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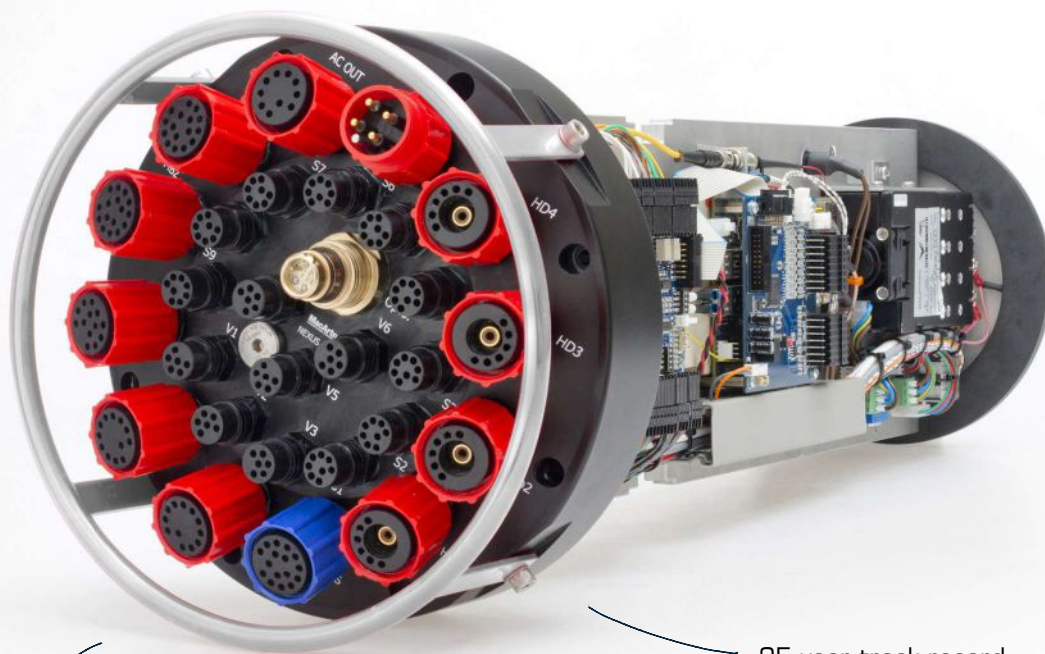
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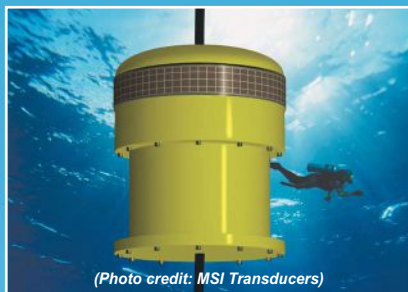
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COVER IMAGE

The officer of the watch monitors radar contacts and AIS tracks on a Raymarine multifunction navigation display while cruising off the Italian coast. Unique colorization of inbound and outbound moving targets brings enhanced situational awareness and instant recognition for watch standers. (Credit: FLIR Maritime, Raymarine Electronics)

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China's Arctic Ambitions

Climate change is opening up a vast, historically frozen region for global shipping, energy and mineral resources, fishing, and tourism. The Chinese, as asserted through the Polar Silk Road extension of their Belt and Road Initiative, have identified the Arctic as key to their economic future and Beijing's quest for global influence. Once northern passages such as the Northern Sea Route (NSR) and eventually the Trans-Polar Route become commercially viable for shipping, they will shave around two weeks off transit times between Asia and Europe compared to traditional southern routes. The Arctic is projected to be significantly ice free for four months annually by around 2030.

China has active energy projects in the Russian Arctic, most visibly with investments in Yamal LNG and the upcoming second Yamal LNG plant. China has become a leading natural gas consumer and has been making plays into Greenland and Iceland for energy, minerals and infrastructure to gain both presence and leverage for influence. China has also joined with Finland to develop subsea cables—a “Data Silk Road.”

With its Arctic policy, China is building a spider web of investment. China's Belt and Road Initiative, a global infrastructure financing mechanism, already has blue economic passages, from the Indian Ocean to the Mediterranean to the South Pacific—with the addition of the Arctic, this web becomes ever more complete. Some call it a maritime Marshall Plan.

For many years the U.S. and, to some extent, Russia were the predominant players in Arctic science, research and technology. That has shifted tremendously in the last five to 10 years, with China strategically pursuing its science in a way that U.S. policy seems to underestimate. China has been ramping up research in the last 20 years in Norway, Iceland, Greenland and Antarctica, as well as increasing the number of ice-capable Arctic research vessels.

The U.S. does not have as centralized or coordinated an approach to pursuing science and research, and industries are not as clearly connected. Meanwhile, China is able to bring vast financial, logistic and scientific resources into play from its government and the private sector.

The U.S. has always been a reluctant Arctic nation. From its purchase of Alaska from Russia in 1867, known as “Seward's Folly,” to Cold War remote radar stations to detect Soviet nukes, America has been episodically engaged in the Arctic in a geostrategic sense.

Russia is also in the Arctic picture. It has the longest coastline of any Arctic nation and relies on the NSR that runs along the Russian Arctic coast as an important toll road and source of resources. More than 20 percent of Russia's GDP comes from the Arctic; this will only grow as climate change makes more petroleum deposits accessible for development. Last year, 18 million tons of goods were transported through the NSR, almost 70 percent more than 2017. By 2024, Russia wants 80 million tons of goods to transit the route.

Currently, there is good cooperation among Arctic nations through the Arctic Council and the Arctic Coast Guard Forum. However, a search and rescue of a large tourist vessel or an oil spill in Arctic waters would stress existing capabilities. How will the United States, Russia, China and others cooperate should such an oil spill occur, or if a tanker or tourist vessel rescue is needed?

The Arctic could become a proxy for assertion of influence in this era of great power competition identified in the latest U.S. National Security Strategy. The Russians and Chinese are building up their military presence there, including scaling up joint exercises. Russia has assigned NSR regulatory responsibility to Rosatom, the Soviet-era agency that develops nuclear capabilities.

The U.S. has been slow to add icebreakers and more ice-capable vessels to the fleet and is only now finalizing plans to build a much-needed heavy icebreaker. The U.S. also needs to be able to conduct Freedom of Navigation Operations in the Arctic in order to exercise sovereignty and ensure access to the global commons. It could prove to be very costly if the U.S. downplays the strategic importance of the Arctic. **ST**

)) Autonomous Ferry Demo Complete in Finland. Rolls-Royce and ferry operator Finferries have successfully demonstrated the world's first fully autonomous ferry in the archipelago south of the city of Turku, Finland. Known as "*Falco*," the 53.8-m, double-ended car ferry, which had 80 invited VIP guests aboard during the demonstration, navigated autonomously during its voyage between Parainen and Nauvo using a combination of Rolls-Royce Ship Intelligence technologies. The ferry's return journey was conducted under remote control. "Today marks a huge step forward in the journey towards autonomous shipping and reaffirms exactly what we have been saying for several years, that autonomous shipping will happen," said Mikael Makinen, president of commercial marine at Rolls-Royce. During the tests in Turku archipelago, Rolls-Royce clocked close to 400 hr. of sea trials so far. Among the technologies that have been successfully tested thus far are the Rolls-Royce Autodocking system, which enables the vessel to automatically change course and speed when approaching the quay and carry out automatic docking without human intervention.

)) Pioneering Oceanographer Honored. For his work in the establishment of a new scientific field, Dr. Nicklas Piasias received the Maurice Ewing Medal, sponsored jointly by the U.S. Navy and the American Geophysical Union (AGU). Piasias, a professor emeritus at Oregon State University, accepted the award at the AGU Fall Meeting in December 2018. Named after Dr. Maurice Ewing, a trailblazing geophysicist and oceanographer, the medal is given yearly to one honoree in recognition of "significant original contributions to the ocean sciences." In the late 1970s, and for the next two decades, Piasias helped establish the field of paleoceanography—the study of the ocean's history through sediment analysis, geochemistry, isotopic dating and time-series analysis of ocean processes and dynamics. The Office of Naval Research (ONR) sponsored some of Piasias's early research, including analysis of sediment cores during the Deep-Sea Drilling Project and Ocean Drilling Program, which lasted from 1968 to 2004. Both international drilling initiatives studied the history of the ocean and the nature of the crust beneath the seafloor. Piasias's research established some of the first continuous, high-resolution records of climate shifts over the past 5 million years.

)) DNV GL Helps Washington State Develop Roadmap for Sustainable Maritime Growth. Washington State partnered with DNV GL in late 2017 to develop the "Washington Maritime Blue" strategy for the sustainable development of the state's \$38 billion maritime industry. With that strategy now complete, the state plans to achieve the



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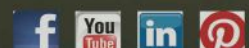
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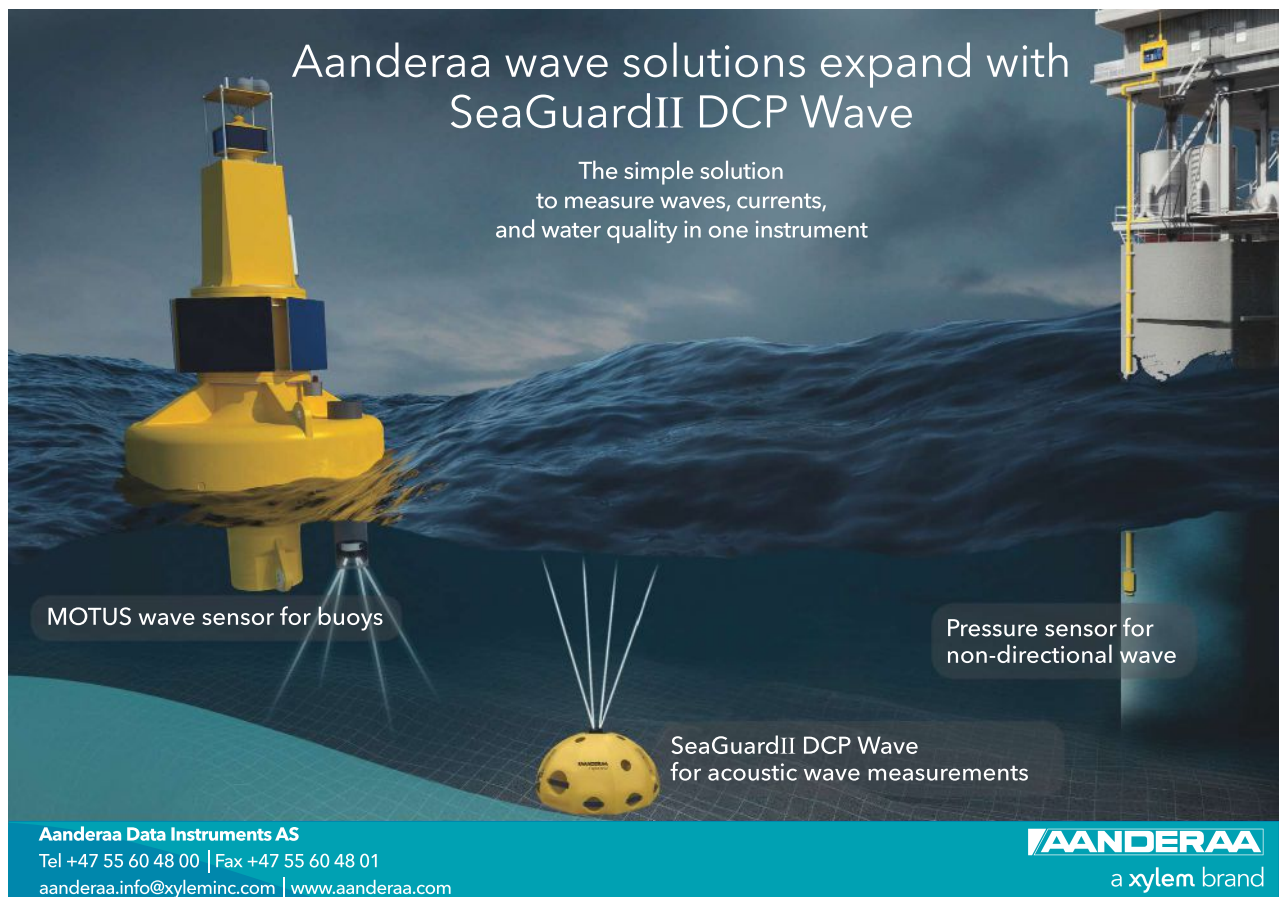
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vision of being home to a world-class, thriving and sustainable maritime industry by 2050. Key demonstration projects identified in the strategy include the state's plan for decarbonization, electrification of Washington State Ferries, driving research and development to commercialization in maritime markets, digitalization and IT for maritime entrepreneurship, green gateway and port investments, youth maritime programming, and tribal engagement in blue and rural economic development opportunities.

)) AI Expands Maritime Autonomy. M Subs Ltd. has installed a game-changing sensor system with connected artificial intelligence (AI) machine-learning technology around Plymouth Sound as part of the vision to turn the city into a center of excellence in maritime autonomy and unmanned vehicles. M Subs will operate a secure network of cameras, radars and other sensors to provide situational awareness and communications with the unmanned vehicles operating out of the city's harbor. The system will also provide the command and control of unmanned vehicles using the nearby ranges at sea. Data from the network are being collected and analyzed by machine-learning programs by M Subs' growing AI team, with the assistance of Thales and a global and corporate partner in the field of machine learning and AI. The results of this work will finalize development of the computing system at the heart of the maritime AI system to navigate the *Mayflower Autonomous Ship*, mayflowerautoship.com, across the Atlantic Ocean in celebration of the 400th anniversary of the original *Mayflower* sailing in 1620.

)) Blockchain to Guarantee Fishing Traceability in Pacific. WWF and its partners have introduced revolutionary blockchain technology to the Pacific Islands' tuna industry, the first of its kind for this region, to help stamp out illegal fishing and human rights abuses. Tracking fish from vessel to supermarket, the Blockchain Supply Chain Traceability Project is using digital technology in the fresh and frozen tuna sectors of the Western and Central Pacific region to strengthen supply chain management. WWF-New Zealand, WWF-Australia and WWF-Fiji have teamed up with global tech innovator ConsenSys, information and communications technology implementer TraSeable, and tuna fishing and processing company Sea Quest Fiji Ltd. to deliver the project in Fiji. Through blockchain, soon, a simple scan of tuna packaging using a smartphone app will tell the story of a tuna fish—where and when the fish was caught, by which vessel and fishing method. **ST**



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Transforming Shipboard Service

Holistic Strategy Reorganizes Product-Service Integration

By Hans Ottosen • Jimmy Grewal



Danelec Marine conducted a total redesign of its product architecture, introducing a completely new concept in marine electronics called SoftWare Advanced Protection (SWAP) in which all the VDR's system programming and configurations are contained on a hot-swappable memory card that plugs into the front panel of the unit.

Modern manufacturing, distribution and service companies around the world are embracing “servitization” strategies to develop and deploy integrated product-service solutions. In a servitized business model, the concept of integrated product and service permeates all aspects of a company’s business, including product architecture, standardization of parts and processes, quality control, worldwide distribution, product maintenance and repairs, spare-parts management and customer interfaces. It has benefits for all parties on the sell-side and buy-side. For the manufacturer it provides competitive differentiation, deeper relationships with customers, enhanced customer satisfaction and a source of recurring revenue. For the customer, it provides more value for the money and lower cost of ownership across the full life cycle of the products and faster and better after-sales service and support.

Until now, adoption of servitization has been sluggish in the global maritime industry. While we have seen an astonishing influx of new shipboard electronics and automation systems over recent decades, the way these products are maintained, serviced and repaired aboard ships has remained largely unchanged.

This is because servicing products on ships sailing on global routes across 24 time zones presents unique challenges.

Shipboard personnel are generally not equipped nor trained to perform repairs at sea, and it is impractical to carry a large inventory of spare parts on ships. Hence, the burden is shifted to technical service facilities ashore to respond promptly with trained technicians equipped with the necessary spare parts to do the job. Commercial pressures mandate fast turnaround in port with a minimum of downtime.



Elcome technician with the HoloLens headpiece on a service job.

New Business Model for Shipboard Service

In this article, we will discuss the challenges and solutions for creating a more streamlined and integrated approach to shipboard service from the point of view of a global manufacturer of shipboard electronics and a major international service company.

First a few words about our two companies. Danelec Marine is a Danish manufacturer of marine electronics, including voyage data recorders (VDRs), electronic chart display and information systems (ECDIS) and Internet of Things (IoT) connectivity solutions. More than 6,000 ships today are equipped with a VDR or S-VDR designed and manufactured by Danelec. Elcome International is one of the world's largest independent marine service companies with headquarters in Dubai and service offices in 11 countries.

Before we turn to proposed solutions, let's briefly look at a typical service scenario: A critical item of navigation equipment experiences a failure at sea, and the crew is unable to get it back into operation. The master reports the problem to the shipowner or manager, who in turn contacts the shipping agent in the next port of call. The shipping agent arranges for a service call from the nearest authorized service provider as soon as the ship docks. The service technicians board the ship, either at anchor or pier-side. They conduct diagnostic routines to determine the problem. They may call the manufacturer's service department for guidance and advice. Once the problem is identified, they return ashore to fetch the needed tools and spares or a replacement unit if needed. Assuming the correct parts are available locally, they return to the ship, make the repairs, reinstall connections and cables, reload the operating system and software programs and test everything to make sure it is working properly. If the parts are not readily available, they must be ordered and

shipped—usually by expensive airfreight. The process may take several days, resulting in costly downtime in port. Because many critical shipboard systems are mandated under international carriage requirements, the port state control authorities often will detain a ship in port until repairs are made satisfactorily. If the authorities grant a waiver and allow the ship to sail, the whole process will be repeated at the next port. Occasionally, the technicians may ride the ship to make repairs underway, flying back to their home office from the next port.

This process is inherently inefficient and unnecessarily expensive. So, how can it be improved? We'll start with the manufacturer.

Servitized Manufacturing

Traditionally, most marine manufacturing companies are organized around vertical "silos" such as product development, engineering, production, marketing, sales and service. The service department is usually not involved in the R&D or product development stage and is treated as a separate cost center.

When it came time for Danelec Marine to introduce its second-generation line of VDRs about five years ago, the management team saw a perfect opportunity to adopt a servitization strategy and initiated a top-to-bottom transformation encompassing all aspects of the business. This involved dissolving vertical silos and creating a company-wide involvement in the streamlining of service.

The first step was a total redesign of product architecture, introducing a completely new concept in marine electronics called SoftWare Advanced Protection (SWAP) in which all the VDR's system programming and configurations are contained on a hot-swappable memory card that plugs into the front panel of the unit. This simplifies and streamlines the service process aboard ship.

When boarding the ship, the service technicians can bring with them a replacement VDR processing unit. They extract the SWAP card and disconnect the old unit. Then they slide the replacement unit into the rack, reconnect the plugs and reinsert the memory card into the new unit. There is no need to reprogram the new unit or reinsert software programs. They are automatically downloaded into the new unit, and the VDR is fully functional as soon as it is switched on. The service call is completed in a matter of hours rather than days. The faulty unit is returned to a Danelec certified repair facility and, if possible, is returned into inventory. The SWAP functionality has now been incorporated into every product manufactured by Danelec.

The second step was a complete reorganization of the company's service organization, establishing new rigorous standards for service providers worldwide and creating standardized policies and practices. All third-party service technicians

are given extensive training prior to becoming certified to perform product installations and the mandatory annual performance tests (APTs). Danelec upgraded and expanded the service network worldwide, augmenting service availability in more than 50 countries and established certified service centers, which are required to maintain a substantial inventory of replacement units and spares. Importantly, Danelec also set up an automatic feedback mechanism for service technicians. A report is automatically initiated for every service call. Danelec monitors and analyzes every installation and APT to ensure it conforms to quality standards, and a below-standard report triggers a requirement for remedial training for the technician.

The third step was the launch of an automated cloud-based eService platform that provides seamless integration of the ship service process by connecting the equipment manufacturer, the local service company and the ship manager. When a

service call is initiated, the service company can log into the eService portal to retrieve information on the product's service history and be fully prepared with trained and certified technicians with the right tools and parts to make the repair quickly with minimum downtime for the ship. At the end of the service call, the technician can use the eService tool to perform an automated error check procedure and extract a data sample from the VDR. The Danelec team reviews the data as part of the quality-control procedure. If the vessel had more than one service call recently on the equipment, eService automatically initiates a red-flag alert, and a plan for solving the recurring problem is developed.

The next step, which is ongoing, is to integrate remote equipment monitoring into an IoT solution using a universal onboard server, which accepts and processes data inputs from all types of shipboard systems for transmission from ship to shore via a relatively inexpensive satellite connection. The Danelec-Connect platform allows for both "push-through" and "pull-through" of data sets from the VDR from shore offices. With this level of connectivity, the manufacturer, ship manager and service provider can have access to data from the shipboard equipment. This will give an early warning of a potential fault or failure and will yield useful inputs prior to initiating the service call.

Digitizing Service

Now let's consider the point of view of the service provider.

Elcome International is a good example of a large service organization. Founded 50 years ago in 1969, Elcome is based in Dubai and has service locations in United Arab Emirates, Egypt, Bahrain, Kuwait, Oman, Saudi Arabia, Sri Lanka, Singapore and Malaysia, as well as a subsidiary and associated companies in India. The Elcome Group has more than 500 employees, including more than 200 highly trained engineers and technicians, and maintains a spares inventory worth more than \$15 million. Elcome is the authorized sales and

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service representative for more than 60 major equipment manufacturers and offers a range of annual maintenance contracts that ensure service and spares availability at predictable costs. Elcome technicians make an average of 800-plus ship-service calls per month with a first-time fix rate of 96 percent. Additionally, Elcome is Southeast Asia's largest supplier of nautical charts and publications, both print and digital, and operates a training center and bridge simulator in Dubai.

In 2018, Elcome embarked on a major top-to-bottom modernization of its service business harnessing new disruptive technologies such as mixed reality, artificial intelligence (AI), holographic computing, cloud-based IoT, analytics, big data, collaborative databases and knowledge-based software tools. The goal was to provide greater transparency, improve efficiency, minimize errors, speed up repairs, reduce operational costs and minimize downtime for customers.

The new platform was developed for Elcome by Hitachi Solutions and built on Microsoft Dynamics 365 software, integrated with the Microsoft HoloLens wearable mixed-reality technology. The comprehensive solution uses cloud-based interconnectivity to automate and streamline all facets of managing shipboard service, including the initial service request, scheduling the service call, assigning the most appropriate available service engineer for the job, ensuring the proper service kit, performing and documenting the service job, logging man-hours, testing, recertifying and following up on the job.

A major part of the effort is the digitization of Elcome's massive paper-based service files, which contain hundreds of thousands of job reports dating back nearly 20 years, reflecting the average lifespan of a ship and installed equipment. The digitized files are being used to construct an easily accessible searchable library using big data and AI tools to provide insights in service history for equipment failures, repetitions, fault symptoms and remedies.

Elcome is also developing standard service kit packages, including tools, spares and documentation for the full range of products and manufacturers represented. These service kits can be customized as needed for each specific job.

The Microsoft HoloLens technology brings a totally new dimension to field service. A combination of virtual reality and holographic computing, the HoloLens headset gives the service technician hands-free access to vital data, including equipment history, service tips, diagnostics, schematic drawings and technical management, as well as remote face-to-face consultations with experts, all superimposed holographically in a 1:1 image over the real-world view. The built-in camera can also be used to document the service call and record the repair work in the job report.

The HoloLens headpieces are currently undergoing test and evaluation, with full system-wide deployment planned for 2019. The headsets will be deployed with Elcome technicians on all service calls as part of their



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standard kit. Elcome will also make them available to all ships covered by annual service plans. This will enable the ships' crew to communicate with Elcome's service center to help diagnose the problem so the Elcome technicians can troubleshoot before initiating the service call. Elcome will preprogram the shipboard HoloLens units with virtual "sticky notes" for specific products and systems as reminders for the crew when performing on-board maintenance and troubleshooting problems. In many cases this may avoid a service call, and if shore-side service assistance is needed the technicians can prepare the proper service kit of parts and tools tailored for the job before boarding the ship.

Elcome is also digitizing its nautical charts and publications business, switching to digital products to reduce expensive inventory and improve response times for customer requests. For customers who still require paper charts, Elcome has invested in a print-on-demand system for faster response times, without need for manual corrections. Elcome's full-size digital printers produce charts directly from the UKHO ADMIRALTY cartographic database. The printed charts meet the highest cartographic quality standards and are fully up to date when printed. This has allowed Elcome to reduce the number of paper charts in stock from 6,000 to about 300 local charts.

Conclusion

For many years, there has been little change in the way shipboard equipment is maintained, serviced, up-

graded, repaired and replaced. That's starting to change, driven by initiatives such as the ones described above.

As servitization takes root in the maritime industry, manufacturers, third-party service representatives and ship managers will gain important benefits—in terms of faster and more efficient service, minimal downtime, lower life-cycle costs and—importantly—vastly improved customer satisfaction across the board.

This will become increasingly important as the maritime industry continues to move toward greater onboard automation. **ST**

Hans Ottosen is the CEO of Danelec Marine.



Jimmy Grewal is the executive director of Elcome International.





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Real-Time Berth Monitoring

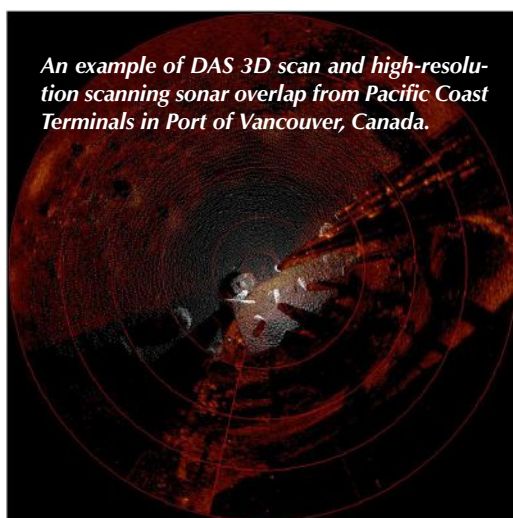
Single-Beam, Dual-Axis Sonar Increases Safety, Profits

By Konrad Mech

Ports, and the vessels using them, are vital to global trade. And global trade continues to grow, driving volumes of goods transported by sea to numbers never seen before. As a result, freight companies demand lower costs. In a drive for economies of scale, cargo carriers have responded by building and operating vessels that are increasingly larger. Ultra-large container vessels (ULCV) are now approaching 20,000 TEUs. Just 15 years ago, a container vessel considered large carried 6,000 TEUs. This trend to larger container vessels is driving increased capital investment in port infrastructure at a rapid pace, but the knock-on effects in capital and operating costs are substantial: longer berths, reinforced quays, higher cranes, and deeper berths and channels are all required.

ULCVs are wider, longer and deeper in draft. Nowhere does this have a bigger impact than in dredging channels and berths to accommodate them. Dredging is very expensive, disruptive to port operations and environmentally demanding. Yet, an attitude of “out of sight, out of mind” still exists in some quarters. We can’t see below the water line, so we are often insensitive to how crucial accurate berth depths are for safe, effective and efficient port operations. The challenge is even greater with autonomous vessels on the near horizon.

When a vessel grounds, multiple stakeholders become involved, including insurers, transport safety board officials, harbormasters, vessel owners and officers, pilots, and terminal operators. Delays ensue, disputes arise about direct and consequential damages, and, ultimately, time is money. Liability is also an issue for terminal operators, following the civil and environmental penal-



An example of DAS 3D scan and high-resolution scanning sonar overlap from Pacific Coast Terminals in Port of Vancouver, Canada.

ties levied in the wake of the *Athos I* tanker sinking. It is obviously better not to ground, but to avoid the time and financial costs of a grounding event, accurate up-to-date knowledge of berth and channel conditions is necessary. Unfortunately, berth-depth data are not always accurate or up to date.

Risk Mitigation

A common method to mitigate grounding risk is to underload vessels. While this is safer, unused draft in a ship is wasted cargo space and lost profit. Cargo carriers are in the business of carrying cargo, so maximizing the available

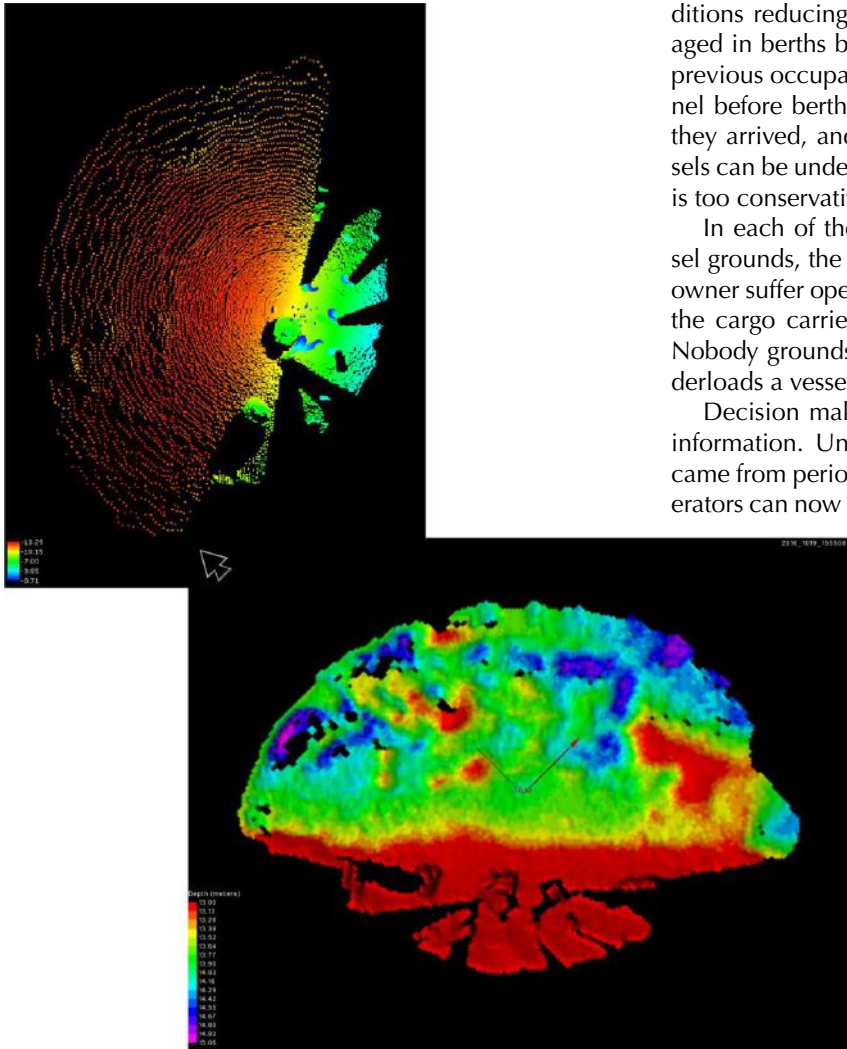
capacity on board is critical. They should have the tools and systems to carry as much cargo as safely and as efficiently as possible.

Berth depths derived from bathymetric surveys and published by ports and terminals are, of necessity, conservative. Bathymetric surveys require sophisticated equipment, trained surveyors and dedicated vessels; because of the costs, they are only conducted periodically.

But berth bottoms are not static; they change constantly. Weather events are increasingly dynamic, so bottom conditions in ports are transforming faster than in the past, and bathymetric survey data start to age as soon as they are published.

In ports with dynamic conditions, users apply increasing factors of safety very soon after the results are published, effectively reducing capacity and the potential profit for every voyage.

In the Port of Houston, for example, where shoaling due to bayou runoff is an ongoing condition, some users start to reduce cargo capacity in the channel just three months after dredging.



(Top) 3D scan of pier pilings at Pacific Coast Terminals using DAS. (Bottom) 3D scan showing depth measurements, looking down on bridge pilings at Pacific Coast Terminals.

The Status Quo

The type of data produced by bathymetric surveys is contingent on the technology used. The contracted surveyor may be using a single-beam echosounder, as opposed to a multibeam survey instrument. Single-beam echosounders produce an incomplete picture of the complete berth topography. They plot single-depth soundings along track lines that may miss key features such as spilled cargo in berths or localized shoaling from effluent deposits. However, even if multibeam is used, the survey is likely conducted prior to events that cause significant changes to the berth topography. Surveys are rarely conducted in the middle of hurricane or monsoon season, for example.

The status quo, then, has a number of issues that present far from optimal circumstances that can severely affect the efficiency of operations for the cargo carrier: Vessels can ground in berths because they are overloaded; vessels can ground in berths because the stated berth depth was incorrect due to dynamic environmental con-

ditions reducing the actual depth; vessels can be damaged in berths because there is debris in the berth from previous occupants; vessels might be lighter in the channel before berthing because conditions changed before they arrived, and at arrival they are overloaded; or vessels can be underload because the published berth depth is too conservative.

In each of the above cases, someone loses. If a vessel grounds, the insurer, the ship's officers and the vessel owner suffer operating costs. If the vessel is underloaded, the cargo carrier and the port lose foregone revenues. Nobody grounds a vessel intentionally, and nobody underloads a vessel without reason.

Decision makers decide based on the best available information. Until now, the best available information came from periodic survey, but there is another way. Operators can now obtain real-time, persistent data on berth depths, resulting in safer operations and higher profits.

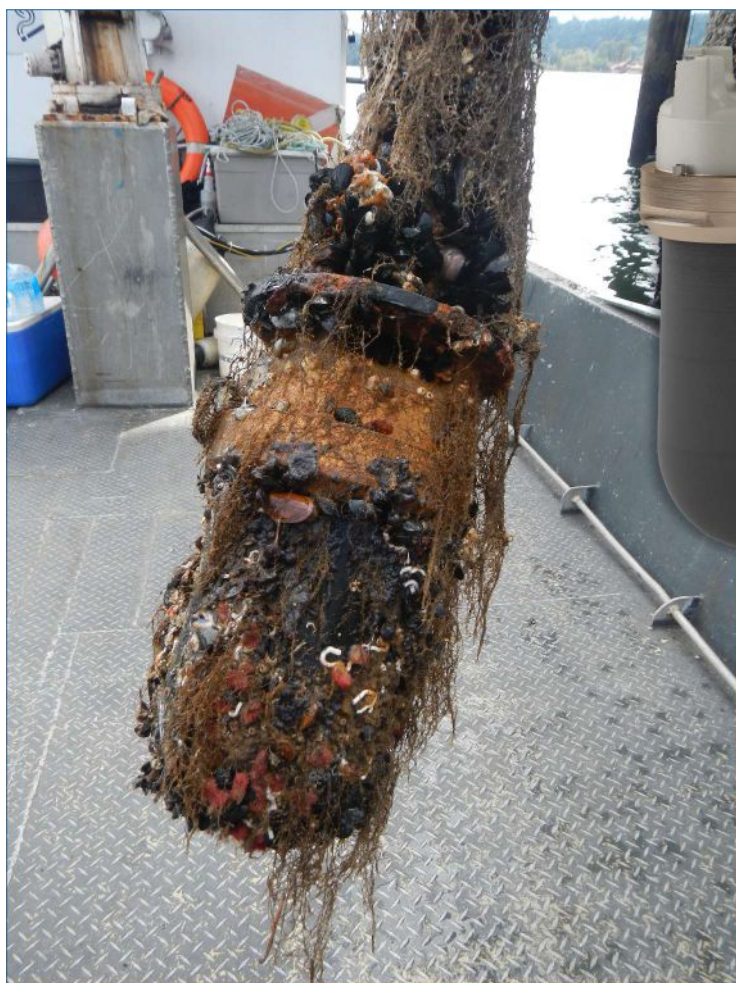
Kongsberg Maritime is a leader in single-beam and multibeam echosounders for hydrographic survey. Kongsberg also introduced the world's first sector-scanning sonar systems. The Dual Axis Sonar (DAS) has been developed from proven technology used for offshore, e.g., oil and gas construction and intervention, and the marine engineering market. DAS is the perfect instrument for persistent berth-depth monitoring and breaking through the inefficient status quo.

Real-Time Monitoring

A berth-depth monitoring and reporting system comprises one or more DAS sonar heads, which are permanently installed on the wall of the berth pocket. The data from each sonar are transmitted to Kongsberg's Mapping Cloud to be accessed by any authorized user for a number of purposes and through numerous devices, including smartphones, tablets, laptops and desktop computers.

The DAS is a single-beam echosounder with a key difference: Unlike single-beam echosounders that are mounted on vessels and create data by pinging along a survey line, the DAS is fixed in location and creates a 3D map of the berth by moving its beam over the survey area. A two-axis step motor changes the aiming point of the beam in defined, precise increments. When each point is plotted, the series of points generates a three-dimensional point cloud of the scan area. Draping a surface over the points creates a topographical image of the seabed at a berth. While the representation of the berth appears as if it were generated by a multibeam, the point cloud is generated by this single beam over time. The user can select scans to be conducted at set times of day, correlated with tidal action, on demand (e.g., prior to vessel arrival) or continuously.

The ability to monitor and report berth conditions in real time is possible because manufacturing costs of so-



DAS sonar head after 11.5 months of continuous deployment and operation; still working flawlessly. (Inset) A close-up of DAS sonar head.

nar and of data processing have decreased dramatically in recent years. Port authorities and terminal operators can deploy this equipment economically and gain the benefits of maximizing cargo loads while improving safety. Real-time berth-depth monitoring allows all stakeholders to get real-time soundings, corrected for tide and weather, at any time, from anywhere.

Benefits

This real-time approach brings significant advantages. Rich data on dynamic changes to berth bottoms are gathered. Conducting frequent periodic surveys is costly and impacts operations. A berth can't be surveyed using vessel-mounted echosounders when a vessel occupies it, and an unoccupied berth doesn't make any money. The DAS sonars work in the background continually, providing rich data about rapidly changing dynamic conditions. The equipment remains in situ even when vessels are berthed, and the DAS can be programmed to work around the vessel arrival and departure schedule.

The DAS system has a simple architecture. The sonar head locations are selected to ensure they provide adequate coverage of the seabed while avoiding impact to

ship docking, loading, unloading and undocking operations. The user-access terminals likewise can be anywhere. This architecture affords the owner flexibility in where to deploy key assets, particularly proximal to whoever will service and maintain them.

The system is scalable. A terminal can start with critical berths and expand the system as budget, permits and needs require. Since data are processed and fused in Kongsberg's Mapping Cloud, scaling is straightforward. Berth-depth data can be accessed from anywhere on any device with the appropriate app and user credentials to access and analyze the data.

The DAS sonar is based on proven, robust technology and features a sonar head that is easy to clean of marine fouling. The DAS is able to pick up small targets in the scanned area. Should a vessel drop material into the berth, the event will be captured and logged by the system. This allows the terminal operator to consider a charge-back of any remediation costs to the vessel responsible, based on the before-and-after data recorded by the system. This is more important than ever based on new jurisprudence.

Vendors of systems designed to optimize and control vessel traffic (VTS) currently don't have real-time berth-depth inputs for ports of departure and ports of arrival. Real-time berth-depth data can be easily integrated into these systems, thus allowing cargo carriers to optimize loading and unloading plans using the latest depth soundings at ports of departure and arrival. Based on the cost (and value) of every centimeter of vessel draft, this is critical to profitability and safe operations of the global container and bulk cargo fleet.

Looking to the near future, the DAS system can also provide critical data for autonomous shipping. Autonomous vessels utilize numerous sensors, and the data are fused to ensure safe navigation and operation. Real-time berth-depth data are a necessary input.

Continuous berth-depth monitoring enables ports and terminal operators to monitor and report real-time berth depths to all stakeholders. The data are of particular value to vessel operators. They can adjust the amount of cargo they load using real data, as opposed to published berth depth that may be out of date and unsafe due to dynamic conditions. This robust, reliable and affordable technology is available now, anywhere in the world, for any operators concerned with optimizing cargo capacity and fleet effectiveness. **ST**

Konrad Mech is a registered professional engineer (mechanical) and a certified project management professional. As director of Subsea Channel Management, his mission is to build, empower, motivate and monitor Kongsberg Maritime Subsea's network of more than 90 agents and dealers worldwide.

AUVSI XPONENTIAL

AUVSI XPONENTIAL will head to Chicago April 29 to May 2, 2019. It is here that 8,500 technologists, regulators and users across commercial and defense sectors will convene at the largest, most comprehensive trade show for unmanned and autonomous systems. As adoption of these systems spreads and applications expand, XPONENTIAL is the one event that brings together the entire unmanned systems community to share ideas, collaborate across markets and capitalize on best practices and emerging trends.

XPONENTIAL offers access to more than 700 exhibitors and more than 150 sessions. Whether it's hands-on demos, thought-provoking keynotes or speed-networking sessions, attendees have the opportunity to experience all things unmanned.

XPONENTIAL includes exciting programming on maritime technology, including two technical tracks on enabling technology, a panel discussion on autonomous shipping and a panel on autonomous precision surveying.

This year, XPONENTIAL also includes more demos, training and networking, including: a low-speed ground demo offering the opportunity to interact with autonomous vehicles through a ride-along around the exhibit floor; the Drone-User Education Track, a series of educational sessions dedicated to safely and effectively deploying UAS across all experience levels and vertical markets; targeted and more inclusive networking events available in smaller settings conducive to conversation and collaboration; and the largest networking event—The MAX—that will take place on the show floor for maximum connections.

Startup Showdown

The AUVSI Startup Showdown, powered by leading accelerator and investor Starburst, is a

competition for early-stage, disruptive companies who are creating, innovating or enhancing unmanned systems technologies and applications. Startup Showdown identifies up-and-

coming, investment-worthy start-ups and gives them a platform to share their innovations with investors and corporations looking to form profitable connections with the next generation of game-changers.

In 2018, one of the five finalists was a start-up that offered autonomous amphibious robots that work in harsh terrains. The 2019 Startup Showdown is bound to uncover more exciting new technology.

Women and Diversity

As the XPONENTIAL 2018 host and session moderator Sara Blackmer stated, "Innovation is not found when you have like people thinking alike."

For the last three years, the Women and Diversity in Robotics event has continued to grow, developing in-depth discussions facilitated by leaders with a wide variety of roles and backgrounds that push attendees to tack-





le difficult questions and reflect on how we can help increase diversity within our own organizations.

STEM Program

Together, AUVSI and RoboNation inspire achievement for STEM. RoboNation is a nonprofit organization with a mission to provide a pathway of hands-on educational experiences that empower students to find innovative solutions to global challenges.

Join AUVSI at the Growing the Industry Hub in the XPO Hall to see exactly how they are working together



to develop tomorrow's problem solvers, risk takers, critical thinkers and innovators. During each break in the show program, they will host candid dialogues between highly skilled young professionals (to share what they look for in an employer) and leading industry professionals (to share what they look for in new hires).

Student teams from each RoboNation competition will exhibit their vehicles, technical knowledge and skills. STEM demos will include SeaPerch and SeaGlide demonstrations, displaying two of our hands-on robotics programs for K-12 students. Stop by and test-drive an underwater SeaPerch ROV or race a SeaGlide and watch it fly underwater.

During XPONENTIAL, RoboNation will also host RoboTour, a one-day free event on May 2 that will introduce future generations of scientists and engineers to the exciting world of unmanned systems.

Students in grades five through 12 will have an opportunity to tour displays and robotic hardware in AUVSI's XPONENTIAL exhibit hall to learn about contributions to the unmanned systems community. Adult chaperones and advance registration are required.

For more information and to register, visit xponential.org. **ST**

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Abalone Aquaculture

Cage System for Growth in Power Plant Thermal Effluent

By Dr. Taeho Kim • Dr. Moo-Hwan Oh • Dr. Jihoon Lee

The aquaculture potential offered by the thermal discharges of power stations is widely recognized. Their suitability for fish farming largely depends on the cooling water sources and on the design and operation of the power station. Water of varying quality and salinity is used to generate steam and drive the turbines, which then drive the generators, and the waste steam is fed to a condenser and discharged as thermal effluent.

The heated water that is discharged from steam-electric generating stations has been considered a nuisance and a direct threat to aquatic life. The survival rates of caged fish in discharge canals have been extremely poor, and, thus, it is necessary to develop an aquaculture system for culturing new species such as abalone that can tolerate high-temperature environments relatively well compared to fish. This development would transform “waste water” into an aquaculture resource.

The Pacific abalone, *Haliotis discus hannai*, is a very valuable species that is commercially available in South Korea. The production of abalone at a commercial scale began in South Korea in 2000 after several years of research and development, and the country is currently the second largest producer of cultured abalone in the world, with 16,027 tons in 2017. The primary objective in designing the abalone cage system described in this study was to provide aquaculture potential in thermal-discharge environments at power plants during the winter season.

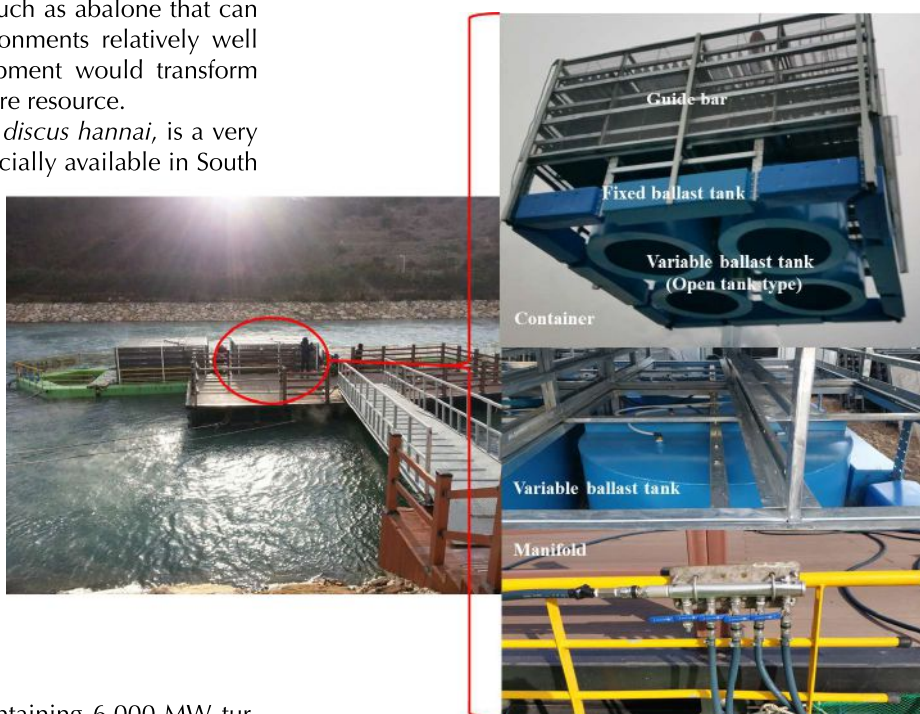
Discharge Channel

A coal-fired power plant containing 6,000-MW turbines located in Dangjin, South Korea, near Dangjin Port in the Yellow Sea, was used in this study. The coolant

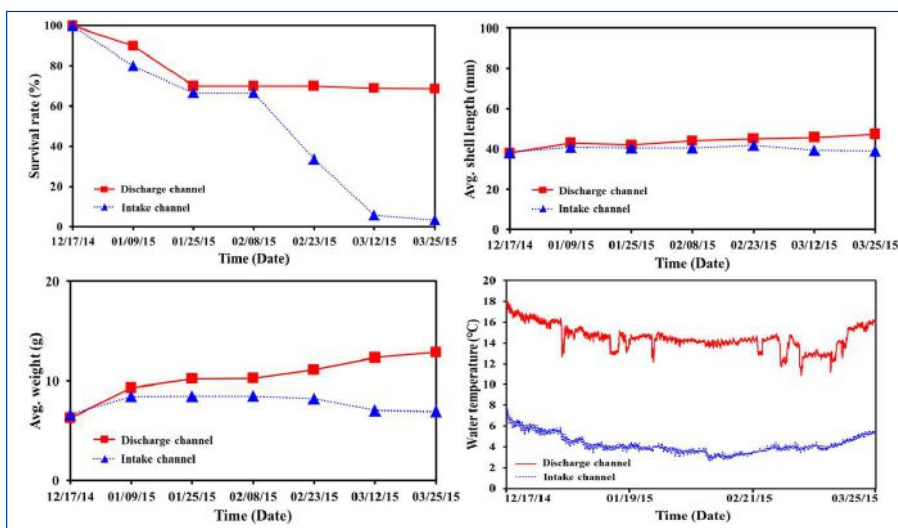
water from the power plant that is used to condense the steam, which is contained in an isolated circuit, is released into the channel.

The length of the discharge channel where the cage system is deployed is approximately 320 m. The channel has a trapezoidal shape with surface and bottom widths of 74.8 and 38.8 m, respectively, and a channel depth of 7.0 m.

Measurements of the various channel conditions were taken periodically to gain an understanding of the seasonal impact. The flow velocity of the channel was measured as 0.20 m/s in May 2014 and 0.57 m/s in August 2014. The maximum temperature of the water was



The abalone cage system deployed in the discharge channel.



(Top) Workers clean the shelter and feed the abalone in the containers. (Bottom) Survival and growth rates of abalone plotted with changes in water temperature in the discharge and intake channels.

28.76° C at the end of August, and the lowest water temperature was 12.44° C in the winter in February 2014. A water temperature of 28° C, which is the water temperature limit for most species of fish, was present from July to September over a period of three months. From January to December 2014, the salinity ranged from 30.44 to 32.12 psu, the dissolved oxygen ranged from 6.85 to 10.86 ppm, and the pH ranged from 7.62 to 8.0. The maximum thermal effluent temperature was 10° C warmer than that of the intake (i.e., thermal power stations have a ΔT of 10° C).

Abalone Cage Design

A rigid aquaculture system was designed for deployment in a discharge-channel-flow environment. The structure consisted of a modular assembly encompassing five containers, an air compressor, a manifold, air hoses to transfer the compressed air, and mooring ropes.

The entire system had a length of 31.67 m. Each component had the general dimensions of 5.47 m in length, 5.04 m in width and 2.70 m in height.

The structural materials were assumed to be made of basic carbon steel galvanized with zinc. The entire abalone containment structure contained 16 boxes (each with 16 plastic plate shelters in a box) filled with abalone and kelp or seaweed. The containers were organized in a four-by-three symmetric geometry within the framed structure. Each container could be raised above the frame to facilitate feed supply, husbandry and maintenance by compressed air.

Each container system comprised 12 fixed ballast tanks, four variable ballast tanks (open-tank type), upper and side frames, a bottom frame, guide rails, guide bar and stopper. The tanks were installed on the bottom of the square shape, so the container system would submerge evenly. Buoyancy was increased when the air generated by the compressor was injected into the tanks through the main evacuation hose. When the compressed air was discharged, gravity drew the seawater into the tank through water injection and a discharge pipe.

Once at the surface, the container could be inspected and cleaned, and the animals fed. When the husbandry operations were complete, air was released from the ballast tanks and the container structure was submerged for three to four days. The total weight of the container system in air was approximately 3,161 kg, with a buoyancy of

4,341 kg and a surplus buoyancy of 1,180 kg.

From the air compressor to the air distributor, one hyper-air hose with a diameter of 19 mm was used, and from the air distributor to the container, four hyper-air hoses with a diameter of 13 mm were used. The open tank used to control the buoyancy of the container was a nylon air hose with a diameter of 12 mm.

A total of 240 plastic shelters for the abalone grow-out could be installed in the container system, and approximately 110,000 individuals with 30 to 50 mm of shell length were cultured in all shelters. The upper, lower and side parts of the containers were all surrounded by stainless-steel netting (mesh size: 20 mm). Each abalone shelter had six sheets of polyethylene plates, or PP (thickness: 2.4 mm; spacing between plates: 132 mm), with an outer frame (pipe diameter: 32 mm). The size of the shelter was 1,000 by 960 by 250 mm (L × B × D).

Comparison of Survival, Growth Rates

Survival and growth rates of abalone were investigated in the cages installed in the discharge and intake channels for a total of 98 days from December 17, 2014 to March 25, 2015. The total number of abalone stocked in the 240 shelters installed in the container system was

“The performance of the variable ballast system to submerge and surface the abalone cage produced acceptable results, and the abalone grown in the discharge channel exhibited a higher growth rate in general...”

approximately 115,000, with about 479 abalone per shelter. The average shell length of each abalone was 37.87 ± 3.29 mm, and the mean wet weight was 6.29 ± 1.74 g. In order to compare the survival and growth rates of the abalone in the hot-water drainage channel and the intake channel, one cage for the control was installed in the intake channel. In the control cage, 500 abalones were enclosed within the abalone shelter, with an average shell length of 38.31 ± 3.35 mm and an average wet weight of 6.62 ± 1.86 g.

About 10 percent of the total stocks (approximately 11,500) were dead three days after stocking the abalone in the discharge channel, and most of the individuals with poor initial health died. Feeding was done about once every 10 days. To prevent deterioration of water quality in the shelter of the cage facilities, the abalone were fed and the remaining feed was removed at the next feed.

Bubbles and biofouling that occur in the channels would interfere with the flow in the container; therefore, the containers were raised above the water surface and cleaned at three- or four-day intervals using a high-pressure washer.

After the initial 10 percent die-off, the mortality rate increased, and the final survival rate of abalone was estimated to be 68.71 percent in the discharge-channel cage.

The survival rate of abalone in the control cage located in the intake channel began to decrease rapidly from February 23, 68 days after the abalone stocking, and the final survival rate of control abalone was 3.4 percent.

In terms of growth rate for the abalone in the discharge channel, the average shell length was 47.34 mm, representing a growth of 9.47 mm (125 percent), compared with 37.87 mm for the control cage. The average wet weight increased by 6.66 g (193.54 percent), from 6.29 to 12.89 g.

In contrast, the average shell length of abalone in the control cage grew from 38.31 to 38.9 mm, an increase of 0.59 mm (101.54 percent). The average wet weight of abalone in the intake channel increased by 0.28 g (104.84 percent), from 6.62 to 6.94 g.

The average growth of abalone shell length in the discharge-channel cage was 8.44 mm higher than that of the control cage in the intake channel.

The weight of abalone in the discharge channel was 5.95 g higher than that of the abalone in the intake channel, indicating that the hot-water drainage channel is more suitable for the growth of abalone than the intake channel in the winter season due to the influence of water temperature.

The growth of abalone is closely related to feeding behavior, activity level and water temperature. Abalone

usually eat less food at 7° C or lower, at which point their activity becomes very low. Because the water temperature in the intake channel was much lower than 15° C, which is the optimum water temperature for abalone, the abalone lowered their food consumption, and the survival and growth rates were poor.

Conclusion

In this study, in-situ tests were conducted to investigate the surface and submerged characteristics of a commercial-size abalone cage system, which was operated using an air control system, in the discharge channel of a power plant. During these tests, the container system was submerged to a predetermined depth and surfaced after a specified time. The performance of the variable ballast system to submerge and surface the abalone cage produced acceptable results, and the abalone grown in the discharge channel exhibited a higher growth rate in general compared to the control group in the intake channel. The successful performance of the abalone cage system in the discharge channel during the tests shows promise for feasibility in aquaculture to maximize growth rates of abalone in the winter season.

Acknowledgments

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Urgent Need for Ropeless Fishing

Removing End Lines to Protect Right Whales

Dr. Mark Baumgartner • Dr. Tim Werner • Dr. Michael Moore

Trap (also known as pot) fishing for lobster, crab and some fish species is a vital part of both the economy and the culture of coastal communities throughout the U.S. and Canada. For example, revenue from lobster fishing in Maine alone during 2017 totaled \$433 million, and an economic impact study by Colby College and the Maine Lobster Dealers' Association in 2016 suggested that the lobster supply chain contributes \$1 billion to the state's economy each year and generates 4,000 jobs. Lobster is as iconic in New England as clam chowder and the Boston Red Sox and arguably contributes as much to the culture as it does to the economy.

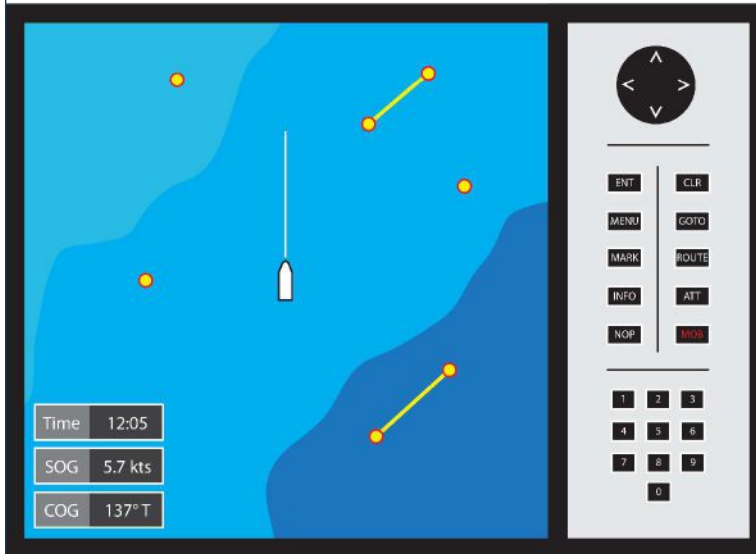
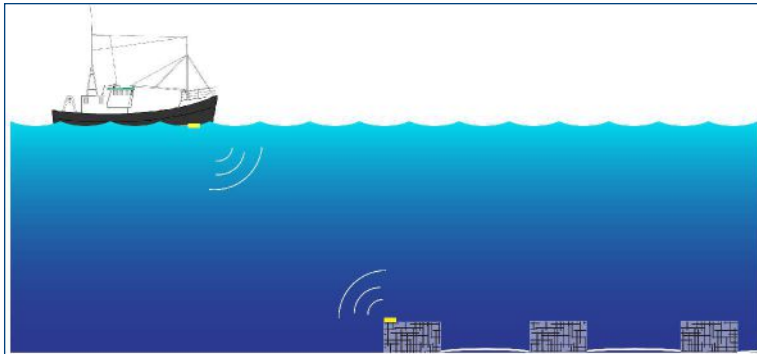
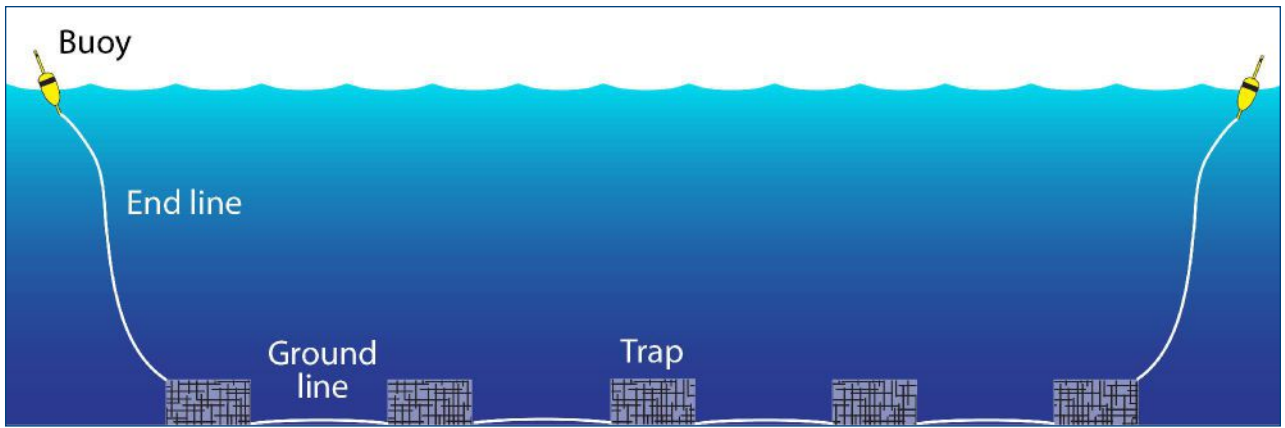
Traditionally, trap fishing uses ropes (called vertical, end or buoy lines) that connect traps to surface buoys, and sometimes ropes (called ground lines) that connect together a series of traps that lay on the seafloor. These ropes can entangle whales, sea turtles and sharks. Entanglements are a serious problem for many species, especially the North Atlantic right whale, a declining species that has fewer than 450 animals left, of which only 100

are breeding females. About 85 percent of right whales bear scars that indicate that they have been entangled at least once in their life, and more than half have been entangled two or more times. Right whale entanglement deaths have been increasing since 2010, likely because of increases in rope strength and changes in the whales' movement patterns.

Fishermen on the U.S. East Coast have been involved in efforts to mitigate right whale entanglements for nearly two decades. A variety of approaches, including seasonal closures, weak links, sinking ground lines and more traps per trawl, have been mandated in many areas along the U.S. East Coast. While some of these efforts have undoubtedly helped, none has solved the problem of lethal entanglements. The recent development of reduced-breaking-strength rope (i.e., rope out of which a whale can more easily break and escape entanglement) has the potential to reduce entanglement severity for adult right whales and may be a viable near-term solution for some fisheries; however, this approach is not



A live, entangled right whale that later died from its injuries. Rope can be seen caught in the mouth and wrapped around each flipper. (Credit: Florida Wildlife Commission under NOAA Permit 17355-01)



(Top) Trap fishing gear with several traps on the seafloor configured in a trawl. The number of traps will vary among fishermen. (Bottom) A trap modem communicating its location to a nearby ship, and the ship's chart plotter showing single traps (dots) and trawls (dots connected with lines).

appropriate for all fisheries, and will not help alleviate lethal entanglements of smaller whales and turtles.

One promising solution that has been discussed in New England for the past 10 to 15 years is the removal of rope from trap fishing, which has the potential to signifi-

cantly reduce or even eliminate entanglements of all marine animals. This approach has been dubbed ropeless fishing. For the purposes of this article, we define ropeless fishing as the removal of end lines only (also known as buoyless fishing).

In 2009, ground lines were mandated in the U.S. to be made of sinking material so that they do not float above the seafloor and pose an entanglement hazard. Although not enough data have been collected to definitively conclude that ground lines are safe for whales, it appears that most entanglements since 2009 occurred in end lines.

End lines serve two purposes: to facilitate the retrieval of traps from the seafloor and to secure a buoy at the sea surface, which allows fishermen and enforcement agencies to see where traps have been set on the seafloor. Any ropeless fishing system must replicate these two functions.

Retrieval Methods

There are currently three mechanisms that have been developed or are under development to retrieve gear from the seafloor. The first involves buoyant rope and one or more buoys that are attached to the gear and stored at the seafloor until the fisherman wishes to retrieve it. The rope can be coiled around a spool or flaked into a mesh bag or container, and its release is triggered with an acoustic signal sent from the fisherman's vessel to an acoustic device attached to the spool, bag or container. The actual release can be accomplished with a burn wire or motor-driven lever arm. The buoy floats to the surface bringing the rope with it, and the fisherman hauls the gear using the rope. This method has a variety of names, such as bottom-stowed rope, on-call buoy or on-demand end line, and has been used for oceanographic applications for decades.

The second mechanism for retrieving gear involves the use of a deflated ruggedized bag that is deployed at one end of a trawl. Upon receiving an acoustic signal from the fisherman's vessel, the bag is inflated from a connected compressed air tank, and the buoyancy provided by the inflated bag brings the first trap in the trawl

“Gear conflict occurs when a trap fisherman lays his or her line of traps (called a trawl) over another fisherman’s trawl, resulting in a tangled mess when the laid-over fisherman retrieves his or her gear.”

to the surface. The fisherman can retrieve this first trap, and then haul the rest of the gear using the ground line that connects the first trap to the other traps. This method is called a lift bag, and is used regularly in the marine salvage industry.

The third method for retrieving gear requires no development at all, because most fishermen already use this method out of necessity: grappling. Today when fishermen lose access to the buoy and end line (e.g., because a passing ship’s propellers cut the end line or the buoy is pulled under by strong currents), they must resort to grappling for the gear. In some fisheries, grappling is the norm because of logistical considerations. For example, the golden crab fishery in the Gulf Stream off the U.S. Southeast Coast uses grappling to retrieve gear because very strong persistent currents do not allow buoys attached to the end line to remain afloat at the surface.

Gear Location Marking

Replacing the function of the buoy as a marker of where gear is located on the seafloor is a particularly important and often overlooked aspect of ropeless systems. Gear conflict occurs when a trap fisherman lays his or her line of traps (called a trawl) over another fisherman’s trawl, resulting in a tangled mess when the laid-over fisherman retrieves his or her gear. Gear conflict also occurs when mobile fishermen using a bottom trawl net or a scallop dredge drag their gear through traps on the seafloor. These gear conflicts are largely avoided today through the use of buoys attached to the end lines as visual location markers for the trap gear. In a 2010 report, the U.S. National Marine Fisheries Service stated that avoiding gear conflict was the most significant challenge facing ropeless fishing.

There have been a few approaches proposed to reduce gear conflict. Zoning areas for particular fishermen to fish only their gear is likely impossible to implement, since this would require a significant change in culture and a high level of cooperation among fishermen that does not exist in most fisheries. Fishermen do record the location of their own gear, and it can be argued that if this information is systematically collected and automatically distributed to other fishermen, then the location of all deployed gear could be available to reduce gear con-

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“Ropeless fishing is currently illegal in the vast majority of trap fisheries, so there is no market to incentivize commercial manufacturers to develop products. The market will only open up if ropeless fishing can be proven to be safe, operationally feasible and affordable.”

flict. Such a system has three significant drawbacks. First, fishermen will likely refuse to share the location of their gear with other fishermen out of fear that these fishermen would then fish in those locations. Second, the system is completely voluntary, and therefore easily manipulated; not reporting deployed gear is a way to hide fishing locations, and not reporting retrieved gear is a way to “hold” an area for the exclusive use of a single fisherman. Third, gear that is moved to a new location after deployment (e.g., by a storm) will be forever lost because the deployment location will no longer represent the location of the gear. Marine debris is a substantial problem already, and the use of surface location marking only for ropeless gear would significantly exacerbate this problem.

Like a buoy that can only be detected on location, the replacement location marking system should be detectable only when a vessel is near the trap gear. The most promising technical solution proposed to date is the use of acoustic modems to relay information about the location of gear on the seafloor to passing ships. A modem affixed to a trap (a trap modem) can communicate information about the trap (or the trawl to which the trap is attached) to an acoustic modem at the sea surface (a surface modem). The surface modem could be mounted on any vessel, such as a trawler, dragger, trap fisherman’s boat or enforcement vessel, and it would send out broadcast messages regularly (e.g., once a minute) to request information from any nearby traps. In response to an information request from a surface modem, the trap modem would report its location, as well as encrypted data that would include the trap owner’s registration number, trap modem serial number, trap identifier and possibly other sensor data (e.g., occupancy sensor data to determine remotely how many lobsters are in the trap). Only the trap owner, regulators and enforcement would be able to decrypt the encrypted data. For trawls, acoustic modems can be mounted to the terminal traps so that the location of both ends of the trawl (thus the orientation of the trawl) can be reported.

The location information from all interrogated trap modems could be displayed on commercially available chart plotters or on a dedicated display system. When a ship equipped with a surface modem returns to port, all of the received data from all of the trap modems with which it communicated that day could be automatically uploaded to a central repository (most trap fishing boats are not equipped with satellite communications systems, and cellular service does not extend very far offshore). From there, all of the data could be decrypted, and in-

formation about a specific fisherman’s gear could be delivered to him or her electronically. These decrypted data could be made available to regulators and enforcement as well. This would be particularly useful for fishermen to aid in the recovery of lost gear, since gear that is moved by a storm would be discoverable afterward by passing vessels, and the owner could be notified immediately about the new location of the gear.

The trap modem must have a way to determine its location, which could be partly achieved by attaching a submersible GPS receiver and using the last position at the surface as a proxy for the location at the seafloor. This would not be a complete solution in locations where gear sets are separated by only a few meters or tens of meters or when storms move gear. In such circumstances, the trap modem must have a way to self-localize. This can be accomplished by simply having surface modems transmit broadcast messages exactly at a known interval and encoding the surface modem’s GPS position in the broadcast message. The trap modem could use this information to determine its own location.

To ensure interoperability, trap and surface modems would need to use an industry standard communication protocol, and messages would be standardized (i.e., similar to NMEA for marine electronics such as a GPS or depth sounder). JANUS is a recently published acoustic communication protocol that may be useful for this application. Trap modems could also fulfill the role of an acoustic release for retrieval methods that require one (e.g., bottom-stowed rope or lift bag). Acoustic messages from a fisherman’s surface modem could include the serial number of the trap modem to be released and a password to ensure that only the gear intended for retrieval is triggered for release.

Challenges and Opportunities

There are significant challenges to the development and adoption of ropeless fishing. Ropeless fishing is currently illegal in the vast majority of trap fisheries, so there is no market to incentivize commercial manufacturers to develop products. The market will only open up if ropeless fishing can be proven to be safe (for both fishermen and whales), operationally feasible and affordable. Affordability, in particular, will be absolutely essential; fishermen will be understandably reluctant to support the development of methods that, at the outset, appear to be unacceptably expensive. Once developed, however, ropeless fishing will be used where the government mandates its use, or by fishermen that are selling their

catch in markets where a “whale-safe” product is valued. To date, ropeless retrieval systems have been developed on a very small scale by small commercial companies and nonprofit institutions and, as of winter 2018/2019, are being put through both engineering tests and preliminary testing by fishermen. These activities are intended to incorporate fishermen feedback on current designs and to cultivate understanding and acceptance of the technology among the fishing and regulatory communities.

The commercial opportunities for ropeless fishing may be significant depending on how widespread the technology is adopted. Whale entanglements are a worldwide problem, including on both the east and west coasts of the U.S. and Canada, and if every fisherman converted to ropeless methods, the market would be massive. The key to affordability will almost surely be manufacturing modems and retrieval mechanisms in the hundreds of thousands to millions of units. The commercial marine technology sector will play a vital role in the development and adoption of ropeless fishing, and this article is intended to encourage the sector’s engagement in the problem.

There are many challenges to overcome to make widespread use of ropeless fishing methods a reality, and we are just at the very beginning of a long process.

But we do not have decades to work on this problem for North Atlantic right whales.

The problem is urgent, and fishermen, regulators, scientists, conservationists and consumers in both the U.S.

and Canada are looking hard for a viable solution. Ropeless fishing has great potential to be that solution.

Acknowledgments

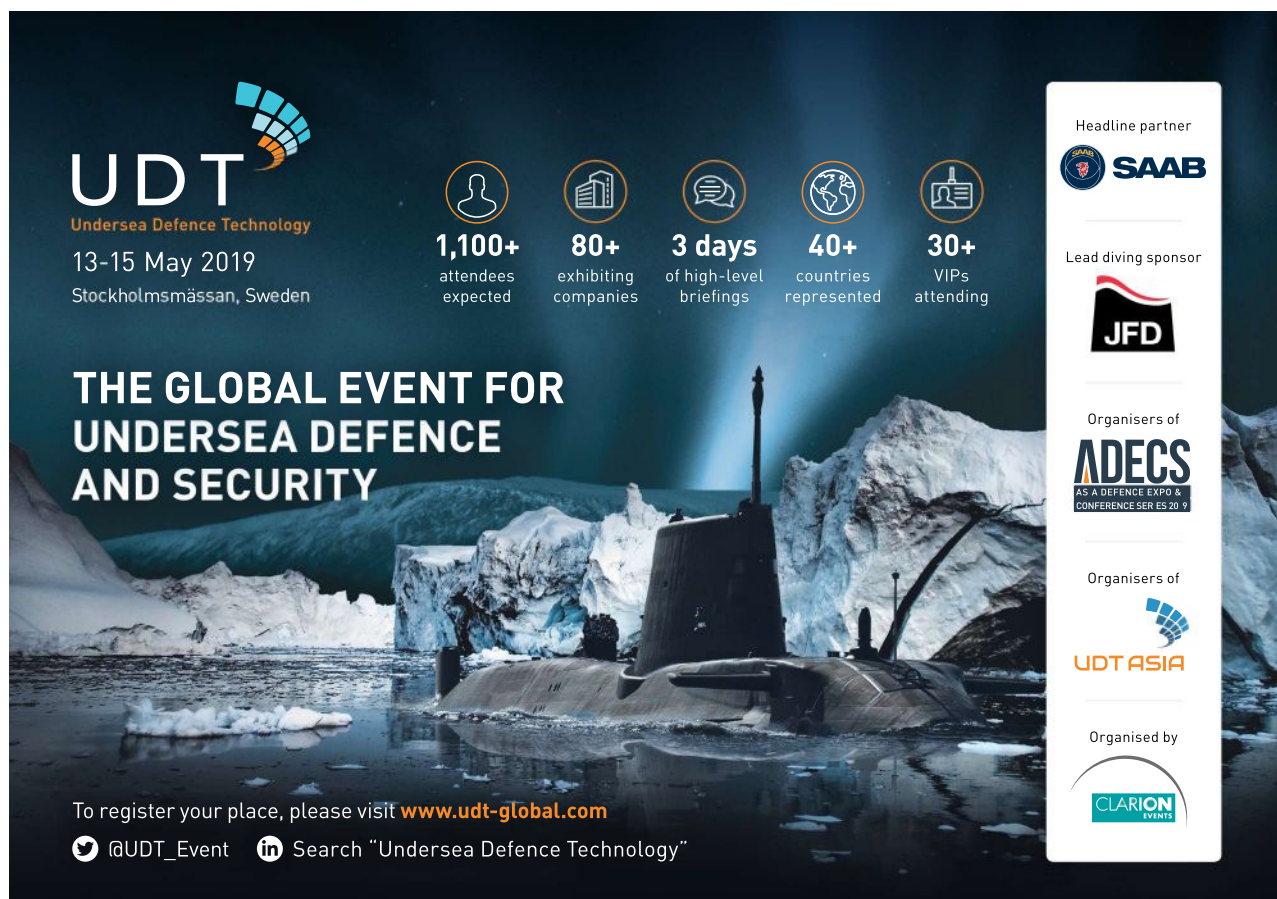
Amy Knowlton and Scott Kraus of the Anderson Cabot Center for Ocean Life at the New England Aquarium contributed to this article.

For more information about whale entanglement mitigation research, visit the Consortium for Wildlife Bycatch Reduction at bycatch.org, and for more information about ropeless fishing, visit the Ropeless Consortium at ropeless.org. **ST**

Dr. Mark Baumgartner is a marine ecologist at the Woods Hole Oceanographic Institution who studies the foraging behavior, prey, distribution, habitat and acoustic ecology of baleen whales, particularly North Atlantic right whales. He has been involved in numerous technology development projects to improve our understanding of marine mammals and support their conservation.

Dr. Tim Werner is a marine biologist at the Anderson Cabot Center for Ocean Life at the New England Aquarium who specializes in using science to conserve biodiversity in ways that also support the livelihoods of fishermen and coastal communities. His research focuses on the evaluation of bycatch reduction technologies for endangered species, including marine mammals, sharks and rays, sea turtles, and seabirds.

Dr. Michael Moore is a marine biologist and veterinarian at the Woods Hole Oceanographic Institution who studies the impact of human activities on the health of whales. Much of his career has been devoted to understanding causes of mortality and morbidity in North Atlantic right whales and developing tools for health-related intervention in large whales.





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Global Alliance on Plastic Waste Launches

Energy company Total is participating in the creation of a global alliance of companies from the plastics and consumer goods value chain to help end plastic waste in the environment, especially in the ocean.

The Alliance to End Plastic Waste, made up of nearly 30 member companies, has committed more than \$1 billion, with the goal of investing \$1.5 billion over the next five years.

The alliance will develop and bring to scale solutions that will minimize and manage plastic waste.

Flow Intervention Tech in Onshore Testing

Enpro Subsea announced that the £1.5 million investment project in its flow intervention services (FIS) technology, which included a grant from Scottish Enterprise, has started onshore testing ahead of planned subsea field trials later this year. The company previously developed a lower pressure 10-kpsi version of its tool, and this investment has allowed them to develop the higher rated 15-kpsi version, extending its operating capabilities to support high-pressure wells common in the Gulf of Mexico.

Biofuel Blend Delivered for Ship

Global mining company BHP, Japanese shipping company NYK, biofuel company GoodFuels and BLOC (Blockchain Labs for Open Collaboration) delivered biofuel to the bulk carrier *Frontier Sky*, with CO₂ savings verified with BLOC's blockchain fuels assurance platform. The biofuel was a drop-in marine gasoil (MGO) equivalent, and it was blended with conventional fossil-based MGO in a mix of 30 percent biofuel to 70 percent conventional MGO, saving more than 50 t of CO₂.

New Options Coming for Ballast Management

BWC and ERMA FIRST are collaborating to increase ballast water management options available to ships. ERMA FIRST provides innovative ballast water treatment systems according to current legislation and has a reference list comprised of shipowners and shipyards worldwide. ERMA FIRST BWTS FIT is an advanced modular system suitable for newbuild vessels or retrofits.

Norwegian Company Orders Survey AUV

Swire Seabed AS of Bergen, Norway, has ordered a HUGIN AUV System configured for commercial survey applications. The system is rated to 4,500 m and is equipped with HISAS 1032 synthetic aperture sonar and the EM2040 multibeam echosounder, plus a CathX Ocean camera and laser profiler, a sub-bottom profiler, magnetometer and turbidity sensor. It also includes an automatic pipeline tracking solution to conduct survey and inspection tasks.

World Bank Funds Inland Water Transport Project

The Indian Register of Shipping and the Government of Assam, a key state in northeast India, plan to enhance

the state's inland water transport system to improve commuter safety. The initiative follows the funding agreement between the government of Assam and the World Bank to modernize and transform inland water transport in the state with the largest network of navigable inland waterways in India. Plans include the integration of passenger and vehicle ferry services into the transport network.

Clean Tech Company Acquires Ballast Specialist

Evac, a fast-growing clean tech solution company, has acquired Transvac Systems, a U.K. business specializing in the distribution and servicing of wastewater treatment systems, sanitary systems and ballast water treatment systems for ships and offshore platforms. Transvac has a long history as a supplier to the U.K. Royal Navy as well as the offshore oil industry.

Subsea Umbilicals Built for Global Locations

Oceaneering International secured three subsea umbilical contracts valued in excess of \$80 million total to supply developments in the Mediterranean Sea, the North Sea and the South China Sea. Two contracts are for electrohydraulic, steel-tube production control umbilicals, measuring approximately 66 mi. total, and related umbilical distribution hardware. The third contract is for three thermoplastic production control umbilicals with a total measure of approximately 26 mi.

MacArtney Reports Global Expansion

MacArtney has established new subsidiaries in Sweden, Chile and China to create a total global footprint across 11 countries in Scandinavia, Europe, Asia, and North and South America. The company has integrated two manufacturing sites and created an operations organization responsible for procurement, supply and service globally, in addition to enhancements in enterprise resource planning, IT support tools and IT infrastructure. MacArtney is also developing solutions for renewable energy, defense, civil engineering and fisheries.

UK Transport Department Launches Long-Term Plan for Marine Sector

Developed in collaboration with Maritime UK, the Department for Transport launched Maritime 2050, the first long-term strategy for the U.K. maritime sector. The strategy sets roadmaps for industry and government to work together to drive growth and highlights the maritime sector's worth: more than aerospace or car manufacturing. Maritime 2050 is based around seven themes: technology, trade, environment, people, infrastructure, security/resilience and the U.K.'s competitive advantage.

Survitec Certified to Service Survival Equipment

Survitec has received DNV GL Z-17 certification as a class-approved service provider for all DNV GL-classed vessels operating various brands of safety and survival equipment, including lifeboats, life rafts, marine evacuation systems, fire-fighting equipment and breathing apparatus. Through three fully owned training centers, Survitec trains its teams to provide inspection and

maintenance services across multiple brands in order to meet ship/fleet managers' safety requirements. DNV GL, which provides services to more than 13,000 vessels and mobile offshore units, audited several Survitec service sites and granted approval in January 2019.

Claxton Opens Office in Norway

Shallow-water engineering services company Claxton opened a new office in Stavanger, Norway. The facility gives Claxton access to a yard and warehouse, providing repair and maintenance capabilities for equipment and room to further expand its operational capabilities in the region. The facility will focus on life-of-field services support to the Norwegian shallow-water oil and gas sector.

Scottish-Japanese Cooperation Encourages Subsea Innovation

Tritech International has secured funding for a collaborative project between the NEC Network Systems Integration Corp. (NESIC) and the Japan Agency for Marine-Earth Science and Technology (JAMSTEC). The funding is comprised of investment of up to \$10 million over a three-year period to five projects and has been committed by Scottish Enterprise and the Nippon Foundation.

Infrastructure Ministry in Netherlands Upgrades Data Processing Aboard Hydrographic Vessels

Rijkswaterstaat, part of the Ministry of Infrastructure and Water Management in the Netherlands, will upgrade its hydrographic data-processing capabilities with Qimera for the processing of multibeam data. Rijkswaterstaat will use the software on board its hydrographic vessels in Qimera Live mode and will do most of the processing on board in order to reduce the turnaround time from survey to validated.

Major European Expo Events to Combine

Mercator Media Ltd. has agreed to purchase the Marine & Coastal Civil Engineering Expo from the Prysm Group.

The expo is Europe's leading event showcasing the latest equipment and techniques in marine civil engineering and construction. It will co-locate with Seawork, an event showcasing the latest equipment and techniques in marine civil engineering and construction.

Mercator publishes the pan-European commercial marine magazine *Maritime Journal* and produces Europe's market-leading Seawork exhibition, now in its 22nd year.

New Weather Systems Installed At 900-Year-Old English Port

Harwich Haven Authority (HHA) has chosen OceanWise to supply, install and maintain new tide and weather systems at the 900-year-old port on the east coast of England. British marine instrument specialist Valeport has partnered with OceanWise to deliver the environmental monitoring systems. The bespoke system for HHA will measure tide, weather and wave conditions at Harwich and Felixstowe. It includes a modern and dynamic environmental monitoring system with dual telemetry. **ST**

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Incubator Seeks Ocean Tech Companies

The Maritime Alliance has openings in its San Diego-based BlueTech Incubator, which pairs companies with mentors and establishes monthly goals over a six-month period to foster the development of science-based ocean and water/wastewater tech companies. Opportunities include space for three companies at the San Diego location and several others off site. Interested companies can apply at bluetechincubator.org.

Profiling-Floats Deal Continues for US Navy

Teledyne Webb Research has received an order for autonomous profiling floats from the Naval Oceanographic Office. The contract includes the APEX profiling float, with optional air-deployment capability and APEX repair services. The contract runs for up to three years, with an estimated total of \$4.4 million. Teledyne Marine has been providing APEX floats to the Naval Oceanographic Office since 1998.

iXblue Adds North American Office

iXblue opened a new office dedicated to commercial activities in the North American region. Based out of Denver, Colorado, the new local team of engineers will provide enhanced R&D, sales and support. iXblue has a global workforce of 600 people doing business in more than 40 countries to provide tools for civil and defense customers working in sea, land and space operations.

Canadian Harbor Modified to Eliminate Swell

The small fishing harbor of Lower Sandy Point near the southern tip of Nova Scotia was modified to reduce the agitating effects of swell. Breakwaters were added, nearly enclosing the harbor. The resulting structure successfully reduced the swell, and, several times each year, in the presence of specific atmospheric forcing, put the harbor at near resonance.

Pipeline Inspected Under San Joaquin River

A Deep Ocean Engineering Phantom T4-H ROV successfully completed a series of pipeline inspections on sections of the Mokelumne Aqueduct Raw Water Pipeline. The system was outfitted with a pipe-profiling sonar and three video cameras. The ROV traversed three, nearly 1,000-ft.-long, 8-ft.-diameter, inverted siphon pipelines running under the San Joaquin River. These pipelines provide 90 percent of the water supply for the East Bay Municipal Utility District.

Pressure Testing for Extreme Cold, Extreme Depth

A precision-testing capability for deep submergence connectors and cable assemblies—an extreme-low-temperature, extreme-depth testing system—allows more than 48 hr. of continuous testing of connectors and cable assemblies at 6 km in a controlled 2° C (±1° C) environment. The cold hydrostatic pressure testing provides automated, programmable multiple pressure cycles with

real-time data recording of electrical and optical testing and digital output of pressure and temperature data.

UUV Procurement Gets Easier

L3 OceanServer was granted a five-year general services administration (GSA) schedule for its Iver3 UUV. The GSA schedule gives registered government agencies a path to procure Iver3 UUVs using pre-established pricing and terms and conditions. The Iver UUV is a commercial product built with warfighter-driven attributes. It features longer run times and precise navigational accuracy, enabling long ingress/egress missions that provide greater standoff distances and increased mission safety.

\$4 Billion in Port Maintenance Needed

A recent report by the American Association of Port Authorities (AAPA) identified nearly \$4 billion in crucial port and supply chain security needs over the next 10 years. “The State of Freight IV” is the fourth report in as many years conducted by AAPA to highlight the needs of America’s deep-draft commercial public ports to effectively move goods into and out of their facilities by land and water. This latest report recommends refocusing the FEMA Port Security Grant Program (PSGP) to better meet the security infrastructure needs of publicly owned commercial seaports and related maritime operations.

Metal Shark Delivers Patrol Boats to Australia

Four new high-speed patrol boats from Metal Shark have entered service with the Dutch Caribbean Coast Guard (DCCG) on the island of Aruba. The vessels were commissioned into service with a ceremony in January 2019 at DCCG’s Station Aruba in the district of Savaneta on Aruba’s southeast coast. The boats were acquired by the Dutch Ministry of Defense to bolster its capabilities across the Caribbean. In all, the DCCG will operate 12 Metal Sharks in the territorial waters of Aruba, Bonaire, Curaçao, St. Eustatius, St. Maarten and Saba.

Iridium Satellite System is Operational

The final six payloads for a second-generation constellation, exactView RT, are now operational, which completes the roll out of world’s first global, real-time satellite-AIS service. exactView RT consists of 58 operational payloads and seven orbital spares that were designed and built by Harris Corp. and are hosted on board the Iridium NEXT constellation of satellites. The Iridium NEXT satellites were deployed over a series of eight successful launches completed in less than two years and are the result of Iridium’s approximately \$3 billion investment to replace its original satellite system.

A 150-Year-Old Technology for Cleaning Ballast

BAWAT is on the verge of achieving full U.S. Coast Guard (USCG) approval for its pasteurization-based ballast water management system using a 150-year-old technological process. BAWAT’s system—which is built from common components, utilizes no chemicals or filters and works simply by heating ballast water—has passed all USCG land-based tests and has only one ship-

board test left to complete. The test is scheduled for April in the waters of Port Klang, Malaysia, and the Mekong River estuary, Vietnam.

Solar-Electric Sewage Pump-out Boat Delivered

Torqueedo has supplied an integrated electric propulsion system for a full-size solar-electric sewage pump-out boat, which was recently delivered to the township of Branford, Connecticut. The 25-ft. aluminum boat was built for the East Shore District Health Department by Pilot's Point Marina in Westbrook to provide free sewage pump-out service for boats, preventing the discharge of untreated human waste into the area's waterways.

Lithium-ion Battery System for Navy Prototype

General Atomics Electromagnetic Systems (GA-EMS) has been awarded a contract from Advanced Technology International to develop and demonstrate a prototype lithium-ion fault tolerant (LiFT) battery system for the U.S. Navy's prototype "Snakehead" large-displacement unmanned undersea vehicle (LDUUV). The LiFT battery system will power the LDUUV's propulsion and support systems. The Snakehead LDUUV is intended to increase endurance, range and payload-hosting capabilities to support a variety of future mission and ops requirements.

FLS Sonar for Exploration Yacht

The FarSounder-1000 3D forward-looking sonar (FLS) has been selected by the OceanX exploration team to

help provide safe passage for *Alucia2*, their new 85.3-m research and exploration yacht. With the FLS, operators of the vessel will be able to view a true underwater 3D image ahead of the ship up to 1,000 m. The sonar will assist in the prevention of collisions and groundings as the OceanX team explores unknown parts of the ocean.

Canadian Navy Places its Biggest Ship Order

The Royal Canadian Navy has contracted Lockheed Martin, BAE and Irving Shipbuilding for its next-generation frigate. It is a \$45 billion contract including 15 ships, possibly the largest contract to date by the Canadian government.

According to MAREX, the design is based on BAE's Type 26 frigate currently under construction, and Lockheed may pull ideas from a frigate variant of the U.S. Navy's FFG(X) contract and its involvement in the *Freedom*-class littoral combat ship building consortium.

Georgia Port Launches Big Ship Plan

The Georgia Ports Authority Big Berth/Big Ship program will allow the Port of Savannah to simultaneously handle six 14,000-TEU vessels by 2024. The January 2019 flow through the port was 433,975 TEUs, a 28 percent increase over the previous year. The port authority plans to add another 21 Neo-Panamax ship-to-shore cranes, replacing 14 of its older models to bring the total fleet to 37. Dock upgrades are already underway to support the new, larger machines. **ST**

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Optical Dissolved Oxygen Logger

RBRduet³ T.ODO is a compact logger for applications down to 6,000 m. The fast version has a 1-s time constant, and the slow version has a protective layer over the optical foil for long-term moored applications. RBR Global Ltd.

Compact Diver Navigation System

D2 DiNIS is a navigation and imaging system with TriTech Gemini sonar built for military, search and rescue and commercial diver use. It stores georeferenced, time-stamped data on a removable SSD disk drive and allows mosaicked sonar data to overlay on navigation maps. Kenautics Inc.

Particle-Size Measurement Tool

LISST-Horizon performs automated measurement of suspended particle

size distribution in flow-through systems on vessels underway. It continuously measures PSD and particle concentration, as well as inherent optical properties, beam attenuation and volume-scattering function. Sequoia Scientific Inc.

Assisted-Docking Technology

Raymarine DockSense is an object-recognition and motion-sensing technology for assisted docking. It uses FLIR machine vision camera technology and video analytics to integrate intelligence from surrounding imagery with the propulsion and steering system for tight docking maneuvers. FLIR Systems Inc.

NOx Control Chemistry

BIONOX²SOLVER uses nitrogen dioxide reducing agents to achieve

more than 33% greater removal efficiency with a simple addition to caustic. It can be used in a wide range of applications without liberating flammable hydrogen sulfide gas at pH-use conditions. Bionomic Industries Inc.

Shipping Industry Data Exchange

Signal Ocean uses machine learning and artificial intelligence technologies to extract key information from fixture reports, tonnage lists and private market information and combines it with publicly available information and automatic identification systems to provide a single commercial view of the shipping market in real time. Signal Group.

Infrastructure Inspection System



SeaDrone Inspector 3 has automated stabilization, integrated sensors, a 5,000 lumen light array, and it captures full HD video with a gimbal camera. Photos and video can be stored on an iPad. The unit weighs 6.5 kg and can overcome 2.5-kt. currents. O-Robotix Inc.

Navigation Light Adapter

A horizontal adapter mounts in an upright or pendant orientation for placement of NaviLED PRO lights in towers or shutter boxes. It increases overall lamp dimensions to better service large vessels up to 164 ft. Hella marine Inc.

Gas Accumulator Valve

Revolution PowerPlus provides a safety barrier during subsea well completion or intervention operations. The valve rapidly cuts any intervention media such as slickline, braided electric cable or coiled tubing and seals the wellbore. Interventek Subsea Engineering Ltd.

Electrical Penetrators

Manned submersible electrical penetrators for depths up to 650 m

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are for use on diving bell and deck decompression chamber systems. They have an operating window of -40° to 60° C and working voltages of up to 500 V. They are ideal for applications in demanding seawater environments. Hydro Group plc.

Rugged "Phablet"

Nautiz X6 is an ultrarugged phone-plus-tablet for industrial applications. It has dual cameras, an 8-core processor, the Android 8.0 operating system with the MaxGo Android software suite and an IP67 rating. Handheld Group.

Ventilation Control System



P/T6 engine room ventilation controller automatically synchronizes intake and exhaust fans for optimal engine room airflow. It can interface with the ship's networked monitoring system, and additional screens are available for remote installation. Delta "T" Systems Inc.

Nautical Chart Validation Tool

7Cs Analyzer Version 4.0 is based on S-100 ECDIS Kernel technology and can be used for both validation of S-57 and S-100/S-101 nautical chart products. It is compliant with edition 6.1 of S-58 ENC validation checks and capable of validating S-101 data sets. SevenCs GmbH.

Ultra-Narrow Bandpass Filters

Thin-film, ultra-narrow bandpass filters optimize the performance of laser-based systems, ideal for use as laser line, laser cleanup or laser excitation filters. They can be customized for CWL at any wavelength from the UV to the mid IR and come in FWHM bandwidths as narrow as 0.1 nm. Alluxa.

Wireless Docking System

Dockmate operates electronically controlled engines, bow and stern thrusters, anchor winches and

horns from anywhere on board with a handheld device. Available in four models: single, twin, twist three-axis joystick and twist IPS. Dockmate Inc.

Electro Optical Testing Software



INFRATEST tests visible, NIR and IR cameras, ICCDs, goggles and laser rangefinders and can remotely monitor the temperature of black-body cooling fluid. It factors background temperature data into calculations of key functions. Electro Optical Industries.

High-Power DC-DC Converters

A range of high-voltage input DC/DC converters for microgrid, data centers and industrial applications operate with an input voltage range of 180 to 425 V DC and deliver output power levels from 150 to 750 W, with a layout optimized for thermal conduction. Powerbox.

Ultra-HD Bridge Display

An addition to the Series X MVD product line, the 43-in. display screen has 4K panel technology with 3,840×2,160-pixel HD display. Flexible inputs allow data display from navigation and automation systems. Hatteland Display AS.

Unmanned Surface Vessel

APACHE 5 has an integrated single- or multibeam echosounder and collects and stores data from multiple sensors in real time. The system can be remotely controlled or autonomous and comes with digital radio and high-resolution wireless video. CHC Navigation Technology.

Ship Design Software

The ShipConstructor R2.1 release allows users to manage welds and correct clashes globally, and work with multiple hulls. Lifting components and vectors can be added directly to model drawings. SSI. **ST**



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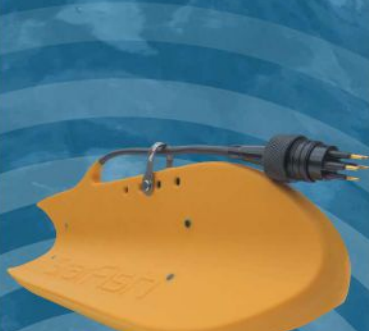
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BUILD Grants for Port Projects

The U.S. Department of Transportation announced \$1.5 billion in discretionary grant funding to 91 projects in 49 states and the District of Columbia. The grants, 14 of which will go to port-related projects, are made through the Better Utilizing Investments to Leverage Development (BUILD) Transportation Grants program and support road, rail, transit and port infrastructure projects nationwide. Port-related projects will receive a total of \$229.23 million, or about 15.28 percent of the \$1.5 billion awarded.

U.S. seaport cargo activity accounts for 26 percent of GDP, more than 23 million American jobs, and more than \$320 billion annually in federal, state and local tax revenues.

Proposed Rule to Redefine 'Waters of the US'

The U.S. Environmental Protection Agency (EPA) and U.S. Army

Corps of Engineers have released a proposed rule redefining the term "waters of the United States" as applied under the Clean Water Act.

If finalized, the rule would replace the definition of "waters of the United States" adopted under 2015 Obama-era "WOTUS Rule," which expanded federal control over several types of water bodies, particularly with respect to tributaries, adjacent waters and wetlands.

The 2015 WOTUS Rule has been subject to numerous legal challenges. As part of these challenges, a patchwork application of the rule has arisen in which its effectiveness has been stayed in 28 states, while the 2015 WOTUS Rule is in effect in 22 states.

NOAA Reports on US Fishing, Seafood Industries

NOAA has released the 11th Fisheries Economics of the United States report. In 2016, commercial

and recreational saltwater fishing in the U.S. generated more than \$212 billion in sales and contributed \$100 billion to the country's gross domestic product. These critical industries supported 1.7 million jobs.

According to the annual Fisheries of the United States report, fishing and seafood consumption increased in 2017, with landings and value of U.S. fisheries continuing a strong, positive trend. Across the nation, American fishermen landed 9.9 billion pounds of fish and shellfish in 2017, while the U.S. imported 5.9 billion pounds of seafood, up 1.6 percent, according to the report.

The U.S. aquaculture industry produced \$1.5 billion in 2016—the most recent year aquaculture data is available—an increase from 1.4 billion in 2015.

Congress Members Pressure Trump on Climate Change

Rep. Suzanne Bonamici (D-Ore.), ranking member of the U.S. House Science, Space, and Technology Committee's Environ-

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ment Subcommittee, and Rep. Don Beyer (D-Va.), vice ranking member of the committee, led 96 members in urging President Trump to heed the dire warnings in the second volume of the Fourth National Climate Assessment (NCA) and act on climate change.

"Rather than ignoring the important findings of the NCA, we request that you reconsider maintaining the nation's commitment to the Paris Agreement and fully implement and enforce the Clean Power Plan, fuel economy standards, methane emission controls, and safeguards for clean air and clean water," the letter says.

"We urge you to recognize the value of the NCA as a collaborative, peer-reviewed effort across federal agencies compiled by the nation's top scientists, and take seriously the grave warnings of the NCA by immediately enacting meaningful policies to protect the environment."

Record Offshore Wind Auction For Massachusetts

The latest offshore wind lease sale offered approximately 390,000 acres offshore Massachusetts for potential wind energy development and drew competitive winning bids from three companies totaling approximately \$405 million. If fully developed, the areas could support approximately 4.1 GW of commercial wind generation, enough to power nearly 1.5 million homes.

The provisional winners are Equinor Wind US LLC, Mayflower Wind Energy LLC and Vineyard Wind LLC.

The U.S. Bureau of Ocean Energy Management now has 15 active wind leases.

Grants for Infrastructure

The U.S. Department of Transportation (DOT) announced the second round of the Infrastructure for Rebuilding America (INFRA) discretionary grant program, transportation.gov/INFRA. The INFRA program is expected to make approximately \$855 million to \$902.5 million, subject to funding provided by fiscal year 2019 appropriations, available to projects that are in line

with the administration's principles to help rebuild America's crumbling infrastructure.

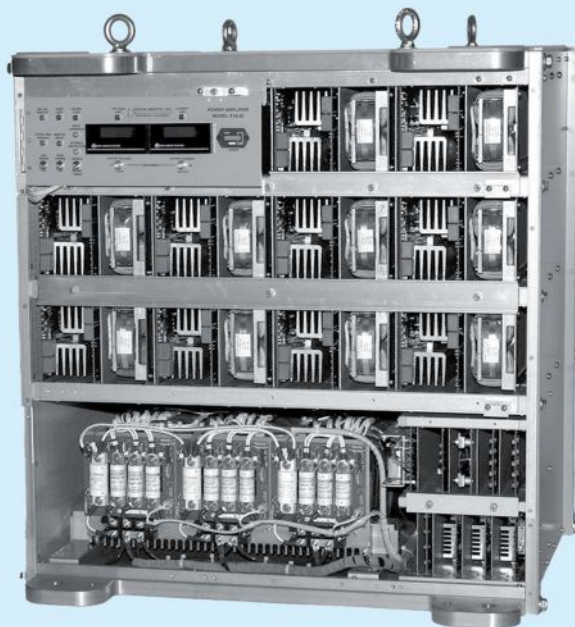
The INFRA program also aims to increase the total investment by state, local and private partners. INFRA advances a grant program established in the FAST Act of 2015 and utilizes criteria that let DOT evaluate projects to align them with national and regional economic vitality goals and to leverage addition-

al nonfederal funding. The program will increase the impact of projects by incentivizing project sponsors to pursue innovative strategies, including public-private partnerships. Additionally, the new program promotes the incorporation of innovative technology that will improve the transportation system.

DOT will make awards under the INFRA program to both large and small projects. **ST**

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Guidance for Analysis, Testing of DP Systems

The International Marine Contractors Association (IMCA) has published "Guidance to Identify DP System Components and their Failure Modes" (IMCA M 247).

Unexpected events that jeopardize station-keeping integrity are regularly reported via the IMCA DP Station Keeping Report Scheme. This guidance will help minimize such events and assist those involved in the analysis and testing of dynamic positioning systems. IMCA M 247 identifies the different components of a DP system and how these systems might fail.

Canopus Transponder for European Geodetic Research

iXblue has been chosen by the European Institute for Marine Studies to provide eight Canopus LBL transponders for a major geodetic mission off the coast of Sicily. Deployed on the seabed, 2,500 m below the surface, the Canopus transponders will measure the crustal deformation along the North-South Alfeo faults with a millimeter-scale resolution over four years.

The Canopus LBL transponder is suited for scientific and industrial applications that require high autonomy, instrumentation, repeatability and accuracy.

Iridium Certus Rolls Out New L-Band Service

For months, Network Innovations Inc. (NI), one of the first Iridium Certus service providers, has been successfully beta and field testing the new Iridium Certus service. With global teams conducting vigorous testing, NI has been able to gain first-hand expertise and in-depth knowledge of both the service and the hardware while assisting Iridium in preparing for the commercial launch. The lessons learned through testing resulted in early customer adoption with one of the first commercial activations.

NSSLGlobal is another company now service ready for Iridium

Certus, the new L-Band service from Iridium. Maritime customers can get immediate access to the enterprise-grade global broadband functionality and high-quality voice capabilities offered by Iridium Certus, either as a standalone service or in conjunction with NSSLGlobal's VSAT IP@SEA service.

Iridium Certus ensures that crews at sea are safely connected with consistent communication, regardless of location. It offers a variety of speed classes.

Dualog Offers First-Line Cybersecurity Defense

Tromsø-based Dualog has launched a new service to protect vessels and onboard IT systems before an attack occurs. Dualog Protect is designed to be the first line of defense in a robust approach to cybersecurity on board, where malware and unwanted data traffic are blocked at the DNS-level.

A Cisco security research paper claims that 91.3 percent of malware uses DNS in attacks.

Dualog Protect blocks ransomware, trojans and phishing attempts, as well as preventing command-and-control call-backs and data exfiltration. It addresses the emerging needs of the shipping industry to implement robust cybersecurity measures, given the advent of always-on operations, digitalization, Internet of Things (IoT) and new connectivity demands from the maritime workforce.

SMD Shanghai Manufactures Quantum MkIII WROV

Soil Machine Dynamics Ltd. (SMD) announced that SMD Shanghai, SMD's Chinese entity, has successfully completed the manufacture and commissioning of a Quantum MkIII work class remotely operated vehicle (WROV) at its facility in Lingang, Shanghai. This is the first WROV to be built at the facility since its opening in 2018.

SMD Shanghai's facility is home to a 3,700 m² workshop that contains an in-house training facility

featuring a state-of-the-art ROV training simulator and 405 m³ test tank. Having this capability in-house means that SMD Shanghai is able offer customers a full solution, from sales support to training and aftercare.

The Quantum WROV is the largest and most heavy-duty WROV in SMD's range. It is ideal for offshore tasks where high thruster performance and tooling power are required. Generous chassis space allows for upgrades and additional equipment to suit customer requirements.

Nigeria Gets New Bathymetric Capabilities

The Nigerian Navy Hydrographic Office (NNHO) has selected Teledyne CARIS to provide solutions for current and future national and international charting requirements. Equipped with CARIS Ping-to-Chart technology, the NNHO is establishing new capabilities for bathymetric analysis and completion of hydrographic and other geospatial data. These tools will ensure an efficient workflow for the production of electronic charts and paper charts according to the International Hydrographic Organization (IHO) and NNHO standards.

The first part of the project was completed in late 2018, with delivery of software and training. It will continue into 2019 with professional services from Teledyne CARIS to help ensure a successful launch of the new software infrastructure.

Connecting ROV Owners And Seekers Online

The first online marketplace dedicated to ROVs has been launched by Scottish company ROVHUB, rovhub.com. It connects ROV owners with opportunities worldwide and allows ROV seekers to shortlist and contact relevant contractors.

David Gault developed ROVHUB after seeing the potential of technology to efficiently bring together the supply and demand sides of the ROV business.

ROVHUB has thousands of ROVs and hundreds of ROV companies in its database. **ST**

environmental monitoring

2018 Global Temps Fourth Highest on Record

The release of provisional figures for the average global temperature in 2018 shows the long-term warming trend has continued. Professor Tim Osborn of the University of East Anglia's Climatic Research Unit, which provides data used in the analysis by the World Meteorological Organization (WMO), said the warming caused by these greenhouse gas emissions is already clear at the global scale.

The WMO provisional Statement on the State of the Climate in 2018 shows the average global temperature in 2018 is set to be the fourth highest on record. The 20 warmest years on record have been in the past 22 years, with the top four in the past four years.

Osborn cites the burning of coal, oil and gas as resulting in the emission of 1.5 trillion tonnes of carbon dioxide to the Earth's atmosphere. The warming caused by these greenhouse gas emissions has knock-on effects for regional climates and the severity of weather events.

Sea Level Variations In Disko Bay

Dr. David Holland of New York University, in collaboration with Dr. Natalya Gomez at McGill University, is leading an investigation of sea level variations in the Disko Bay region of western Greenland. A shore-based system compares the direct arrival of GPS signals to the signals reflected off the sea surface to obtain sea level. The presence of sea ice and icebergs complicate the measurements. A shore-mounted camera provides information about the surroundings and the presence of sea ice and icebergs when there is daylight. Underwater sonar devices can supplement the camera-based observations and eliminate the dependence on daylight to characterize the ice.

An ASL ice-profiling sonar (IPS) was chosen to make ice-draft measurements at two sites located within 150 m of shore in water depths

of 20 to 30 m. In the 2019 field season, the team will service the shore-based and mooring-based instruments and recover the data.

Hypoxic Dead Zones Found in Urban Streams

A new Duke University-led study reveals that hypoxic dead zones also occur in freshwater urban streams. Researchers measured dissolved oxygen concentrations, light levels, water chemistry and stream flow in six streams draining urban watersheds in Durham and Raleigh, North Carolina, from 2015 to 2017. They used the data to model the growth of algae and oxygen-consuming bacteria in the streams and examine the frequency at which dissolved oxygen concentrations dropped below 2 mg per liter—the danger point for fish and other aquatic organisms.

Streams draining developed areas are subject to intense, erosive storm flows when roads and stormwater pipes rapidly route runoff into streams during storms, without allowing the water to infiltrate into the soil. Erosion caused by these intense flows changed the shape of some stream channels to such an extent that water essentially stopped flowing in them during late summer. They became a series of pools containing high levels of nutrient runoff and organic matter, including nitrogen from leaking sewer pipes, fertilizer and pet waste. The elevated nutrient levels spurred greater consumption of dissolved oxygen by bacteria in the water, causing the pools to become hypoxic until the next storm flushed them out.

Dam building and other human alterations that stop the flow of water make these freshwater ecosystems particularly vulnerable to hypoxia, with negative implications for biodiversity.

Improved Cyclone Modeling Helps Infrastructure Design

It is hard to predict precisely where and how severely cyclones are likely to affect a particular loca-

tion. Cyclones are erratic weather phenomena, and the historical data available are often not sufficiently detailed for accurate predictions.

HR Wallingford scientists have developed a method to expand the data set for specific sites, allowing for much more precise modeling of likely future cyclone events. In a study, cyclones were modeled using TELEMAT-2D and SWAN open-source software to predict surge and wave conditions at a particular site for each cyclone (<https://youtu.be/wpiX3Qzu6bo>).

The new Probabilistic Cyclone Modeling Tool uses statistical methods in combination with surge and wave modeling. This can be used to inform the design of coastal infrastructure such as seawalls and breakwaters to match the conditions of a specific site.

pH Sensors at Experimental Aquaculture Site

Three meters below the surface of Washington State's Hood Canal, the very first SeapHOx V2s hummed along next to an experimental sugar kelp farm. In a previous life, these SeapHOxes were among the first SeaFET V1s.

When Sea-Bird Scientific made the decision to upgrade the line of pH sensors to the SeaFET V2, these early instruments were readily available for upgrades. Engineers pulled the original boards out of these instruments, fitted them with all new hardware, and combined them with a 37-SMP-ODO to form the first alpha "SeapHOx V2."

The aquaculture site itself is an experiment to identify if sugar kelp farming can help sequester carbon to combat ocean acidification, funded by the Paul Allen Foundation and led by the Puget Sound Restoration Fund.

The SeapHOx V2s were joined by a 16plusV2 CTD, chlorophyll sensors, current meters and another colorimetric pH sensor.

Researchers are still analyzing the data for the larger aquaculture project. For Sea-Bird Scientific, the successful deployment provided a trove of field validation data from the prototype sensors. **ST**

offshore oil & ocean engineering

Oil Spill Monitoring Tech for Petrobras

Miros Group will supply eight oil spill detection (OSD) systems to Petrobras in the world's largest X-band radar-based OSD surveillance and response contract to date. The agreement is in partnership with Ulstein Belga Marine, primary supplier to Petrobras, and includes radars and thermal imaging cameras for Petrobras mobile offshore production units (MOPUs) in the Campos Basin. Delivery and commissioning are scheduled for 2019.

The backdrop for the record delivery is a February 2018 agreement between Petrobras and the Brazilian federal environmental agency, Ibama, committing Petrobras to recently enhanced Ibama standards for controlling oil discharge in water.

ROSEN Expansion in Aberdeen

The ROSEN Group continues to implement its North Sea growth strategy with the opening of a new Aberdeen office. Since opening the new office, ROSEN is already working with several of the major operators in the North Sea, providing pipeline integrity, asset life extension and corrosion management services.

Acting as a hub for the company's North Sea integrity consultancy services, ROSEN's Aberdeen base is headed by Technical Manager Bryn Roberts, who has more than 25 years' experience in integrity, materials, corrosion and welding engineering for both service companies and oil and gas operators.

The next two years will see ROSEN's Aberdeen base increase in size to at least 20 personnel, reflecting an investment in both established industry expertise and the development of recent graduates.

UTEC Awarded Multivessel Survey Work Offshore India

UTEC, an Acteon company, has been awarded a subcontract by McDermott International for a series of survey works off eastern India. UTEC will provide surface

and subsea positioning services during the installation of subsea flowlines, pipeline end manifolds and terminations, jumpers, risers and umbilicals that form part of the development of a field in water depths to 2,100 m.

The work was to commence in December 2018. The project management team is based in Singapore, supported by personnel from UTEC's office in Perth, Australia. Project support is also being provided by McDermott's office in Kuala Lumpur.

Scottish Grant Award To Support Decom Market

Decom North Sea, the membership organization for the oil and gas late-life and decommissioning sector, has successfully secured a Decommissioning Challenge Fund grant award from the Scottish government. The £5 million fund aims to provide opportunities for the supply chain in Scotland supporting the acceleration of projects to develop investment-grade business cases and to fund new structures and infrastructure, allowing recipients to compete within the decommissioning market.

Following a consultation with its membership and external stakeholders, Decom North Sea identified the need for a more integrated, collaborative approach to share knowledge across the decommissioning sector. The grant was requested to create and develop a digital knowledge hub.

Deloitte, Oil & Gas UK Annual Collaboration Survey

The oil and gas industry's drive to increase collaboration between suppliers and operators in the U.K. Continental Shelf (UKCS) has continued to maintain a consistent performance, according to an annual survey by Deloitte and Oil & Gas UK that includes the Collaboration Index, measuring the effectiveness of companies as partners in collaboration. The findings of the UKCS Upstream Supply Chain Collab-

oration survey 2018 showed that while activity levels in the basin were gradually picking up and the appetite for collaboration remains very high, the industry-wide Collaboration Index score of 7.1 has remained the same as 2017. This is a strong sign that the industry can increase efforts to build on the track record it has attained over the past three years.

However, suppliers and operators switched places, with the operator score falling from 7.2 to 7.0 and the supplier score moving up by the same amount. This means that suppliers were once again scoring higher than operators, as they were in 2015 and 2016.

Where collaboration was successful, trust was cited as the most important reason, followed by mutual benefits.

Graham Hollis, senior partner for Deloitte in Aberdeen, said: "We expected to see greater awareness among respondents about the value of digital technologies, which has the potential to drive a new wave of productivity across the industry. Organizations do not necessarily need large up-front investments of time and capital to test and roll out new technologies and processes. Effective collaboration should not be forgotten when oil prices rise and the industry gets busier; this will only lead to a reversal of the efficiency gains of the last three years."

Innovation Incubator To Spur Job Growth

Atollo Offshore has launched its Aberdeen-based Innovation Incubator for smarter operations of the assets required for late-field life, decommissioning, rigless well intervention, plug and abandonment, and offshore wind projects.

Expected to create 20 jobs, the Incubator will bring Atollo's operational and academic minds together to accelerate the digital transformation of its offshore operations using automation, data analytics and artificial intelligence. Atollo will also study how the modern workforce can better engage with technology to enhance human capability in the offshore environment. **ST**

contracts

Damen Shipyards Group, Gorinchem, Netherlands, will build a diving bell ship to succeed the existing *Carl Straat*, in operation since 1963, to operate in the River Rhine and its tributaries. WSA Koblenz.

Global PCCI, Irvine, California, will provide engineering and technical services to operate an emergency ship salvage material system and support the U.S. Navy oil and hazardous substance spill response program. Navsea Supsalv.

Unique Group, Sharjah, United Arab Emirates, will design, manufacture and deliver classed air and saturation dive systems for integration on a fleet of Singaporean vessels. POSH Subsea.

NSSLGlobal, Redhill, England, received a multimillion-dollar contract to provide upgraded bandwidth fleetwide, along with installation of its Cruise Control+ appliance and the CrewVision crew entertainment service. Teekay.

TechnipFMC, London, England, received an engineering, procurement, construction and installation contract for the Luno II and Rolvsnes development in the North Sea, including umbilicals, rigid flowlines, flexible jumpers and subsea production systems. Lundin Norway.

CleanShip Solutions Ltd., Glasgow, Scotland, is the dedicated scrubber engineering partner for a large container vessel operator's scrubber retrofit program through 2019, including more than 30 vessels from 7,500 to 15,000 TEU. Undisclosed.

Equinor ASA, Stavanger, Norway, signed its largest agreement to date to fund basic research at academic institutions, for NOK 315 million over five years for six Norwegian universities. Norwegian University of Science and Technology.

UTIAS Space Flight Laboratory, Toronto, Canada, will develop multi-

purpose microsatellites to support Arctic surveillance, including a prototype and two additional microsatellites to make up a small formation. Canadian Department of National Defence.

Fugro N.V., Leidschendam, Netherlands, received a three-year maintenance contract for the hydrodynamic element of the Anglian Coastal Monitoring program and support of the full network of Regional Coastal Monitoring Programmes (RCMP) across England. DEFRA.

Survitec Group, London, England, will provide its new line of rapid-deploy military inflatable boats, which are capable of adaptable single-point inflation to suit subsurface operations, paradrops and helocasts. LFB. **\$T**

meetings

APRIL

April 1-3—Waterpower Week, Washington, D.C. 918-831-9560, andrea.harner@clarionevents.com or www.waterpowerweek.com.

April 2-4—MCE Deepwater Development, London, England. 281-491-5900, Bo.Howard@questoffshore.com or <https://mcedd.com>.

April 8-11—SubOptic, New Orleans, Louisiana. 703-444-0845, knielsen@stfevents.com or www.suboptic2019.com

April 9-10—Intelligent Ships Symposium, Philadelphia, Pennsylvania. asnehq@navalengineers.org or www.navalengineers.org/Symposia/Intelligent-Ships-Symposium-2019.

April 9-11—Ocean Business, Southampton, England. +44 (0)1453 836363, hdavis@divcom.co.uk or www.oceanbusiness.com.

April 10-11—Offshore Survey, Southampton, England. +44 (0) 1453 836363, info@oceanbusiness.com or <https://bit.ly/2Q735Bj>.

April 10-12—NOIA Annual Meeting, Washington, D.C. jwilliams@noia.org or www.noia.org/2019-noia-annual-meeting.

April 15-19—MTS International Buoy Workshop, Hobart, Australia. MTSevents@mtsociety.org or www.whoi.edu/buoyworkshop/2019.

April 25—Scottish Marine Data and GIS Workshop, Edinburgh, Scotland. +44 (0) 1420 768262, ka.tie.eades@oceanwise.eu or www.whereyourdatamatters.com.

April 26-27—Inland Ocean Action Summit, Dallas, Texas. cevans@inlandoceancoalition.org or <https://earthx.org/ocean>.

April 29-May 2—AUVSI XPONENTIAL, Chicago, Illinois. 571-255-7786, tmcMahon@auvsi.org or www.xponential.org.

MAY

May 6-9—Offshore Technology Conference, Houston, Texas. 972-952-9494, meetingsotc@otcnet.org or <http://2019.otcnet.org>.

May 8-9—Unmanned Maritime Systems Technology, London, England. +44 (0)20 7827 6000, events@smi-online.co.uk or www.smi-online.co.uk/defence/uk/Unmanned-Maritime-Systems.

May 13-15—UDT, Stockholmssäsan, Sweden. +44 (0)20 7384 7808, misha.agarwal@clarionevents.com or www.udt-global.com.

May 14-15—UK Ports Conference, London, England. conference@thewaterfront.co.uk or <http://bit.ly/2QY1F7X>.

May 14-16—IMDEX Asia, Singapore. +65 6542 8660, enquiries@imdexasia.com or www.imdexasia.com.

May 16-18—OceanTech, Zhoushan, China. katherinelee@together-expo.com.

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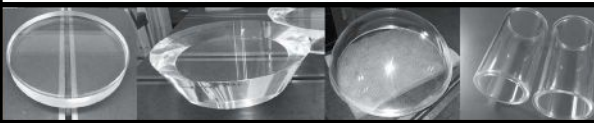


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A Worrying Prognosis for Ocean Health—Alex Hammond

Alex Hammond is the technical communications executive at the Institute of Marine Engineering, Science and Technology. He has a master's degree in ecology from the University of Southampton in the U.K. Hammond has experience in science communications across the science and engineering domain, with particular experience in marine biology and issues relating to coral reef ecology.



Funded by the European Union (EU) and implemented by Mercator Ocean International, a center for global ocean analysis and forecasting, Copernicus Marine Environment Monitoring Service (CMEMS) is one of six services delivered by the EU Copernicus Earth Observation Programme (CEOP). Dedicated to ocean observation and monitoring, it provides regular and systematic core reference information on the state of the physical oceans and European regional seas.

The continued findings of this ocean monitoring program are published annually in the CMEMS Ocean State Report, which charts physical changes in the world's ocean over several decades. The second edition of the report focuses on the more pronounced variations recorded in 2016 and arrives in the wake of a number of record-breaking extreme weather events across Europe.

The report is a summation of the work of more than 100 scientific experts from more than 30 European research centers, which draws upon empirical data gathered from both satellite and in-situ measurements, as well as numerical models carried out under CEOP. Its overarching aim is to collate, analyze and interpret this unique corpus of data, describing both natural oceanic variation, as well as consequential changes resulting from climate change.

The report draws particular attention to the rising heat content of the global oceans and European seas. Corroborating previous studies, the research indicates that the volume of sea ice in the Arctic is declining by an estimated 15.4 percent, and sea ice extent is receding by 6.2 percent per decade. It reveals a simultaneous decline in the volume and extent of Antarctic sea ice in the closing stages of 2016—an event unprecedented in the history of satellite observation of the region.

This is startling news given that, until now, it was understood that Antarctic sea ice was slowly but steadily growing at a rate of 1.6 percent in extent and 8.8 percent in volume per decade. The triggers for this reversal are unclear; however, it has been hypothesized that it could be the consequence of a complex interplay of variations in ocean hydrography and air-sea interfaces, such as wind-driven processes.

The large variations in the Atlantic Meridional Overturning Circulation (AMOC), a sweeping ocean conveyor system that circulates water throughout the Atlantic, between 1993 to 2016 are also chronicled in detail. AMOC has weakened significantly since 2005; however, owing to historically high variability, researchers are still reluctant to declare this as an ongoing trend. The weakening of the AMOC has also been linked with a deceleration of the Gulf Stream over the past 25 years. This is of particular concern, given that the Gulf Stream affects sea levels and draws nutrients up from the ocean depths, both of which are crucial in sustaining marine ecosystems and fisheries worldwide.

The potential future consequences on marine ecosystems are further explored in the report's documentation of oceanic carbon sequestration. The latest results illustrate that while carbon uptake by the world's oceans was relatively stable during

the 1990s, a sharp increase in CO₂ sea-to-air exchange has been recorded since the early 2000s. Often referred to as climate change's "evil twin," this acidification of the oceans will have a devastating impact on biodiversity and knock-on effects on fisheries and aquaculture. When coupled with a weakened AMOC, this presents a significant threat to food security for millions of people worldwide.

While this article can only offer a snapshot of the 150-page report, it is clear that the extensive assortment of data collected and analyzed by CMEMS paints a bleak picture for ocean health in the coming century. To develop effective mitigation measures, it is vital we develop better sustainable and science-based reporting and management strategies. Achieving these requires long-term, continuous and state-of-the-art monitoring of the oceans on a variety of spatial scales.

The ongoing publication of the Ocean State Report will assist in this endeavor, as it presents great value as a reference document on ocean health and climate. It is designed to serve stakeholders across the commercial and scientific marine sectors, as well as to support major EU policies. In doing so, it helps businesses in the blue economy better understand and anticipate future changes in the environment in which they operate, while also informing and stimulating further multidisciplinary scientific research.

Furthermore, it will support national and regional authorities in preparing more effective and robust strategies for tackling the challenges of an ever-changing climate.

The Ocean State Report is an open-access publication issued as an annual special supplement in the Institute of Marine Engineering, Science and Technology (IMarEST) Journal of Operational Oceanography (JOO). To read the full report, visit tandfonline.com/tjoo. **ST**

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San Diego, CA

FEBRUARY

Instrumentation: Measurement, Processing & Analysis

****U.S. HYDRO 2019**, March 18-21, Biloxi, MS

****Ocean Business**, April 9-11, Southampton, U.K.

MARCH

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

****AUVSI XPONENTIAL 2019**, April 29-May 2, Chicago, IL

APRIL

Offshore Technology/Alternative Energy & Ocean Engineering

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

****UDT 2019**, May 13-15, Stockholm, Sweden

MAY

Communications, Telemetry, Data Processing

****BlueTech Expo**, June 4-5, Washington, DC

****Oceans '19 MTS/IEEE Marseille**, June 17-20, Marseille, France

****CLEAN PACIFIC 2019**, June 18-20, Vancouver, Canada

JUNE

Seafloor Mapping/Sonar Systems/Vessels

JULY

Deck Gear, Cable, Connectors, Power Systems & Salvage

AUGUST

Geophysical Exploration/Seafloor Engineering

****SEG 2019**, September 15-20, San Antonio, TX

SEPTEMBER

Ocean Resources Development & Coastal Zone Management

****Offshore Energy 2019**, October 7-9, Amsterdam, The Netherlands

****CLEAN GULF 2019**, October 28-30, New Orleans, LA

****Oceans '19 MTS/IEEE Seattle**, October 28-31, Seattle, WA

OCTOBER

Environmental Monitoring, Remote Sensing & Pollution Control

****International Water Conference**, November 10-14, Orlando, FL

NOVEMBER

Undersea Defense/Antisubmarine Warfare

DECEMBER

Diving, Underwater Vehicles & Imaging

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