conference, May 2-5, Houston, TX

MAY

Communications, Telemetry, Data Processing

**Undersea Defence Technology (UDT), June 7-9, Rotterdam,
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JUNE

Seafloor Mapping/Sonar Systems/Vessels

JULY

Deck Gear, Cable, Connectors, Power Systems & Salvage

AUGUST

Geophysical Exploration/Seafloor Engineering

**SEG 2022, September 11-16, Dallas, TX

SEPTEMBER

Ocean Resources Development & Coastal Zone Management

**OCEANS 2022 Hampton Roads, October 17-21, Virginia Beach, VA

**Offshore Energy 2022, dates TBD, Amsterdam, The Netherlands

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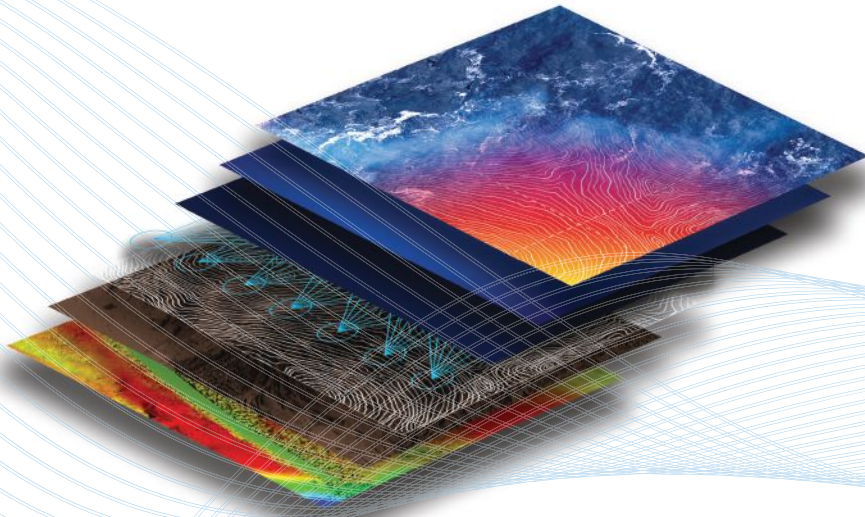


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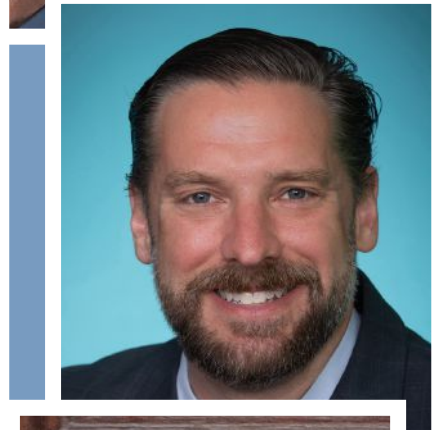


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)) Toward a Clean Ocean by 2030. The Clean Ocean International Expert Group of the UN Decade for Ocean Science for Sustainable Development has established its short list of activities and goals and a strategy to reach them in a “manifesto.” The statement charts the most direct route to a clean ocean, citing the following objectives for 2030: to enlarge understanding of pathways for spread and fates of pollutants; reduce and remove top-priority forms of pollution (e.g., marine debris) by as much as 50 to 90 percent; prevent recurrence and reduce sources or emission of pollutants (e.g., anthropogenic noise, discarded plastic and harmful chemicals, farming practices adding harmful sediment outflow); improve dramatically the outcomes of control measures (e.g., decrease amounts of mercury in tuna, die-offs of marine life, eutrophication); improve monitoring (often as part of the Global Ocean Observing System, or GOOS) for more accurate, precise, timely, comprehensive, real-time tracing of spills and monitoring of ocean soundscapes; improve systems to provide timely warning of pollutants emerging and increasing; identify and accelerate development and adoption of technologies to promote a clean ocean; improve national mechanisms (legal, regulatory) for control and prevention, better align financial incentives, and increase compliance with international treaties; and increase public engagement and understanding with access to information associated with behavioral shifts favoring the motto of “reduce, reuse and recycle,” and encourage participation in citizen science as part of events involving sailing, surfing and other activities dependent on a clean ocean. With such a framework agreed and in place, specific objectives can be identified and efforts activated, with targets and timetables similar in scope and character to an anticipated world agreement to protect 30 percent of the marine environment by 2030 and the completion of high-resolution mapping of the seabed by 2030.

)) Apply for US Regional Pilot Projects in Support of Sustainable Aquaculture. The Atlantic States Marine Fisheries Commission, in partnership with the NOAA Fisheries Office of Aquaculture, is issuing a request for proposals (RFP) seeking marine aquaculture pilot projects focused on sustainable aquatic farming techniques and regional business practices to grow U.S. domestic seafood. The geographic scope of the proposed projects is the U.S. East Coast states from Maine to Florida. The primary location of the proposed projects must be in the marine/estuarine environment. Examples of the types of pilot projects being sought through the RFP include: research and development related to the production and distribution of shellfish seed stock; finfish, shellfish (other than oyster) and seaweed farming systems, especially for those species new to aquaculture in the region or that use novel production systems; identification and development of Aquaculture Development Zones with pre-planning and pre-permitting for a range of aquaculture activities; resolution of issues (e.g., enforcement, water quality, public trust concerns or impacts) related to open-water finfish farming in state waters; business incubators; and regional market and economic impact studies. NOAA Fisheries plans to issue approximately \$600,000 for the funding period of July 1, 2022 to June 30, 2023. Individual proposals should not exceed \$200,000 or be less than \$75,000. It is anticipated that approximately three to five projects will be funded. Eligible applicants include researchers at U.S. academic institutions, research laboratories, for-profit companies/firms, nonprofits and state agencies. Applicants must submit an electronic proposal by email no later than midnight on February 1, 2022. The RFP is available at: www.asmfmc.org/files/RFPs/2022PilotAquacultureRFP_Nov2021.pdf.

)) DNV Invests in Cybersecurity. DNV will acquire industrial cybersecurity specialist Applied Risk with the aim to build the world’s largest industrial cybersecurity practice, defending critical infrastructure in maritime and other industrial sectors against emergent cyber threats. Threats to industrial cybersecurity are becoming more common, complex and creative. The maritime industry witnessed a 400 percent increase in attempted attacks between February and June 2020 alone, according to NavalDome. Recovery from an attack can cost organizations hundreds of millions of dollars. Applied Risk and DNV will operate together under the DNV brand. A combined leadership team from both companies will be tasked with scaling a merged cybersecurity business with ambitions for significant growth by the end of 2025.

)) Public Comment Sought on Pacific Coast Port Access Route Study. The Coast Guard is conducting a Pacific Coast Port Access Route Study (PAC-PARS) to consider whether existing or additional routing measures are necessary to improve navigation safety due to factors such as: planned or potential offshore development; current port capabilities and planned improvements; increased vessel traffic; existing and potential anchorage areas; changing vessel traffic patterns; effects of weather; or navigational difficulty. Vessel routing measures are implemented to reduce the risk of marine casualties. Examples of potential measures include: traffic separation schemes; two-way routes; recommended tracks; deepwater routes; precautionary areas; and areas to be avoided. The recommendations of the study may be implemented through rule makings or in accordance with international agreements. The primary areas of this study include: San Diego, Los Angeles/Long Beach, San Francisco and Humboldt Bay, California; Coos Bay, Yaquina Bay and Astoria, Oregon; and Grays Harbor and Puget Sound, Washington. Mariners may submit comments at: www.regulations.gov (search for Federal Register docket number “USCG-2021-0345”) by January 25, 2022. **ST**

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The Fuel of the Future Is Collaboration

For shipping, the pressure to decarbonize has never been more urgent. Transition faster to get to zero has been the message of the Intergovernmental Panel on Climate Change (IPCC) and the delegates of UN COP26.

Around the world, governments are making their climate ambitions clear. The European Union is targeting climate neutrality by 2050 and China by 2060, while the U.S. wants greenhouse gas (GHG) cuts of 50 percent by 2030, with Japan and Canada both converging on a similar goal.

The challenge in front of us is huge, but the incentive to transform could not be greater: It is survival itself, for both industry and society.

As an industry, we have a very clear direction with targets—but little clarity on how to get there. One thing we do know is this: The fuel of today will not be the fuel of tomorrow. There must be an energy transition for shipping.

Previous energy transitions were comparatively straightforward. Vessels moved from wind to coal, to steam, and then to oil. You either moved on or got left behind.

Today, we have many fuel and technology options, but the burden of decision making has been left mainly to shipowners. If you are ordering a new-build, what is the fuel strategy that ensures your vessel remains competitive, compliant and attractive?

In addition to knowing the future fuel mix, availability, infrastructure, technical maturity, operational experience and pricing must also be addressed.

With between 1,000 and 2,000 ships expected to be ordered annually up to 2030, informed decisions must be made considering various factors: from cost to fuel storage and propulsion, flexibility in design, strategic approach, and fuel-ready solutions; all underpinned by the enduring need for safety.

The industry needs to collaborate, internally and with a broad range of external stakeholders, to initiate R&D projects, form partnerships and begin testing real-world solutions with real-world commitment. Safety issues also need to be thoroughly investigated, analyzed and addressed to ensure confidence in future fuels from both industry and society. We also need to build seafarer competence in line with these technological developments.

When it comes to vessel design and fuel choice, we must challenge ourselves with collaboration in mind. Owners should look to informed partners, with dedicated networks and knowledge bases, to correctly assess the technology, fuel and dynamic energy production and infrastructure landscape.

We need action if we are to stand any chance of attaining our goals. There are some signs we are already underway. DNV's Maritime Forecast to 2050 predicts that around 12 percent of current newbuild orders have alternative fuel systems specified; double the percentage recorded in 2019. LNG is leading the pack as a key "transition fuel." Gas, whether LNG or LPG, as a result of its combination of availability, technological maturity and price, allows us to take positive action now with a practical solution that makes a tangible impact on industry GHG emissions.

DNV has worked with many owners to develop and class advanced dual-fuel gas tanker vessels that, together with onboard energy-reducing systems, can bring GHG emissions down by 15 to 25 percent. As fuels, LNG and LPG are also "in transition." Shifting to e- or bio-fuel versions unlocks the potential for even greater GHG reductions—all with the same engines, tanks and bunkering infrastructure. Gas fuels might not be our end game, but they're an excellent, attainable, realistic start toward emissions reduction.

By working together as an industry, embracing fuel flexibility and consulting with expert partners, shipping can reach its destination. **ST**

Annual Review & Forecast

For the 56th year, leaders in ocean technology, research, business and policy give their perspectives on promising new developments and critical changes in the ocean world.



Review&Forecast

NOAA Focuses on Climate Resilience, Blue Economy and Equity

By Dr. Rick Spinrad
Under Secretary of Commerce, Oceans and Atmosphere
Administrator, NOAA

It is a great honor to lead NOAA at a time of such immense challenges and opportunities for our nation, ocean and environment. With 18 climate-fueled disasters each costing more than \$1 billion so far this year, NOAA is at the forefront of addressing climate change.

NOAA's mission of science, service and stewardship—to understand and predict changes in climate, weather, oceans and coasts; to share that knowledge and information with others; and to conserve and manage coastal and marine ecosystems and resources—has never been more in demand.

As the new administrator of NOAA, although not new to the agency, my top three priorities are: to establish NOAA as the primary provider of authoritative climate information and services to help the nation tackle the climate crisis; promote economic development while maintaining environmental stewardship; and integrate equity across our operations, services and workforce.

Going into 2022, NOAA is well positioned with significant new federal investment through the Bipartisan Infrastructure Law to expand equitable access to our ocean, weather and climate data and predictive tools that will help communities and businesses meet the challenges and opportunities of a changing climate.

Climate Crisis Response

In our response to the climate crisis, NOAA pays special attention to the role of the ocean as a major influencer of climate and weather. The ocean is also a key to climate mitigation, adaptation and resilience.

We are expanding NOAA's world-class climate products and services to reach more people, especially people and communities who are most at risk. NOAA is working to provide reliable, accurate, accessible, relevant, and easy-to-use climate information for planning, adaptation, and resilience decisions and actions. In October, we launched a redesigned version of Climate.gov, NOAA's award-winning, flagship website that provides the public with clear, timely and science-based information about climate.

NOAA is also advancing new forecasting and information tools to address a range of climate, weather, ocean and Great Lakes challenges. We transitioned two harmful algal bloom forecast systems into operations, which will inform Florida and Texas coastal residents about where and when red tide might impact beaches, and give Lake Erie residents an early outlook of an algal bloom's like-

ly severity. We launched the first national rip current forecast model, aimed at saving lives of beach-goers around the country. And we awarded a contract last April to build the Earth Prediction Innovation Center, which will help us accelerate improvements to our operational weather, climate and Earth system forecasting. The center is encouraging greater collaboration between NOAA, academic institutions and the private sector climate and weather forecasting community to bring in new ideas for forecast improvements.

Expanding the Blue Economy

As part of the U.S. Department of Commerce, NOAA promotes economic development with an emphasis on the blue economy. NOAA provides the data and information to manage our nation's \$244 billion commercial and recreational fishing industries, as well as to advance aquaculture. We provide data, information and tools to aid safe marine transportation, rapid recovery of ports after severe storms, and advancement of the economic vitality of our ports and coastal communities.

NOAA plays a key role in advancing what I call the *new blue economy*, which is driven by data, information and knowledge about the status and trends of a rapidly changing ocean environment. We're seeing the ocean equivalent of what has been happening in the commercial weather enterprise over the last 40 to 50 years. Entrepreneurs are taking NOAA ocean data and forecasts to create tailored services and businesses. NOAA will continue to play a leading role in collecting and providing these open data to public and commercial users who are expanding our economy and creating jobs.

Ocean and Great Lakes Conservation

NOAA also supports tourism and recreation centered around the ocean and Great Lakes. This past year, NOAA nearly tripled the size of Flower Garden Banks National Marine Sanctuary in the Gulf of Mexico, designated Wisconsin Shipwreck Coast National Marine Sanctuary on Lake Michigan (*Sea Technology*, December 2021), proposed a new sanctuary in Lake Ontario and one along California's coast, and proposed a new national estuarine research reserve along the shores of Long Island Sound.

These conservation efforts boost President Biden's America the Beautiful initiative to conserve 30 percent of America's lands and waters by 2030 to fight climate change and reverse the destruction of our wildlife, waters and natural places. They also strengthen the blue economy, foster inclusive and locally led stewardship, and create jobs.

Mapping the Ocean

Working with partners and harnessing new uncrewed technologies, NOAA is accelerating the pace of mapping to achieve the national goal of fully mapping the U.S. Exclusive Economic Zone by 2030. On November 1,



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we reached an important milestone when NOAA Ship *Okeanos Explorer* had mapped 2 million sq. km of ocean since its commissioning in 2008.

Ocean mapping, exploration and characterization are necessary to advance maritime commerce, domestic seafood production, coastal resilience, energy production, tourism and recreation, environmental protection, and national and homeland security. The mapping is also leading to exciting discoveries, including our discovery of the SS *Bloody Marsh*, the wreck of an oil tanker lost in 1943 when it was struck by a U-boat, as well as the discovery by NOAA and the Coast Guard of the storied U.S. Coast Guard Revenue Cutter *Bear*, one of the most historically significant ships in U.S. history for its long and meritorious service.

“NOAA plays a key role in advancing what I call the new blue economy, which is driven by data, information and knowledge about the status and trends of a rapidly changing ocean environment.”

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Diversity and Equity Across NOAA Mission

NOAA is actively working to ensure our workforce represents the rich diversity of our nation. We do this with proactive job recruitment programs, internships and partnerships with historically black colleges and universities and minority-serving institutions. We are also prioritizing equity in all climate products and services for our nation's communities. We are increasing our outreach to the communities most vulnerable to climate change impacts. We began a series of roundtable discussions that will continue in 2022 on climate equity and how NOAA can best work with communities to aid them in developing strong climate adaptation and resilience plans.

NOAA touches the lives of every American, every day. Our mission, especially in the ocean realm, is more important today than ever. We look forward to working with ocean lovers, entrepreneurs, technologists, explorers, nonprofits, policy makers and all Americans to meet this moment of great challenge and opportunity. **ST**

Review&Forecast

People, Infrastructure and Research For Ocean Solutions

By Clea Harrelson
Ocean Science Policy Fellow

Terry Quinn
Director, Division of Ocean Sciences
U.S. National Science Foundation

The ocean is at the center of our world's increasingly complex environmental crises, including the sweeping threat of climate change. The U.S. National Science Foundation's (NSF) Division of Ocean Sciences (OCE) supports essential research that helps us understand how the ocean can also provide solutions to these crises and play a key role in building a healthy, sustainable future for all.

OCE supports a wide range of programs to power innovation through people, infrastructure and research. For example, OCE supports the Research Experiences for Undergraduates (REU) Site Program, which funds summer internships for undergraduate students to participate in ocean-related research efforts, and the University-National Oceanographic Laboratories System (UNOLS), which coordinates the U.S. Academic Research Fleet.

As NSF Director Dr. Sethuraman Panchanathan acknowledged, "Ocean issues are not just a science problem, or an engineering problem, or a behavior problem, or a social problem, or a cultural problem, or a policy problem; it is all of the above and more."

As a result, in addition to these initiatives and other long-term investments in ocean science, OCE also funds research that is interdisciplinary, international and targeted to meet the needs of the ocean science community and the nation.

Coastlines and People (CoPe)

Coastlines and People (CoPe) is NSF's agency-wide response to a growing need for research at the intersection between natural processes and hazards, people and communities, and the built environment. Research conducted at Coastal Research Hubs is at the nexus between coastal sustainability, human dimensions and coastal processes to transform understanding of interactions among natural, human-built and social systems in coastal, populated environments.

CoPe Hubs fall into two categories: Focused Hubs, which are awarded \$1 million or less per year and fo-

cus on a narrow geographic region or set of research questions; and Large-Scale Hubs, which are between \$2 million to \$4 million per year for a project with broader scope—collaborative or geographic. CoPe Hubs embrace interdisciplinary science that brings together researchers across the physical, engineering, social and behavioral sciences to build strong partnerships between research teams and stakeholders. Additionally, these hubs will engage critical sectors of the coastal economy, such as tourism, construction and fisheries. In fiscal year 2021, NSF awarded more than \$29 million to CoPe Hubs.

Mid-Scale Research Infrastructure

NSF-supported science and engineering research increasingly relies on cutting-edge infrastructure. As part of its "Big Ideas" campaign in 2016, NSF identified investment in mid-scale research infrastructure as a critical gap, with a majority of funding for research infrastructure being awarded to the lower and higher ends of infrastructure scales across science and engineering disciplines. In the fall of 2021, NSF funded 10 mid-scale research infrastructure projects totaling \$127 million to advance next-generation discovery, including one project focused on the design and construction of ocean-bottom seismographs (Award #: 2131932). This project will provide a fleet of modern, uniform, high-performance, seafloor seismic instrumentation to better understand Earth processes and dynamics, such as earthquakes and volcanoes.

NSF's Ocean Decade Actions

2021 marked the first year of the U.N. Decade of Ocean Science for Sustainable Development (Ocean Decade). The Ocean Decade is a visionary, global effort to build collaborative science and technology efforts around the world and catalyze innovative partnerships to create sustainable ocean solutions. NSF has answered the call of the Ocean Decade, "the science we need for the ocean we want," through five programs that have been endorsed as "Decade Actions" by the Intergovernmental Oceanographic Commission. These programs include:

Coastlines and People (CoPe). Supports multi-institution "hubs" described above.

Navigating the New Arctic (NNA). Brings together research across the social, natural, environmental, computing and engineering sciences to inform our understanding of Arctic change and its local and global effects, and to create new directions in Arctic science and technology.

International Ocean Discovery Program (IODP). An international marine research collaboration that explores Earth's geological and environmental history and dynamics using ocean-going research vessels, including the NSF-supported *JOIDES Resolution*, to collect subseafloor



sediments and environmental samples.

GEOTRACES. An international program collecting data on trace elements in the ocean—rare chemicals that play important roles as essential nutrients, act as tracers of past and present processes, and affect organisms as toxic contaminants.

Global Ocean Biogeochemistry Array (GO-BGC). A multi-institutional program contributing 500 robotic floats to collect chemistry and biology data from the ocean surface to more than 1 mi. deep, allowing us to transform how we observe the global ocean.

Advancing ocean science, technology and sustainable development capabilities through domestic and international partnerships enables every country to achieve more together than alone. Through these five programs, NSF can leverage international attention to amplify the impact of its work and showcase U.S. leadership in the international scientific community.

Equity, Diversity and Inclusion in Ocean Sciences

NSF prioritizes equity, diversity and inclusion in all of its activities because these activities catalyze innovation. For example, CoPe Hubs, mid-scale research infrastructure investments, and the Ocean Decade all offer important pathways to broaden participation, support diverse early-career professionals, and ensure that ocean solutions include and empower communities and individuals historically left out of scientific processes.

In addition to these activities, NSF supports equity, diversity and inclusion through a wide range of other actions, including the GOLD program, which aims to create inclusive networks of champions across the geosciences, as well as through awards such as Unlearning Racism in Geoscience (URGE), which is centered around a community-wide journal-reading and policy-design curriculum to develop and implement anti-racist policies in the geosciences.

Looking Forward

OCE looks forward to future actions from the Biden-Harris Administration on ocean issues through the recently reconstituted Ocean Policy Committee (OPC). Activities within this lead interagency body, coupled with domestic calls for Ocean Shots from the U.S. National

Committee for the Ocean Decade, will help ensure federal coordination and a strong response to domestic and international ocean science challenges. **ST**

Review&Forecast

Supporting Deployment of Marine Renewable Energy Technologies

By Sarah Loftus
Fellow
Water Power Technologies Office
U.S. Department of Energy

In 2021, the U.S. set a goal of reaching 100 percent clean electricity generation by 2035, a target requiring a variety of renewable energy sources.

Marine energy technologies generate electricity from waves, tides, river and ocean currents, ocean thermal gradients, and salinity and pressure gradients. These technologies could charge equipment in the ocean such as oceanographic research devices, provide power to remote coastal communities, and eventually supply electricity to the grid.

Marine energy technologies are still being developed and tested, but their power potential is considerable. A report published in 2021 by the National Renewable Energy Laboratory (NREL) found that just 10 percent of technologically available marine energy sources could power roughly 6 percent of U.S. electricity needs, or about 22 million homes.

The U.S. Department of Energy's Water Power Technologies Office (WPTO) boosts the research, development and deployment of marine energy technologies through competitive funding opportunities and technical



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assistance programs, which supported developers who launched their devices this past year.

Deploying Marine Energy Devices Across the Country

In 2021, several marine energy developers deployed their new or updated technologies across the U.S. coastline, or planned deployments for early 2022.

"It takes many, many years to get marine energy devices in the water," said Tim Ramsey, marine energy program manager at WPTO. "It takes an appetite for risk and considerable upfront capital expenses. Mitigating risks and costs are ways the federal government can support developers."

In New York's East River between Manhattan and Queens, Verdant Power has been operating three 5-m-diameter tidal turbines since 2020 in the U.S.'s first commercially licensed tidal power site. In May 2021, Verdant pulled up its 100-ton triangular steel frame that holds the three turbines on the bottom of the river. The frame can reduce time and costs of retrieving, maintaining and replacing the turbines because it moves multiple turbines at once.

One of Verdant's turbines was switched out for a turbine modified with thermoplastic blades developed by the National Renewable Energy Laboratory (NREL). This new blade material is potentially more durable in seawater than the other blades' epoxy material. This latest deployment will test how the new material behaves outside the lab, while also delivering power to Manhattan's grid.

Meanwhile, far from New York City in a rural village in southwest Alaska, Ocean Renewable Power Corp. (ORPC) and Igiugig Village members deployed an updated version of ORPC's river current turbine in the Kvichak River in August. ORPC's earlier version of the turbine, deployed in 2019, was removed to be refurbished (*Sea Technology*, July 2020). The natural flow of river water rotates the horizontal turbine, which resembles a larger version of the blades on a push lawn mower.

This project aligns with the village's goal of turning off its diesel generators by 2025. ORPC and Igiugig's next steps are to install a battery storage system and microgrid controller that could switch off the diesel generators when they're not needed.

Farther south on the Pacific Coast, developer CalWave deployed its wave energy device off the coast of San Diego, California, in September. The device is submerged below the ocean surface, which provides protection from harsh storms and makes it invisible to beachgoers. CalWave is also partnering with researchers from the Pacific Northwest National Lab (PNNL), which is testing environmental monitoring technologies that measure potential impacts of the wave energy device, including underwater noise.

Across the Pacific Ocean, two wave energy developers will demonstrate their technologies at the U.S. Navy's Wave Energy Test Site (WETS) off Hawaii's coast in 2022. The test site is pre-permitted for demonstrations and comes with infrastructure such as moorings and cable connections to the grid.

One of the developers, Oscilla Power, will test a wave

energy device that could provide power to a remote coastal community where energy costs are typically high. The device includes a floating platform, 10 m long and 2.5 m wide, designed to capture the energy of wave movements coming from all possible directions.

Oscilla plans to use a variety of technologies, including hydrophones and underwater cameras, to monitor the environment and marine animals around the device, partnering with academic researchers and PNNL.

C•Power (*Sea Technology*, July 2021) will also deploy its wave energy device at WETS in 2022. Instead of supplying power to the grid, its system is intended to charge technologies in the ocean, such as an autonomous vehicle collecting oceanographic data, or equipment operating an offshore fish farm. The device sends electricity generated from waves to a battery on the ocean floor, storing it for later use.

C•Power's device has its own data collection and control system, developed by NREL. This system uses dozens of sensors to collect information about the device and its surrounding conditions and delivers it to the cloud. The demonstration at WETS will test the charging of an autonomous vehicle and will also test environmental monitoring equipment for detecting marine animals around the device.

Providing Testing Facilities and Permitting Tools to Developers

Several developers that launched marine energy devices in 2021 are also building larger devices capable of generating more power to supply to the electric grid. Before reaching this scale, developers need access to testing facilities and must navigate a maze of permitting requirements.

To fill these needs, WPTO is funding programs that could streamline the complex permitting process. PNNL's Triton Initiative tests environmental monitoring methods and technologies around deployed marine energy devices, including several of those deployed in 2021 and 2022. The monitoring technologies and data collected can reduce uncertainties about environmental risks of marine energy devices and provide recommendations for regulators.

WPTO also funded a project to develop a marine energy permitting toolkit that could assist both regulators and permitting applicants by packaging useful data, information and guidelines in one place. The toolkit team is partnering with marine energy developers to test out the tool as they apply for permits.

WPTO is funding programs that provide testing infrastructure both in the lab and in the marine environment. Testing Expertise and Access for Marine Energy Research, or TEAMER, pairs selected applicants with testing facilities across the country. In 2021, after a year of connecting applicants with lab and tank facilities, TEAMER began accepting applications for open-water testing at sites in Alaska and Washington.

In 2021, construction also began on a permitted, grid-connected wave energy test facility called PacWave off the coast of Oregon. Now, WPTO is funding \$27 mil-

lion for researchers and developers to design and test wave energy devices at PacWave, which is scheduled to be ready in 2023 to 2024.

"There are still many challenges to tackle," Ramsey said. "Our focus will be on getting projects in the water, and that's where programs like TEAMER and PacWave come in to connect the path from lab bench to ocean." **ST**

Review&Forecast

Deep-Sea Sampling Critical to Advanced Understanding of Hazards, Minerals, Biodiversity and Dynamic Earth Systems

*By Trent Richardson
Acting Associate Director
Natural Hazards Mission Area
U.S. Geological Survey*

Earth's seafloor occupies more than 75 percent of the planet's surface, and much of it is still unexplored, despite the fact that it contains critical evidence needed to advance our understanding of the hazards, processes and ecosystems of our dynamic planet. Because much of the seafloor is still a mystery, exploring these areas presents significant opportunities for Earth scientists to obtain missing information. The National Mapping, Exploration, and Characterization (NOME) strategy for the United States Exclusive Economic Zone (U.S. EEZ) establishes the framework for a national effort to fill these gaps.

The U.S. Geological Survey (USGS) has a unique role and mission as the federal provider of research expertise on marine geology, geophysics, and the processes that form and alter seabed and sub-bottom environments. USGS capacities in marine geology, geologic and oceanographic processes, and marine biology, ecology and geochemistry are all essential to NOME goals to map and characterize marine hazard and resource potential, seabed ecosystems, and the consequences of human and natural change. The diverse science portfolio the USGS offers creates opportunities to integrate our investigations and, with our partners, understand regional and global Earth systems that influence climate, tectonic hazards, and the development, accumulation and cycling of materials.

The USGS maintains and deploys capabilities to collect, analyze, and interpret physical samples from marine settings to meet the science and mission goals of both the USGS and NOME. Specialized laboratory, geospatial, and data management skills are essential to harnessing what we learn from physical samples and applying that to interpreting remotely sensed data. Physical samples

from remote and challenging environments are critical to this research, and accessing them presents significant challenges.

The good news is that new technologies applied in ocean environments, such as robotic and autonomous sampling and imaging platforms, complemented by remote mapping tools and technologies, are empowering faster mapping and characterizing activities at higher resolution than ever before. In addition, advances in telecommunications have made it possible for remote scientists to virtually participate in deep-sea dive events and consult with global experts in real time.

Mapping and characterizing mineral deposits in the U.S. EEZ are good examples of how USGS applies our expertise to support the NOME community. Deep-sea mineral deposits vary considerably in how and where they form across the seafloor. Global mineral resource inventories, which are incomplete without considering those in the marine environment, require physical samples to accurately evaluate them. Growing interest in the role marine minerals could play in the development and application of green energy technologies is increasing the demand for a better understanding of marine mineral potential.

The USGS, through the Global Marine Minerals Team, provides expertise on the nature and distribution of marine minerals in the U.S. EEZ and beyond. We conduct research on deep-sea geologic formations of ferromanganese crusts, polymetallic nodules and massive sulfides that possibly contain economically viable concentrations of critical minerals. This research relies on analyzing physical samples, especially cores and ROV-based grab samples, in the laboratory. Strategic partnerships developed with other federal agencies such as BOEM and NOAA have greatly expanded mapping and exploration of hazards and deep-sea ecosystems off the west coast of the United States. Collaborations with private and academic collaborators such as the Scripps Institution of Oceanography, Schmidt Ocean Institute, and Ocean Exploration Trust have enabled us not only to collect these much-needed samples but also to characterize the associated environments and biological communities where they form.

In 2021, the USGS provided expertise and analysis for more than 10 different collaborative research expeditions in the Atlantic and Pacific Oceans and the Gulf of Mexico, capitalizing on ROVs for sampling and imagery and cloud computing for systematic ocean mapping. Many of these efforts were telepresence enabled, bringing diverse researchers together virtually as they explored remote ocean depths. Such sampling and related discoveries demonstrate the value of partnerships, including those established in response to the NOME call for collaborative field campaigns. These partnerships are actively engaged in defining shared priorities with future field expeditions designed to support them.

The exciting exchange of expertise, skills and tech-



nologies will continue in the summer of 2022, with a planned research cruise to the Escanaba Trough, a hydrothermal system within the U.S. EEZ that contains significant amounts of sulfide minerals enriched in critical elements. The USGS will lead the multidisciplinary effort, employing new mapping techniques while collecting extensive geologic, geochemical and biological samples that advance our understanding of marine minerals, the structural and geochemical conditions where they form, how they are distributed, and their relationship to deep-sea biological communities and associated biodiversity.

Other collaborative campaigns are enabling partnerships to accomplish NOMECE objectives along with targeted research goals. The USGS, working with Natural Resources Canada, is mapping the offshore extent of the Queen Charlotte Fault to advance our understanding of risks posed by hazards associated with the fault. Evidence of how the fault has evolved over the last 20,000 years has been preserved in the rock record and is invaluable for characterizing recent seismic activity. In addition, researchers discovered areas in the seafloor along the fault where fluid and gas seeps are supporting chemosynthetic biological communities, as well as long-lived, deep-sea corals. The fluids and gases present along the fault influence almost every chemical, physical, mechanical, and thermal process that occurs within the sediments and structures. Analyses of the fluid and gas samples are expected to shed light on a variety of Earth processes, including earthquake, landslide and tsunami hazards.

Seafloor geology also records information on ocean currents and circulation patterns that both drive and respond to climate and weather. Through offshore mapping, our scientists discovered more than 700 tracks carved into seafloor sediments by icebergs as they were carried in glacial meltwater south along the Atlantic coast of North America, perhaps all the way to Florida. Scientists collected sediment cores and used radiocarbon dating to determine that the icebergs, perhaps as tall as the Eiffel Tower, made their scour marks about 30,000 years ago, shedding insights on the timing of glacial ice-break events and how meltwater volume can impact ocean circulation patterns. These geologic analyses can be instrumental in understanding climate history and related impacts. The data are also critical inputs needed for predictive climate modeling.

The USGS brings together cutting-edge analytical techniques with the ability to integrate results into models and assessments to support not only our mission but also those of our many federal, academic, and private partners.

The USGS continues harnessing the latest technology and leveraging our resources to “think big” and expand the scope and impact of the work that we do. As we advance our collective knowledge about the ocean, we learn more about our dynamic planet Earth.

You can learn more about USGS deep-sea research at: www.usgs.gov/special-topic/deepsea.

You can learn more about NOMECE at: <https://iocm.noaa.gov/about/documents/strategic-plans/20200611-FINAL-STRATEGY-NOMECE-Sec.-2.pdf>. **ST**

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Review&Forecast

International Collaboration is the Future Of Scientific Discovery

By CAPT Andy Berner, USN
Executive Officer
U.S. Office of Naval Research Global

Felipe Reisch
Strategic Communications Specialist
U.S. Office of Naval Research Global

Did you know that according to the 2017 Global R&D Funding Forecast, 80 percent of the world's research is accomplished outside of the United States?

Were you aware that, according to the Times Higher Education World University Ranking 2021, 25 of the top 50 universities, and 63 of the top 100, are outside of the United States?

These facts mean that the United States would be significantly behind if it adopted an isolationist mindset when it comes to science and technology. Indeed, tons of great science is happening all around the globe, all of the time. Brilliant minds across every continent continue to make discoveries and significant technological advances. Since one of the main ingredients for discovery and advancement is the collaboration and synergy that results from trust-based relationships, the United States should reach out to collaborate with the many researchers beyond its borders. That is precisely what the Office of Naval Research (ONR) Global has done for the last 80 years and continues to do.

As the Chief of Naval Research's international arm, ONR Global maintains offices in seven strategic locations: London, Prague, São Paulo, Santiago, Tokyo, Singapore, and Arlington, Virginia. ONR Global will soon re-establish an office in Melbourne, Australia, and has plans for an office in India as well. Through this international presence, ONR Global builds relationships with international researchers and finds pathways for collaborative solutions that positively influence the Department of the Navy and its sailors and Marines.

These collaborative solutions require a constant effort and a presence that can adapt to navigate ever-changing political, social and economic environments. Presence and flexibility are paramount and ensure that long-lasting, trust-based relationships endure despite hard times, such as those presented by COVID-19.

COVID-19 changed the science and technology community's way of doing business, and ONR Global needed to get creative in order to accomplish its mission. It had to leverage video teleconferencing and web-based technologies to visit laboratories, review proposals, receive updated analysis, attend critical technological

conferences and informational briefings, view experiments and futuristic demonstrations, and, most importantly, continue to build the personal connections that spark and develop technological innovations.

Despite the pandemic, ONR Global continued to accomplish its international mission. ONR Global successfully launched the second edition of its Global-X Challenge to address capability gaps in the polar region. It funded a world-leading group of researchers from Japan, Finland and the U.K. to find ways to navigate in GPS-denied environments. ONR Global also enabled Brazil's health system to save more lives through a collaboration with the University of São Paulo to create low-cost ventilators for COVID-19 patients.

With continued interest in the impact of climate change and its effects on the rapidly changing Arctic Ocean, ONR Global worked through its International Engagement Office (IEO) to lead an iceberg tagging effort. This effort provided much needed situational awareness to the international maritime community through the use of unmanned aerial vehicles (UAVs) that deployed GPS tags onto icebergs near Disko Bay, Greenland. Tracking these tags closely will improve understanding of ocean circulation and meteorological impacts on icebergs—key factors to improve and ensure maritime situational awareness in this increasingly important part of the globe.

ONR Global also continued to explore the benefits of synthetic biology through ongoing research at the Imperial London College on self-healing "living materials." This groundbreaking effort, co-founded by ONR Global and published in *Nature Communications*, could lead to the creation of real-world materials that detect and heal their own damage, such as fixing a crack in a windshield, a tear in the fuselage of an aircraft or a pothole in the road.

Without a doubt, ONR Global stayed busy over the past year.

Looking Ahead

ONR Global is committed to building relationships that enable worldwide science and technology leaders to partner with the United States and the broader naval community. Through its worldwide presence, ONR Global will continue to find ways to build relationships and trusted partnerships. It will "leave no stone unturned" so that researchers can achieve the most innovative and mutually beneficial international advancements that anyone might imagine.

More specifically, ONR Global sees a future in which artificial intelligence (AI) is an increasingly instrumen-



tal component in science at a global scale. This is the main reason that it is building ties with local AI scientific communities to understand AI's main challenges and opportunities. Most recently, ONR Global spearheaded the launch of a Woman in AI Association in Chile, led by one of its science directors in Chile.

Through efforts such as AI and many others, ONR Global will continue to adapt to the future. However, its overall mission will remain constant. It will continue to be the international component of the U.S. Office of Naval Research. It will continue to do whatever it can to ensure the United States is the partner of choice when it comes to science and technology, and that international researchers can leverage creative minds and technology in the United States. Simply put, ONR Global will continue to be an international team builder, and it will continue to advance the development of innovative, problem-solving technologies through long-standing, as well as brand new, international collaborations. **ST**

Review&Forecast

How NAVSEA Warfare Centers' S&T Supports US Navy Focus Areas

*By Christian Schumacher
Chief Development Officer, Undersea Warfare
U.S. NAVSEA Warfare Centers*

As the U.S. Navy's laboratories, the Warfare Centers work to accelerate research, development, test and evaluation for the fleet. Their build/test/build approach starts with the science and technology (S&T) community, allowing researchers to rapidly test, fail fast and iterate. The result is a comprehensive and prolific portfolio of projects at varying stages of technical maturity. The challenge is supporting current mission goals while planning for the future.

The Navy's S&T community works to understand the mission needs and the dynamic nature of adversaries to identify opportunities and apply basic science to both new and old challenges. Maintaining a firm connection to the mission, the warfighter, the urgency, and understanding the conflict, the conflict space, the players, their tools and their objectives allows the Navy's scientists and engineers to work smarter, not harder.

In January 2021, the Chief of Naval Operations (CNO) Adm. Michael Gilday released his Navigation Plan outlining the Navy's strategic direction, with particular attention to four key focus areas. The CNO's guidance is far looking and strategic. By aligning S&T to these objectives, Navy labs support current and future capabilities.

Here are the CNO's four key focus areas and how Warfare Centers' S&T supports them.

Sailors: Develop a Seasoned Team of Naval Warriors

One way the Warfare Centers make the mission feel more personal is by connecting researchers and warfighters. This interaction has an invaluable and long-lasting impact that influences every decision that a researcher makes. Whether the experience is an at-sea tour or a stint in a shipyard, understanding how the warfighter interacts with the technology is crucial.

The Capability to Fleet program couples engineers to warfighters to examine the operational benefits of emerging technologies. This also includes tabletop exercises and war game, analysis, and technology insertion into demonstration events. The ultimate goal is interaction with the fleet and making sure that Warfare Center investments address warfighter needs.

The Office of Naval Research (ONR) also supports a cadre of global science advisors—civilian scientists, engineers, and technologists who report to Joint, Navy and Marine Corps commands worldwide. These advisors maintain a constant focus on domestic and international technologies related to naval warfare. They communicate needs and requirements back to ONR and the naval research enterprise to help shape S&T investments, as well as provide rapid technology insertions and surge capability in support of high-priority fleet issues.

Readiness: Deliver a More Ready Fleet

The Navy's four public shipyards—Norfolk Naval Shipyard, Portsmouth Naval Shipyard, Puget Sound Naval Shipyard and Intermediate Maintenance Facility, and Pearl Harbor Naval Shipyard and Intermediate Maintenance Facility—build and maintain combat-ready ships and submarines for the fleet.

Warfare Centers provide technical expertise and innovative technologies that address various technology gaps among the Navy's shipyards.

Navy laboratories also work to improve shipyard efficiency.

An established Warfare Center/Naval Shipyard point of contact facilitates communication and information sharing for the Shipyard Support Program. These efforts seek to directly contribute to the on-time delivery of combat-ready ships, submarines and systems.

One example of S&T's support of fleet readiness is the use of light detection and ranging (LiDAR) scanning technology. LiDAR has demonstrated utility in single-use cases with its high efficiency and accuracy.

In fiscal year (FY) 2020, one Warfare Center used LiDAR tools for comprehensive scanning of littoral combat ships. These scans supported installations, as well as the design of new combat system components.

In the next year, a Warfare Center team will apply the process to USS *San Diego* to prepare the vessel for CNO availability, demonstrating LiDAR technology at the platform level and improving completion of its on-time availability.



***“As the U.S. Navy’s laboratories,
the Warfare Centers work
to accelerate research,
development, test and
evaluation for the fleet.”***

**Capabilities: Deliver a More Lethal,
Better-Connected Fleet**

Developing the Navy’s best capabilities is what the Warfare Center enterprise does every day. Several initiatives are designed to bring forth innovation quickly and effectively provide structure and accelerated timelines for the S&T community.

One example is the Undersea Rapid Capability Initiative, which the submarine force leverages for good ideas across the naval research and development enterprise, including ONR, Warfare Centers and university-affiliated research centers.

Another initiative is “Mega Projects,” under the leadership of the NAVSEA’s Surface and Undersea Warfare Center chief technology officers. Established in FY 2021, this plan directs internal investment funds to develop innovative prototypes for fleet demonstration. The focus is on warfighting capabilities, with an emphasis on working across the Warfare Center enterprise. Mega Projects currently underway encompass a wide range of research efforts, from surface mine delivery and the aforementioned use of LiDAR technologies.

Capacity: Deliver a Larger, Hybrid Fleet

The advice that “You can do anything, but you can’t do everything” certainly applies to Navy S&T. Collaboration with industry, academia and allied navies is a force multiplier.

University partnerships yield outstanding results, as some of the best ideas come from scientists and engineers who may have never thought of a Navy problem before. The Naval Engineering Education Consortium program has awarded more than 50 grants to U.S. universities. Cutting-edge projects range from developing autonomous navigation systems for undersea vehicles in the warm waters of the Gulf of Mexico to evaluating under-ice acoustics at the Great Lakes.

In addition to connecting with academia, the Navy’s S&T community continues to work with allied partners to learn how others are solving similar challenges through bilateral agreements and partnerships. Recognizing the value of these partnerships, the CNO issued a fragmentary order in December 2019 calling for building alliances and partnerships with U.S. allies.

Navy S&T nurtures innovations that support a hybrid

fleet of long-endurance unmanned systems operating across all domains and alongside surface and undersea platforms. Convergent technology initiatives are joining autonomy, artificial intelligence, machine learning, information science, cognitive science and human systems integration as this future fleet develops.

The CNO’s focus areas provide the foundation for the S&T workforce. Creative freedom to experiment while operating under the CNO’s guidance will ultimately benefit the warfighter and advance the U.S. Navy’s capabilities. It is how Warfare Center S&T elevates the Navy now and 30 years from now. **ST**

Review&Forecast

Mapping a Strong Future For Ocean Science and Technology

*By Rep. Eddie Bernice Johnson (D-Texas)
Chairwoman
Committee on Science, Space, and Technology
U.S. House of Representatives*

We are at a pivotal time for ocean science and protection, and we must take action. This next decade provides an opportunity for the U.S. to clarify, define, prioritize, and accelerate ocean, coastal, and Great Lakes science and technology goals to strengthen our blue economy and improve the health and resilience of our water resources.

The past year marked the beginning of the UN Decade of Ocean Science for Sustainable Development, or the Ocean Decade.

According to the Intergovernmental Oceanographic Commission, the Ocean Decade will focus on initiatives across the globe to drive the science needed to ensure sustainable use of ocean resources and long-term ocean health. The U.S. has already shown leadership in defining the goals of the Ocean Decade, and it is imperative that the U.S. lead the international effort to achieve those goals in cooperation with other nations. We must use this opportunity to invest in our domestic ocean science and technology to advance solutions, which will require extensive public-private partnerships, coordination and collaboration across the scientific enterprise, and participation from diverse stakeholders and under-represented groups.

As a nation, we have taken positive steps this year toward protecting our oceans and combating climate change. The Biden-Harris Administration has prioritized climate and ocean solutions since day one. From a wide range of executive orders on climate change and the en-



vironment on their first day in office to installing qualified and well-respected scientific experts as heads of our federal science agencies, the administration has made clear their respect and support for science-driven solutions. We have scientists, including NOAA Administrator Richard Spinrad, leading our national science agencies. A career ocean expert, Dr. Spinrad brings decades of experience with him as administrator of the nation's principal civilian ocean science agency.

We have also made strides in legislation. The National Oceanographic Partnership Program (NOPP) was reauthorized and revitalized in the passage of the Fiscal Year 2021 National Defense Authorization Act. The Ocean Policy Committee was also codified in law in the defense bill, which will improve federal coordination of ocean science and policy. And, as chairwoman of the House Science, Space, and Technology Committee, I shepherded the passage of bipartisan ocean acidification legislation through the House, where it awaits action by the Senate.

This is all promising. However, we must do more as policy makers to support advances in ocean science and technology. With a diverse cadre of scientists, I believe the U.S. research enterprise can inspire transformative, ambitious and cross-disciplinary ideas to advance the nation's understanding of the ocean. Prioritizing science-based solutions to address the most pressing challenges facing our ocean is vital to our continued existence, given our dependence on the ocean for the oxygen we breathe, climate regulation, food, and other goods and services.

Ocean science is particularly exciting and ripe for new discoveries because of how much is still unknown. I am dedicated to working with my colleagues across the aisle and across the Capitol to support increased funding for existing ocean science and technology programs across our federal science agencies like NOAA.

We can and must encourage public-private partnerships and international cooperation in our ocean research activities as we work to pass science-driven legislation on ocean solutions.

The Ocean Decade can and should involve wide participation from all sectors of society because the ocean benefits and has an impact on everyone.

Representing a landlocked city like Dallas has not decreased my appreciation for the importance of the world's oceans. A lot of attention is rightfully given to the impacts of extreme weather, sea level rise and subsidence on coastal communities. But the oceans also impact those of us who do not live on the coasts. Having a better understanding of our oceans, through observations, will improve weather forecasts regardless of where we live.

This is also an opportunity to increase diversity and inclusion in the ocean science workforce by building a STEM pipeline through recruiting, training and retaining students from different backgrounds. Ocean sciences, and geosciences overall, including Earth and atmospheric sciences, are the least diverse of all STEM fields. In 2016, only six percent of graduates in the geosciences, including ocean science, were from under-represented groups, and among them black students made up less

than 2 percent of graduates. We must do better to ensure our scientific workforce reflects the rich diversity of our nation.

The U.S. must chart a strong and steady course this decade and beyond, both in conducting research to better understand our oceans and in developing innovative technologies to support the blue economy and Ocean Decade goals. I look forward to working with my congressional colleagues to support a strong U.S. ocean science enterprise. **ST**

Review & Forecast

Cryptocurrency Can Finance Conservation, Climate Efforts

By Kristijan Tot
COO
World of Waves

My family didn't have a lot of money to go on vacation when I was a kid, so I only saw the ocean and its wildlife in movies and on the internet. The first time I was able to see the ocean in real life was when we went to Montenegro when I turned 13. What I saw crushed the romantic view I had in my head: The pollution on the beach was horrific, and the water was very dirty. As I began researching aquatic wildlife and the importance of the ocean for all humans and the planet, I realized how wrong we were in terms of how we have been treating our oceans.

Global warming combined with humans' uncanny ability to generate trash has devastated our oceans' ecology and wildlife. From oil spills to microplastics, our oceans have been infiltrated, with devastating consequences. There is now a global push for ocean conservation and cleanup, fueled by some of the most brilliant minds of this century, and cryptocurrency, a digital form of currency, can be a key to this process.

How Cryptocurrency Can Help NGOs

Fiat currency, such as a dollar bill, has a finite function; it is an object you use to trade one thing for another, and its value is based on government stability/decreed supply and demand. Imagine, instead, that your money was smart enough to have built-in functions that send and distribute it to different locations to earn you more money while you help the world.

Smart money can do more than just be used as a currency. Through a smart contract, digital tokens can both



“World of Waves (\$WOW) is a nature conservation effort with a goal of global sustainability fueled by cryptocurrency. It has created the world’s first NFT Marketplace, based on the \$WOW token, dedicated to a vast ecosystem of charitable organizations.”

serve as a storage of value and as a rewarding system where people can generate passive income and automatically contribute to charities without the need to manually press a “donate” button.

With a recent UN report that cites humans as the driving cause behind unprecedented rates of climate change, the need for nongovernment organizations (NGOs) to adopt blockchain technology to advance climate goals has never been more crucial. NGOs have a tremendous ability to profit by using proof-of-stake technology, which is a form of cryptocurrency that is not derived from mining coins like Bitcoin and does not require massive amounts of energy. For example, the Binance Smart Chain is not only fast and secure but also sustainable and green.

As the world moves toward digital currency, there is a unique advantage to using cryptocurrency to drive charitable donations. With a simple tax on transactions of a digital coin valued at fractions of a U.S. dollar, cryptocurrency can produce significant charitable contributions at scale. Through cryptocurrency, NGOs can extract funds for charitable donations and enable community giveaways to charities, cleanup organizations, nonprofit groups, public groups, wildlife rehabilitation programs, and more.

World of Waves’ NFT Marketplace

World of Waves (\$WOW) is a nature conservation effort with a goal of global sustainability fueled by cryptocurrency. It has created the world’s first NFT Marketplace, based on the \$WOW token, dedicated to a vast ecosystem of charitable organizations. An NFT is a non-fungible token that is a type of digital currency with proof of stake; common forms include art and media. Driven by an experienced group of developers and specialists with over 40 years of experience in technology and finance, the \$WOW token holds the key to empower people everywhere to better safeguard the environment as they earn passive income.

\$WOW started as a crypto token built on the Binance Smart Chain with an overall vision to clean up the oceans, protect and preserve ocean wildlife, and promote sustainability in all business practices. Through experience, the \$WOW team realized how ocean sus-

tainability is only one issue among other large issues that must be addressed globally for a better future for humans and the planet. The NFT Marketplace will be the first step in a journey to promote and provide sustainability to not just the oceans but the world’s other ever-changing ecosystems.

\$WOW is a frictionless yield and liquidity generating token that has a limited supply of 2 billion tokens. With an 11 percent fee on each transaction, this token provides: 3.3 percent redistribution to all holders, 3.3 percent to the liquidity pool, and 4.4 percent to the charity wallet to finance wildlife and nature conservation. Every four weeks, funds are extracted for charitable donations and community giveaways to charities, cleanup organizations, nonprofit groups, public groups, wildlife rehabilitation programs, and more.

The \$WOW NFT marketplace will include features that are not available anywhere else and will give many crypto artists the chance to sell their art and connect it with a charitable cause.

As \$WOW introduces a brand new concept for an NFT marketplace, it hopes to achieve a much greater reach to charity organizations around the world than ever before.

The \$WOW token also offers a huge benefit to its investors. \$WOW launched with a market cap of \$1 million during the V2 launch in July 2021, and within nine days reached its first all-time high with a market cap of \$16 million, providing investors with a 1,600 percent increase from their original investment. In the near future, the team plans to take this charity token to entirely new levels, giving back to the world in community-minded ways.

When it comes to the climate change crisis, there is an urgency to take action right now. NGOs around the world are not fully equipped to tackle their missions in their current financial state. That’s why we need to get NGOs ready for blockchain and start using newer technology to finance their causes. By using proof-of-stake cryptocurrency, NGOs can more effectively reverse the harm we’ve done to the environment and reduce our carbon footprint.

You can learn more about \$WOW and buy tokens at: <https://wow.surf>. **ST**

Review&Forecast

Comprehensive Open-Source Software For Ocean Energy Sector

By Pablo Ruiz-Minguela
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The European Commission's FP7-funded DTOcean project (2014 to 2017) produced a first generation of freely available, open-source design tools for wave and tidal energy arrays. Built upon this solid foundation, the DTOceanPlus project (2018 to 2021), with a total budget of €8 million, further developed and demonstrated a suite of second-generation advanced design tools for the selection, development, and deployment of ocean energy systems. The consortium brought together representatives of all key user and stakeholder groups, plus developers of Europe's leading ocean energy sub-systems, devices and arrays. Two U.S. institutions also took part in the project.

Users of the DTOcean+ suite of tools will be able to generate designs for innovative ocean energy technologies and deployments. These designs are optimized for a wide variety of key metrics, including lifetime costs, reliability, availability, maintainability, survivability, performance, environmental impact and socioeconomic impact. They also balance technological and financial risk, which, in combination with greatly improved cost-effectiveness, ensures that ocean energy technologies become more commercially attractive.

Open-Source, Integrated Suite of Design Tools

The functional requirements of the software suite were developed considering both the expectations of potential users, identified during a consultation phase, and the functionalities not covered by the various tools available on the market. Feedback from the DTOcean project was also valuable.

Standalone versions of the different tools were first developed: The core functionality of each tool or module was complete and could run independently. To provide

additional valuable results to the users, the tools were integrated into a software suite. A main application manages projects and design workflow among and between the different modules, supported by catalogs of reference components, vessels and activities. Industrial partners ran the open-source integrated suite of design tools with data from real projects to demonstrate the operational capabilities and value of the software.

The final release from the project is now freely available in the form of a TRL 6 product with tutorials and user guides. The open-source nature of the tools allows the community to continue the development, optimization and further validation of the tools, including adding functionalities as the ocean energy sector develops and new needs are identified.

From Concept Selection to Assessment Of Ocean Energy Systems

The DTOcean+ suite includes four design tools to support users in the innovation, development and deployment of ocean energy systems.

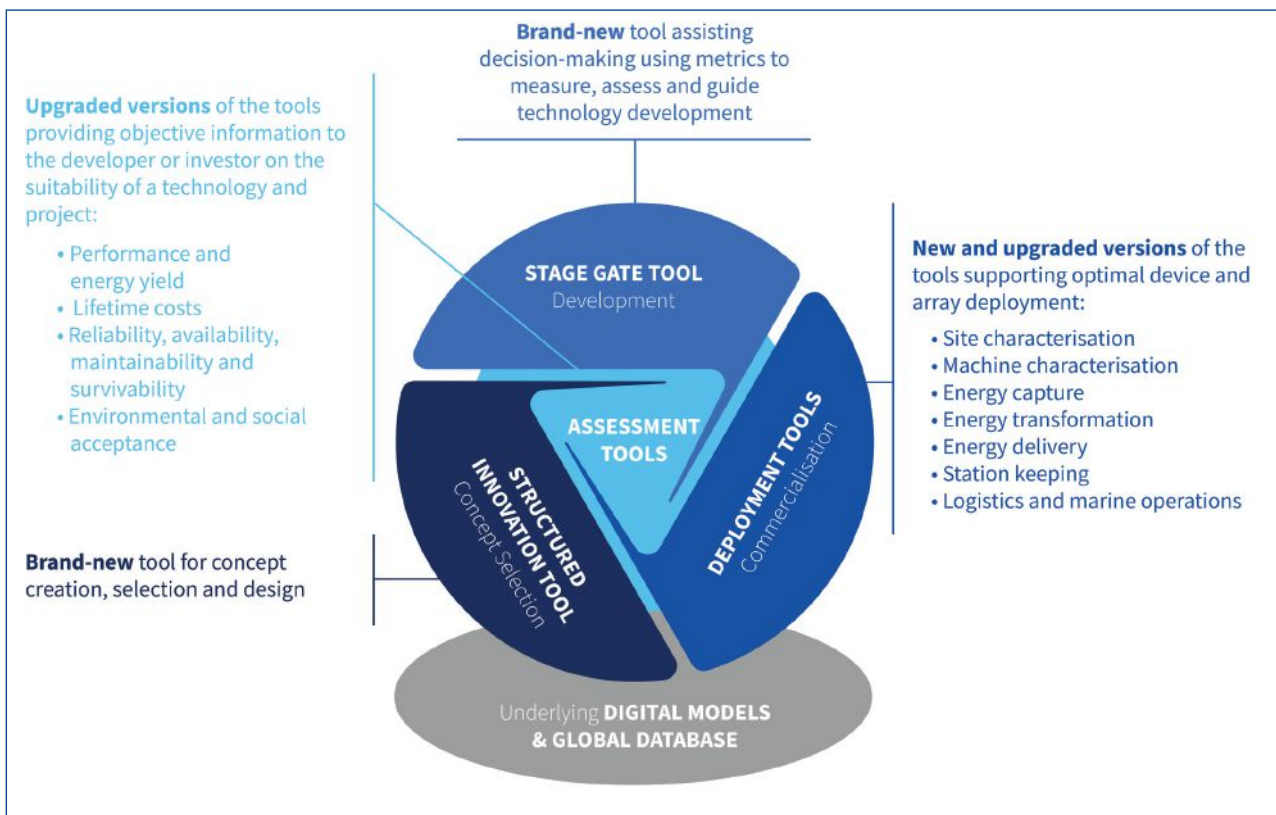
The Structured Innovation Tool guides the innovation process and concept selection for ocean energy systems.

The Stage Gate Tool enables an objective assessment of ocean energy technologies and supports decision making in the technology development process, thanks to a common set of evaluation criteria.

The Deployment Tool comprises seven modules. Site Characterization and Machine Characterization covers a wide spectrum of use cases, from the development of a project for a specific site to the treatment of more generic environmental conditions to evaluate machine performance. Energy Capture has two main modes of operation: assessment of a user-specified array layout and identification of the optimal array layout.

Energy Transformation has two main use modes: assessment of a specific technology in a specific development stage and under a control strategy, and a design mode where the main power take-off characteristics are functionally optimized for a selected criterion. Energy Delivery is for maximization of the power delivered to shore, considering the cost and value of the solution proposed and ensuring overall grid compliance. Station-Keeping is for full design of foundations, anchors and mooring lines; mechanical design of dynamic cable and its interaction with the other elements of a mooring system; and defining a local optimal design solution based on the cost of components. Finally, Logistics and Marine Operations is for minimization of the logistic costs associated with all life-cycle stages of a

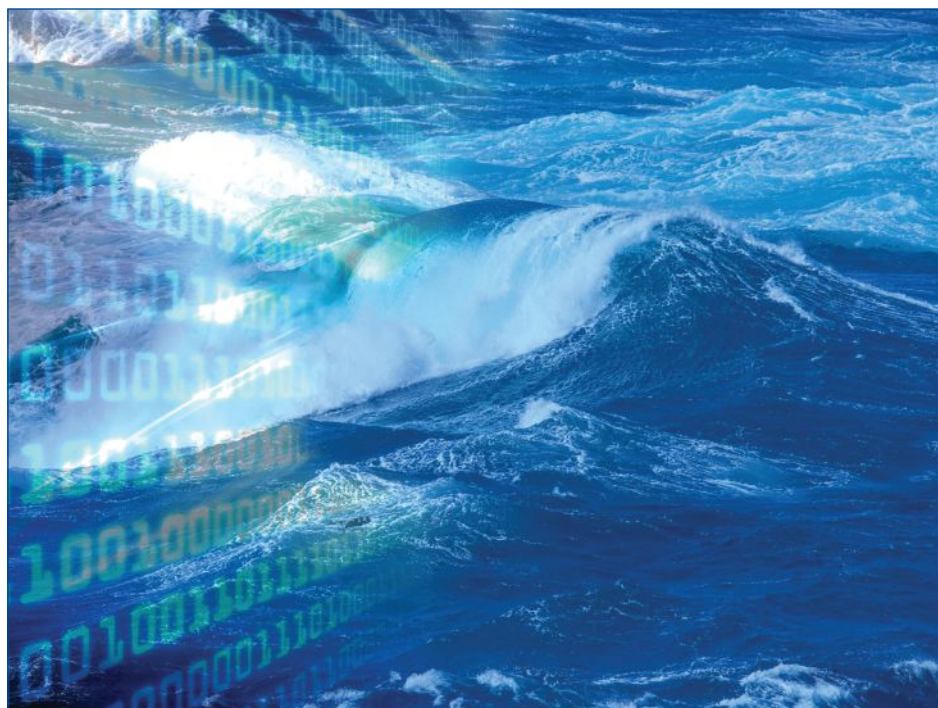




(Above) *The design tools composing the DTOcean+ software suite. (Credit: DTOceanPlus)*
(Right) *(Credit: Tecnalía)*

given offshore renewable energy project, while considering suitable combinations of ports, vessels and support equipment for logistical requirements.

The Assessment Tool comprises four modules. System Performance and Energy Yield provides and generates data performance at subsystem, device, and array level, as well as downtime due to operations. Reliability, Availability, Maintainability and Survivability (RAMS) delivers end-users a solution to assess and evaluate the RAMS of an ocean energy system at three stages. System Lifetime Costs is for estimation of the costs associated with the subsystems, devices or arrays throughout the project's lifetime, and ultimately the project's economic and financial viability. Environmental and Social Acceptance assesses the potential environmental and social impacts in terms of pressure existence, receptor sensitivity and social acceptance for each life-cycle operation of a given project.



Data Format Standardization For Ocean Energy Systems Design

In the context of the DTOceanPlus project, a framework was developed to standardize the data formats describing an ocean energy design as a common interchange language among different sector actors. This has been done by means of the definition of a digital representation for the elements of the whole system at different levels of aggregation (from component to farm), and

“Users of the DTOcean+ suite of tools will be able to generate designs for innovative ocean energy technologies and deployments.”

accounting for different levels of complexity of a project (from simplified to detailed case).

In order to fully capture the main aspects of an ocean energy system, the digital representation framework has accounted for: elements of the technology design, phases of the technology life cycle and constraints from the context; a vertical dimension that describes a set of hierarchical connections among subsystems and components; and a transversal dimension accounting for the individual and specific components of a system.

Detailed Analysis of the Ocean Energy Market

Given the large potential of the ocean energy sector, a review of current market sizes, potential applications, geographical locations and future market outlook was prepared. Then, an assessment of the supply chain across Europe was carried out to deliver a complete understanding of the current and future supply chain, and to guide sustainable exploitation of the software in the sector.

A global cost-benefit analysis was conducted considering both technology-push and market-pull funding options for economically achieving or surpassing long-term cost reduction targets. In combination, the analysis considered gross value-added and other environmental and socioeconomic benefits.

Standard approaches to business management models were developed, combining the value of the DTOcean+ toolset with knowledge of both the potential markets that ocean energy technology can be applied to and the supply chain in place to exploit the opportunities. They include pricing methods to support development of business, funding and support cases.

A critical evaluation of the ocean energy sector's legal, institutional and political frameworks was carried out by analyzing barriers and enabling features for the deployment of ocean energy during both the development and industrial roll-out stages for both wave and tidal energies.

The DTOcean+ software suite is a comprehensive toolset that will accelerate the development of the ocean energy sector by enabling stakeholders to evaluate the viability of initiatives in terms of technology, economics, and environmental and social aspects. **ST**

Review&Forecast

Offshore Energy Aligns with Biden Energy, Climate Goals

By Erik Milito
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Americans are dealing with a fragile economic recovery but still want the government to do more to address the climate challenge. Thanks to the American offshore energy sector, the Biden Administration does not have to choose between the two. The American offshore energy industry can advance economic and environmental goals across the board.



However, the administration has been somewhat selective in its support of offshore energy. Offshore wind projects are moving forward with encouraging momentum, but oil and gas policy has sputtered. The administration spent much of last year unsuccessfully pursuing a pause on new federal leasing.

The imbalanced policy approach is happening as American families are losing out to inflationary impacts on energy prices. Gasoline prices are hitting highs that have not been seen since 2014. *Fortune* even published the piece “Explaining the sharp jump in gas prices—and why you should get used to shelling out an extra \$600 per year” (<https://fortune.com/2021/10/13/gas-prices-2021-outlook-price-jump-oil>).

American families are rapidly adjusting to a higher priced energy reality. But instead of trying to alleviate inflationary pressures through increased American energy production, the Biden Administration has unfortunately looked abroad for help.

In August 2021, President Biden called on OPEC+, which includes the super-emitter Russia, to increase oil and gas production to help lower energy prices. On the way to the 2021 United Nations Climate Change Conference, also known as COP26, Biden echoed that call for OPEC+ to increase production. Biden also used his meetings at the G20 to again take the same course of action.

These calls came despite the near concurrent attempt by the administration to “pause” new federal oil and gas leasing. The U.S. Department of the Interior is required by law to expeditiously develop America's energy resources, and this includes the obligation to schedule and hold offshore oil and gas lease sales. A court confirmed these legal requirements, overturning the ban.

Offshore leasing resumed in November, with Gulf of Mexico Lease Sale 257. While the resumption of off-

“By pursuing energy policies that simultaneously support continued Gulf of Mexico oil and gas production and advance U.S. offshore wind, President Biden can deftly deliver the economic, energy and environmental progress Americans desperately need.”

shore lease sales seems to be on more stable footing, the current offshore oil and gas leasing program expires this summer.

The most crucial action for the administration this year is the promulgation of a new Five-Year Program for offshore oil and gas leasing. Not only are there the legal requirements that were reaffirmed by the court last summer, but American offshore oil and gas production is simply smart policy.

The Gulf of Mexico provides a way to reach emissions objectives. Gulf of Mexico oil and gas production has a carbon-intensity one-half of other oil-producing regions. Deepwater production, which accounts for 92 percent of production in the Gulf of Mexico, provides the lowest carbon intensity out of any oil-producing region.

Offshore production platforms are incredible pieces of continuously evolving technology. A relatively small footprint can produce tremendous amounts of energy. Eighteen deepwater facilities, which equate to about the size of only nine city blocks, produce about the same amount of oil as the entire state of North Dakota.

The Obama Administration also considered the climate impacts of Gulf of Mexico lease sales. In 2016, the Bureau of Ocean Energy Management (BOEM) found that U.S. greenhouse gas (GHG) emissions would be higher with no lease sales. Asking higher-emitting countries such as Russia to increase oil and gas production should be a nonstarter for any policy maker.

Likewise, America needs the investment and high-paying jobs associated with offshore energy production. Gulf of Mexico oil and gas production supports more than 345,000 high-paying and accessible jobs, and generates spending and investments in every single U.S. state.

More than 200 types of jobs are directly involved in offshore oil and gas projects. These jobs have an average salary nearly 30 percent higher than the national average. In 2019, the Gulf supported \$28 billion in investment, 1.8 million barrels of oil production per day, and 345,000 jobs throughout the country.

Without new lease offerings, American jobs and investment, energy and national security, and emissions progress will disappear.

U.S. offshore wind, on the other hand, has had smoother sailing under President Biden. The Department of the Interior greenlit the construction and operation plan of what will be the first commercial-scale offshore

wind project in the U.S., located off the coast of Martha's Vineyard.

The administration has a roadmap of when and where new offshore wind leases could be held, including in areas offshore the Carolinas, California and the Gulf of Mexico. Many of the same companies that have built the U.S. Gulf of Mexico oil and gas industry are helping to build our country's nascent offshore wind sector. This means billions of dollars in investment, thousands of new jobs, and a pipeline of projects that will effectively reduce our nation's carbon footprint.

Likewise, Congress passed the landmark bipartisan Infrastructure Investment and Jobs Act that includes around \$550 billion in much needed federal investment in America's infrastructure. There is \$17 billion in funding for waterway and coastal infrastructure, including port infrastructure, in the legislation. The Department of Transportation's Port Infrastructure Development Program (PIDP) will see \$450 million per year for five years. Ports are the gateway to America's offshore wind opportunity; supporting one helps the other.

The bill also advances climate-related efforts through coastal resiliency funding and low- and zero-carbon transportation commitments. It also provides for continued funding for bipartisan programs, such as large-scale carbon capture, direct air capture and wind energy projects.

We are at an energy transition that will lean on American offshore oil, gas and wind. The ambitions of the Paris accords will require global action that address demand-side emissions. Through the course of an energy transition, we must ensure that supplies of all forms of energy remain available and affordable, while we work together to reduce consumer-side emissions.

The U.S. offshore stands out as a key part of this equation. A burgeoning offshore wind sector can provide zero-carbon power generation along our coastlines. The Gulf of Mexico can continue to provide the petroleum resources required to fuel the U.S. economy, helping to bring low-carbon supplies to market and provide energy relief.

By pursuing energy policies that simultaneously support continued Gulf of Mexico oil and gas production and advance U.S. offshore wind, President Biden can deftly deliver the economic, energy and environmental progress Americans desperately need. **ST**

Review&Forecast

The Pandemic's Impact on Global Maritime Mobility, Supply Chain

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The rapid spread of COVID-19 in February 2020 pushed the World Health Organization (WHO) to recommend containment measures to slow down the spread of the virus. Aimed at “flattening the curve” of infections to avoid overwhelming healthcare systems, many countries have implemented unprecedented confinement measures, ranging from bans to travel and social gatherings to the closure of many commercial activities. Many of the restrictions were exceptional and in contradistinction to “normal” routines.

The hope was that the macroeconomic system, global supply chain and international trade relations would not revert back to “business as usual,” but that there would be a successful adoption of new types of economic development and governance models instead.

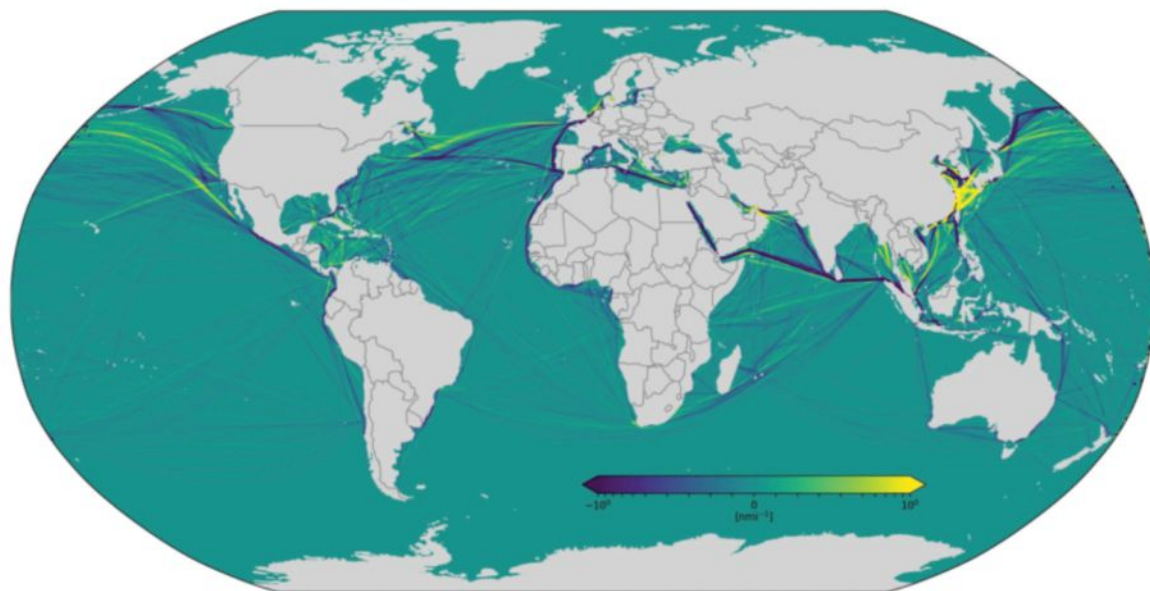
However, the reduced industrial activity caused a reduction of shipping mobility, which in turn disrupted the global supply chain during the global health crisis.

The global economy is slowly starting to recover from the COVID-19 pandemic thanks to massive vaccination campaigns, but disruption of the global supply chain continues and has led to chaos for the manufacturers and distributors of goods that cannot produce or supply as much as before the pandemic.

There are several factors behind this crisis, such as worker shortages and lack of key components and raw materials, and the situation is under investigation by the scientific community and economic observers. Clearly, there is not a single root cause, but there is a combination of negative effects.

Maritime transportation is certainly one of

Monthly CNM density difference between 2020 and 2019 for container shipping. The considered time period is from March 13 to April 13, taking the difference between 2019 and 2020. Each grid cell is colored based on the variation of the 2020 value with respect to 2019, ranging from dark purple, which represents a decrease of CNM in 2020 with respect to 2019, to bright yellow, which represents an increase of navigated miles in 2020 with respect to the previous year. (Credit: NATO)



“This study represents a fundamental step toward understanding the global maritime effects of the COVID-19 pandemic and being able to plan accordingly for resilience strategies for future worldwide systemic shocks.”

the most important enablers of the supply chain, representing over 80 percent of global trade by volume being carried on board ships and handled through seaports worldwide. To put these numbers in perspective, the obstruction of the Suez Canal for six days in 2021, caused by the grounding of the *Ever Given*, created a loss estimated at \$9.6 billion worth of trade.

The monitoring of global maritime trade can be performed efficiently and accurately by processing the very large volumes of data produced by terrestrial and satellite automatic identification systems (AIS) throughout the world. A team of scientists from NATO's Science and Technology Organization - Centre for Maritime Research and Experimentation (NATO STO-CMRE), in collaboration with MarineTraffic (a provider of ship-tracking and maritime intelligence), the University of the Aegean (Greece), the University of Connecticut (U.S.) and the University of Salerno (Italy), conducted a study using maritime traffic data, collected via a global network of AIS receivers, to assess the impact that the COVID-19 pandemic and the consequential necessary containment measures have had on the maritime shipping industry.

To support the study, an unprecedented data set (for uniqueness and completeness) was used, which comprises 1 trillion AIS messages broadcast by 50,000 ships worldwide. The study is based on data-driven maritime mobility indices, which quantitatively assess ship mobility in a given unit of time. Examples of mobility indices are cumulative navigated miles (CNM), the number of active and idle ships, and ship average speed.

Spatial changes due to COVID-19 containment measures have been represented with vessel density maps that highlight significant changes in the shipping routes and operational patterns between 2019 and 2020. Compared with previous years, and considering an unchanged growth rate with respect to past years, 2020 mobility levels underwent the effects of COVID-19 containment measures. Indeed, following the outbreak, an unprecedented drop in maritime mobility was observed, across all categories of commercial shipping.

With only a few exceptions, a generally reduced activity has been observed from March to June 2020, when the most severe restrictions were in force. The variation of mobility is between -5.62 and -13.77 percent for con-

tainer ships; between +2.28 and -3.32 percent for dry bulk; between -0.22 and -9.27 percent for wet bulk; and between -19.57 and -42.77 percent for passenger traffic.

It appears likely that this unprecedented drop in commercial ship mobility is a symptom of the global supply chain crisis currently affecting markets and operators all around the world.

This study represents a fundamental step toward understanding the global maritime effects of the COVID-19 pandemic and being able to plan accordingly for resilience strategies for future worldwide systemic shocks.

References

For a list of references, contact: Sandro.Carniel@cmre.nato.int. **ST**

Review&Forecast

Mapping the Ocean Floor For the People and Planet

By Jamie McMichael-Phillips
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Seabed 2030

A little over 8 million people speaking more than 800 languages reside in New York City's captivating urban jungle of skyscrapers and billboards. Welcoming over 60 million visitors a year pre-pandemic, it is the most linguistically diverse city on our planet. Given the ocean's interconnectivity and importance to all of humankind, New York was a fitting stage for the ocean to be placed at the forefront of global affairs during the 2017 UN Ocean Conference. This conference was a world first at a time when the need to map the 70 percent of Earth's surface was growing increasingly more urgent—at the time, only 6 percent of the seafloor had been mapped to an adequate resolution.

The lack of bathymetric data challenges our ability to sustainably manage marine resources and protect coastal communities around the globe. As a solution, Yohei Sasakawa, chairman of The Nippon Foundation, launched the Seabed 2030 project during the first UN Ocean conference in collaboration with the General Bathymetric Chart of the Oceans (GEBCO). The goal is to have a complete map of the global seafloor by 2030.

There are many benefits to having a complete bathymetric map of the ocean. Beyond supporting the development of a sustainable blue economy, knowing the shape of the seabed is critical to understanding the circu-



“Seabed 2030 has now collectively mapped just over 20 percent of the world’s entire ocean floor, but that still leaves four-fifths of the ocean unmapped.”

lation of ocean currents and associated effects on climate change, weather systems, tides, and tsunami wave propagation. For these reasons, the mission of The Nippon Foundation-GEBCO Seabed 2030 project is to discover how much of the seafloor has been mapped already and what is held in private databases, and then compile all existing bathymetric data into the freely available GEBCO digital map. This map will then identify areas for which no data exist to inform future mapping expeditions.

Almost five years later, efforts to achieve the ambitious goal of mapping the entire ocean floor by the end of this decade have gathered momentum. Seabed 2030 now has over 166 partnerships, data contributors and supporters in 50 countries, significantly expanding the crowdsourcing efforts that are central to its success.

In the last 12 months alone, the project has realized several important achievements. In 2021, Seabed 2030 celebrated a major milestone by welcoming New Zealand as the first country to sign up to the ocean mapping initiative, as well as 11 additional partners across academic and private sectors. The project was also one of the first to be endorsed by the UN’s Decade of Ocean Science for Sustainable Development (2021 to 2030), known widely as the Ocean Decade, and by the fourth edition of the Paris Peace Forum, recognizing the importance of bathymetric data and giving a major boost to efforts to map the entire seafloor by 2030.

In October 2021, the results of an important new survey were released. Nearly 800 professionals representing 90 countries across the scientific, academic, philanthropic and business communities, as well as government and defense officials, took part in a survey commissioned by Seabed 2030 and managed by NLA International. The survey consolidated the views on the value of seabed mapping and where activities to map using modern digital methods should be focused. The survey also identified some key challenges that need to be addressed in order to achieve the ambitious goal. In addition, it achieved its secondary aim of finding new data that could immediately feed into the emerging global map, with respondents identifying 154 potential sources of new data to be explored.

While the project has achieved much over the last year, there were also many challenges. Crowdsourcing has occasionally been difficult, with some nations hesitant to share seabed data within their exclusive economic zones (EEZs). The severe restrictions on human movements brought about during the height of the COVID-19 pandemic continue to affect academic scheduling of

seabed mapping expeditions and crew changes for ship-based activities. The need to map the ocean floor also competes for funding and resources against other pressing issues, such as tackling plastic pollution.

Even with its challenges, 2021 will likely be remembered as a critical time in history for ocean exploration and recovery. Last year marked the start of the Ocean Decade and the UN Decade of Ecosystem Restoration (2021 to 2030), and saw several important pledges from governments that will further support ocean mapping efforts. Several key reports were published, including the Intergovernmental Panel on Climate Change’s Sixth Assessment Report and the UN Environment Programme World Conservation Monitoring Centre’s Protected Planet report, further emphasizing the necessity of accurate climate models and regional maps for managing and monitoring protected areas. These activities culminated with the 2021 UN Climate Change Conference, COP26, where several countries announced ambitious plans to increase marine reserves and direct much-needed funds to important ocean initiatives.

I was invited to speak in Glasgow at a COP26 side event organized by Schmidt Ocean Institute, a Seabed 2030 partner, on “Climate and the Deep Sea World.” It was exciting to speak on the first day of this critical climate change summit to raise awareness about the importance of seabed mapping for informing climate models, extreme weather predictions and more.

Seabed 2030 has now collectively mapped just over 20 percent of the world’s entire ocean floor, but that still leaves four-fifths of the ocean unmapped. When it comes to modeling, reconnaissance, etc., it means we are operating on 80 percent guesswork. We need to do better.

We shouldn’t forget that the reference map needs to exist to support everything else—you need this information if you want to develop better climate models, predict where plastic will wash up, or provide accurate and timely tsunami warnings to coastal communities in marginal zones. Mapping the seabed shouldn’t be seen as an activity in competition to all these crucial concerns, but as something that will complement them.

The 2022 UN Ocean Conference will take place June 27 to July 1 in Lisbon, Portugal. Looking ahead to the upcoming conference, we can celebrate the positive strides that have been made since 2017 and remain hopeful that other nations will follow the footsteps of New Zealand by joining global efforts to map the remaining 80 percent of our ocean. After all, almost 8 billion people residing on Earth are relying on it. **ST**

international

World's First Fuel-Cell Harbor Tug

Svitzer, A.P. Moller (Maersk's towage operator) has signed an agreement with Robert Allan Ltd., a naval architect company, to design the world's first fuel-cell tug for harbor operations, running on green methanol. The project builds on close cooperation between Svitzer and Maersk with the aim to jointly explore the combination of methanol fuel cells, batteries, storage/handling systems, electric drives, and propulsion units as a carbon-neutral alternative to the conventional fossil-fueled propulsion train.

Sea Vorian Acquires Seafin Group

Sea Vorian has acquired Seafin Group, the holding company of RTsys, enhancing the business as a European player in the naval, civil and defense underwater markets. This will support the continuous growth of RTsys through its four sectors of activities: PAM (passive acoustic monitoring), MCM (mine countermeasures), AUVs and ASW (anti-submarine warfare).

Cornerstone Investors in Blue Economy Fund

The European Investment Fund (EIF), Chr. Augustinus Fabrikker, Builders Initiative and Minderoo Foundation have approved commitments to become cornerstone investors in Ocean 14 Capital's inaugural fund, the first large investment fund to focus exclusively on the blue economy.

EIF has approved a commitment of €35 million to the fund, while Chr. Augustinus Fabrikker is allocating €15 million. Builders Initiative and Minderoo Foundation will commit €10 million together, bringing the total to €60 million.

The fund is a unique combination of marine industry and nature conservation knowledge that comes from Ocean 14 Capital, a private-equity firm focused on the United Nations' Sustainable Development Goal 14 (SDG14), which aims to conserve and sustainably use the oceans, seas and marine resources for sustainable development. The Ocean 14 Capital Fund will target investments in growth-stage technologies and companies promoting sustainable fishing, aquaculture and alternative proteins, as well as ocean conservation and health, including marine flora and plastic waste solutions.

The global blue economy, according to OECD predictions, will grow from \$1.5 trillion in 2016 to \$3 trillion by 2030 and will provide 200 million jobs.

Partnership for Maritime Sustainability

The World Ocean Council (WOC) has signed a memorandum of understanding (MoU) with Green Marine, an environmental certification program for the marine industry for collaboration on reducing the maritime industry's carbon footprint and catalyzing improved environmental performance in the sector. WOC and Green Marine will work together to create more awareness of initiatives, cross-promote projects across their respective

networks, and find more opportunities for maritime sector participation in sustainable ocean development.

Fugro Opens 'Drishti' ROC

Fugro has announced the opening of a new state-of-the-art remote operations center (ROC) in India. Fugro currently operates a core global network of eight major ROCs, ensuring full system redundancy in all parts of the world. This backbone infrastructure is complemented with several regional ROCs, strategically positioned near Fugro's major clients and projects.

This new regional facility will be known by the name "Drishti," the Sanskrit word for "vision." It will allow clients in the Middle East and India to benefit from Fugro's remote inspection and positioning solutions.

XOCEAN Expands to Norway

International ocean data company XOCEAN has opened a new entity in Norway to service growing demand in the market for the company's pioneering, carbon-neutral, data collection services using remotely controlled USVs. The company uses its unique robotic technology to collect ocean data sustainably across a range of industries, including offshore wind.

Marine Parts, Accessories Group Adds Brands

Brunswick Corp.'s Advanced Systems Group has announced that both Mastervolt and Whale will become part of the Advanced Systems Group EMEA (ASG EMEA) portfolio, joining the largest and most complete parts and accessories businesses in the global marine and mobile industries. ASG EMEA now brings together 13 brands in power management, digital control and monitoring, electrical components, networked devices, and water systems to operate as a single organization in the region of Europe, the Middle East and Africa.

CRP Invests in Production for Renewables

CRP Subsea has made a large-scale investment in a new manufacturing facility to support its transition from primarily oil and gas into the renewables market. The purpose-built manufacturing facility includes a state-of-the-art, semiautomated production line for the NjordGuard cable protection system used in offshore wind farms. The new facility enables CRP Subsea to significantly improve flow of materials, achieve throughput efficiencies and increase productivity; increasing bend stiffener production output by a factor of 20.

ROV Hull Cleaning Available at Port of Colombo

In-water hull-cleaning specialist HullWiper Ltd. has formed a partnership with underwater and related services company World Subsea Services Pvt Ltd. to bring sustainable and affordable hull-cleaning solutions to vessels calling at the Port of Colombo in Sri Lanka. Strategically located in the Indian Ocean, Colombo Port is one of the country's largest and busiest ports, particularly for container vessels.

HullWiper's ROV provides an eco-friendly, safe alternative to traditional methods of hull cleaning that use

divers with brushes or karts. With HullWiper's advanced onboard filter unit technology, hull-cleaning operations can be performed while the vessel is in port, day or night, in most weather conditions, and while cargo operations are underway.

Hampton Roads Maritime Initiatives

The Hampton Roads Maritime Collaborative for Growth & Innovation (HRMC) and Old Dominion University (ODU) have announced two major maritime initiatives to advance the region's economic development. One will advance ODU as a globally recognized institution for maritime opportunities. The other is the release of "A Pathway for Maritime Innovation in Hampton Roads," a report prepared by TEconomy Partners that identifies opportunities to leverage and expand the region's innovation and workforce support for industry partners. They are: to develop a national hub for autonomous systems; organize a maritime small business innovation collaborative; establish a Department of Defense center of excellence for naval sustainment and mission engineering; and build a sustainable home and brand for maritime innovation in Hampton Roads.

Costs Rise for Coastal Virginia Offshore Wind

Dominion Energy Inc. said its offshore wind farm will cost about \$2 billion more than expected, *Virginia Business* reported. Instead of the previously estimated \$7.8 billion, the 2.6-GW commercial project will cost ap-

proximately \$9.8 billion, including a cost increase due to rising commodities expenses and general cost pressures across a number of industries amid mounting inflation, plus costs associated with the need to build about 17 mi. of new transmission lines and other onshore infrastructure.

Construction will begin in 2024. When completed in 2026, the wind farm is expected to power 660,000 homes.

Digitizing Spare Parts Management

ABS Nautical Systems (ABS NS) and Spares CNX, a global provider of spare parts supply chain technology, are partnering to digitize spare parts inventory management and deliver significant time and cost savings to vessel owners and operators.

PROPELLER platform, Spares CNX's proprietary software for vessel inventory management, will be integrated with ABS NS's NS Enterprise software suite, offering clients seamless data-driven support for the procurement process, including increased visibility into onboard spare parts levels, locations and real-time consumption.

ZeroNorth Opens Two New Offices

Maritime technology company ZeroNorth has opened two new offices, located in Varna, Bulgaria, and Mumbai, India.

The company offers services in weather advisory, voyage optimization and vessel optimization. **ST**

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Lightweight Radar Beacon



HEKLEO-2XSR is ideal for national or port and harbor authorities requiring IALA CAT 1 aids to navigation. It offers a line-of-sight range that can be greater than 15 NM, and it operates on marine S-band and X-band frequencies. Sealite Pty Ltd.

Electric Power System

This outboard, retractable system is designed for commercial vessels in inland and urban waterways. It combines Torqeedo's Deep Blue high-voltage electric power system

and Italdraghe's steerable azimuth thrusters to provide emission-free power and directional thrust, ideal for maneuvering on environmentally sensitive waterways. Torqeedo GmbH and Italdraghe SpA.

Automated Data Acquisition

Ship Connect has been upgraded to enable the processing and visualization of real-time and historical data both on board and ashore. Readings are transferred from vessel equipment to the METIS cloud platform for immediate availability for analysis. METIS Cyberspace Technology S.A.

Maritime Internet of Things

The KVH Watch suite of maritime IoT solutions has expanded with Cloud Connect, a service designed to utilize advanced edge com-

puting for smart shipping. Cloud Connect manages data from hundreds of onboard sensors with a comprehensive package containing data-source definitions, data mappings and associated dashboards. KVH Industries Inc.

Marine Temperature Calibrators

The MTC Series of dry-block temperature calibrators covers the most common oil lubrication temperature ranges. The MTC offers a temperature range of 28 to 650° C (82 to 1,202° F); stability to $\pm 0.1^\circ$ C ($\pm 0.18^\circ$ F); one-year accuracy of $\pm 0.9^\circ$ C ($\pm 1.62^\circ$ F); and three-year accuracy of $\pm 1.8^\circ$ C ($\pm 3.24^\circ$ F) for the entire temperature range. AMETEK STC and JOFRA.

Variable Frequency Drive



Available in both the Optidrive P2 and Optidrive Eco ranges, with an IP55/NEMA 12 enclosure for direct mounting and IP20 for control cabinet mounting, the Size 8 VFDs can accurately control electric motors rated up to 480 amps with a power rating up to 250 kW/400 hp. They are suitable for onboard applications for vessels and ports, such as winches, cranes and bow thrusters. Invertek Drives Ltd.

GNSS Signal Splitter

TW162A automotive-grade smart power GNSS signal splitter supports the full GNSS spectrum: GPS/QZSS-L1/L2/L5, QZSS-L6, GLONASS-G1/G2/G3, Galileo-E1/E5a/E5b/E6, BeiDou-B1/B2/B2a/B3, and L-band correction service frequency band. Tallysman Wireless Inc.

Hydrodynamic Software

HydroComp PropExpert 2021 offers new user experience and technical



features for Windows 10/11. The overall workflow process remains unchanged. HydroComp Inc.

Rugged Mobile Computing



NAUTIZ X9 PDA's new version is an ultrarugged enterprise handheld built for fieldwork in the most challenging outdoor and industrial environments. With an upgraded platform, the Nautiz X9 Android rugged handheld runs Android 11 and is Android Enterprise Recommended (AER). It has a sturdy magnesium casing. Handheld Group AB.

Digital Engine Monitoring

Shell LubeMonitor now offers enhanced fleet and vessel insights, including vessel comparison from fleet level all the way down to cylinders; a step-by-step guide for on-board engineers to help standardize the inspection process; a comprehensive engine inspection feature; integration with the Shell LubeAnalyst oil condition monitoring; and availability via internet, iOS and Android operating systems, and offline. Shell Marine.

Port Weather Insights

Vaisala's weather station solution collects real-time hyperlocal observations from the port area. Combined with the real-time port data sharing and control system developed by Unieke, it enhances port operations and improves safety. Vaisala Oyj and Unieke Oy.

Electronic Inclinator

DanEI-300, type approved to the IMO performance standard, is an advanced heel-and-pitch measuring device that is not sensitive to horizontal and vertical accelerations. It also measures and records pitch and yaw, with a vessel's three acceleration parameters measured

and recording heave, sway and surge. Daniamant A/S.

Electric Work ROV

eWROV's electrification is the key to its improved performance and sustainability. As well as being more efficient, electric systems use minimal oil, making the eWROV significantly more environmentally friendly than equivalent hydraulic work-class systems. Saab Seaeye Ltd.

ROV Simulator

This high-fidelity simulator delivers a realistic operational experience for training and mission practice for the VideoRay Defender, Pro 5 or Pro 4. The only requirements for the simulator are a PC and hand controller. Era Marine AB and VideoRay LLC.

Expansion Module for ROV

The Phantom T5's expansion module is a small-size addition to the system, housed in its own pressure vessel and depth-rated for 300 m. It allows the ROV system to accommodate additional sensors by providing both power and a high-speed data path to the surface. Deep Ocean Engineering Inc.

Multiparameter CTD

HydroCAT-EP V2 is designed for moored deployments of all kinds, from open-ocean buoys to biologically rich coastal environments. It measures CTD, dissolved oxygen, pH, fluorescence and turbidity in a single package. Sea-Bird Scientific.

Turbidity Logger

Measuring turbidity from 0 to 10,000 FTU, the AQUAlogger 310TY series comprises models suitable for 1,000- 4,000- and 6,000-m depth. Suspended Sediment Concentration Converter is standard. Aquatec Group Ltd.

Underwater Drones

FIFISH models are depth-rated to 350 m max. Applications include aquaculture, emergency rescue, security, bridge construction and wind farms. QYSEA Technology Co. Ltd. **ST**



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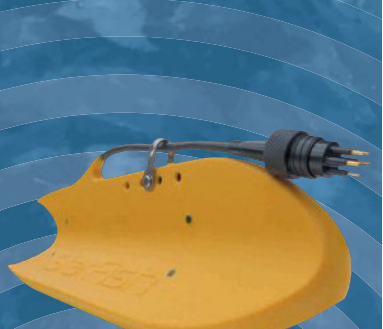
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environmental monitoring

New Tools to Process, Classify Echogram Data

ASL's collaboration with the University of Victoria through the Mitacs Accelerate Internship Program is two years old. Mitacs is a nonprofit group that fosters industrial-academic partnerships.

ASL has partnered with Professor Stan E. Dosso and M.S. student Alex Slonimer to fund a research study in ocean acoustics. This graduate research is focused on multi-frequency echosounders—specifically, data collected with ASL's Acoustic Zooplankton and Fish Profilers (AZFPs) that are used to measure the presence and abundance of fish and plankton. The goal of this industry-academic partnership was to develop new tools for the processing and classification of echogram data.

The results of this partnership have been the development of software and tools for the analysis of

multi-frequency acoustic echogram data. These new capabilities include extraction to a convenient format and a viewer application to quickly and efficiently review the data. For preprocessing the data, tools have been developed for noise removal, calculation of mean volume backscatter and surface detection. For manual review and categorization, an interactive tool has been developed to pre-classify the echograms using an unsupervised clustering algorithm and enable manual classification into more detailed classes.

The output of this classification may be fed directly into further processing for echo-integration and calculation of nautical area scattering coefficient for biomass estimates. Alternatively, the data may be used to train convolutional neural networks (CNNs) to automate the classification of echograms.

Through the Mitacs partnership,

a CNN was developed that, in addition to the echogram data, was also trained with ancillary information, including depth and solar angle. The classification of the data into different classes at a pixel level was achieved with this CNN.

This method of automation is a first step to rapid processing of large echogram data sets and will enable in-house processing with a short turnaround time from data intake to results.

Virginia Juvenile Striped Bass Abundance Remains Steady

Preliminary results from an ongoing long-term survey conducted by researchers at the Virginia Institute of Marine Science (VIMS) suggest that another average year-class of young-of-year striped bass was produced in Virginia tributaries of the Chesapeake Bay in 2021. The 2021 year-class represents the group of fish hatched last spring that will grow to fishable sizes in three to four years.

The VIMS Juvenile Striped Bass

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Seine Survey recorded a mean value of 6.30 fish per seine haul in the Virginia portion of the Chesapeake Bay. The 2021 value (recruitment index) is similar to the historic average of 7.77 fish per seine haul and represents the ninth consecutive year of average or above-average recruitment in Virginia waters.

Although there can be considerable variation in striped bass recruitment among years, the indices observed in recent years suggest that abundance of juvenile striped bass in Virginia has been relatively stable.

Striped bass play an important role as a top predator in the Chesapeake Bay ecosystem and are a valuable resource for commercial and recreational anglers. The striped bass population in Chesapeake Bay has rebounded from historic lows in the late 1970s and early 1980s after fishing bans were enacted in Delaware, Maryland, and Virginia in the mid- to late-1980s.

Global Microplastics Data Set

A global team of oceanographers led by Kyushu University researchers has calibrated and processed data from expeditions to build a publicly available data set for more accurately assessing the abundance of microplastics and their long-term trends in the world's oceans. To create the new data set, which was published in the journal *Microplastics and Nanoplastics*, the researchers collected, calibrated and gridded data from a total of 8,218 pelagic microplastic samples taken from oceans around the world between 2000 and 2019.

The team estimates there are 24.4 trillion pieces of microplastics in the world's upper oceans, with a combined weight of 82,000 to 578,000 tons—or the equivalent of roughly 30 billion 500-ml plastic water bottles.

There are regional data gaps, and data are missing for microplastics less than 300 micrometers in size and on the nano scale. This is due to the lack of field survey protocols for such plastics and limitations in equipment and the mesh size of nets used in the field. The hope is

that future surveys will continue to fill in data gaps using common protocols to facilitate data sharing.

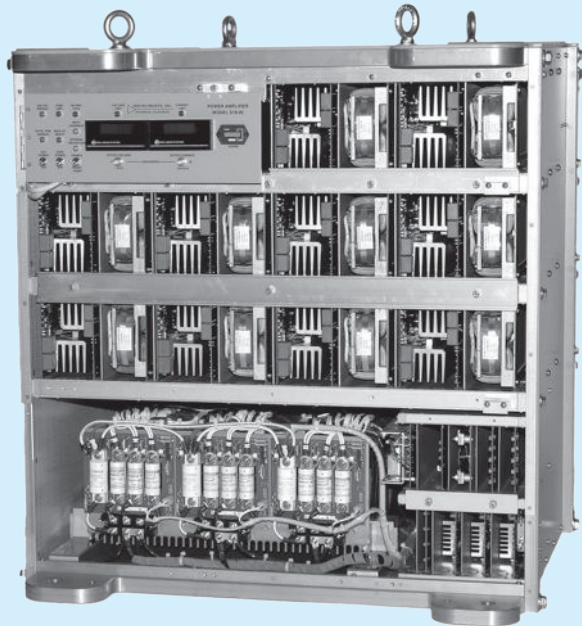
Climate Change Could Undermine Conservation

Climate change is altering the world's oceans, which could undermine efforts to protect sea life in the world's largest marine protected areas (MPAs), new research from Oregon State University, published

in the journal *One Earth*, shows. Analysis of multiple climate scenarios indicate that 60 to 87 percent of the ocean is expected to experience multiple biological and chemical changes, i.e., increases in water temperature, higher levels of acidity and changes in oxygen levels, by the year 2060. The rate of change is expected to be 76 to 97 percent in very large MPAs. Increases in pH (acidity) are expected by 2030. **ST**

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Initiative for Actionable Environmental Science

For the first time, a new initiative will give local policy makers access to critical real-time greenhouse gas (GHG) and pollution emission data and accurate model forecasts. Leading scientific societies Optica (formerly OSA) and the American Geophysical Union (AGU) are spearheading this effort to provide “actionable science” to local and regional policy makers as part of their Global Environmental Measurement & Monitoring (GEMM) collaboration.

“This initiative addresses a crucial need—to bridge the gap between science and policy at the local level, directly in the cities and towns where the policies needed to limit the magnitude of climate change and reduce air pollution will have the greatest impact,” said GEMM Initiative Chair and Stanford Professor Tom Baer.

New networks of real-time, low-cost, direct, ground-level observations of GHGs and air pollutants can provide immediate feedback to measure progress toward achieving urban air quality and emission goals. They also help identify and address air quality inequities in neighborhoods and communities. Localized urban networks can be integrated with longer-term, broad-area data from satellites and other observing systems to create more accurate climate and air quality maps and models for regions, states and nations.

US Makes Moves to Cut Methane Emissions

U.S. President Joe Biden and the Environmental Protection Agency (EPA) Administrator Michael Regan have taken steps toward cutting methane emissions. Biden, along with the president of the European Commission, launched the Global Methane Pledge with the support of 100 nations to reduce worldwide emissions of methane by 30 percent by 2030. Additionally, the EPA proposed a new Clean Air Act rule to sharply reduce pollution from the oil and natural gas industry, including reductions from existing sources nationwide.

The EPA projects that, by 2030, its proposed oil and gas sector rule would reduce methane emissions from covered facilities by 74 percent relative to their emissions in 2005.

EPA further estimates that the proposed rule would reduce a total of 41 million tons of methane emissions by 2035, the equivalent of 920 million metric tons of carbon dioxide. This amount exceeds the total amount of carbon dioxide emitted from all U.S. passenger cars and commercial aircraft in 2019.

Washington State Marine Debris Action Plan

The NOAA Marine Debris Program (MDP) announced the release of the 2021 Washington Marine Debris Action Plan, which is the result of a collaborative effort between the MDP and federal and state governments, tribes, non-governmental organizations, industry and academia, and represents a partner-led effort to guide marine debris actions in Washington state for the next two years.

The action plan has four goals, with 20 strategies and 169 actions that define how each goal will be achieved. The goals are: to prevent the generation of marine debris through coordinated actions that include community engagement, policy changes, best management practices and incentive programs; locate, identify, remove, and recycle or dispose of land- and ocean-based marine debris from Washington’s shorelines and waters; conduct coordinated, high-quality research to inform actions that reduce the adverse impacts of marine debris; and coordinate marine debris actions effectively throughout Washington state.

\$1 Trillion Bipartisan Infrastructure Bill Signed

President Biden has signed a \$1 trillion bipartisan infrastructure bill that covers transportation, utilities and broadband, including \$550 billion in new funding, CNBC reported. This is a major bill to upgrade critical transportation and utility infrastructure, which has become more vulnerable because of extreme weather.

The infrastructure package will provide \$17.4 billion in funding for waterway and coastal infrastructure, inland waterway improvements, and port infrastructure. Of those funds, \$450 million per year for five years would go to the Department of Transportation’s Port Infrastructure Development Program.

The legislation also advances climate-related efforts through coastal resiliency funding, low- and zero-carbon transportation commitments, and continued funding for bipartisan programs supporting large-scale carbon capture, direct air capture, and wind energy projects, NOAA said.

Nancy Hann to Lead NOAA Office of Marine and Aviation Operations, NOAA Corps

The U.S. Senate has confirmed President Biden’s nomination of NOAA RAdm. Nancy Hann to lead the NOAA Office of Marine and Aviation Operations (OMAO) and NOAA Commissioned Officer Corps (NOAA Corps), one of the nation’s eight uniformed services.

“From flying into hurricanes to crewing remote explorations to the deepest depths of the ocean, the NOAA Corps drives NOAA’s science forward,” said U.S. Secretary of Commerce Gina M. Raimondo. “Rear Admiral Hann’s leadership will continue to advance how we understand our planet through key observational platforms.”

As director of OMAO and the NOAA Corps, Hann will be responsible for NOAA’s fleet of 15 research and survey ships, nine aircraft, and the uncrewed systems operations program, as well as guiding the approximately 330 uniformed officers and 1,000 civilian personnel assigned to OMAO and the NOAA Corps.

Hann has served in many operational and management assignments during her NOAA career. She holds a master’s degree in public administration from Harvard University, a master’s in aeronautical science and space studies from Embry Riddle Aeronautical University, and a bachelor’s degree in marine science and biology from the University of San Diego. **ST**

offshore oil & ocean engineering

UTEC Uses iXblue's New Subsea Positioning Tech

Survey provider UTEC, the lead brand for Acteon's geoservices segment, has successfully deployed iXblue's new subsea positioning technology on an ultradeepwater field development project in Africa at depths beyond 2,000 m.

iXblue's sparse LBL solution brought together Canopus intelligent transponders, Ramses transceivers, inertial navigation systems, and Delph subsea positioning software to provide positioning and spool-piece metrology at multiple drill centers throughout the project.

UTEC was the first company to operate iXblue's new sparse range-aided INS subsea positioning technology on a commercial project in the energy industry.

iXblue's solution offers significant installation vessel time savings compared to conventional subsea positioning methods. Combined with a new innovative and cost-effective ROV simultaneous localization and mapping (SLAM) box-in method, it drastically reduced the time spent on calibration and maintenance during the project.

Fugro's InclinoCam for Precise Pile Positioning

Fugro was awarded a monitoring contract by Saipem to support the construction of an LNG jetty for BP's Greater Tortue Ahmeyim field offshore Senegal/Mauritania.

Beginning in December, Fugro deployed its InclinoCam vision technology to install more than 190 piles with centimeter precision over a period of approximately six months, working from a jack-up barge. Fugro's rapid precise positioning is providing actionable geodata on the monopile inclination to accelerate the project schedule, and a touchless solution that is much safer than conventional monitoring.

As one of the industry's most accurate verticality monitoring instruments, Fugro's InclinoCam is acquiring geodata to position the monopiles at the exact location on

the Earth's surface, delivering to Saipem's tight installation tolerances and providing continuous verticality measurements via machine vision cameras and intelligent visual object recognition algorithms.

The use of vision technology to install the piles for the jetty improves safety by reducing the need for human intervention and increases overall project efficiency by providing real-time inclination measurements without having to pause the piling operations.

Alliance for CCS in US Gulf

TechnipFMC and Talos Energy Inc. have entered into a long-term strategic alliance to develop and deliver technical and commercial solutions to carbon capture and storage (CCS) projects along the U.S. Gulf Coast. The alliance combines Talos's offshore operational strength and subsurface expertise with TechnipFMC's extended history in subsea engineering, system integration, and automation and control.

Cultivated through a shared vision to responsibly deliver CCS solutions that will help to reduce the global carbon footprint, this innovative partnership will accelerate offshore CCS adoption with reliable, specialized CCS systems.

Under the alliance, the companies will collaborate to progress CCS opportunities through the full life cycle of storage site characterization, front-end engineering and design (FEED), and first injection through life of field operations.

This further advances the companies' leadership in the emerging Gulf Coast CCS market, building on Talos's recent successful award as the operator of the only major offshore carbon sequestration hub in the U.S.

Venterra Wind Energy Services Group Acquires FoundOcean

Scottish firm FoundOcean has joined Venterra Group, a new wind energy services company. Established in 1966, FoundOcean says it

has become the world's largest dedicated offshore construction grouting company, providing life-extension solutions for offshore assets.

Venterra Group aims to create a "global services champion" to meet demand and accelerate growth in the offshore wind sector.

The expertise of its member companies covers the entire wind farm life cycle, from planning and development to installation and build to operations, maintenance, and lifetime extension.

Joint CCS Projects in Malaysia

ExxonMobil and PETRONAS, the state-owned energy company of Malaysia, have signed a memorandum of understanding (MoU) to collaborate and jointly explore potential carbon capture and storage projects in Malaysia.

The companies will assess the viability of carbon capture projects in select locations offshore peninsular Malaysia and share subsurface technical and infrastructure data for pipelines, facilities, and wells as they evaluate potential projects for the storage, transport and reutilization of captured CO₂.

The MoU strengthens a decades-long strategic partnership between ExxonMobil and PETRONAS, and has the objective of helping Malaysia reduce emissions and achieve its net-zero ambitions.

The MoU with PETRONAS is the ninth carbon capture and storage opportunity that ExxonMobil has announced since establishing its Low Carbon Solutions business in March 2021 to commercialize low-emission technologies.

The company has an equity share in approximately one-fifth of global CO₂ capture capacity, and has captured approximately 40 percent of all the captured anthropogenic CO₂ in the world.

The International Energy Agency projects that carbon capture and storage could mitigate up to 15 percent of global emissions by 2040, and the U.N. Intergovernmental Panel on Climate Change estimates global decarbonization efforts could be twice as costly without its wide-scale deployment. **ST**

Obstacle Avoidance Demo With XLUUV

Underwater obstacle avoidance technology from Sonardyne and Wavefront has been successfully demonstrated on board an extra-large UUV (XLUUV) built and operated by Plymouth-based MSubs Ltd.

As part of the demonstration, the XLUUV was programmed to travel beyond the breakwater outside Plymouth Sound. Sonardyne's Vigilant obstacle avoidance tech was used to create a bathymetric map to enable the XLUUV to navigate. The data were also overlaid on existing charts of the area, demonstrating the higher resolution provided by Vigilant.

The demonstration of the Vigilant forward-looking sonar was part of the first phase of the U.K.'s Defence and Security Accelerator's (DASA) Uncrewed Underwater Vehicle Test-bed – Opportunity to Integrate competition, run jointly with the Royal Navy and the Defence Science and Technology Laboratory.

The DASA competition is focused on testing and validating commercial-off-the-shelf technologies sensors and payloads, like Vigilant, to help the Royal Navy understand the future roles for XLUUVs for surveillance, reconnaissance and anti-submarine warfare, and deliver new capabilities to the Royal Navy at an accelerated rate.

Vigilant, developed by Wavefront and manufactured and commercialized by Sonardyne, is a navigation and obstacle avoidance sonar for ships, USVs and underwater vehicles. It provides crews with automated long-range detection of objects in the water column, showing them where it is safe to navigate and alerting them to potential underwater dangers that could result in a collision or grounding.

The system has two operating modes. In 3D mode, Vigilant produces accurate 3D bathymetry and color-coded depth imagery out to 600 m and down to 100-m depth. In sonar mode, Vigilant processes

the intensity of the acoustic data to extract long-range positional data out to 1.5 km and over a 120° field of view. The sonar returns are used to generate alerts highlighting the presence of a navigationally relevant obstacle.

Development of Ship-Based Autonomous Robotic Arm

Marine-i has agreed to support the next stage of development for a futuristic robotic arm designed by Submarine Technology Ltd. (STL).

STL's innovation is a ship-based multi-axis robotic arm for autonomous operations. It will form an integral part of a new autonomous synchronized stabilized platform (ASSP) to enable intervention tasks from ASVs, including equipment transfer and payload management, survey and inspection, and launch and recovery.

The aim of this next stage is to develop a remote sensing system to allow STL's hydraulically actuated robotic systems to achieve synchronous stabilization without the need for data communication between the moving target and the host vessel. The remote sensing system will add machine vision to STL's sophisticated robotic control systems.

This will enable the movement of objects to be tracked. Movement data will be fed back into the control system allowing robotic arms to synchronize with the object. These could include AUVs, ROVs and floating wind turbines.

As well as grant funding, the Marine-i team created a program for STL's new technology that comprised: evaluation of object tracking systems; design and build of an object tracking system, together with modifications to the ASSP robotic arm; trials in the Ocean Basin at University of Plymouth COAST Lab; and sea trials at the FaBTest site in Falmouth Bay.

Launch of USV with eROV

Fugro's Blue Essence, an offshore certified USV with an electric ROV (eROV), will begin its first project

in the Netherlands. During operations, the vessel is controlled from an onshore remote operations center (ROC) via a satellite connection.

It will be used for the inspection of offshore assets, construction support services, and hydrographic and geophysical surveys.

USVs play an important role in the future of the maritime sector by improving safety, reducing carbon emissions and delivering data more efficiently. USV operations remove personnel from high-risk offshore environments to an onshore ROC and reduce carbon footprint by 95 percent when compared to traditional survey methods. Cloud-based data processing allows near-real-time data delivery, leading to faster and more informed decision making.

CFD Software for CCS Tech

Equinor has partnered with DNV for the next three years of further development of DNV's KFX CO₂ computational fluid dynamics (CFD) software for carbon capture and storage (CCS) technology.

KFX CO₂ software simulates accidental releases of CO₂ from storage facilities or leaks from pipelines, trucks or ships.

Simulation will be used as a basis for CCS design and to mitigate consequences in the event of accidental release.

CO₂ is usually transported and stored in liquid or supercritical state. It is much heavier than air, so a release of concentrated CO₂ will typically follow the contours of the terrain and accumulate in pits, valleys and lower-lying grounds.

KFX CO₂ will take complex thermodynamics and interaction between geometry and terrain into account, including dry-ice formation and sublimation of CO₂.

DNV's experience using advanced CFD simulation tools in safety analyses for full-scale CO₂ capture projects is based on many years of development work of KFX software, which was acquired by DNV in 2017. Equinor has been a key partner in the development of KFX computational fluid dynamics software for 25 years. **ST**

SBIR Award to Develop Hi-Res SWIR Electro-Optical Seeker

Princeton Infrared Technologies Inc. (PIRT), specialists in indium gallium arsenide (InGaAs) imaging technology and affordable shortwave-infrared (SWIR) line-scan cameras, visible-SWIR science cameras, and 1D and 2D imaging arrays, has received a Phase II Small Business Innovation Research (SBIR) award from the Office of the U.S. Secretary of Defense to fund the development of a megapixel high-resolution seeker with extended wavelength detection capability covering the entire SWIR range.

The camera will have a high pixel operability with a digital output at greater than industry standard frame rate at full resolution. The imager will be manufactured on InP substrates using the InGaAs/GaAsSb system, allowing for low cost and the ability to utilize modern III to V semiconductor processing. It will be manufactured and hybridized at wafer scale to minimize cost.

Austal to Build US Navy Towing, Salvage, Rescue Ship

The U.S. Navy has awarded Austal USA a \$144 million two-ship towing, salvage, and rescue ship (T-ATS) detailed design and construction contract. This award marks the first steel new-ship construction program for the company. Austal USA will utilize its new enclosed steel production facility, set to open in April.

Predictive Ship Machine Health Monitoring

McQ Inc. has been awarded a Phase I SBIR contract for the development of a wireless machinery health monitoring system for U.S. Navy vessels. This system will continuously monitor for machinery component wear through the continuous collection of various data sources, including vibration and power, enabling the Navy to detect machinery failures before they occur, optimize maintenance schedules, and reduce fleet maintenance costs/service downtime. It will provide crucial data to train Navy CBM artificial intelligence/machine learning-based algorithms.

Existing instrumentation systems are expensive, require connection points on ships' machinery, and do not provide accurate time synchronization across multiple sensors. McQ's approach is to develop a design that will advance contactless power measurement technology with smaller and lower cost tools that will facilitate wide-scale deployment, which will be completely unobtrusive to the existing machinery.

Sea Falcon UAS for German Navy

The Federal Office of Bundeswehr Equipment, Information Technology and In-Service Support (BAAINBw) has concluded a contract with ESG Elektroniksystem- und Logistik-GmbH as the main contractor for the procurement of three unmanned aircraft systems (UAS), intro-

duced in the Bundeswehr under the name "Sea Falcon," for the K130 corvettes of the German Navy. With the implementation of the project "Reconnaissance and Identification in the Maritime Operational Area (AlmEG)," the corvettes' capabilities for imaging reconnaissance will be significantly expanded. In the future, objects can be detected and identified with the Sea Falcon far beyond the onboard sensor system.

New Landing Ship Transport for Nigerian Navy

The new, 100-m LST (Landing Ship Transport) 100 for the Nigerian Navy has been launched at Albwardy Damen, Sharjah, United Arab Emirates. The vessel will be a 100-m, roll-on-roll-off landing ship with deck space for vehicles, a helicopter/UAV deck and significant space for cargo, which can be loaded via both a stern and a bow ramp or using the 25-tonne main crane. It will enhance the Nigerian Navy's ability to deploy troops and military hardware and vehicles in support of maritime security operations and disaster relief.

US Navy Modifies HII LHA Contract

Huntington Ingalls Industries' (HII) Ingalls Shipbuilding division has received a contract modification from the U.S. Navy for \$113.6 million to enable long-lead-time material and advance procurement activities for amphibious assault ship LHA-9. LHAs are the centerpiece of the Navy's amphibious-ready groups and Marine Corps' air-ground task forces. **ST**

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Oyster Aquaculture Could Improve
Oyster aquaculture in the Potomac River Estuary could result in significant improvements in water quality, according to a new NOAA and US Geological Survey study published in the journal *Estuaries and Coasts*. The study found that oyster aquaculture could remove 40 percent of its suspended solids from the water column, according to the study. [ST-001](#)

Navy's Laser Weapon Ready
Navy engineers are making final bid to a laser weapon prototype that will be the first of its kind to deploy aboard a ship. The prototype, an upgrade of the laser weapon system, will be used for testing in the Gulf of Mexico for at least a year. The US Navy has made the decision to proceed with the development of the laser weapon system, which will be used to counter threats such as small boats and unmanned aircraft. [ST-002](#)

Ferry Sinks Off Coast of South Korea
With 460 passengers on board, the ferry *Seonam* sank off the southern tip of South Korea on Monday. The ship was carrying 460 people on the ship when it sank. The ship was carrying 460 people on the ship when it sank. The ship was carrying 460 people on the ship when it sank. [ST-003](#)

Pay Increase for Sailors Soon to Come
Sailors working for the US Coast Guard are set to receive a pay raise. The pay raise is set to be 3.1 percent. The pay raise is set to be 3.1 percent. The pay raise is set to be 3.1 percent. [ST-004](#)

US Senate Reviews DOE Budget
The US Senate is reviewing the Department of Energy's budget for fiscal year 2015. The budget is set to be \$22.5 billion. The budget is set to be \$22.5 billion. The budget is set to be \$22.5 billion. [ST-005](#)

US Technology Helps in Search
A new technology has been developed that can help in the search for missing aircraft. The technology is called 'Acoustic Doppler Current Profiler' (ADCP). The technology is called 'Acoustic Doppler Current Profiler' (ADCP). The technology is called 'Acoustic Doppler Current Profiler' (ADCP). [ST-006](#)

contracts

Fugro, Nootdorp, Netherlands, has secured two geotechnical site investigation contracts for Denmark's proposed Energy Island project. A global first, this purpose-built artificial island will be situated 80 km offshore in the North Sea and act as a hub connecting hundreds of surrounding wind turbines. Energinet.

Argeo AS, Kongsberg, Norway, has selected the Eelume autonomous "snake robot" to work with its USV as a mobile survey solution, complete with deployment and recovery system, for inspection and light intervention and monitoring of subsea assets and infrastructure. Eelume.

Shell Global Solutions BV, The Hague, Netherlands, has signed a broad strategic collaboration agreement to accelerate the global energy transition by helping achieve respective commitments for net-zero carbon emissions and advancing solutions to decarbonize energy and industrial sectors. Baker Hughes.

Woolpert, Dayton, Ohio, has been selected for a coastal geospatial services contract, including data acquisition, thematic mapping, high-resolution topographic and bathymetric product generation, photogrammetric mapping, survey and control services, GIS services, cadastral mapping, and geospatial training. NOAA.

Light Structures AS, Oslo, Norway, will deliver comprehensive ice-load monitoring systems for 10 Arctic LNG carriers operated by Russia's largest shipping company, Sovcomflot. Samsung Heavy Industries.

The World Ocean Council, Honolulu, Hawaii, has signed a memorandum of understanding for collaboration on catalyzing improved environmental performance in the maritime industry. Green Marine.

The British Antarctic Survey, Cambridge, U.K., has added a DriX USV to help conduct multidisciplinary

sciences, such as surveying the impact of ocean currents on melting ice flow and mapping the seabed in the polar regions. iXblue. **ST**

meetings

Note: The coronavirus (COVID-19) pandemic could affect event dates. Check event websites for the latest updates.

FEBRUARY

February 1—Technology, Systems, & Ships, Arlington, Virginia. www.navalengineers.org/Symposia/CSSTSS22.

February 1-3—Euromaritime, Marseilles, France. www.euromaritime.fr.

February 1-4—SPE Offshore Europe, Aberdeen, U.K. www.offshore-europe.co.uk.

February 2-3—Combat Systems Symposia, Arlington, Virginia. www.navalengineers.org/Symposia/CSSTSS22.

February 17-18—Indian River Lagoon Symposium, Fort Pierce, Florida. www.fau.edu/hboi/50/events.

February 21-24—OCEANS 2022 Chennai, India and Virtual. <https://chennai22.oceansconference.org>.

February 22-24—Blue Innovation Symposium, Newport, Rhode Island. info@blueinnovationsymposium.com or <https://blueinnovationsymposium.com>.

February 22-24—Subsea Expo, Aberdeen, Scotland. www.subseauk.com.

MARCH

March 1-3—Floating Wind Solutions, Houston, Texas. <https://floatingsolutions.com/fws-22>.

March 15-17—Oceanology International, London, U.K. www.oceanologyinternational.com/london/en-gb.html.

March 27-29—Canadian Underwater Conference and Exhibition, Halifax, Canada. www.cuce.ca.

APRIL

April 12-14—Tech Surge: Florida Estuary and Coastal Monitoring - Looking Ahead to 2030, Fort Pierce, Florida. www.mtsociety.org/fl-techsurge.

April 20-22—NOIA Annual Meeting, Washington, D.C. aparkins@noia.org or www.noia.org/noia-2022-annual-meeting.

April 25-28—AUVSI Xponential, Orlando, Florida. www.xponential.org/xponential2022.

MAY

May 2-5—Offshore Technology Conference, Houston, Texas. www.otcnet.org.

JUNE

June 1-2—Navigate, Turku, Finland. info@navigate.fi or www.navigate.fi.

June 7-9—Undersea Defence Technology (UDT), Rotterdam, Netherlands. www.udt-global.com.

June 19-24—Frontiers in Hydrology Meeting, San Juan, Puerto Rico, and Virtual. www.agu.org/FIHM.

June 21-23—Interspill, Amsterdam, Netherlands. info@interspill.org or www.interspill.org.

SEPTEMBER

September 18-23—International Marine Debris Conference, Busan, South Korea. www.7imdc.org.

September 19-22—Moored Systems for the Future Buoy Workshop, Wilmington, North Carolina. <https://mtsociety.memberclicks.net/buoy-workshop>.

OCTOBER

October 18-21—EURONAVAL, Paris-Le Bourget, France. euronaval.fr.

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

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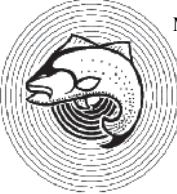
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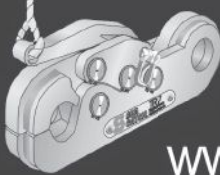
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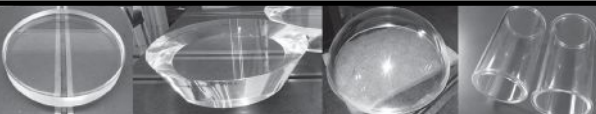
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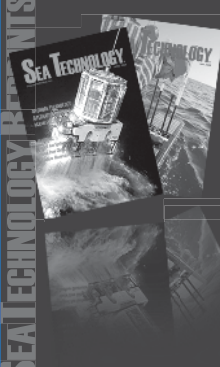
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An Interoperability Standard for Ocean Tech to Meet Climate Goals—Evan Shapiro

Evan Shapiro is chief technology officer (CTO) and co-founder of Sofar Ocean Technologies, where he is helping to develop the world's largest real-time ocean intelligence platform to provide insights to science, society and industry for a more sustainable planet. As Sofar's lead technical architect, he is driving the company's platform and product to scale across the world's five oceans.



The oceans play a critical role in our everyday lives. They serve as the backbone of global transportation, provide a huge portion of the food we eat, bear an astonishing array of biodiversity and beauty, and play a leading part in shaping our weather and climate. Yet, we know embarrassingly little about them. With a full understanding of the complex dynamics and mechanisms of our oceans, we could drastically improve operational efficiencies of marine industries, protect and manage valuable resources, and greatly increase the well-being of the hundreds of millions of us who live in coastal regions and are at climate-related risk.

Our oceans are a key barometer of climate change, with sea level, temperature, and acidification providing telltales for modelers and researchers. The oceans also store and transport unfathomable amounts of physical energy. In the wake of COP26, we're seeing heightened awareness of the ocean's essential role in reaching our collective decarbonization goals. Riding this wave, the next critical step is to drive ocean-based, cross-industry collaboration with a massive global data-gathering effort.

Scientists and engineers have long grappled with the incredible challenge of building systems to survive in our oceans. Each mission requires a custom engineering proj-

ect to navigate a sea of disjointed platforms, connectors and protocols. And, there's the ever-looming fear that "the ocean is probably going to break our stuff," which accompanies every deployment.

There has been no broad adoption of standards for marine hardware interoperability—until now, with the introduction of the "USB of the sea." As one of the largest providers of marine sensing platforms by volume, we saw an opportunity to prime the pump toward a plug-and-play ecosystem that will enable a step change in the growth and scale of ocean sensing systems. The first-of-its-kind maritime open standard, Bristlemouth (www.bristlemouth.org), named for a tough little fish that's the most numerous vertebrate on our planet, is aimed at catalyzing more collaboration, research and innovation for gathering big data from the oceans. With Bristlemouth, teams are able to leapfrog engineering and application obstacles by creating completely interoperable and modular hardware and software systems. Bristlemouth incentivizes those investing in new capabilities with immediate access to existing user bases and a broad range of compatible systems.

Today, most people don't think twice about the phenomenal magic of connecting two devices with a USB cable. You buy a mouse off the internet, you plug it into your computer, and it works. This trivial everyday experience is the culmination of decades of technology development and industrial collaboration. Similarly, Bristlemouth acts as the USB of the sea, providing interoperability between modular ocean systems (sensors, processors, batteries, etc.) by abstracting away power and data interfaces while being able to withstand the harsh conditions of the ocean. It provides a robust connection at full ocean depth, can carry high power and data rates, and can operate

extremely efficiently for low-bitrate, resource-constrained systems.

We knew that the hardest part of making a standard isn't the technology; it's getting the first person to use it. So it was critical to have buy-in from a variety of stakeholders in the marine technology space early on. This led us to build strong partnerships with organizations that had a shared commitment, including the U.S. Office of Naval Research, Defense Advanced Research Projects Agency and Oceankind.

Today, our partners span across energy, climate, weather and more. For example, philanthropic non-profit Aqualink is leveraging Bristlemouth via our Smart Mooring system to measure sea surface temperatures in hundreds of vulnerable coral reef sites. The data are then shared with scientists, reef managers, conservationists, and recreators to monitor reef health and take action where needed. Another group is rapidly developing and validating an operational monitoring system to protect wrecks from piracy. These largely different and niche applications share the core needs of power, data and telemetry, and benefit greatly from the ability to build small and affordable plug-and-play systems with Bristlemouth.

Bristlemouth will make big waves, not only in ocean research and industries but in the daily lives of everyone who depends on the oceans for transportation, food, energy, and/or weather—and that's basically all of humanity. Bristlemouth puts the power of ocean discovery and innovation into everyone's hands, making it easier and more affordable to build new applications. Ocean-based researchers, companies and recreationists alike can expand the bench of technical capabilities built on top of this new open standard. Through Bristlemouth, we're growing a diverse community to help build the future of ocean sensing. **ST**

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