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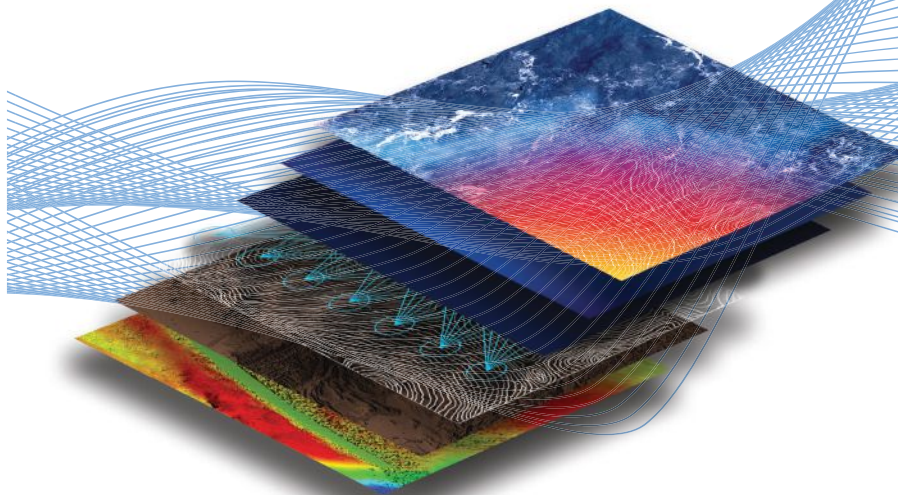
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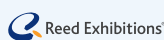


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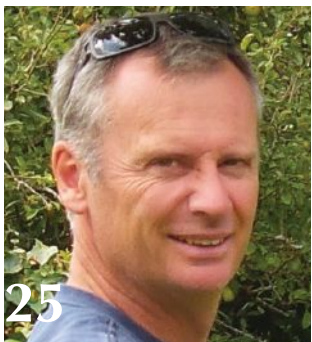
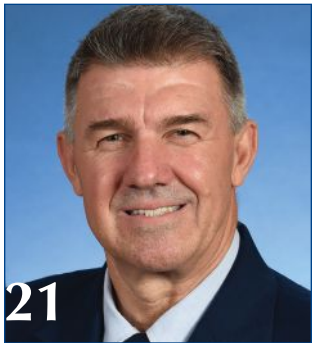
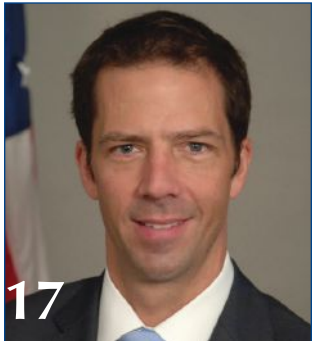


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Growth of the Blue Economy

In 2019, the blue economy and ocean sustainable development continued to grow in substance and awareness among industry, government and the public. This will accelerate in 2020 as the kinds and levels of ocean use expand. At the same time, the deteriorating condition of the ocean and its effects on the future of the planet are becoming increasingly evident, creating challenges and opportunities for technology, business, science, government and society.

Governance of the high seas, which cover about 45 percent of the planet's surface, was a major focus in 2019 and will continue to be in 2020. Formal work on a new international legally binding instrument to address biodiversity in areas beyond national jurisdiction (BBNJ), under the UN Convention on the Law of the Sea (UNCLOS) started in 2018, and two rounds of negotiations were held in 2019. The BBNJ treaty is scheduled to be concluded in 2020, with requirements for area-based management and marine protected areas, environmental impact assessment, the transfer of technology, and a regime for marine genetic resources management. Related to this is a drive to protect 30 percent of the ocean by 2030, under the UN Convention on Biological Diversity (CBD).

In the maritime sector, a major transition in fuel production and supply chains, engines, technology and operations is fully underway. After years of work and major decisions at the International Maritime Organization (IMO), the global shipping industry begins 2020 with new standards limiting the sulphur content of fuel oil, significantly reducing the amount of SOx emissions from ships, which should have major health and environmental benefits. More broadly, recent IMO decisions require global shipping to reduce total greenhouse gas emissions by at least 50 percent by 2050, compared with 2008.

Many other key ocean issues are global and multisectoral and need to be tackled at a comprehensive ocean-ecosystem scale. For example, 2019 saw the launch of the international GloFouling project in which government and industry are working to address the complex challenge of biofouling and the spread of invasive species. This issue requires a coordinated effort to engage all industries with ocean vessels and infrastructure, as well as the sectors involved in the prevention of fouling, e.g., marine coatings and cleaning of ships and structures. The World Ocean Council (WOC) is the key private sector partner in the program, working to engage the range of ocean industries in collaborating to ensure a comprehensive, long-term approach to the issue. This kind of global, multi-industry approach will increasingly be developed to tackle other complex ocean issues, e.g., marine sound, marine debris/plastics.

Innovation is critical to addressing key ocean issues, and the past year has seen the continued growth in the number of ocean-related accelerators, incubators and challenge competitions to spur entrepreneurial efforts for the blue economy. In an effort to ensure that this growing ocean-innovation ecosystem can best connect and collaborate on ocean sustainable development challenges, the WOC Global Blue Economy Innovation Network will serve as a shared platform to foster synergies and economies of scale.

Sea technology will be critical to the coming Decade of Ocean Science for Sustainable Development as the basis for improving the information available on maritime economic activities and the status of ocean conditions, resources, biodiversity and ecosystems. Industry vessels and platforms will increasingly host sensors or deploy instruments, for which the WOC Smart Ocean-Smart Industries program is providing a system for "matchmaking" industry assets with data-collection technology and ocean-observing priorities. These efforts address data-deficient parameters such as acidification and areas such as the Arctic, which is changing rapidly and fundamentally as ice cover recedes.

The coming year will present more opportunities for the ocean technology, business, science and government communities to collaborate in developing solutions to a range of ocean challenges. **ST**

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Annual Review & Forecast/Buyers Guide/Directory

**Canadian Hydrographic Conference, February 24-27, Quebec, Canada

FEBRUARY

Instrumentation: Measurement, Processing & Analysis

**Oceanology International 2020, March 17-19, ExCel London, U.K.

**OCEANS 2020 Singapore, April 6-9, Singapore

MARCH - digital only

Electronic Charting/Vessel Management/

Ports & Harbors/Dredging/Homeland Security

APRIL

Offshore Technology/Alternative Energy & Ocean Engineering

**AUVSI XPONENTIAL 2020, May 4-7, Boston, MA

**Offshore Technology Conference, May 4-7, Houston, TX

**UDT 2020, May 26-28, Rotterdam, The Netherlands

MAY

Communications, Telemetry, Data Processing

**BlueTech Expo, June 10-11, Washington, DC

**CLEAN PACIFIC 2020, June 9-11, Seattle, WA

JUNE

Seafloor Mapping/Sonar Systems/Vessels

JULY - digital only

Deck Gear, Cable, Connectors, Power Systems & Salvage

AUGUST

Geophysical Exploration/Seafloor Engineering

**SEG 2020, October 11-16, Houston, TX

SEPTEMBER

Ocean Resources Development & Coastal Zone Management

**Offshore Energy 2020, dates TBD, Amsterdam, The Netherlands

**OCEANS 2020 Gulf Coast, October 19-22, Biloxi, MS

**CLEAN GULF 2020, October 20-22, San Antonio, TX

OCTOBER

Environmental Monitoring, Remote Sensing & Pollution Control

**International Water Conference, November 8-12, San Antonio, TX

NOVEMBER

Undersea Defense/Antisubmarine Warfare

DECEMBER

Diving, Underwater Vehicles & Imaging

**Underwater Intervention 2021, dates TBD, New Orleans, LA

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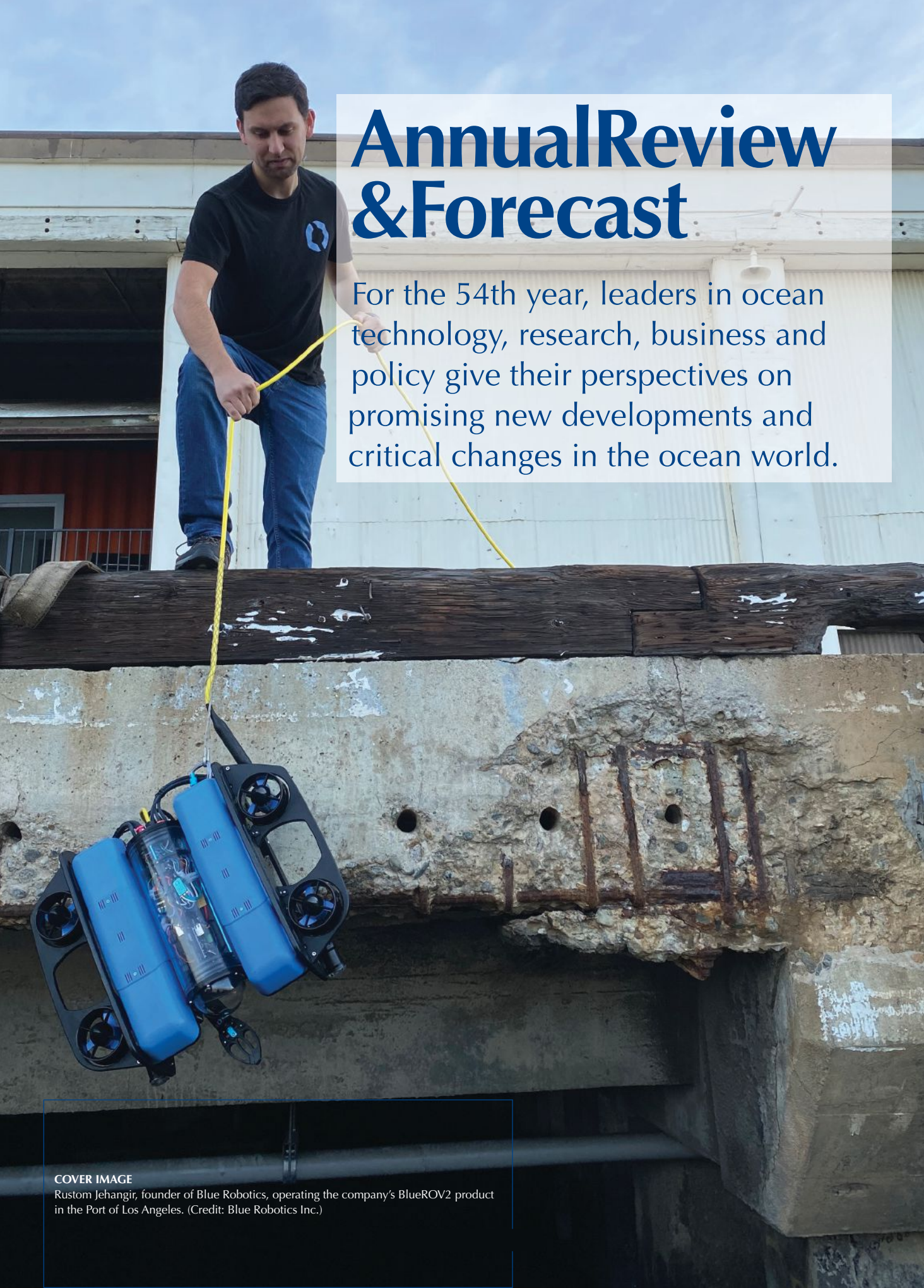
)) Comments Wanted on NOAA's Elimination of Paper Charts. NOAA is initiating a five-year process to end all traditional paper nautical chart production and is seeking the public's feedback. Chart users; companies that provide products and services based on NOAA raster and electronic navigational chart (NOAA ENC) products; and other stakeholders can help shape the manner and timing in which the product sunset process will proceed. Comments may be submitted through NOAA's online ASSIST feedback tool (<https://nauticalcharts.noaa.gov/customer-service/assist>) and are due by February 1, 2020. Over the next five years, NOAA will work to ease the transition to ENC-based products while continuing to support safe navigation. NOAA will focus on improving data consistency and providing larger scale coverage of NOAA ENC, as well as providing access to paper chart products based on ENC data, either through the NOAA Custom Chart prototype or third-party commercial data providers. Further details can be found in the announcement posted on the NOAA Office of Coast Survey website at <https://tinyurl.com/tol7zd6>.

)) Wave, Tidal Energy to Grow in 2020. Ocean Energy Systems (OES) predicts strong advances in ocean wave and tidal energy in 2020, driven by public and private sector funding. The latest OES annual report highlights significant international investment, including \$25 million pledged by the U.S. Department of Energy to support 12 next-generation marine energy projects and Wave Energy Scotland committing £7.7 million for two wave energy machines in 2020. In the last year, there has been major progress with global tidal projects achieving extensive operating hours and wave technology progressing in large-scale laboratory and offshore test sites. A growing range of devices is now being tested in open water, with an acceleration of cross-border R&D projects supported by the European Commission. OES has also been working closely with the U.S. Department of Energy, Wave Energy Scotland and the European Commission to achieve an internationally accepted approach of performance metrics for ocean energy development that will benefit technology developers, investors and funders. OES expects to see many more advances in 2020, with large investments being made by governments around the world.

)) NEPTUNE Connects US Veterans with Universities to Produce Tech. A wetsuit to help Navy divers fight the deadly effects of hypothermia and a portable power source for warfighters serving in desolate combat zones are just two products to emerge from the Naval Enterprise Partnership Teaming with Universities for National Excellence initiative, known as NEPTUNE. NEPTUNE's mission is to leverage the unique experiences, knowledge and "can-do" attitude of military students with delivery of university-derived technologies. The effort has been so successful that NEPTUNE 2.0 will launch in early 2020, providing new research grants to universities to align naval and national defense strategy requirements with campus laboratory capabilities. Currently, NEPTUNE sponsors research projects at six civilian universities, the U.S. Naval Academy and the Naval Postgraduate School. Since its inception, it has involved more than 225 veterans and active-duty students in 34 different projects—resulting in 22 patents, a strong record of employment in technology industries and multiple veteran-owned business start-ups. Projects use theoretical research to develop products that can be used by today's warfighters. The goal is for student projects to address real-world problems. To achieve this, NEPTUNE project teams must include military students to ensure that evaluations of proposed solutions incorporate their practical experiences in uniform.

)) ABB Proves World-First Subsea Power System. ABB's pioneering subsea power distribution and conversion technology system is now commercially viable, bringing groundbreaking potential for cleaner, safer and more sustainable offshore oil and gas production, following the completion of a 3,000-hr. shallow-water test. For the first time worldwide, energy companies will be able to access a reliable supply of up to 100 MW of power, over distances up to 600 km and down to 3,000 m water depth, at pressures that could shatter a brick. This is all achievable with a single cable with little or no maintenance for up to 30 years, making oil and gas production feasible in far out and deep ocean environments. The \$100 million research, design and development joint industry project (JIP) between ABB and Equinor with its partners Total and Chevron was initiated in 2013. The validation of the shallow-water test at a sheltered harbor in Vaasa, Finland, means the majority of the world's offshore hydrocarbon resources are now in reach for electrification. By powering pumps and compressors on the seabed, closer to the reservoir, ABB's subsea power distribution and conversion technology can significantly reduce power consumption and carbon emissions. ABB's subsea power technology can connect to any power source, enabling future integrations with renewable energy, such as wind and hydropower.

)) Online Shopping Experience Enhanced for Shipping Industry. GAC Marine Logistics (GML) has formed a partnership with maritime e-commerce developer Moscord to provide global last-mile delivery services for its digital marketplace, which brings the world's maritime buyers and sellers together. Moscord.com gathers the world's products and suppliers in one convenient online location with a single, simple interface. It enables any supplier or manufacturer to sell to the global market and any ship or company to purchase supplies and spares directly from manufacturers. Hailed as "the amazon.com of shipping," moscord.com currently offers 200,000 products to the shipping industry. **ST**

A man in a black t-shirt and blue jeans stands on a wooden pier, holding a yellow rope that is attached to a blue and black underwater robot (BlueROV2) hanging from the pier. The robot has two large blue cylindrical tanks and a transparent central section showing internal components. The background shows a building with a corrugated metal roof and a cloudy sky.

Annual Review & Forecast

For the 54th year, leaders in ocean technology, research, business and policy give their perspectives on promising new developments and critical changes in the ocean world.

COVER IMAGE

Rustom Jehangir, founder of Blue Robotics, operating the company's BlueROV2 product in the Port of Los Angeles. (Credit: Blue Robotics Inc.)

Review&Forecast

Scaling Understanding of the Oceans With Affordable Marine Robotics

By Rustom Jehangir
Founder
Blue Robotics Inc.

With ocean health becoming a topic of increasing public concern, there's a growing interest in using marine robotics and sensing to solve ocean-related problems. Marine robotics and sensing can drive public awareness, scientific understanding and direct intervention for ocean health problems at a scale that would not be feasible or affordable without robotics.

One person taking advantage of marine robotics is Allison Chua, an Oceanography Ph.D. student at Dalhousie University in Halifax, Canada. After getting an undergraduate degree in mechanical engineering, she's decided to dedicate her Ph.D. to marine robotics. She and her team at the Dalhousie CERC.OCEAN Lab undertook a project sponsored by ExxonMobil to use low-cost technology to detect and measure the impact of oil spills and other pollutants in the water with the goal of decreasing detection and response times. To accomplish this, Chua's team took a low-cost Blue Robotics' BlueROV2, customized it with an array of chemical sensors, and tested it with a simulated oil plume. The project was a success, and now their goal is to remove the human pilot topside and move the system to an affordable AUV platform. If they can pull it off, their detection system will provide more researchers with low-cost, scalable tools to study and reduce the impact of chemical spills.



Chua is just one of many students who are inspired to apply their engineering skills and technology to solve big issues facing our planet. I think we'll see a lot more students like her in the next decade.

One of the most impactful drivers that will bring more students into marine robotics is ocean-focused science, technology, engineering and math (STEM) programs at high schools and universities around the world. Right now, the U.S. Navy's Office of Naval Research (ONR) sponsors the RoboSub and RoboBoat competitions through the RoboNation organization. These competitions are extremely challenging, requiring students to push the current limits of autonomous robotics. That, along with the cost of the components needed to participate, has made it difficult for many teams to compete.

At Blue Robotics, we do everything we can to support these competitions—we make sure that our products are accessible regardless of budget, we provide open documentation and resources, and we provide support to the organizations hosting these events. Before affordable components were available, many teams were limited in what they could accomplish. Often, their entire budgets were eaten up by the cost of underwater thrusters, and most of their engineering effort went into just keeping things dry. Only a few teams made it to the point of accomplishing meaningful competition objectives. With the advent of low-cost thrusters, enclosures, sensors, electronics and software, they can now focus on solving bigger problems and pushing the limits of marine robotics.

In the last five years, the number of student teams participating in these competitions has increased by over 30 percent, and the technical level at which they compete has risen dramatically, driven by the availability of components and open-source electronics and software. At the most recent RoboSub competition, more than 70 percent of the teams were using thrusters, enclosures and other components from Blue Robotics, something that we're extremely proud of.

The students participating in these competitions today will have a profound impact on marine technology in the future. These competitions, and others like them, will continue to grow; there will be more students like Allison Chua, who take their skills and carry them into real-world applications of the future. I would encourage every company in the marine technology industry to consider supporting robotics competitions however possible.

Interest in marine technology to understand and preserve the oceans goes well beyond the academic world, and, similarly, the enabling effect of low-cost technology also applies elsewhere.

Pierre-Yves Cousteau is the founder and president of Cousteau Divers, a nonprofit organization dedicated to uniting divers around the world to protect marine life. As part of that mission, he recently launched an initiative called Project Hermes, an effort to build a network of citizen-science data-collection devices at dive centers around the world. Each device, called a Remora, will be sent out daily on rental dive equipment and will log georeferenced ocean data at depth. When the diver returns within range of a Wi-Fi signal, the data are uploaded to the cloud, generating a huge database of ocean measurements

that are updated on a daily basis. Using a number of affordable components from Blue Robotics to provide an overall low-cost solution, the Remora can be scaled to thousands or tens of thousands of devices passively collecting data points with every dive.

The data from Project Hermes will be made available to scientists around the world and contribute to our understanding of the ocean's state and how it is changing. It has the potential to contribute to wide-ranging scientific efforts and public awareness.

These projects are just a sliver of the opportunities for innovation in marine robotics when it's affordable and accessible. Since our founding in 2014, Blue Robotics has made it our mission to support that, and we will continue into the future. We're working on growing and improving our product line to enable students, scientists, businesses and explorers to go deeper and learn more about our oceans. We expect 2020 and the decade that follows to be the most exciting yet for marine robotics. **ST**



(Above) A flap being deployed at the U.S. Army Corps of Engineers Field Research Facility in Duck, North Carolina, in 2014. (Below) Schematic of the Wave₂O system (electric plant not shown).

UNEP also reports that approximately 50 percent of the world's population lives within 60 km of a coastline and, therefore, if made available, desalinated seawater is within easy reach of millions of people who may desperately need it.

However, seawater desalination technologies are generally inaccessible to those countries and regions that most need them because the scale of the current generation of desalination plants is too large, which means that they are too expensive and take too long to build and commission.

To address this problem, Resolute Marine Energy is developing a trademarked breakthrough technology, called Wave₂O, which harnesses the power of ocean waves to produce large quantities of freshwater and electricity and provide rapid relief from the harmful economic and social effects of water scarcity.

Resolute believes that Wave₂O is a breakthrough technology because it provides affordable access to seawater desalination for a large and previously unserved market, and it displaces the diesel-driven desalination systems that are in common use worldwide.

Resolute's platform technology is fairly simple: a flap-type wave energy converter that pressurizes seawater and pumps it ashore. Once delivered ashore, the bulk of the pressurized seawater directly drives the reverse osmosis separation process, and the remainder is diverted to an electric plant that provides "house" power for the desalination plant and additional electrical power to, for

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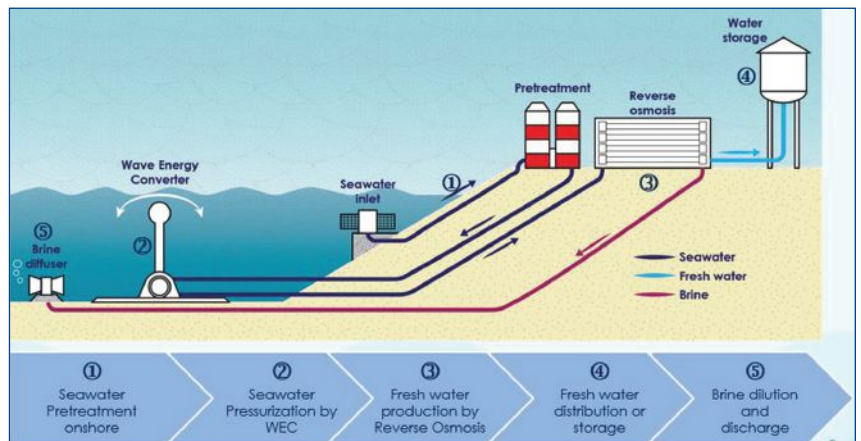
Addressing the World's Water Crisis

By Bill Staby
Co-founder and CEO
Resolute Marine

Climate change is greatly magnifying the challenges associated with providing year-round access to sufficient quantities of clean freshwater for people and enterprises. According to the United Nations Development Programme, today, more than 1 billion people lack access to clean and safe drinking water, and the World Commission on Water forecasts that the problem will dramatically worsen in the next 20 years unless clean water supplies increase by about 50 percent and access is more evenly distributed. If these new supplies are not made available by 2025, an estimated 4 billion people—one-half of the world's population—will be living under conditions of severe water stress.



It is generally accepted that desalinating seawater on a major scale is a viable means of alleviating the world's water crisis. A United Nations Environment Programme (UNEP) report states that 97 percent of all water on Earth is saline and therefore unfit for human consumption and unusable for agriculture except for a few salt-tolerant crops.





Mindelo, Cape Verde—a community to be served by Wave₂O.

example, pump water from the freshwater storage tank to wherever the customer wants it delivered. A key attribute of Wave₂O is that it requires no connections to an electrical grid, which means that it can be deployed almost anywhere regardless of available onshore electrical infrastructure.

Recognizing that wave-powered desalination systems may have significant near-term commercial potential, the U.S. Department of Energy recently launched its “Waves to Water Prize,” which is intended to stimulate innovation through a multi-stage evaluation process that culminates in the top candidates testing their systems in ocean conditions. Because the prize rules stipulate specific size, weight and production requirements, the winning technologies will likely see immediate demand for use in disaster recovery operations. Wave₂O has potential to be among these technologies.

Wave₂O addresses virtually all of the United Nations’ 17 Sustainable Development Goals, particularly those related to poverty reduction, health, gender equality, sanitation, sustainable cities and communities, and climate action. The need for clean-energy technologies that can cost-effectively solve the World’s Water Crisis will continue to grow as the human population expands and as environmental stressors multiply and become more severe. With almost half the world’s population expected to be living in water-stressed areas within the next several decades, technologies such as Wave₂O will quite literally be life changing for billions of people.

Resolute has devoted the past 10 years to the development of its Wave₂O technology, starting with the design and implementation of advanced computer-modeling tools, transitioning to five rounds (so far) of reduced-scale prototype testing in wave tanks around the world and two rounds (so far) of ocean trials, which were conducted on the Outer Banks of North Carolina. Currently, Resolute is fitting out its 5,000-sq.-ft. lab with equipment that will serve as a permanent testbed for various Wave₂O subsystems, components and control mechanisms.

Looking ahead, Resolute expects to conduct a final round of ocean testing within the next two years and to deploy its first commercial system in Cape Verde by 2022. With funding provided by the African Development Bank, Resolute and its partners are conducting a series of feasibility studies for Resolute’s Cape Verde proj-

ect, including bathymetric surveys, geotechnical surveys, water quality analyses and environmental impact studies. The freshwater produced will be used for the further development of a community on the island of Sao Vicente and, eventually, to supply water to a nearby aquaculture farm and greenhouse operation. **ST**

Review&Forecast

More Sustainable Oil-Spill Cleanup

*By Julie Hampden
Environmental Director
Earthwise Sorbents*

Global, national and local news frequently focuses on water pollution. Water pollution is affecting our health and that of the freshwater and ocean food sources upon which we depend.

In Europe and the United States, strategies against chemical pollution of surface waters are being developed at multiple scales. European Union-wide regulatory efforts are already underway (Water Framework Directive 2000/60/EC), and solutions are being actively pursued by individual countries. The Clean Water Act is the primary federal law in the United States governing water pollution, and the National Pollutant Discharge Elimination Program, administered by the Environmental Protection Agency and various state agencies, addresses water pollution by regulating point sources that discharge pollutants to waters of the United States.

A key component to improving and protecting water quality begins with limiting pollution at its source. Oil-related water pollution stems from a wide range of sources.

Oil Spills and the Aquatic Environment

Oil enters surface waters via many sources: accidental spills or leaks, careless disposal or storage of oil and oil products, atmospheric deposition, and stormwater runoff from cities and farms. It is estimated that approximately 706 million gallons of oil enter the ocean every year, with over half (approximately 363 million gallons) coming from municipal and industrial runoff and waste disposal. Routine maintenance of ships (bilge cleaning and other maintenance operations) releases nearly 20 percent of this total (approximately 137 million gallons). Air pollution, mainly from cars and industry, generates 13 percent of this total (approximately 92 million gallons) by depositing hydrocarbon particles on water surfaces and on land, where it washes into rivers, lakes and oceans during rainstorms. Big spills from tankers account



“A key component to improving and protecting water quality begins with limiting pollution at its source.”

for approximately 5 percent of this total (approximately 37 million gallons). Offshore drilling and production operations typically contribute less than 2 percent of the total (approximately 15 million gallons). The remainder comes from natural seepage from the seafloor (over 8 percent).

When oil is spilled into water, it initially spreads on the surface, forming a sheen or slick, due to its relative density and composition. When a slick forms, it may remain cohesive, or may break up due to waves, currents and wind. These same forces can distribute the slick over large areas, impacting the open water, coastal and shoreline areas, and aquatic and terrestrial habitats and species. A little bit of oil can go a very long way; 1 gallon of motor oil can contaminate 1 million gallons of freshwater.

In water, oil transforms in many ways. Oil that contains volatile organic compounds partially evaporates, becoming denser and more viscous over time. Some oil dissolves in the water. Oil can disperse almost invisibly in the water, in thin sheens, or form a thick mousse in combination with the water. Oil wastes may adhere to

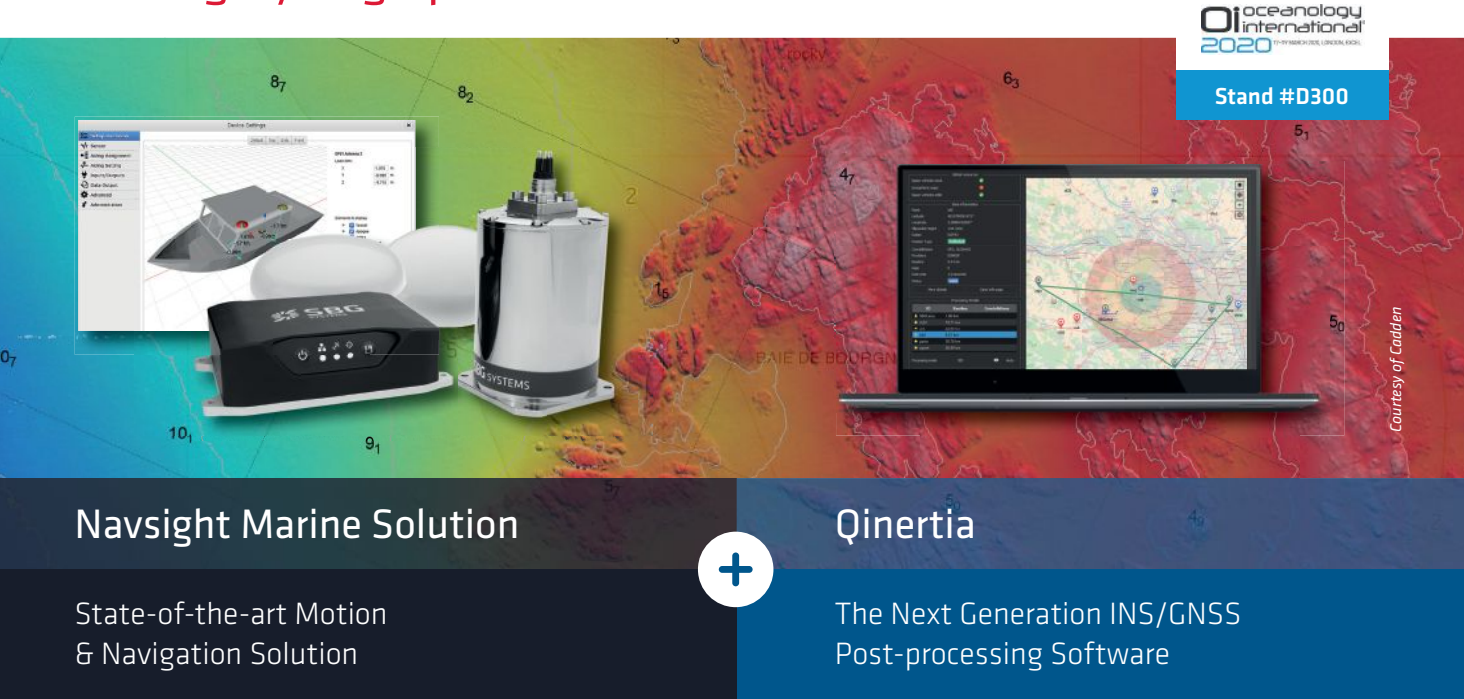
suspended particulate matter then sink to the bottom, or congeal into sticky tar balls. Over many decades, oil waste decomposes from exposure to sunlight and micro-organisms, but this process is very slow. For example, residues of the 1989 *Exxon Valdez* oil spill are still visible on the Alaskan coast, 30 years later. Until oil has fully decomposed, its toxic environmental legacy persists.

Oil waste in the aquatic environment is destructive and pervasive. Heavy slicks can fatally smother fish and wildlife, or reduce the thermal insulation and damage the reproductive systems of the oil-coated birds and wildlife that survive. Lingering residues can contaminate fish and food resources for extended periods. In the long-term, oil waste permeates the sensitive marine and coastal organic substrate, limiting colonization by micro- and macro-organisms and vegetation, thus interrupting the food chain upon which the aquatic ecosystem depends. Oil pollution can directly and indirectly damage human health and property in affected areas.

Oil-Spill Cleanup Strategies

The techniques used to clean up oil spills depend on

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The advertisement features a background of a colorful bathymetric map. In the foreground, there is a laptop displaying a software interface with a map and various data points. To the left of the laptop, there is a black SBG Systems motion sensor unit and a white SBG Systems GNSS receiver. Above the units, there is a small inset image showing a 3D model of a ship. In the top right corner, there is a logo for 'Oceanology International 2020' and a blue box with the text 'Stand #D300'. On the right side, there is a vertical text credit: 'Courtesy of Gaiden'.

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the characteristics of the oil and the type of environment involved. Measures that are applied to limit pollution associated with oil spills include containment (with booms, skirts or socks), followed by removal of the oil (by skimming, filtering, absorption [soaking up] or adsorption [sticking to]), dispersing it into smaller droplets to limit immediate surficial and wildlife damage, biodegradation (either natural or assisted), and natural weathering.

If valuable resources lie in harm's way, preventing the spread of oil and removing it from the environment as quickly as possible is of utmost importance. Spill responders choose techniques and materials that can mitigate the environmental threat as efficiently as possible, given site-specific conditions.

Focus on Sustainability

Sorbents are commonly used for oil- and chemical-spill cleanup and come in a variety of forms: powders, pads, pillows, booms, etc. Most sorbents currently available are made from virgin polyurethane (foam) and polypropylene (fabric) materials. Many natural or alternative sorbent products are clay and natural-fiber based. These alternatives frequently lack durability or absorb water in addition to oil and chemicals, reducing their effectiveness and elevating disposal costs because of this additional weight.

Earthwise Sorbents, a San Diego, California-based company, has developed an array of highly effective, sustainable sorbent products, made from recycled and repurposed foam and fabric materials. Earthwise Sorbents repurposes polyurethane wastes into high-performance sorbent pillows and recycles plastic and polypropylene wastes from other large vendors into melt-blown pads, open-net and sock booms, and sweeps. Earthwise products are oleophilic (absorb oil) and hydrophobic (repel water). They have been third-party tested in comparison to industry standard products and demonstrate equivalent or better absorbency.

Working with Industry

Earthwise is a proud member TMABlueTech, a San Diego-based nonprofit that promotes ocean and water technologies and economic growth in these sectors worldwide. This relationship has provided invaluable national and international networking opportunities to introduce our sustainable products to a global audience.

The largest annual contributors of oil into global waters include municipalities and industries using oil and oil-based products in their fleets (51 percent of annual releases) and the maritime industry via maintenance activities and spills (25 percent of annual releases). Earthwise is working with these and other entities to proactively contain and properly dispose of petroleum products and prevent oil from entering stormwater runoff by deploying Earth-friendly spill kits and absorbent booms in maintenance and fueling areas.

For example, in 2018 and 2019, Earthwise completed trials with several departments of transportation throughout the Puget Sound area, Holland America cruises on its Seattle-to-Alaska runs, some U.S. Coast Guard spill-re-

sponse teams, and the companies Vane Brothers and Maxum Petroleum. We also completed comprehensive third-party testing of our spill-response products with Findlay University.

In 2020, we will further develop these relationships and are positioned to complete testing with several Department of Defense bases in the San Diego area, as well as with Galp Energia in Portugal.

These efforts will help reduce pollution into waterways at their sources. **ST**

Review&Forecast

Reducing Noise Pollution For Marine Animal Welfare

By Ivy Terry

Environmental and Technology Impact Analyst

Business Development

Marine Construction Technologies

Over the last century, growing human activity in our oceans has led to the substantial increase in underwater noise pollution. This sort of noise pollution is a rising concern for the health and wellbeing of marine organisms and ecosystems. Marine construction, and more specifically pile driving, contributes considerably to this noise problem.



Pile driving is commonly used in the construction of foundations for docks, bridges, wind turbines, and offshore oil and gas platforms. Pile driving produces high sound-pressure levels in both the surrounding air and underwater environment. Sound levels can vary substantially; the size of the hammer, diameter and thickness of the pile, as well as properties of the seafloor, influence these noise levels.

During impact pile driving, as a pressure wave propagates down the length of the pile from the hammer strike, sound radiates into the surrounding air, substrates and waters. This noise radiation is what is troublesome for the surrounding marine life.

Underwater sound travels five times faster and 60 times further than in-air sound. The anthropogenic noise generated by driving piles is a significant threat to marine organisms. The extent of impacts on these species depends on a variety of environmental and biological factors.

Research indicates that the effects of marine noise on mammals, fish and diving birds range from minor disturbances to injury and, in worst cases, death. For aquatic animals, behavioral changes in response to underwater

noise pollution include increased stress, avoidance of the sound and reduced communication due to sound masking. Avoidance can impact migration patterns, foraging, nursing, mating activities and the overall fitness of a marine species. Masking of important sounds can also limit foraging and mating success and predator detection and avoidance. Physical injury can arise in the form of temporary or chronic hearing damage, injury to air-filled organs or soft tissues, and physiological stress and/or injury. Damage varies based on the intensity of noise and the cumulative exposure to elevated sound levels, creating chronic or temporary injury, or even death.

Ocean noise turns the surrounding marine environment into a 3D array of pressure, turbulence and turmoil, requiring immediate mediation. In marine construction today, current methods for pile-driving noise attenuation are lacking. These methods are often difficult or expensive to deploy, offer highly variable and/or minimal noise reduction, and can lead to increased project time, higher project costs and limited security for local marine life.

BOSS Pile

In contrast, the BOSS Pile Technology is a self-attenuating system that is versatile, easy to deploy and cost effective, and it greatly minimizes potential negative impacts to surrounding marine life. The engineers behind the BOSS Pile Technology are committed to developing innovative, engineering-driven solutions that benefit both industry and the underwater ecosystem.

With the growing demand for new marine infrastructure, developing a technological solution to limit underwater noise pollution during construction while remaining cost competitive is crucial. BOSS Piles use a double-wall design and proprietary shoe to encapsulate noise along the full length of the pile, blocking noise propagation via the water and seabed. Only a small amount of noise escapes from the pile bottom, resulting in significantly improved noise attenuation.

The BOSS Pile consists of an outer pile, into which a fixed or reusable inner pipe is inserted for driving purposes. A consistent air gap is maintained between the piles by spacers along the length of the pile and by the shoe at the base. As the driving hammer strikes the inner pipe, the pressure wave (noise) dissipates as it travels down the inner pile and into the air gap between the two piles, limiting the spread of noise along the entire length of the pile. The shoe provides additional attenuation by limiting sound propagation into the seabed.

The BOSS Pile Technology is incredibly versatile. There are two versions of the pile: the mandrel and the double-walled designs. Both versions can be installed using standard marine construction equipment (impact or vibratory hammers). After installation, if the mandrel double pile is used, the inner pipe can be removed and reused to drive multiple piles. If the permanently affixed double pile is used, because two pipes are deployed, both wall thicknesses can be reduced, resulting in near-equivalent material usage when compared to a





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conventional pile. The interstitial space can also be filled with concrete after installation to further strengthen the pile. With either design, the shoe remains in place. This technological design reduces sound energy during pile driving by 90 percent.

The regulation of noise for sensitive species is generally implemented by establishing noise-impact thresholds for species and/or hearing-frequency groups. BOSS Piles can help pile-driving projects to stay below these biological thresholds by reducing noise during pile driving and reducing ensonified or impacted areas by up to 88 percent.

The BOSS Pile also greatly reduces project time and cost for marine construction projects because it is a self-attenuating, or self-quieting, system and does not require deployment of additional noise-reduction technologies during pile driving.

Looking to the Future

Oceans and bodies of water represent 95 percent of the world's biosphere and are among the richest sources of biodiversity on Earth. However, human activities such as the construction of marine infrastructure pose a threat to the quality of our marine ecosystems.

The BOSS Pile Technology contributes to a more sustainable future by proactively addressing both the economic costs and environmental impacts associated with the anticipated expansion of marine infrastructure. BOSS represents the new age of marine construction: a simpler, smarter and safer way to build. **ST**

Review&Forecast

NOAA Working to Advance Our Nation's Blue Economy

*By Dr. Neil Jacobs
Assistant Secretary for
Environmental Observation and Prediction
Acting Undersecretary of Commerce for
Oceans and Atmosphere*

As NOAA celebrates its 50th anniversary this year, our mission to advance the blue economy in the United States follows a long tradition of using the best science to serve our nation. NOAA's support for the American blue economy involves science-based management and sustainable use of ocean resources in support of national economic and environmental security, jobs and economic growth, and healthy ocean and coastal ecosystems.



Underpinning a strong blue economy are advancements in global weather and climate prediction, which save lives, protect property and strengthen the national economy. NOAA made significant strides in 2019 to improve weather prediction, putting into operation the first major upgrade in 40 years to our flagship weather-forecast model, the Global Forecast System. Powered by a software engine developed by NOAA scientists, the model provides more timely and accurate forecasts of severe weather, storms and hurricanes.

This past year was also the first time NOAA's next-generation satellites, GOES-16, GOES-17 and NOAA 20, were fully operational during a hurricane season, providing better, faster and higher resolution imagery for forecasts.

We also launched our major effort to unleash the power of community weather modeling to help our nation regain international leadership in numerical weather prediction. The newly created Earth Prediction Innovation Center will open up weather modeling code to innovators in academia and industry. Our goal is to accelerate research advancements by crowdsourcing model development.

As part of the Department of Commerce, NOAA focuses on strengthening the blue economy in five key areas: seafood production; marine transportation; ocean exploration; science and emerging technologies; and coastal resilience.

Increasing Seafood Production, Strengthening Domestic Fisheries

NOAA takes a comprehensive approach to expanding the nation's domestic seafood industry through regulatory efficiencies, curbing illegal, unreported and unregulated (IUU) fishing and expanding aquaculture. NOAA has completed 38 deregulatory actions since 2017 with a cost savings of \$715 million. IUU fishing harms America's fishermen, who adhere to international standards, yet must compete in the global marketplace with foreign fishermen who often run afoul of international law. NOAA recently issued a biennial report to put certain nations on notice to curb IUU fishing, singling out China for problems with its distant water fleet.

The U.S. has the second largest Exclusive Economic Zone (EEZ) in the world, but ranks 17th in the world in aquaculture. Considering that half of the seafood consumed in this country is imported aquaculture product, there is significant potential to expand our domestic industry. NOAA is advancing the science and technology to improve siting of aquaculture facilities and accelerate permitting through improved coordination with other federal agencies.

Supporting Maritime Transportation

Another crucial part of our nation's blue economy involves maritime transportation and commerce. More than 95 percent of U.S. foreign trade moves through our ocean and Great Lakes ports. With billions of tons of product valued at trillions of dollars, even small improvements in our ports' efficiencies have tremendous

economic impact. NOAA provides nautical charts, tides and current predictions, ocean and coastal mapping, marine weather forecasts, real-time oceanographic data, and other foundational information necessary for safe and efficient navigation.

Those essential 21st century navigation decision-support products and services include our Physical Oceanographic Real Time System (PORTS), which incorporates NOAA electronic navigational charts, high-resolution hydrographic survey data, and expertise in geodetic and tidal control.

In 2019, NOAA continued to advance its information products to better serve mariners. Examples include an extensive survey of currents in the vicinity of the Port of New York/New Jersey to improve tide and current predictions and new oceanographic forecast models for Lake Michigan, Lake Huron and Alaska's Cook Inlet. Working with local partners, NOAA also installed new technologies on the Delaware Memorial Bridge to help large ships navigate safely underneath.

Ocean Exploration, Mapping and Characterization

To sustainably use the ocean and effectively conserve and benefit from its valuable natural resources, we need to map and characterize the ocean. This work benefits shipping, marine transportation, critical minerals and pharmaceuticals, fishing, energy development, tourism, and national security.

Last year's missions with NOAA Ship *Okeanos Explorer* and partners made important discoveries, including a 19th century shipwreck in the Gulf of Mexico, and furthered the mapping and characterization of what is the largest deep-sea coral reef documented in U.S. waters off the southeast coast.

In 2020, we will commemorate the 75th anniversary of the end of World War II by looking back on recent NOAA and partner discoveries of shipwrecks and aircraft wrecks from that era.

Science and Emerging Technologies

NOAA is also investing in its airborne and at-sea science programs. We recently awarded a contract to purchase a new Gulfstream G550 aircraft, which will supplement the capabilities of our existing Hurricane Hunter high-altitude jet, known for flying above and around hurricanes to support accurate track and intensity forecasts. We are also working with the U.S. Navy to acquire two new oceangoing research vessels. Construction of the first vessel is slated to begin in 2021.

NOAA is rapidly expanding the application of new technologies, including: unmanned systems, scalable satellite architectures and new commercial data sources. These data, combined with artificial intelligence, machine learning and bioinformatics, will accelerate improvements in the quality of NOAA science, products and services.

Toward a Resilient and Prosperous Future

Our science and services support sustainable ocean and coastal tourism and recreation, including national

marine sanctuaries, marine recreational fishing, and the restoration of coasts, estuaries, reefs and sea life. This past year, NOAA established the first new National Marine Sanctuary created in nearly 20 years at Mallows Bay on the Potomac River in Maryland. With strong bipartisan support from the administration and Congress, as well as expanding partnerships with academia and the private sector, NOAA will continue to advance our nation's security, prosperity and leadership today and throughout the 21st century. **ST**

Review&Forecast

Collaboration, Partnerships Amplify Ocean Science Investments

*By Molly Grear
Marine Policy Fellow
U.S. National Science Foundation*

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

The National Science Foundation (NSF) Division of Ocean Sciences supports basic research that advances the frontiers of knowledge and drives technological innovation while improving our understanding of the many processes that affect the ocean environment. With a 2019 annual budget of approximately \$350 million, it supports basic research and education to further understanding of all aspects of



the global oceans and their interactions with the earth and the atmosphere. NSF teams up with academia, nonprofits, industry, other federal agencies and international partners to provide critical knowledge to address challenges in the ocean environment.

For long-term investments in infrastructure and technology, the Division of Ocean Sciences supports the operation, acquisition, construction and conversion of major shared-use oceanographic facilities needed to carry out oceanographic-related research programs. Additionally, the division invests in next-generation ocean technology to support a broad range of research and technology development activities.

Coastlines and People

NSF recently launched a new program soliciting interdisciplinary research on Coastlines and People (CoPe). Through CoPe, NSF is interested in supporting projects to build capacity and explore research focused on understanding the impacts of coastal environmental variability and natural hazards on populated coastal regions. CoPe projects will explore the complex interface between coastal natural processes, geohazards, people and their natural and built environments. CoPe will include coastal variability and hazards on a range of spatial and temporal scales, from local to global and seconds to millennia, to put current changes in the context of pre-anthropogenic changes.

The landscape of individuals interested in coastal research is diverse, including but not limited to researchers, decision makers, practitioners (individuals dealing with the day-to-day operations in coastal areas), and stakeholders (communities impacted by coastal change). Multiple workshops were recently held to listen to the needs and interests of a broad diversity of people and entities.

The next step is expected to be the release of a solicitation for research activities that link interests from scientists to stakeholders, develop partnerships and build the networks needed to delve more deeply into these ideas, while complementing work already underway across the Bureau of Ocean Energy Management, U.S. Geological Survey, NOAA and others in the coastal environment.

Ocean Observatories Initiative

The Ocean Observatories Initiative (OOI) completed its first year of operations under the management of the Woods Hole Oceanographic Institution (WHOI). The current OOI network includes approximately 800 individual sensors across two global arrays, two coastal arrays and a cabled array (oceanobservatories.org).

In addition to overall management, WHOI supports the global array and one of the coastal arrays; Oregon State supports the West Coast coastal array; the University of Washington supports the cabled array; and Rutgers supports the hardware components of the OOI cyberinfrastructure.

There were many successes with the infrastructure in 2019, including a full year of operations in the Irminger Sea off the coast of Greenland. Known publications that use the freely available OOI data can be found at <https://oceanobservatories.org/publications/journal-articles-and-books>.

Long-Term Ecological Research

The Long-Term Ecological Research (LTER) Network is looking ahead to its 40th anniversary in 2020. A self-study document was recently released as a kickoff to the fourth decadal review of the program (<https://lternet.edu/documents/2019-lter-network-self-study>).

The NSF Biology Directorate initiated the LTER Network, with the Office of Polar Programs joining shortly after the first call for LTER sites. The Division of Ocean Sciences has supported the LTER program since 1998 with the Plum Island Ecosystem site and now supports

eight unique sites. All LTER sites promote understanding of long-term and large-scale phenomenon through sustained funding.

Recent work out of the Moorea Coral Reef LTER site in French Polynesia has shown that coral reefs are changing in response to pressure from human activities. LTER scientists are evaluating the ecosystem-wide impacts of this change and working with the local fishing community to understand the impacts of changing fish-species richness and abundance on food security in the region.

International Ocean Discovery Program

The International Ocean Discovery Program (IODP) is currently in its 16th year of systematically exploring the seafloor, discovering insights into the workings of our planet. The NSF contribution to the IODP is the drillship *JOIDES Resolution (JR)*, with five additional years of its operation recently authorized by the National Science Board. The international ocean-drilling scientific community is in the process of developing a framework for operations involving a *JR* replacement beyond 2024.

Since its inception, the IODP has broadened the base of international participation and collaboration to more than 20 countries (www.iodp.org). The *JR*'s recent expedition to the Southern Ocean explored the Antarctic Circumpolar Current by drilling into the seabed to understand ancient water temperatures, nutrient concentrations and other indicators about the past behavior of the current. The *JR* is planned to head to the South Atlantic in

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2020 and 2021, after spending recent years operating in the Indian and Pacific Ocean basins.

Academic Research Fleet

The U.S. Academic Research Fleet comprises 18 vessels and one deep-ocean research submersible (Alvin). These vessels are managed and scheduled through the University-National Oceanographic Laboratory System (UNOLS), collaborating and partnering across U.S. funding agencies to conduct ocean science and technology research with a diverse fleet capable of operating in coastal, open-ocean and Great Lakes waters.

In 2019, NSF received full funding for three regional-class research vessels (RCRVs). Oregon State University will operate the first RCRV, the RV *Taani*, which is expected to be delivered in early 2021. The East Coast Oceanographic Consortium, led by the University of Rhode Island, will operate the second RCRV, RV *Resolution*, which is expected to be delivered in late 2022. The third operator selection was completed in 2019, going to the University of Southern Mississippi (lead) and Louisiana Universities Marine Consortium (LUMCON), under the Gulf – Caribbean Oceanographic Consortium. Expected delivery is slated for 2023, after a year of rigorous sea trials.

Conclusion

NSF Division of Ocean Sciences will continue to support transformational science in the ocean environment. Through partnerships and collaboration, this knowledge can be used to predict natural hazards, develop management techniques, inform policy decisions and develop future ocean technology. **ST**

Review&Forecast

Energy Department Prizes Powered by the Ocean

By Alejandro Moreno
Director
Water Power Technologies Office
U.S. Department of Energy

In 2019, the Water Power Technologies Office (WPTO) at the U.S. Department of Energy (DOE) announced two new prizes to inspire the next generation of scientists, engineers and entrepreneurs to expand the state-of-the-art for the marine energy industry. The Powering the Blue Economy Ocean Observing Prize is a joint DOE-NOAA prize that challenges innovators to pair marine renewable en-



ergy technologies with ocean-observing platforms, and the Waves to Water Prize challenges innovators to desalinate water using the power of ocean waves. Both prizes stem from WPTO's Powering the Blue Economy, a trademarked initiative that seeks to understand the power requirements of harnessing the emerging coastal and maritime markets and to advance technologies that could integrate this marine renewable energy to relieve power constraints and promote greater economic growth.

In November 2019, DOE participated in a White House Summit on Ocean Science and Technology focused on opportunities to utilize partnerships to accelerate understanding and research in the ocean. As part of the roundtable, DOE announced exciting developments in its two marine renewable energy prizes (www.energy.gov/articles/departments-energy-challenges-innovators-harness-power-oceans).

Powering the Blue Economy: Ocean Observing Prize

DOE's newest prize, the Ocean Observing Prize, officially opened at the summit, will contribute to revolutionizing our ability to collect data needed to understand and map the oceans. The prize includes a series of competitions over several years to encourage rapid innovation in the fields of marine renewable energy and ocean observations to develop solutions that meet the needs of ocean researchers, government agencies, explorers and other end-users.

Ocean observations underpin our ability to understand the ocean, predict and track potentially destructive tropical storms, monitor fish stocks that communities depend on for sustenance, alert coastal areas to deadly tsunamis, and even monitor subsea activities for national security purposes. Because many marine-based applications and markets are located far from shore—sometimes in deepwater—delivering power to these systems can be expensive and difficult. Powering systems that use energy derived from the ocean itself offers a potentially cost-effective alternative.

Ocean-observing platforms encompass a wide range of stationary and mobile technologies, including AUVs, buoyancy gliders, profiling floats, weather and drifter buoys, and electronic tags for marine animals. Marine renewable energy could provide the electrons needed to recharge ocean-observing equipment, drastically reducing the need and expense of a support vessel. It also offers a promising opportunity to help alleviate the power constraints that limit all ocean-observing missions, with implications for deployment duration, increased sampling rates, and the numbers and types of sensors and platforms deployed.

Removing power constraints could enable new technologies and accelerate growth across the blue economy, creating new markets for sustained economic development. Marine energy resources could be particularly well poised to address these power constraints because they are abundant, geographically diverse, energy dense, predictable and complementary to other energy sources. DOE is seeking prize entries in five thematic areas: charging unmanned systems; ocean communications

and underwater navigation; extreme environments; buoys, floats and tags; and “Blue-sea” ideas (other).

Waves to Water Prize

Building off the success of the office’s first-ever prize in 2016—the Wave Energy Prize (www.energy.gov/eere/water/wave-energy-prize-home)—WPTO launched its \$2.5 million Waves to Water Prize in June 2019 to spur innovation in wave-energy-powered desalination systems. It was the first prize under the U.S. Water Security Grand Challenge (www.energy.gov/eere/water-security-grand-challenge), a White House-initiated, DOE-led framework to advance transformational technology and innovation to meet the global need for safe, secure and affordable water. The prize takes a unique approach to accelerate technology development through a series of contests to demonstrate small, modular, cost-competitive desalination systems.

Announced at the summit, the Waves to Water Prize Stage 1 - CONCEPT winners were awarded a combined \$200,000 in prize money. The winning submissions came from industry, academia and new innovators, and provided compelling ideas for systems that could harness the power of waves to desalinate water. The announcement also marked the opening of the Stage 2 - DESIGN competition, which challenges competitors to provide modeling documentation and a plan to advance their concept through the remaining stages of the prize. Stage 2 is open for 120 days and offers up to \$800,000 in prizes.

The prize will culminate in the Stage 4 - DRINK competition, requiring competitors to demonstrate their full-scale system at an open-water test site. A grand prize of \$500,000 will be awarded to the competitor with the highest overall score during open-water testing. Several prizes will be distributed from an additional prize pool of \$500,000 based on specific technical metrics.

Both prizes are administered by the National Renewable Energy Laboratory and are hosted on the American Made Challenges platform. This platform brings together America’s world-class research base with its unparalleled entrepreneurial support system—including pioneering university teams, dozens of energy incubators and 16 National Laboratories—to create a sweeping portfolio of innovations primed for private investment and commercial scale-up.

WPTO’s Work in Prizes

U.S. government agencies constantly work to address issues that affect people, communities and industries throughout the country and the world. Through challenge.gov, WPTO is taking an active role in collaborating with other federal agencies in the design and implementation of prizes to bring people together from the private sector to leverage government resources. The website serves as the official hub for prize competitions and challenges across all federal agencies.

Additionally, WPTO is co-funding a National Academies of Sciences, Engineering and Medicine study on the “Role of Inducement Prizes,” which will analyze the role of prizes in the American innovation process (www8.na

tionalacademies.org/pa/projectview.aspx?key=51203). The National Academies are private, nonprofit institutions that provide expert advice on some of the most pressing challenges facing the nation.

Prizes like Waves to Water and the Ocean Observing Prize are well suited to achieve technology innovation and development goals and complement other traditional forms of government-supported R&D because they can attract nontraditional stakeholders, incentivize collaborations, strengthen partnerships, accelerate innovation and stimulate new market development. These prize models also support the administration’s work to spur manufacturing, develop innovative solutions and products, and create new domestic jobs and opportunities through public-private partnerships. **ST**

Review&Forecast

The Coast Guard’s Technology Revolution

*By Admiral Karl L. Schultz
Commandant
U.S. Coast Guard*

Three months after assuming command of the U.S. Coast Guard, our nation’s only Armed Service outside of the Department of Defense, I closely monitored the first major storm of the 2018 Atlantic hurricane season. Hurricane Florence threatened millions of people in the southeastern United States



and caused catastrophic flooding in the Carolinas. As the storm made landfall, my faith in the Coast Guard’s men and women was affirmed as they conducted thousands of response sorties to save lives, protect the environment and restore the economic engines of our coastal ports.

At the same time, my confidence in the Coast Guard’s technologic foundation was shaken when our antiquated email servers failed in the middle of this massive response operation. Thousands of responders and senior operational commanders, including me, lost the ability to send or receive a simple email for an entire weekend.

Over the year since then, I have come to find that this is far from an isolated incident. Just this spring, another critical equipment failure took 95 vital systems offline for several days, impacting our ability to conduct search-and-rescue cases, execute law-enforcement operations and, yes, even access email. It has become routine for Coast Guard members to report to work and realize they can’t even log in to their computer.

Our fine men and women will never fail their country, but our technology is failing them. This can no longer be

considered business as usual for the world's best Coast Guard.

We need a Tech Revolution; a whole-of-service effort to ensure our dedicated people are supported by an information system that is reliable, mobile and integrated. The solution is not simple or cheap, but vitally necessary to restore the Coast Guard's readiness and position the Service to remain a world leader in the maritime domain.

Over the years, we have made difficult trade-offs to recapitalize our front-line air and surface assets to ensure we can meet America's needs for decades to come. Now, we are fielding the most advanced fleet the Coast Guard has ever seen, but are often forced to sustain it with pencil and paper. Lacking ready access to accurate, integrated internal databases, today's Coast Guard members rely on Google to locate and research Coast Guard manuals. Without a modern technological infrastructure we will not be able to unlock the full potential of our people or our assets.

To remain relevant in a world of rapidly innovating industry and technologically sophisticated adversaries will require considerable advances in our 1990s-era hardware, software and data analytics. Any one of these three pillars would vastly improve our readiness, yet through years of underinvestment and cumbersome acquisition cycles we have brought all of them to the precipice of catastrophic failure. The sustainable solution to this systematic shortfall can only be rectified through regular and recurring funding.

In the meantime, I have challenged the Service to make gains where we can. In December, the Coast Guard began to transfer our email services to a more resilient cloud architecture. We have also issued more than 1,000 tablets to Coast Guard marine inspectors in the field, soon to be equipped with mobile apps that will streamline service at the 361 ports across our country. Additionally, in the spring, we will conduct a pilot program to issue new mobile devices that can access Coast Guard networks on the go. Similarly, we have begun to lay the foundation for online distributed learning to empower our workforce with the training and resources they need to carry out their duties. Other simple improvements, such as one-click ordering for parts replacement and a transition to electronic maintenance-procedure cards, are incremental progress toward our goal to give Coast Guard members the tools they need to be ready, relevant and responsive into the future.

While these are vital steps forward for our organization, it is not enough. These initiatives are a house of cards if we do not ensure a reliable, agile and secure network architecture to support our operations. Furthermore, our young workforce expects to be empowered in their jobs by the same level of capability they carry in their pockets every day. Tech has become an issue of long-term retention as we strive to be an employer of choice in an increasingly diverse and competitive labor market. This is the only way the Service can compete in a world where our youngest members grew up knowing that any question can be answered at the touch of a button.

It is also not lost on me that antiquated manual processes at our documentation centers significantly lag the tech-enabled efficiencies of the United States' Marine Transportation System (MTS). Just two of our centers are responsible for issuing over 60,000 merchant mariner credentials and over 200,000 Certificates of Documentation for commercial and recreational vessels each year. However, this past summer, critical IT failures resulted in limited access to vital systems and a growing backlog of work. Going forward, we must look to recapitalize these aging systems in order to ensure a safe, secure, economically viable and environmentally sound MTS manned by fully qualified U.S. mariners.

Lastly, the Coast Guard must revolutionize how we use information. While the Service collects large amounts of data, many of our systems are disconnected from each other, creating information silos that are difficult to access and do not support comprehensive analytics. Data is the linchpin of modern organizations, and all processes and systems are reliant on the best use of the right data. We owe it to our personnel, and the American public we serve, to better integrate and use information to conduct our missions and increase the Service's effectiveness.

The Coast Guard is thinking differently than we have in the past about how we develop, deploy and integrate new technologies into our organization. We have taken the first steps in the Coast Guard's Technology Revolution, but they can't be our last. No matter the difficulties, we must act now to secure the Service's future readiness and provide the American people with the Coast Guard they deserve. **ST**

Review&Forecast

We Need Science-Based Ocean Policies

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

Our oceans are one of the globe's most precious resources. Covering over 71 percent of our planet, oceans help regulate the climate system, produce half the oxygen we breathe, and supply protein for billions of people and habitat for countless species. They are also culturally important and provide other essential benefits, but, unfortunately, they have been severely impacted by climate change. The oceans have been absorbing significant amounts of excess heat and carbon dioxide from the atmosphere for



decades, creating major changes in seawater. This past September, the United Nations' Intergovernmental Panel on Climate Change (IPCC) released its first-ever "Special Report on the Ocean and Cryosphere in a Changing Climate." This landmark report made clear that the impacts of climate change on the oceans are accumulating. It also made projections for future changes in the oceans and cryosphere that were more severe than those in their previous reports due to improvements in observations and modeling.

The science is clear, and the findings are bleak. Sea level rise is accelerating, and we can expect an additional 4 to 8 in. by the end of the century, even under a low-emissions scenario, due to glacier melt. Sea ice and ice sheets in the Arctic are melting at unprecedented rates. Marine heat waves have doubled in frequency since the 1980s. The possible collapse of marine ecosystems, such as warm-water coral reefs, continues to loom.

Adaptation efforts may help "buy time" for some communities. Protecting mangroves and tidal marshes to preserve their ability to mitigate the impacts of natural storm surge and flooding is one such strategy. Investments in early-warning systems to help coastal communities prepare for extreme events is another necessary measure to save lives. However, adaptation strategies alone will not be enough. We need to simultaneously pursue mitigation options to reduce our emissions and potentially remove excess carbon dioxide from the atmosphere.

While the Special Report paints a dire picture of projected ocean change, another major report from 2019 stresses that with policy solutions, there is still hope. That report (tinyurl.com/y6zorajt), written by a group of world leaders on the High Level Panel for a Sustainable Ocean Economy, found that ocean-based solutions to climate change could play a big role in reducing global temperature rise to 1.5° C by 2050. Solutions include offshore energy sources like wind and wave power, decarbonizing the marine transportation system, and restoring "blue carbon" ecosystems like salt marshes and seagrasses. These actions will lessen impacts to the oceans from warming, acidification and deoxygenation, as well as promote job creation, more abundant fisheries, improved ocean and human health, and increased coastal resilience. This report makes clear that with science-backed policies and sustained investments in innovative technologies, the oceans can be part of the climate solution.

Moreover, the U.S. must chart a strong and steady course both in conducting research to better understand our oceans and in developing innovative technologies to ensure that we can maintain competitive globally. As a coastal nation, the prosperity of the United States is dependent on our oceans. The U.S. has the largest ocean economic zone in the world, with over 13,000 mi. of coastline and containing more area than the 50 states combined (www.gc.noaa.gov/documents/2011/012711_gcil_maritime_eez_map.pdf). The oceans and coastlines play a major role in our economy and national security (oceanservice.noaa.gov/facts/oceanconomy.html). Despite the importance of oceans and coasts, less than 15 percent of our nation's seafloor has been explored, and

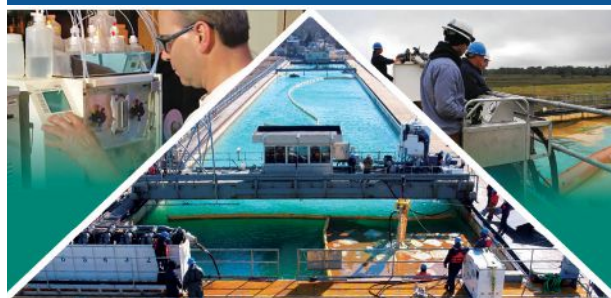
we dedicate relatively little federal funding to researching and protecting our oceans compared to their value.

As the chairwoman of the Science, Space and Technology Committee, I have made it a priority to elevate the conversation surrounding our oceans this Congress. Over the past year, the committee held several hearings related to climate change, including hearings that specifically discuss the impacts of climate change on the oceans and coasts and on glacial and ice-sheet melt. We have heard from experts on the state of our knowledge of current rates and future projections of ocean acidification, warming and deoxygenation, as well as the need for improved understanding of resulting impacts to marine ecosystems and the importance of exploring the remaining 85 percent of the seafloor in the U.S. Exclusive Economic Zone.

We have also examined ocean exploration opportunities. This past June, in celebration of World Ocean Month, the committee held its first-ever Ocean Exploration Expo. This expo brought together over 17 different federal agencies, private companies, academic labs and philanthropic organizations who all highlighted the important role of technology in studying and exploring the oceans.

Ocean issues have received more bipartisan support in the House this Congress than I have seen in recent years. So far, five bipartisan bills that support research and community adaptation to ocean acidification, as well as address harmful algal blooms and hypoxia, passed through my committee and later passed the House floor. I remain

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hopeful that these important bills will pass the Senate this year and be signed into law.

While there has been progress in advancing science-based policies, there is so much more that we need to do. It is time for the role played by the oceans to become more of a focus in the discussions of mitigating climate change. I am committed to continuing to write and support bipartisan legislation that advances ocean exploration, fills gaps in ocean research, and seeks ocean-based solutions to climate change. **ST**

Review&Forecast

Act Now to Save the Oceans

*By Rep. Salud Carbajal (D-Calif.)
U.S. House of Representatives*

Growing up in Oxnard, California, I spent some of my free time at the beach taking in the beauty of our ocean. In the Central Coast communities that I now represent in Congress, we recreate on our coasts and beaches, and our economies thrive from fisheries and ecotourism. This is not uncommon throughout the U.S.—almost half of this nation's population lives along the coast. Protecting our oceans is vital to our public safety, environment and economy.

The tides of our world have rapidly changed and our oceans have suffered the consequences. The industrial revolution shaped the modern world we know today, but it left a detrimental mark on our environment. Since the late 1700s, our population has grown from 700 million to nearly 8 billion. The rapid change in population, as well as oil drilling, increased carbon dioxide emissions and plastic pollution, has quickly depleted our oceans.

Oceans absorb carbon dioxide that is emitted into the atmosphere, shifting the water's acidity. Over the past three centuries, ocean acidity has increased by 30 percent. This increase is 100 times faster than any change in ocean acidity over the past 20 million years. Ocean acidification threatens the survival of plankton, the base of the marine food chain that are key to the survival of larger species. Highly acidic oceans harm coral reefs, impairing coastal tourism and biodiversity.

In addition to increased acidity, our oceans have endured devastating oil spills. In Santa Barbara, part of the district I represent, we've experienced the impact of oil spills time and time again. First, in 1969, when 3 million gallons of oil gushed into the ocean, making the spill the largest in our nation's history at the time and sparking broad environmental action and the creation of



Earth Day. Again, in 2015, the Plains All American oil spill deposited nearly 143,000 gallons of crude oil along the coast. Wildlife workers collected 202 dead birds and 99 dead mammals, including 15 dolphins, after the spill. The California Economic Forecast Director calculated that the spill cost Santa Barbara approximately \$74 million, including around \$37 million in lost property taxes, \$32 million in lessened worker income and \$5 million in reduced federal royalties.

On top of this, plastic buildup persists. At any given moment, over 5.25 trillion pieces of plastic are floating in the ocean, weighing over 250,000 tons. According to the Natural Resource Defense Council, California alone spends an average of \$428 million annually to clean up plastic debris and waste from waterways.

Protecting our oceans goes beyond being stewards for the natural world; it directly impacts our economy. Between six major industries—including tourism, marine transportation and fisheries—the ocean provides 2.3 million jobs and generates more than \$200 billion annually. The ocean is an economic powerhouse. We must safeguard it because we can't afford not to.

Fortunately, people are taking action at every level to reverse the marks we have left. The Central Coast of California understands the grave impacts of an unhealthy ocean on our communities—that's why we come together for regular beach cleanups, why we fight against offshore oil drilling and why our citizens are vocal advocates for climate action. I feel lucky to meet with advocates, host cleanups and build action around my community's concerns in Congress.

But here's the truth: The responsibility to care for our oceans cannot lie solely with engaged community members. We must all do our part, but it should never be on individual people to clean up the messes of powerful polluters, under-regulated corporations and big oil.

We need change at a macro level, including federal laws that prioritize our environment and public health.

This year, Congress has championed bills to protect our environment and our oceans. Most recently, the House passed the Coastal and Marine Economies Protection Act (H.R. 1941), which included my bill, the California Clean Coast Act, within it. This landmark legislation will ban all future offshore oil and gas leasing off our coasts. It is a bold step to reject big oil and preserve our oceans, and it was bipartisan, too.

As we stop pollution from harming our oceans, we must work to reverse the damage that is already done. That's why I introduced the Ocean Acidification Research Partnership Act with Republican Congressman Don Young of Alaska. This bill would authorize NOAA to fund \$5 million in annual research grants to research and raise awareness for acidification. In the Senate, there is a partner bill that does the same. We must know more about why our oceans are acidifying so we can change course to save them. In red and blue districts alike, legislators have to step up and act now.

Climate change is real, and it is impacting our daily lives. We must look forward with a realistic lens and do what we can to mitigate this change, while prepar-

ing for its effects. We have seen fires, floods, mudslides and hurricanes pop up across the nation with increasing rapidity—we must be prepared. I introduced the bipartisan Coastal State Climate Preparedness Act (H.R. 3451) to ensure coastal regions are resilient and ready in the face of climate disasters. This crucial bill would promote planning and strategic investments to address the natural disasters that wreak havoc on our communities and coastal ecosystems.

Our wellbeing is directly linked to the wellbeing of our oceans. We must protect and restore what we have damaged—from re-evaluating our own wasteful habits to passing laws banning offshore oil drilling and joining global climate agreements. Now is the time to be bold. If we are not, our economy will falter; our coastal communities will wither; and future generations will not be able to enjoy the ocean in the way so many of us do. Moments with my children and grandchildren at the same beaches I enjoyed with my parents and siblings are invaluable. It is on us, here and now, to protect the oceans so all children can experience these same cherished memories for generations to come. **ST**

Review&Forecast

On Thin Ice in the Arctic

By Sandro Carniel
Head, Research Division
NATO Science & Technology Organization
Centre for Maritime Research and Experimentation, Italy

Eric Pouliquen
Head, Innovation Branch
NATO Allied Command Transformation, U.S.

In September 2019, the Intergovernmental Panel on Climate Change (IPCC) released “The Ocean and Cryosphere in a Changing Climate,” a special report that devoted considerable attention to the vast area of the Arctic. Covering nearly 5 percent of the Earth’s surface and dominated by the Arctic Ocean, the region is one of the most heavily affected by the devastating consequences of global warming.

The marine environment of the Arctic Ocean is rapidly changing due to climate change. The volume and thickness of the sea ice is decreasing by 4 percent per decade, a rate of loss that has jumped to 280 gigatons per year, which is more than 3,000 times the weight of the Roman Colosseum per day. The massive loss of ice is making way for new shipping routes that are changing the economic and geopolitical context of the entire region. Addition-



ally, significant amounts of deep-sea resources are becoming available, which is enticing huge appetites for research and exploration, even before having complete scientific evidence on how much has changed.

Arctic economic and environmental interests have intensified, requiring efforts that are escalating beyond

the capabilities of the eight members of the Arctic Council (Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden and the United States) and even perhaps beyond the 13 observing nations, among which are China, India, Italy and Japan.

In the wake of the peace dividend following the end of the Cold War, the decrease in defense spending has left the maritime strategic value of the region a low priority for many nations. However, through the engagement of icebreakers from Russia (40), Canada (seven), China (three) and the United States (two), the freedom of navigation and trade in the Arctic is becoming increasingly available to the international stage.

Historically, NATO has refrained from engaging in multilateral discussions on the rapidly evolving Arctic, leaving a subgroup of allies in the role of “NATO in the North.” Although there is no formal engagement in the region, times are ripe for an enhanced scientific interest by NATO.

The severe lack of scientific knowledge in areas such as ice rheology and dynamics greatly limits analysis and accurate forecasting in the new era of submarine cat-and-mouse games. Issues that demand further research include: how much the overturning circulation of dense water masses (related to the “conveyor belt”) is slowing down in response to the astounding freshwater input from melting ice; how sound speed in water has changed in relation to the new hydrographic properties; and, further, what is the role of ambient noise generated by melting-ice processes. The amount of data available in the region is inadequate to define the new climatology and is at the root of a lack of understanding of the climate stability of the region as a whole.

In order to fully understand the impact of climate change on Arctic oceanography, scientists need to gather a vast amount of data, also from under Arctic ice. The large temporal and spatial sampling required can only be achieved by unmanned maritime underwater systems which exploit “new technologies” and concepts in collaborative autonomy.

Many challenges remain to be tackled. These include dealing with harsh environmental conditions, limited platform endurance, under-ice navigation, limited speed and bandwidth of underwater acoustic communications, onboard computation capacity, and poor coverage from marginally present geostationary satellites.

While investing to solve these problems and working on advanced sensing and processing technologies (e.g.,

those related to quantum sensing), it appears clear that higher volumes of more “classical” oceanographic data would provide an immediate knowledge advantage, allowing the use of consolidated approaches (e.g., big-data analytics) at the same time.

The rapidly changing climate is also driving the evolving geopolitical situation in the Arctic, and the lack of a strategy to understand and anticipate environmental changes increases the risk of political and military conflict. The new reality brought on by climate change has to be faced scientifically, militarily and politically by the institutions and nations dealing with the Arctic. These entities must develop a mid- to long-term strategic vision that adopts multidisciplinary and interdisciplinary approaches while anticipating the role of new technologies that can support the science and apprehending security and environmental considerations together in their agenda.

A multilateral organization such as NATO is naturally suited to address these critical security issues, and, indeed, a shift in the perspective on the Arctic is already happening within the organization.

In response to the above-mentioned concerns, NATO is strengthening its presence in the Arctic by leveraging and coordinating efforts already underway. For example, the NATO Research Vessel (NRV) *Alliance* has conducted research in the High-North region for the past few years in collaboration with many NATO nations that are on the Arctic Council or are observer states.

This is creating a broad interest and request for a

better understanding of scientific drivers in the region. Several options are being considered to more formally discuss this matter within NATO. In the interim, the Science and Technology Organization Centre for Maritime Research and Exploration and the Allied Command of Transformation are taking the initiative to provide a forum for discussion about the scientific and geopolitical climate in the Arctic.

Dealing with the complex Arctic problem is both simple and visionary. NATO recognizes and understands the changes that are rapidly approaching by relying on increased scientific understanding. Furthermore, NATO and its member nations are increasingly working collaboratively among different disciplines, leveraging existing assets and resources within the organization. This approach will mitigate the funding challenge and address what is over and above what individual NATO nations can do on their own.

A proactive stance is the best way to engage with the immense challenges of the Arctic. **ST**

Review&Forecast

2020: A Fresh Start For the Offshore Industry

By Erik Milito
President

National Ocean Industries Association (NOIA)

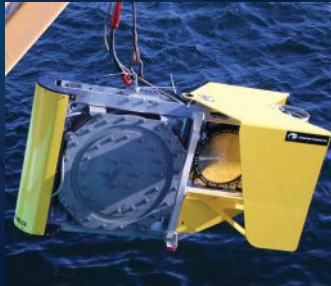
After years of downturn, the energy industry is in the midst of an offshore revival. For the first time in five years, offshore spending increased in 2019 and should continue to grow in 2020 and beyond. The past year is also likely to be the first time in years that offshore spending has outpaced spending on on-shore shale activity. Adding to the offshore momentum, construction has begun on the first wind farm in U.S. federal waters, which is expected to power 3,000 homes by the end of 2020.



In many ways, offshore oil and natural gas is bouncing back because it has to. The global economy relies upon oil and gas to ensure a high quality of life and will continue to do so for years to come. Rapidly growing populations are going to need more and more energy. Between 2016 and 2040, the global population will increase by 1.8 billion people—the equivalent of adding an additional China and India to the world. The growing world—and the accompanying global middle class—will demand more cars, air conditioning, household appliances, cell phones and the other staples that make

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“Not only is the U.S. the leader in oil and natural gas production, the U.S. is a world leader in the reduction of greenhouse gas emissions.”

modernity. Oil and natural gas will continue to meet the bulk of growing energy demand for the foreseeable future.

To meet rising oil and natural gas demand, offshore platforms will need to become stable anchors of energy production. These technological marvels account for massive production, with some platforms producing upwards of 100,000 barrels of oil per day for decades. Globally, the offshore region accounts for nearly 30 percent of total oil production.

More than 100 offshore projects were expected to come online in 2019—more than double the number of projects from 2016. This past year also had the potential of an additional \$127 billion in new offshore projects globally that could have been sanctioned. Along with meeting global demand, new production will drive economic growth and energy security.

While new projects offshore Brazil and Guyana are winning the headlines, the U.S. Gulf of Mexico is no less important. The U.S. Gulf of Mexico is expected to continue its record-setting oil and natural gas production numbers of 2018 and 2019 into 2020. Thanks to new technologies and systems, offshore oil and natural gas companies are lowering development costs and are offering stronger financial returns for producers and investors, and the industry is delivering this energy while continuously improving the safety of operations.

Just as exciting, the U.S. offshore wind industry is poised for dramatic growth. In 2016, the U.S. had exactly one offshore wind farm. Today, wind farms are under contract offshore seven states, with even more on the way. Twenty-two gigawatts of offshore wind has been approved or committed in the U.S. In just a few short years, the largest wind turbines in the world will crown the U.S. Atlantic Outer Continental Shelf.

As construction begins on new wind projects, Americans will be able to count on a headwind of jobs and economic growth. A recent report by the Special Initiative on Offshore Wind (SIOW) predicts that by 2030, offshore wind companies will spend nearly \$70 billion in capital expenditures. Thousands of foundations and wind turbine generators and thousands of kilometers of cables will need to be manufactured, delivered and installed. Americans are truly witnessing the start of an ascendant industry.

However, the energy industry still faces substantial challenges. A chorus of anti-energy voices want to re-

move our industry as a source of safe, affordable and reliable power. Their ideas are the last thing Americans need.

On the campaign trail, cavalier promises by presidential hopefuls to ban oil and natural gas production and exploration have become popular catechisms. Even the candidates branded as moderates are calling for the banning of new leases on federal lands and waters.

In Washington, D.C., the House of Representatives returned from the August recess with a trio of bills banning energy development. Among other things, the bills would indefinitely lock away oil and natural gas development in the Atlantic and Pacific Oceans and the Eastern Gulf of Mexico. The bills, which are the opening salvo of the Green New Deal, increase our foreign-energy dependency and ship off billions of dollars' worth of jobs and economic growth abroad. Offshore oil and gas development is also the primary revenue source for the Land and Water Conservation Fund, with billions of dollars provided to state and local governments to fund parks, recreation and wildlife programs. Turning the clock back on offshore oil and gas production would also set back this important, bipartisan conservation program.

Even progress on wind projects has been targeted. Some of the voices that say the U.S. cannot afford new investments in oil and natural gas projects are calling for a two-year moratorium on U.S. offshore wind projects.

Our industry can be proud of its record. American energy production means sustainable and environmentally conscious energy production. Not only is the U.S. the leader in oil and natural gas production, the U.S. is a world leader in the reduction of greenhouse gas emissions. Americans do not have to choose between environmental responsibility and energy security—we can do both.

Our industry's record is why there are still bipartisan energy solutions that Washington, D.C., will embrace. American offshore energy has enhanced our national security, providing a much needed geopolitical buffer for our allies, many of whom prefer U.S. supplies on the global market rather than Russian or Iranian oil. From oil and natural gas producers to wind operators to the service and supply companies that keep the industry running, each one of NOIA's members tells a compelling story that policy makers need to hear. As the pendulum swings back offshore, NOIA is proud to echo your voice and lead the way to a stronger offshore industry. **ST**

Review&Forecast

The Power of Partnerships

By Jon White
President and CEO
Consortium for Ocean Leadership (COL)

An enduring ocean image is that of a clownfish resting in its sea anemone home. In this symbiotic relationship, the clownfish finds safety among the anemone's poisonous tendrils, thanks to its immunity to its toxins, while the anemone benefits from the fish's waste and movement. The partnership allows the individual species to survive, which benefits the larger ocean ecosystem.



It's not only in the ocean these partnerships exist to the benefit of individuals and for the greater good. Partnerships are equally important to advance ocean science and technology in support of a healthy, sustainable, productive ocean. The diverse stakeholders working to this end, such as the federal government, academia, industry and philanthropy, have interests that look like an over-

lapping Venn diagram with more shared priorities than unique ones. As a consortium of academic institutions, industry, philanthropy and aquariums, COL is uniquely positioned to enhance these partnerships, which was clearly articulated by attendees during November's "White House Summit on Partnerships in Ocean Science and Technology."

Critical to growing ocean partnerships is increased support for and revitalization of the National Oceanographic Partnership Program (NOPP). For more than 20 years, NOPP has advanced ocean science and technology partnerships over a range of topics, including ocean exploration, technology development, environmental monitoring and Earth systems modeling. Our 2019 Public Policy Forum, "U.S. Ocean Policy: Past, Present and Future," underscored the importance of working across sectors to advance ocean science and effective policy and to rapidly grow the inclusive, dynamic partnerships necessary to advance ocean technology. Revitalizing and further investing in NOPP will do this, growing our nation's ocean science and technology enterprise to grand new successes.

COL's 2019 Partnerships

Advanced Ocean Science Education. COL hosted the National Ocean Sciences Bowl (NOSB) Finals in Washington, D.C., instead of at one of our regional bowl locations. Our partners in the local ocean science community showed up in droves to help, offering their time



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as moderators, field-trip leaders, mentors and more. We are so grateful to them for demonstrating the power of partnerships and showing students how teamwork will be essential to their success long after graduation.

Ensured a Lasting Legacy. Following the *Deepwater Horizon* oil spill, dedicated research from the Gulf of Mexico Research Initiative (GoMRI) and the convening power of the Gulf of Mexico Oil Spill and Ecosystem Science (GoMOSES) Conference, each a COL-supported partnership in its own right, have been key to ensuring science is shared across sectors and disciplines. As GoMRI prepares to wrap up in 2020 following a decade of groundbreaking work, COL has coordinated synthesis and legacy efforts to ensure the lasting impact of discoveries made over the last decade and that future partnership efforts build off what has already been done. The 2019 GoMOSES Conference contributed to this by bridging basic and applied research to inform decision making and identify information gaps, and the 2020 conference will continue bringing stakeholders together to assess and synthesize how far Gulf science has come and to set a course for restoration.

Helped Understand Offshore Wind. Last year's annual Industry Forum, in collaboration with the Special Initiative on Offshore Wind, focused on our nation's nascent offshore wind energy industry—a critical part of growing the blue economy.

Chief among takeaways was the need for strong partnerships to ensure the enterprise coexists with others in the marine space, from North Atlantic right whales to fishers to the U.S. Navy. More collaboration and communication across sectors are necessary during the planning stage for the community to take full advantage of all possibilities: Imagine if every offshore turbine has ocean observing capabilities!

Convened a Decadal Meeting of the Minds (OceanObs'19). Last year saw the third installment of the decadal OceanObs conference, a community-based event that brought together stakeholders across national, sectoral and disciplinary divides to plan the future of ocean observing. COL organized the scientific program in collaboration with international program committee members and sponsors. One big takeaway was the global scientific community needs to codevelop and employ new ocean observing technologies with those who use the data to maximize value and to better anticipate potential uses.

In 2020, COL will continue advancing partnerships. While in some cases our role is clearly defined, in other cases our role is still evolving as we get a better look at the ocean-scape of tomorrow.

COL's 2020 Partnerships

Setting the Stage for the Next Decade. We need to make sure the UN Decade for Ocean Science for Sustainable Development (2021 to 2030) is a UN Decade like none other. The ocean science and technology community must take the lead and work in partnership to achieve goals such as “revers[ing] the cycle of decline in ocean health.”

Growing the Blue Economy. The stability of the blue economy is critical to that of our national economy. Projections show growth in the ocean economy will outpace the global economy from 2010 to 2030, doubling its contribution to global value from \$1.5 trillion to \$3 trillion. As was evidenced during our Industry Forum, it's critical industries not operate in silos but successfully coexist with others—which will require strengthening cross-sector and public-private partnerships.

Leading to an Ocean ‘Moonshot.’ NOAA's Office of Exploration and Research (OER), our only federal organization dedicated to exploring the global ocean, is one of NOAA's most successful undertakings. Recently, there's been an uptick in ocean exploration outside the federal sector. To take advantage of all available resources and to make ocean exploration a truly national venture, we must create partnerships between the government, academia, technological innovators and more. In 2020, COL is thrilled to be working with OER in strategic planning and partnership building. Maybe we can capture the public's imagination enough for an ocean “moonshot.”

Opportunities for ocean partnerships are endless. What is needed to further advance environmental DNA technologies to better understand our ocean with just a sample of seawater? Can genomics and genetic engineering address our conservation challenges? COL looks forward to using the partnership tools of today—like NOPP—to move our ocean science and technology partnerships into tomorrow. **ST**



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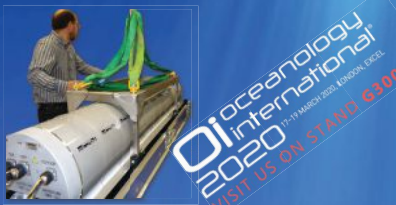
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Merger Creates OneOcean

ChartCo and Marine Press have announced their merger. The move will result in the creation of a new company called OneOcean that will offer the largest range of navigation and compliance solutions into the maritime sector, according to the companies.

During the coming months, the two companies will transition to a single OneOcean business operation.

SGS Makes Two Acquisitions

Subsea Global Solutions (SGS) has acquired Underwater Contractors Pte. Ltd. (UWC), a commercial diving firm based in Singapore, and Gray Diving Services Pty. Ltd. (GDS), a commercial diving firm based in Sydney, Australia, through separate transactions.

With these two tandem acquisitions, SGS expands its global footprint in Asia-Pacific beyond Busan, South Korea, and increases the number of its homeports worldwide to 13.

New Polar Ship Guidelines

The International Code for Ships Operating in Polar Waters (Polar Code), adopted by the UN International Maritime Organization (IMO), requires shipping companies intending to operate in polar waters to develop a Polar Water Operational Manual (PWOM) in order for their ships to be issued with a Polar Ship Certificate.

New joint guidelines from the International Chamber of Shipping (ICS) and the Oil Companies International Marine Forum (OCIMF) aim to support shipping companies by providing advice on how to develop a PWOM that best suits their needs, taking into account the environmental hazards and the nature of their operations.

MacArtney Expands in Europe

MacArtney Underwater Technology will launch MacArtney Italy to support local Italian customers. At the helm will be Managing Director Vincenzo Mauro, who has a background in academia and the private sector, including underwater technology sales and management positions.

Support for Maritime Businesses

Seabury Maritime LLC, a global maritime investment banking and industry advisory company and a subsidiary of Seabury Capital Group, has formed a strategic partnership with Lloyd's Register (LR) to support maritime clients with key business decisions. The partners will build a platform to help shipowners and other shipping stakeholders better assess the risks and opportunities facing their businesses.

This service will help clients navigate operational and capital expenditure challenges in a fiercely competitive marketplace, boosting profitability, revenue and operational efficiency, and addressing ongoing concerns, including regulation, shrinking margins, geopolitical risks, and physical and cybersecurity threats.

Funding Support for XOCEAN

Ocean data company XOCEAN has announced successful completion of a €7.9 million funding round to support international scaling plans. XOCEAN is transforming the way ocean data are collected by using USVs. The company has recently delivered projects for BP, Equinor, PX Group and the U.K.'s Maritime and Coastguard Agency. The services provided by XOCEAN include seabed mapping, subsea structure inspection and environmental monitoring.

New Approach to Deploy NGSO Satellites

The 38th ITU World Radiocommunication Conference (WRC-19) has adopted a new innovative milestone-based regulatory approach for the deployment of nongeostationary satellite orbit (NGSO) satellites in specific bands and services, including megaconstellations in low-Earth orbit (LEO). The milestone-based approach will provide a regulatory mechanism to help ensure that ITU's Master International Frequency Register reasonably reflects the actual deployment of such NGSO satellite systems in certain frequency bands and services.

In defining more flexible time lines and objective criteria, this approach seeks to strike a balance between the prevention of spectrum warehousing, the proper functioning of coordination mechanisms, and the operational requirements related to the deployment of NGSO systems.

Collaboration for Major Fuel Savings

Norwegian Golden Energy Offshore's long-term collaboration on vessel performance monitoring with Kongsberg Maritime and recent deployment of the containerized SAVE Energy battery system is now delivering operational fuel savings of 20 percent. The results have been achieved on Golden Energy Offshore's UT 776 CD design platform supply vessels. Golden Energy Offshore and Kongsberg Maritime have been monitoring and analyzing data from the ships since 2015.

Octans for SEA Vessels

iXblue will supply the Octans fiber-optic gyrocompass to both tall ship research vessels operated by the U.S.-based Sea Education Association (SEA).

For nearly 50 years and more than 1 million nautical miles sailed, SEA has educated students about the world's oceans through its Boston University-accredited study abroad program, SEA Semester.

Intellian Now Manufactures Certus

Iridium Communications Inc. has announced Intellian as the newest manufacturer of Iridium Certus maritime terminals. Intellian is introducing the C700 terminal to enable a variety of applications, including safety, bridge and crew-welfare communications; connected-ship IoT capabilities such as engine monitoring and remote diagnostics; and situational awareness reports.

Designed to provide the fastest L-band broadband service in the industry, the C700 will deliver up to 352 kbps transmission and 704 kbps reception speeds. **ST**

US to Formally Withdraw from Paris Agreement

In November, the U.S. began the process to withdraw from the Paris Agreement by submitting formal notification of its withdrawal to the United Nations. The withdrawal will take effect one year from delivery of the notification.

U.S. President Donald Trump made the decision to withdraw from the Paris Agreement because of what he deems the unfair economic burden imposed on American workers, businesses and taxpayers by U.S. pledges made under the agreement.

Critics argue this is short-sighted. Rep. Eddie Bernice Johnson (D-Texas) said in a statement, "It is embarrassing that the U.S. has now formally abandoned not only this international agreement but the Americans who are dealing with the very real consequences of climate change."

Fugro USA Executive Continues as Head Of NOAA Hydrographic Panel

NOAA has reappointed Fugro USA President Edward Saade to its Hydrographic Services Review Panel (HSRP). The 15-member federal advisory committee comprises individuals with a range of maritime expertise to provide independent recommendations for improved navigation services and coastal resilience.

Saade has served on the panel since 2016.

House Bill to Reform Harbor Maintenance Trust Fund Act Passes

The American Association of Port Authorities (AAPA) expressed support for H.R. 2440, the Full Utilization of the Harbor Maintenance Trust Fund Act, which has advanced in the U.S. House of Representatives. The legislation would enable Congress to appropriate \$34 billion over the next decade to restore America's federal navigation channels to their originally constructed widths and depths, thereby improving their safety and reliability to handle today's larger ships and growing trade.

House Transportation and Infrastructure Committee Chairman Peter De Fazio (D-Ore.) has continued to lead the push to fully use the Harbor Maintenance Tax (HMT), of which AAPA seeks comprehensive reform.

"Passage of H.R. 2440 is a critical first step to solve the problems with the HMT," said AAPA President and CEO Chris Connor. "The legislation will stop the diversion of HMTF payments and provide a means for Congress to spend down the more than \$9 billion that has been diverted in previous years."

House passage of this bill is a major milestone toward full Congressional HMT legislation enactment. The next action lies with the Senate, where the Environment and Public Works Committee is anticipated to release initial HMT legislative language as part of its Water Resources Development Act. AAPA wants legislation to address the needs of donor and energy-transfer ports and provide funding certainty for emerging harbors and the Great Lakes navigation system. **ST**



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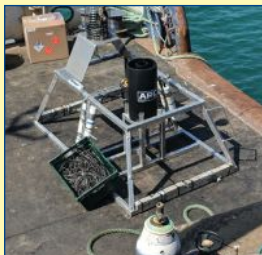
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Underwater Acoustics



SonarPoint is capable of localizing various marine mammal vocalizations to within 1- to 3-m accuracy. SonarPoint's localization method relies on a differential time of arrival of each vocalization between the deployed recorders. Vocalizations may be plotted on a hyperbola relative to the recorder positions and DTOA. Desert Star Systems LLC.

Wave-Height Sensor

Utilizing GNSS to measure wave

statistics, the Brizo-X directional wave-height sensor runs autonomously and can output over RS-232 or send messages over one of the embedded telemetry options available. Wave statistics include: max wave height, significant wave height, peak period, mean wave direction and mean spread. Xeos Technologies Inc.

3D Forward-Looking Sonar

Designed with a smaller and lighter transducer, the Argos 350 has a 350-m range of detection. It is well-suited for mid-size yachts from 18 to 40+ m. FarSounder Inc.

Updated Sonar Software

SonarWiz 7.5 is a new release that includes more than 100 novel features and updates. Key enhancements include processing for

Klein MA-X 600 View data (a nadir gap-filler sonar) and support for EdgeTech 4205 tri-frequency sonar. Chesapeake Technology Inc.

Tension Load Cell

Subsea Link is a standard product for applications up to 2,000-m depth. It can be rigged with Crosby's ROV shackles and Trawlex shackle range. The IP68/NEMA 6P-rated Subsea Link has components from SubConn. Straightpoint.

Coating for Transducers

Foulfree releases marine growth, reducing the maintenance needed to keep transducers clean and streamlining water flow. It is biocide-free and does not poison marine growth. Once cured, Foulfree forms a super-slippery surface over the transducer, preventing marine growth from attaching to its surface. Proppspeed.

Oil-Spill Monitoring



Oil-spill monitoring buoys and land-based systems utilize a real-time, noncontact hydrocarbon sensor, which is equipped with a pulsed UV LED beam and optical photo-detector with onboard software to enable detection of oil spills autonomously and immediately alert the users to any changes to protect vulnerable areas. OSIL.

Visualization Platform

ALViVi (Alewijnsse Virtualization & Visualization) is a digital platform that can visualize multiple ship's systems on individual screens. At the same time, a single system can be selected for display on multiple screens around the vessel. Alewijnsse Marine.

Marine Drill

Mounted on a large ROV, MD-5000-T is a marine drill designed to

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collect seabed cores. It can collect cores at multiple points in one dive and can drill ocean floor points by using an ROV manipulator arm. Koken Boring Machine Co. Ltd.

Convertible VSAT System



The latest model of the NX Series is the v130NX, the world's first Ku-Ka convertible VSAT terminal with a 1.25-m reflector. It is an ideal platform for high-speed global internet on ships, offshore vessels and superyachts. It is compatible with GEO, MEO and LEO constellations. Intellian Ltd.

Monitoring Platform

Sofar Strider suits coastal, nearshore and inland environments. It collects real-time video from above and below the waterline and can collect water-quality parameters, perform bathymetric surveys and monitor underwater acoustics. Sofar Ocean Technologies.

Deck Purge Box

DPB-107, in combination with a self-sealing purge port and pressure-proof cap, removes moisture from deep-sea housings, both spheres and cylinders. Global Ocean Design LLC.

Offshore, Subsea Lever Hoist

SSL5 incorporates the patented quad pawl (QP) mechanism that synchronizes a set of four pawls that constantly work together to minimize the time and distance to the next point of engagement. It overcomes the current industry norm of single-use immersion hoists. William Hackett Ltd.

Radar-Absorbing Material

Frame is designed for offshore wind turbines, blades and nacelles. It mitigates wind turbine radar interference problems, unlocking gigawatts of new potential wind farm

sites. The lightweight nanocomposite polymer solution is available from 1 to 12 GHz. Trelleborg AB.

Bespoke Cyber Protection

S-Marine Dome and S-Port Dome are suitable for ship, offshore energy and terminal operators. They can be easily installed on all ship, port or offshore OT systems, including navigational equipment, machinery control systems and cargo-handling equipment. Naval Dome Ltd.

Display Graphics

State-of-the-art vector graphics with the latest in data presentation techniques combine in Poseidon to offer the user the ability to create stunning data and control displays and the functionality to import floor plans and beautiful photographs into the system. It can be installed with simple, low-cost cables between devices. Oceanic Systems (UK) Ltd.

Ballast Water Management System

Ecochlor's treatment technology uses chlorine dioxide on board the vessel to treat ballast water in a single pass at uptake. It is effective in all water types and conditions without the need for crew to adjust the operating parameters. Ecochlor Inc.

App for Ropeless Fishing

Trap Tracker is a mobile phone-based app to control the EdgeTech Ropeless Fishing System. It allows fishers to virtually mark their traps and trawl lines on a chart, record the position and catch quantity, and upload the information to a cloud database. EdgeTech.

Sulphur Cap Compliance Check

To support improved industry management of risk and safety ahead of the implementation of the 2020 IMO sulphur cap, the operators of vessels over 8,000 DWT can confirm their compliant fuel choices and ship implementation plans in the new compliance assessment platform Qi. Users will have the ability to view the vessel's method for IMO 2020 compliance as declared by the ISM operator. RightShip. **ST**



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USCG Approves Evac BWMS

The Evac Evolution Ballast Water Management System (BWMS) has received type approval from the U.S. Coast Guard (USCG). The system is manufactured by Cathelco, now part of the Evac Group, which attained USCG Alternate Management Systems (AMS) acceptance for its original BWMS more than four years ago.

Hyper-bb Development

Sequoia Scientific Inc. Scientist Dr. Wayne Slade has developed a hyperspectral backscattering instrument (Hyper-bb) through a NASA Phase II SBIR (Small Business Innovation Research) grant. A prototype has been delivered to NASA for testing. This is Slade's and Sequoia's second SBIR-funded development and delivery in 2019.

The Hyper-bb product is expected to be available for order in the first quarter of 2020.

MTS, SUT Join Forces

The Marine Technology Society (MTS) and the Society for Underwater Technology (SUT) have entered into a three-year memorandum of agreement to explore ways to work together to the benefit of their collective membership. Both SUT and MTS focus on the facilitation, development and application of marine science and technology for purposes of exploration, understanding and sustainable use of the ocean and its resources.

Canada's Ocean Supercluster Commits Funding to Kraken

Kraken Robotics Inc.'s wholly owned subsidiary, Kraken Robotic Systems Inc., has been conditionally approved by the Ocean Supercluster to move forward with its OceanVision project.

OceanVision is a three-year, \$20 million project to develop new marine technologies and products to

enable an underwater robotics data acquisition and data analytics as a service business for ultrahigh-definition seafloor imaging, mapping and analytics.

The Ocean Supercluster will provide an investment up to a maximum of \$5.9 million to the OceanVision project.

Funding for Marine Firefighting Rescue Vessel

The Canaveral Port Authority will receive \$1.5 million from the state of Florida to support the acquisition of a specialized fireboat to provide marine firefighting and rescue capabilities for Port Canaveral and the surrounding communities. The Marine Firefighting Rescue Vessel (MFRV) will offer enhanced fire protection and response-time capabilities to serve the port's growing maritime operations.

TTI to Stock SEACON Products

TE Connectivity will begin stocking six of its high-demand SEACON product lines for the marine, oil and

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gas market with TTI Inc., a specialty distributor of electronic components and one of TE's largest global distribution partners. The SEACON product lines that customers will be able to buy through TTI are: 55 Series, All-Wet, HUMMER, Micro WET-CON, Rubber Molded Connectors and WET-CON.

L3Harris Arises from Merger

L3Harris Technologies Inc. is merging with Harris Corp. to create an agile global aerospace and defense technology company uniquely positioned to deliver innovative, affordable mission solutions that can be rapidly fielded. The new company is called L3Harris.

WFS Expands

WFS Technologies, specializing in Subsea Internet of Things (SIOT) devices for asset integrity management, has expanded into Houston and Brazil.

Energy Industry Sales Director Molly Reyes joins the WFS senior leadership team to lead the new office and explore opportunities in the growing energy sectors of the Gulf of Mexico and North American territories.

Quiet Ship Workshop Results

Acentech, a Cambridge, Massachusetts-based noise, vibration and acoustical consulting firm, has issued its final report to Transport Canada concerning the Quiet Ship Workshop held at the International Maritime Headquarters (IMO) in London.

Some of the key policy and research recommendations that came out of the event include: biological underwater radiated noise (URN) limits are not available at this time, so ship-based URN limits should be studied; noise mitigation measures should align with efforts to improve energy efficiency and reduction of greenhouse gas emissions; vessel URN data should continue to be gathered to understand issues and validate modeling; research on shipboard noise control technologies should be advanced; a comprehensive framework of international standards for URN measurement

should be developed; and there should be an increase in education/outreach to shipowners, designers and builders, and machinery and equipment manufacturers.

Port of Cartagena Invites More Traffic

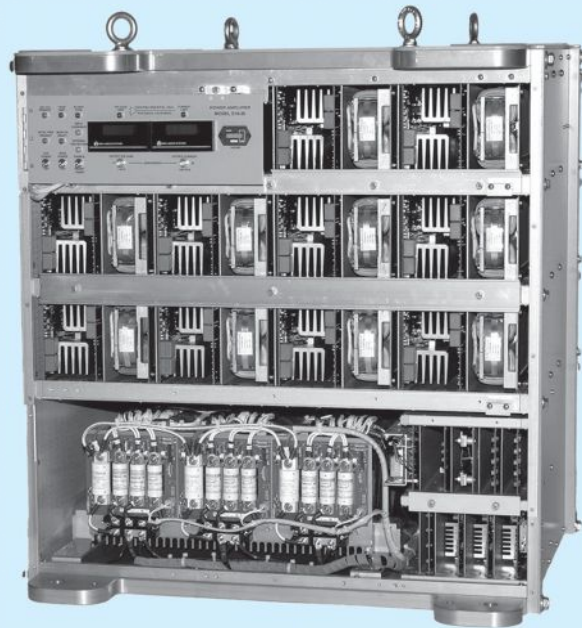
Cartagena, Colombia's premier port, is becoming increasingly important as a regional transportation hub. Last year, Panalpina set up the

first ocean freight hub in Cartagena for Central and South American LCL (less than container load) cargo.

The Port of Cartagena had the fourth highest throughput of all container gateways in Latin America and the Caribbean in 2018, according to the UN's Economic Commission for Latin America and the Caribbean. The port handled 2.9 million TEU in 2018, 6.9 percent more than in 2017. **ST**

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offshore oil & ocean engineering

Industry Collaborates with Scientists for INSITE

The INSITE program has launched a major collaboration between offshore industries and researchers, designed to give marine scientists access to valuable industry-acquired ecological data.

INSITE is a scientific research program to increase understanding of the influence of man-made structures on the ecosystem of the North Sea. It has attracted recognition and support from industry, government (through BEIS and DEFRA) and the scientific community (through the Natural Environment Research Council, NERC).

Now in its fifth year, following the completion of a foundation phase of research, the program has moved into a second phase. A key outcome from the foundation phase was that new data are needed to maximize the outcomes from the science program. The second phase has been developed in partnership with NERC and CEFAS and includes a new GIS-based data-sharing portal, INSITE Interactive, to give scientists access to industry data.

MacGregor to Supply Chinese R&D Deepwater Project

MacGregor has received an order from the China National Offshore Oil Corp. (CNOOC) to supply the riser pull-in system for a deepwater floating production unit (FPU) located in the Lingshui 17-2 gas field. Delivery will take place in 2020.

The Lingshui 17-2 gas field is CNOOC's first R&D deepwater project, situated in the northern part of the Qiongdongnan Basin in the western continental shelf of the northern South China Sea, with water depths from 1,220 to 1,560 m.

Using LiDAR for Subsea Survey-Grade Measurements

3D at Depth Inc. recently conducted a successful technology showcase in partnership with the Norwegian Forum for Offshore Survey and Positioning (NOSP)

and OneSubsea to demonstrate the potential of survey-grade measurements from hovering (moving) resident systems with an emphasis on utilizing subsea LiDAR technology.

The event took place in Horsoy, Norway, and was developed to engage subsea energy experts to pose the question: At what stage does the survey community need to be involved with field layout planning to ensure survey-quality measurements are reliable from a resident system?

The program successfully demonstrated that from controlled survey markers (targets) placed around the survey location, 3D at Depth's subsea LiDAR-controlled beam repeatably acquired survey-grade measurements in single-sector scans while hovering. Simultaneously during data acquisition, a small simulated gas leak was also detected.

Viewport3 Transitions To New Market

Aberdeen-based subsea 3D scanning specialist Viewport3 is entering the decom market after securing two pre-removal scanning contracts.

Viewport3 will provide the operators with the intelligence they need to make decisions about the removal of items from the seabed, reduce ad-hoc engineering and minimize time spent offshore.

Saturation Diving System For COOEC Vessel

Unique Group has been awarded a contract by China Offshore Oil Engineering Co. Ltd. (COOEC), an EPCI contractor, to design, manufacture and deliver a classed saturation diving system to be integrated on COOEC's vessel, including technical support during and after installation.

All equipment will comply with DNV and International Marine Contractors Association (IMCA) guidelines.

Additionally, the turnkey package will include Unique Equip-

ment Manager (UEM), a digitalized planned maintenance system to accurately track the status of the equipment, thereby minimizing operational downtime.

Motive Adds New Division

Motive Offshore Group, a specialist in marine equipment fabrication and rental, rounded off the final quarter of 2019 with the launch of a new Flexibles division and supporting acquisition.

Motive has completed the acquisition of Stavanger-based Pumptech, reflecting the ambitious growth strategy that followed significant investment in 2019 from EV Private Equity.

Specialists in flexible flowlines and umbilical testing, Pumptech brings a large fleet of Zone 2-credited hydraulic pump units (HPUs) to the company.

On the back of a strong international operational history in oil and gas, renewables and maritime markets, the new combination of services will be fundamental to Motive's continuing global growth, providing clients with an enhanced one-stop shop.

Deep Site Survey via AUV For Brunei Shell

Fugro has successfully completed the first deepwater AUV site survey for Brunei Shell Petroleum Co. Sdn Bhd (BSP).

The survey was performed in water depths of 600 m using the Fugro *Equator*, a dedicated geophysical survey vessel, and the Fugro ES-V AUV, and completed with zero HSSE incidents. The survey results will be critical for planning a safe drilling program and will provide key inputs for engineering and design studies for pipeline routing and subsea structures in future deepwater field developments.

Following the successful site survey, BSP subsequently awarded Fugro the associated geotechnical site investigation and geoconsultancy contract. The project included a review of the geophysical data and desktop study to assist BSP in defining the geotechnical scope of the work. **ST**

Improvement Project For Fishery Simulator

Kongsberg Digital (KDI) has signed a new contract with the Norwegian Seafood Research Fund (FHF) to initiate a new phase of development on its groundbreaking K-Sim Fishery simulator system. One of the goals is to enable research and training on release in purse seine operations to prevent loss and death rate of fish.

The new project will include development of additional purse seine capabilities for research purposes, with the aim of improving safety and efficiency in operations and enhancing the fishing gear and methods as well as the catch and storage procedures needed to improve the fish quality and reduce the environmental impact. The new simulator system will also be ideal for education and training in purse seine fishery.

The project will be handled by Kongsberg Digital in partnership with Hordaland Vocational School, Mørenot Austevoll AS, Austevoll Seafood ASA and Sørheim Holding AS. Following completion of the project, the K-Sim Fishery simulator will be installed in several educational establishments.

Electric Propulsion for *Mayflower* Autonomous Ship

Fischer Panda UK has announced a contract to supply, install and commission a complete electric propulsion system for the *Mayflower* Autonomous Ship (MAS) project. The installation, which will include motors, batteries, diesel generators and associated power and control electronics, will be crucial to ensuring the success of the unmanned Atlantic crossing, which is scheduled for September 2020.

The voyage, from Plymouth, U.K. to Plymouth, Massachusetts, will be in celebration of the 400th anniversary of the voyage of the Pilgrims in their eponymous ship. Equipped with advanced research sensors and IBM's latest AI, power servers and edge technologies, the 15-m trima-

ran is expected to make the crossing in approximately 12 days at speeds up to 20 kt., a huge leap from the original *Mayflower's* 60 days at 2.5 kt. This will be achieved by a fully electric propulsion system from Fischer Panda, primarily charged by wind and solar energy, with Fischer Panda diesel generators as backup.

Another Multiplexer for MMT, Reach Subsea

Sweden-based MMT, in close collaboration with Reach Subsea, has ordered the customized NEXUS MK C connectivity solution (named the Super MUX by MMT) from MacArtney Underwater Technology. MMT offers customized marine surveys for the offshore energy industry, and Norway-based Reach Subsea has a comprehensive knowledge of subsea operations.

Multiplexers, designed to simultaneously transmit data along a single channel of communication, enable the gathering of numerous types of data at once. The NEXUS MK C is a customized plug-and-play multiplexer for work-class ROVs and is a mobilization time saver. Fitted to new ROVs or as an upgrade to existing systems, it can handle data for ROV setups that require multiple cameras, sonars, attitude sensors, manipulators, cable and pipe trackers.

The new NEXUS MK C is the latest delivery in a series of seven multiplexers provided to MMT since 2018. The system provides connectivity between the vessel and the ROV sensor package in one compact unit. The topside unit features an open interface for data acquisition work on a wide range of vessels.

Kepler, Cobham Partner To Offer Trial Service

Kepler Communications, specializing in nanosatellite telecommunications, and Cobham SATCOM, a provider of radio and satellite communications solutions, have announced a strategic partnership to eliminate barriers to widespread

adoption of high-capacity data services over Kepler's Low Earth Orbit (LEO) network.

Under the new arrangement, organizations evaluating Kepler's ability to cost-effectively move multiple gigabytes of data per day around the globe can experience a fully managed trial of the service anywhere with no upfront capex spend, no lengthy service commitment, and certified installation and support executed through Cobham SATCOM's global Technical Service Partner network.

Offering "user terminal-as-a-service" (UTaaS), the Kepler-Cobham partnership has three core principles: shifting equipment costs to a monthly operational fee from a more traditional one-time capital expense; embedding installation, technical support, terminal maintenance, warehousing and transport services into the monthly fees, with future capabilities for add-on services; and exchanging technical know-how to improve the delivery of LEO wideband services.

SSY, Marine Benchmark Join Forces for Maritime Data

Simpson Spence Young (SSY), the world's largest independent shipbroker, has partnered with Gothenburg-based tech company Marine Benchmark, a specialist in maritime data analytics. Marine Benchmark will bring a competitive advantage by providing expertise in statistical analysis across a wide range of maritime market data. SSY's resources and reach will further strengthen Marine Benchmark's presence in the global market for maritime research and data.

In-Mission Processor Added to REMUS

Hydroid Inc., a subsidiary of Kongsberg Maritime, has integrated an in-mission processor on a REMUS 600 UUV with the Kongsberg high-resolution interferometric synthetic aperture sonar (HISAS) 2040 for a customer. High-resolution images from the HISAS module can now be quickly downloaded when the vehicle returns from a mission. **ST**

environmental monitoring

Antarctic Sea Ice Acts As Lid on Carbon

Half the drop in atmospheric carbon dioxide levels during glacial periods is the result of Antarctic sea ice modifying ocean circulation and acting as a lid, trapping carbon stored in the ocean beneath, according to new research by scientists at the U.K. National Oceanography Centre (NOC) and the University of Chicago.

The ocean is the largest carbon reservoir over geological time scales, so studying the role that the ocean plays in the carbon cycle helps to more accurately simulate future environmental change.

When we transitioned into the current interglacial period, the sea-ice lid was partially lifted, releasing carbon back into the atmosphere.

The implication of future Antarctic sea ice loss is unclear from this research.

The ice core record shows that over the past 2.5 million years, the climate has been shifting between periods with higher surface-air temperatures and atmospheric carbon dioxide concentrations, such as the present day, and cooler periods with lower concentrations.

This study uses an ocean-sea-ice numerical model, including a simulation of the carbon cycle, to demonstrate a mechanism for triggering these transitions: Atmospheric temperature changes cause Antarctic sea ice and ocean circulation changes that account for half of the observed differences in atmospheric carbon.

Dredging Service Helps Doha Prep for FIFA World Cup

Dredging companies are able to better plan their schedules in advance thanks to HR Wallingford's new service that can provide improved forecasting of sediment plumes caused by dredging. The service enables dredging contractors to improve their adaptive management of dredging works, thereby helping to ensure that environmental objectives are achieved. The re-

sponse-based forecasting model has already been used successfully at Doha Port in its preparation for the FIFA World Cup in Qatar in 2022. As part of the preparation, Doha Port is widening its channels to accommodate large cruise ships that are planned to be used as floating hotels during the event.

HR Wallingford's service predicts sediment dispersion several days in advance.

SIMBA Device to Inform Scotland Flood Predictions

Technology designed by the Oban-based Scottish Association for Marine Science (SAMS) that could provide early warning for floods has been deployed in the Scottish Highlands.

The device, known as SIMBA (Sea Ice Mass Balance Array), was originally developed to analyze sea ice in the Arctic and is now used by researchers around the world.

SAMS has been working with a multi-agency cooperation comprising the Scottish Avalanche Information Service (SAIS), the Scottish Environmental Protection Agency (SEPA) and the University of Dundee to test the application of this technology in monitoring snowpacks forming on the Cairngorm mountains.

The equipment remotely gathers data in snow accumulation zones at around 1,000-m altitude, primarily measuring ground, snow and air temperature profiles; snow accumulation and melt rates; and total depth. It can give readings 24 hr. a day during storms and dangerous snowpack conditions.

The deployment this winter in Glen Feshie will test the ability of the equipment to detect and monitor snow melt, providing data that can help scientists understand the contribution of snow melt in floods and ultimately enhance flood prediction models in Scotland.

Good Report Card For Chesapeake Bay

An annual model-based report on dead zone conditions in the

Chesapeake Bay during 2019 indicates that the total volume of low-oxygen, hypoxic water was on the high end of the normal range for 1985 to 2018, a finding that scientists actually consider relatively good news.

Dr. Marjy Friedrichs, a Virginia Institute of Marine Science professor and report card co-author, said, "Even with environmental conditions that favor severe hypoxia, including record-high river input and light winds, our analysis shows that the total amount of hypoxia this year was within the normal range seen over the past 35 years."

This suggests that nutrient reductions since the 1980s have been successfully improving water quality in the bay.

"If the record-breaking river flows we saw last year had occurred back in the 1980s, we would more likely have seen a record-breaking dead zone in 2019," said Friedrichs.

"The fact that the 2019 dead zone was within the normal range is a positive sign for bay restoration," she explained.

MacArtney LARS for Canadian Great Lakes Research

Working with Environment and Climate Change Canada, a government-affiliated department, MacArtney Canada has supplied a launch and recovery system (LARS) for freshwater oceanography in the Great Canadian Lakes.

Installed aboard a Canadian Coast Guard multipurpose vessel, the Danish-designed and manufactured LARS provides a complete package for easy installation and removal of a CTD rosette sensor suite of underwater instrumentation.

Water Science and Technology (WST), a research support section of Environment and Climate Change Canada, provides support to research and monitoring groups for vessel sampling operations in partnership with the Canadian Coast Guard.

MacArtney Canada provided a CORMAC Q5 high-speed winch, MERMAC A10 A-frame, hydraulic power unit and remote control system. **ST**

contracts

Damen Marine Components, Hardinxveld-Giessendam, Netherlands, has received a contract to supply the rudders and steering gear for the fifth *Infinity*-class vessel to be built for SunStone Ships by China Merchants Heavy Industries to an Ulstein design. Brunvoll Volda.

OFW Ships, Paris, France, has chosen a provider of a multiband connectivity solution, combining high-throughput global VSAT with an L-band backup for connectivity redundancy. Marlink.

Mitcham Industries Inc.'s Seamap subsidiary, Huntsville, Texas, has recently completed additional deliveries of its BuoyLink 4DX RGPS positioning systems. Undisclosed.

Rovco, Bristol, England, has successfully completed an extensive ROV inspection contract for a baseline asset integrity survey at the newly constructed Galloper offshore wind farm, with 353-MW installed capacity off the coast of Suffolk, U.K. Innogy Renewables UK.

Corvus Energy, Richmond, Canada, has signed a contract to supply the energy storage system (ESS) for the world's first hybrid surface effect ship (SES) for crew transfer, being developed in response to an industry-wide push for innovative technologies that reduce CO₂ emissions while cost-effectively servicing offshore wind farms. SEC Marine Ltd.

Ardyne, Aberdeen, Scotland, has signed a frame agreement for fishing services covering all of an operator's assets on the Norwegian Continental Shelf. Equinor.

Trelleborg's applied technologies operation, Trelleborg, Sweden, has been awarded a contract to provide NjordGuard, an integrated cable protection system, for the Greater Changhua 1 and 2a offshore wind farms in Taiwan. Trelleborg will provide 235 NjordGuard cable protection systems and bellmouths to pro-

tect all interarray and export cables on the projects. Ørsted.

Bisso Towboat Co. Inc., Luling, Louisiana, has delivered its first EPA Tier 4 Final and Subchapter M azimuth stern drive (ASD) tractor tug. At 6,008 bhp, *Andrew S.* is the most powerful Tier 4 tug on the Mississippi River. Caterpillar Marine collaborated with Bisso to select the engine package. Undisclosed. **ST**

meetings

FEBRUARY

February 3-6—Gulf of Mexico Oil Spill & Ecosystem Science Conference, Tampa, Florida. lsmith@oceanleadership.org or www.gulfofmexicoconference.org.

February 4-6—EUROMARITIME, Marseille, France. +33 1 56 59 15 07, anne-charlotte.micca@gican.asso.fr or www.euromaritime.fr.

February 4-6—Underwater Intervention, New Orleans, Louisiana. ui@naylor.com or www.underwaterintervention.com.

February 11-13—Subsea Expo, Aberdeen, Scotland. www.subseaexpo.com.

February 16-21—Ocean Sciences Meeting, San Diego, California. 571-279-0037 or www.agu.org/Ocean-Sciences-Meeting.

February 17-21—European Shipping Week, Brussels, Belgium. Smoloney@elabor8.co.uk.

February 24-27—Canadian Hydrographic Conference, Quebec, Canada. chc2020@conferium.com or www.chc2020.org.

MARCH

March 9-10—World Ocean Summit, Tokyo, Japan. +971 552215208, oceansummit@economist.com or www.woi.economist.com/world-ocean-summit.

March 17-19—Oceanology International, London, England. +44

(0)20 82712133 or www.oceanologyinternational.com.

March 23-25—International Lidar Mapping Forum, Washington, D.C. www.lidarmap.org.

March 24-26—Challenge of Science Leadership Training, Cambridge, England. info@scienceleadership.co.uk or www.scienceleadership.co.uk.

March 25—AUVSI Hill Day, msmithsky@auvsi.org or www.auvsi.org/events/hill-day/auvsi-hill-day-science-and-tech-fair-2020.

March 31-April 1—Decommissioning & Abandonment Summit, Houston, Texas. www.decommissionworld.com/gom.

APRIL

April 6-9—OCEANS 2020 Singapore, Singapore. info@oceans2020singapore.org or https://singapore20.oceansconference.org.

April 13-16—MTS Buoy Workshop, Wilmington, North Carolina. rickcole@rdsea.com.

MAY

May 4-7—AUVSI XPONENTIAL, Boston, Massachusetts. meetings@auvsi.org or www.xponential.org.

May 4-7—Offshore Technology Conference, Houston, Texas. 972-952-9494, meetings@otcnet.org or http://2020.otcnet.org.

May 6-7—Remote Hydrography Conference, Southampton, England. helen@ths.org.uk or www.ths.org.uk/content.asp?page=99.

May 18-19—Maritime Transport Efficiency Conference, Geneva, Switzerland. bernard.schopfer@maxcomm.ch.

May 19-21—MegaRust, San Diego, California. 703-836-6727, asnehq@navalengineers.org or www.navalengineers.org/Symposia/MegaRust-2020.

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

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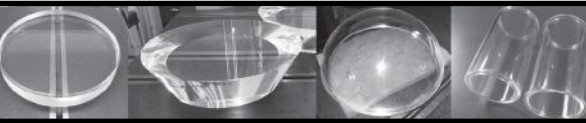
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Super Cables: Re-Imagining Subsea Systems—Clifford Holliday

Clifford Holliday, B.S.E.E., P.E., M.B.A., prepared the "Super Cables: Re-Imagining Subsea Systems" report. It is his 50th significant telecommunications marketing/technical report for Information Gatekeepers Inc. of Boston since 1999. The report is currently available at www.igigroup.com. In addition to writing for Information Gatekeepers, Holliday is the founder and president of A and C Consulting Services.



There is a quiet revolution going on that is little seen and almost entirely unknown. Even though this process is happening in a world that is hidden, it is vitally important to all of us.

The world of undersea cables has come to make daily life, as we now know it, possible. These cables connect the continents of the world and carry 95 percent of all international communications.

In the last 10 years, the total amount of this traffic has been dramatically increasing. It is now the second largest of all traffic classes in the U.S.A. and the fastest growing. In addition to this increase in volume, the fundamental nature of the traffic carried on these cables has changed. These changes in amount and kind have been taken into consideration in creating the requirements detailed in the new report "Super Cables: Re-Imagining Subsea Systems."

Previously, the vast majority of international cable traffic came from the global backbone of internet providers—the international carriers. Until 2010, they were responsible for about 80 percent of all international traffic. Now, they are only responsible for about 30 to 35 percent.

Most of the rest of the load is to and from the major internet content providers: Facebook, Google, Amazon and Microsoft. They have

dispersed their data centers all over the world so that now, for example, if you look up something online in Kentucky, the answer may come almost instantly from Hong Kong, taking advantage of the most readily available computer complex with the required information. Without subsea cables, such global access to information would never be possible.

The content providers (primarily Facebook, Google, Amazon and Microsoft) have become the primary users of subsea cables. Last year, such traffic accounted for 77 percent of the traffic coursing beneath the Atlantic and 60 percent of that under the Pacific; thus, the entire thrust of the market has changed.

With such a preponderance of utilization, it is only natural that the content providers want to take more control of this asset that is so key to their underlying business.

Google requires a 100 percent increase in its available subsea bandwidth every year to meet its requirements, meaning virtually a new, large cable every year.

While this Google growth is remarkable, the subsea market as a whole is growing (and projected to continue to do so) at a rate of 40 percent a year. At that rate, the entire market will double in a little less than two years.

A significant aspect of getting more control over subsea assets is, of course, actually owning the cables. All of these content-provider companies are committed to the ownership, construction and operation of many facilities. Some are joint ventures of more than one of the content providers. Taking control of this critical asset of their businesses is critical.

To have more direct control of this key asset, the large content providers want more direct control of the signals and, thus, the cables. The landing-station configuration has begun to change to help

achieve these control objectives. As this process has already started, it is expected to become the rule as the content providers demand to directly control a portion of, or all of, the cable.

The subsea world is borrowing heavily from the terrestrial optical world to meet the increasing traffic and enable the content providers to have better control. These two communications worlds have developed separately. Terrestrial developments have led the subsea ones, in spite of the subsea developments starting decades earlier.

Now, these two worlds are beginning to merge. This merger will result in the "super cable" that can provide extreme flexibility of control.

The new "Super Cables" report provides a discussion, explanation and forecast for the latest developments in the subsea-cable field. It explains how these developments will work together to meet this structural and growth requirement by ushering in the age of the super cable. Many alterations have already started; some are just beginning, while others are anticipated.

We use traffic forecasts and the known and deduced business interests of the major players as the drivers for cable growth and make appropriate forecasts on those bases, including details of the design and drivers of the coming super cables.

A discussion of the impact of cloud computing on subsea cables and a listing of the major companies participating in that area are in the report.

The report concludes with specific forecasts for submarine cable construction: likely routes and likely significant participants.

It also includes forecasts for cable-size changes, a time line for developments of cable technology, traffic forecasts and much more.

For more information on the report, visit www.igigroup.com. **ST**

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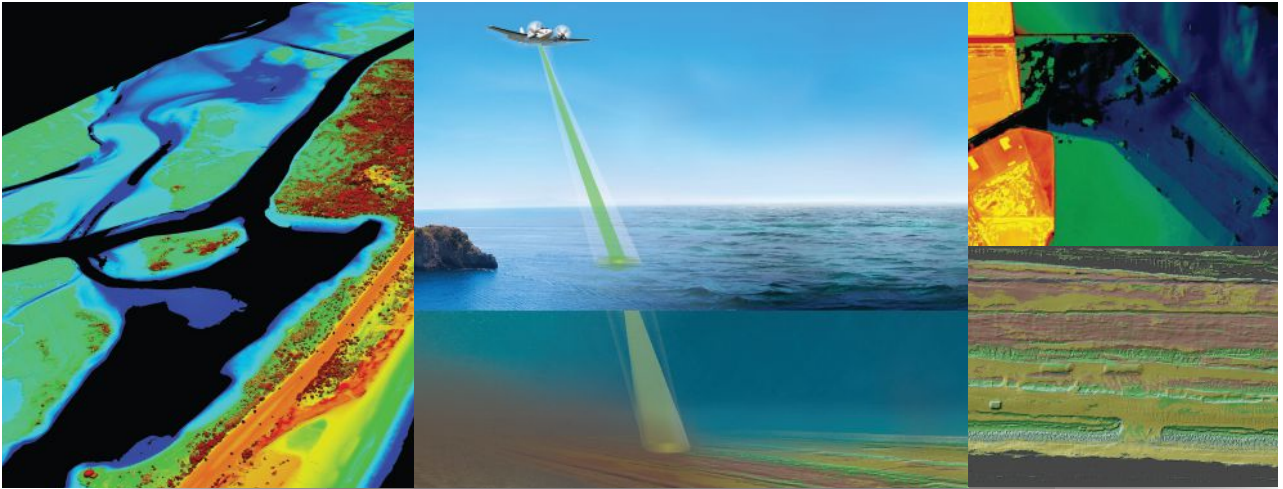
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