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We will continue to have an online *Buyers Guide*, which will contain *Industrial Firms*, *Products* and *Services* listings as well as those for appropriate educational institutions, geophysical survey vessels, and oceanographic research vessels.

The Buyers Guide's *Industrial Firms* and *Products* and *Services* listings will now be featured in the print version of the January 2019 issue of *Sea Technology*! (These sections will be exclusive only to the print version of the January issue).

And there will be something new for the Products and Services listings: we will include your company URL beside your company name.

The *Ocean/Marine Market overview* that has appeared in the *Buyers Guide* in the past will be supplanted by *January's Review & Forecast* offerings.

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TOTAL OCEAN MARKET COVERAGE 2019

JANUARY

Annual Review & Forecast / Buyers Guide/Directory

FEBRUARY

Instrumentation: Measurement, Processing & Analysis

****U.S. HYDRO 2019**, March 19-21, 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**, dates TBD, Amsterdam, The Netherlands

****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

****Underwater Intervention 2020**, dates TBD, New Orleans, LA

****EXTRA SHOW DISTRIBUTION** (additional shows will be added as information is obtained)

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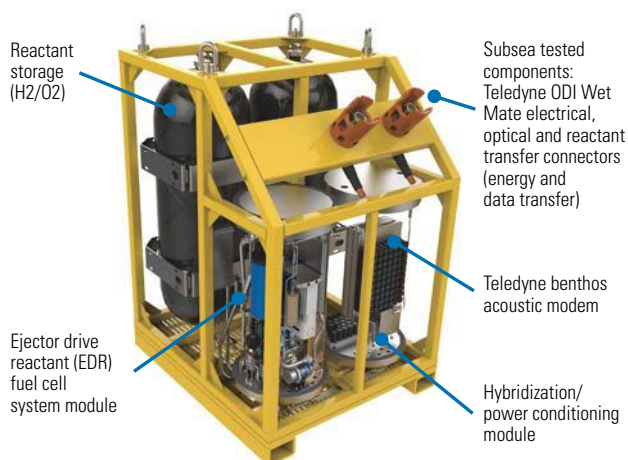
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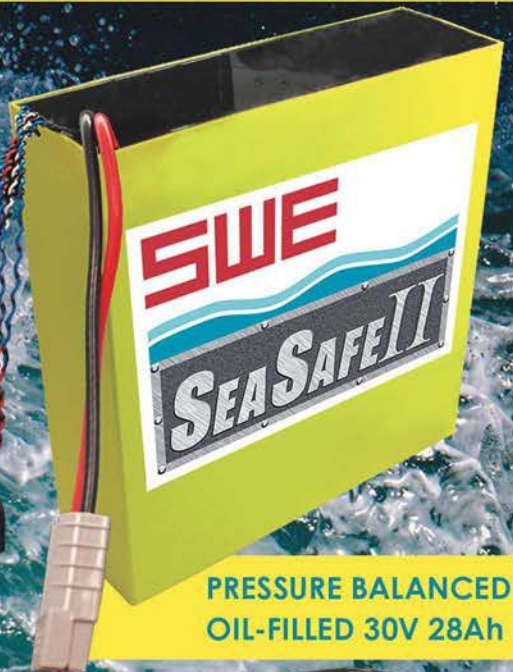


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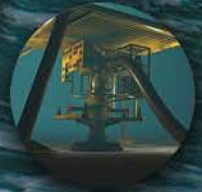
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Maritime Industry to Ride Blockchain Wave

Blockchain is the new buzzword in the shipping industry. Put simply, blockchain has the capacity to transform and fully digitize contracts in the sector. The beauty of blockchain, which is essentially an online communication protocol, is that it allows users who are interdependent to participate in a transaction without any one user having more control over the transaction than the other users. All parties to the transaction have access to the same information and no one party can attempt to amend or vary the transaction unilaterally without acquiring the permission of the others.

It is virtually impossible for blockchain transactions to be manipulated by an external party as the whole process is guarded by sophisticated cryptography, with exact copies of the transaction's ledger distributed among the participants.

For the global shipment of goods to occur, numerous parties have to reach agreements by entering into contracts that will govern every step of this process. Some of these agreements, such as sales contracts, will provide a road-map for the desired outcome. Other contracts, such as charter parties and bills of lading, will then have to be entered into to facilitate this performance.

All shipping contracts have numerous terms and conditions, some of which will work as triggers for information to be exchanged and for physical performance to be carried out. Traditionally, these actions would have involved several manual steps, with each step having the potential to create bottlenecks, delays and increased costs. Furthermore, the information can be altered, not delivered, delivered from a wrong source, or simply be fraudulent.

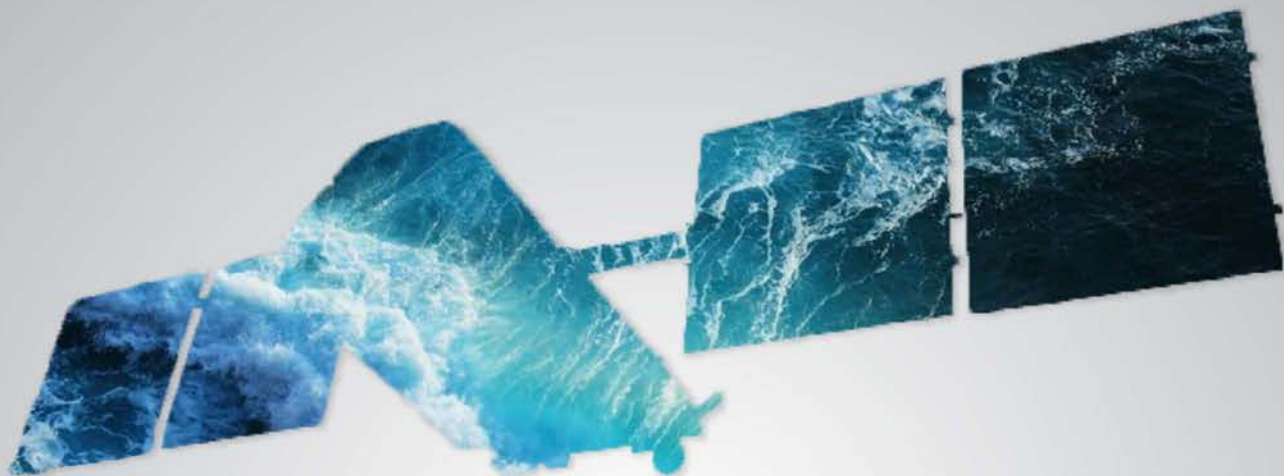
Blockchain can enable a conversion of the contractual terms and conditions into self-executable computer software that automatically implements and polices the terms and conditions between the parties to the contract. As the technology progresses, human-language contracts might even be replaced entirely with code.

The higher the degree of automation in a contract, the larger the potential benefits that contract can bring. Smart contracts can have a transformative effect on the maritime industry, leading to increased accuracy, security and transparency, as well as decreased reliance on intermediaries and savings of cost and time.

Traditional email exchanges would be replaced by automated and pre-coded information dissemination. Documents could be automatically generated and delivered to the appropriate parties. This would shorten wait times for cargo receipt and completion of shipping procedures from days to minutes. Computerization of contract execution would reduce risks of errors inherent in manual processes. Since blockchain information cannot be manipulated, instances of corruption in the form of demands for "grease payments" may also decrease as no party will be able to manipulate the bureaucracy of the shipping process to its advantage.

Such immediate visibility that blockchain brings can also improve contractual performance, enabling easier and quicker apportionment of liability and overcoming the problem of lack of trust in international sales and shipping.

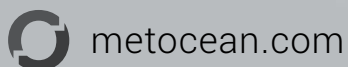
The potential impact of blockchain on trade is significant; the World Economic Forum estimates that 10 percent of GDP will be stored on blockchain by 2027 (<https://bit.ly/1KIN8ZR>). Smart contracts technology is still in its infancy and some legal hurdles need to be cleared. Nevertheless, smart contracts will gradually become pervasive in the wider maritime industry, offering practical solutions to issues that have negatively impacted trade for years. **ST**



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)) Russia Tests Waters in North Pole. The ocean carrier Maersk Line began a test passage through the Northern Sea Route in late August, *The Maritime Executive* reported. The newbuild sub-Panamax *Venta Maersk* headed north from Vladivostok for a voyage to St. Petersburg, skipping the Strait of Malacca and the Suez Canal. Maersk intended to determine the operational feasibility of the route. While the company said in a statement: “Currently, we do not see the Northern Sea Route as a commercial alternative to our existing network, which is defined by our customers’ demand, trading patterns and population centers,” a Maersk spokesperson noted that, although the passage is only accessible three months out of the year, accessibility “may change with time.” Costly ice-classed vessels are required for the voyage. There has been no large-scale commercial interest in using the Northern Sea Route so far beyond project cargo and site-specific shipments. Climate change could increase commercial activity, and seasonal transits across the pole could be viable by midcentury. Russia recently created a new Northern Sea Route Directorate to lead regional infrastructure development.

)) Student Team Journeys to Arctic to Study Climate. A group of scientific experts supported by 22 students, most of them young undergrads from Chicago, New York, Miami and Richmond, embarked August 23 on a three-week investigation. Departing from Resolute Bay in Canada aboard the One Ocean Expeditions’ 384-ft. vessel *Akademik Ioffe* and returning to Iqaluit September 13, the Northwest Passage Project team observed conditions and collected data to improve the resolution of the scientific picture of, and assess changes underway in, the Far North, considered a harbinger of climactic change for the rest of the world. The team updated the public in real time en route via 31 interactive sessions hosted by the Smithsonian Institution National Museum of Natural History (Washington, D.C.), the Exploratorium (San Francisco, California) and the Alaska SeaLife Center (Seward, Alaska). The team also reported via Facebook, Twitter, Instagram and YouTube and posted blogs on NorthwestPassageProject.org. The team took questions directly from classrooms, citizen scientists and the public worldwide in the first-ever interactive Facebook Live sessions from the Northwest Passage, four in total. The researchers were led by chief scientist Dr. Brice Loose of the University of Rhode Island Graduate School of Oceanography, Dr. Donglai Gong of the Virginia Institute of Marine Science and Holly Hogan of the Canadian Wildlife Service. The team’s mission is to assess and chronicle the consequence of the warming trend over the Arctic Circle on waters of the Canadian Arctic Archipelago. The research focuses on: volumes and flows of freshwater ice melt entering the Arctic Ocean, which, when it enters the Atlantic has global impacts; changing water column chemistry and its effects on greenhouse gases; and vulnerable constituents of the Arctic food web: plankton, seabirds and marine mammals.

)) Norway Maps Seabed Mineral Deposits. After the Ministry of Petroleum and Energy assumed administrative responsibility for mineral deposits on the continental shelf, the Norwegian Petroleum Directorate (NPD) was assigned the task of mapping potential deposits. The NPD conducted an extensive data acquisition expedition in the deeper areas of the continental shelf in western parts of the Norwegian Sea in August and September. The NPD has engaged Swire Seabed AS, which partnered with Ocean Floor Geophysics Inc., to carry out mapping of potential sulphide minerals on the seabed over the Mohns Ridge. This is a spreading ridge in the Atlantic Ocean that separates two oceanic plates, where potential valuable minerals have been formed through hot volcanic sources. The focus of the expedition is not the active hydraulic systems such as “black smokers,” but rather nonactive extinct systems that are now left as mineral-rich piles of gravel on the seabed. The mapping was carried out using a Kongsberg HUGIN AUV. After the data were processed on board, mineral samples were taken from the seabed where the data indicate the presence of deposits. Sampling was carried out using an ROV lowered down to the seabed as deep as 3,000 m.

)) Metocean Data Open for Scottish Innovation Challenge. The European Marine Energy Centre (EMEC) has provided a series of metocean data sets to be used in a new Scottish open innovation competition aiming to stimulate creative thinking and data science to design new data products for the benefit of the marine environment, communities and economy. Organized by Highlands and Islands Enterprise (HIE) and the Data Lab, Scotland’s Blue Growth Data Challenge made available data sets from 2015 in-situ observations and numerical modeling from EMEC’s wave and tidal energy test facilities in Orkney. The data sets include wave conditions at EMEC’s Billia Croo wave test site; meteorological observations in two locations adjacent to EMEC’s wave and tidal test sites, collected using MetPak weather stations; data from a short tidal current observational campaign using TRDI acoustic Doppler current profiler; and numerical modeling results for four locations around Orkney, showing simulated time series of tidal water level and currents. Data sets will also be provided by the Scottish Centre of Excellence in Satellite Applications (SoXSA). The challenge is open to those who are studying, researching or working with data or the marine environment. The aim is to stimulate people to create new or innovative solutions without predetermining what those solutions will look like. Prizes will be awarded to teams and individuals who are judged to have produced the best output for the benefit of the Highlands and Islands region, and the winners will receive a package of support to help further develop their ideas. The challenge event will take place October 22 to 24. To find out more, visit www.blue-growth-data.net. **ST**

Verifying ISFET Sensors

Test Bath, Field Experiments to Check Accuracy of pH Measurements

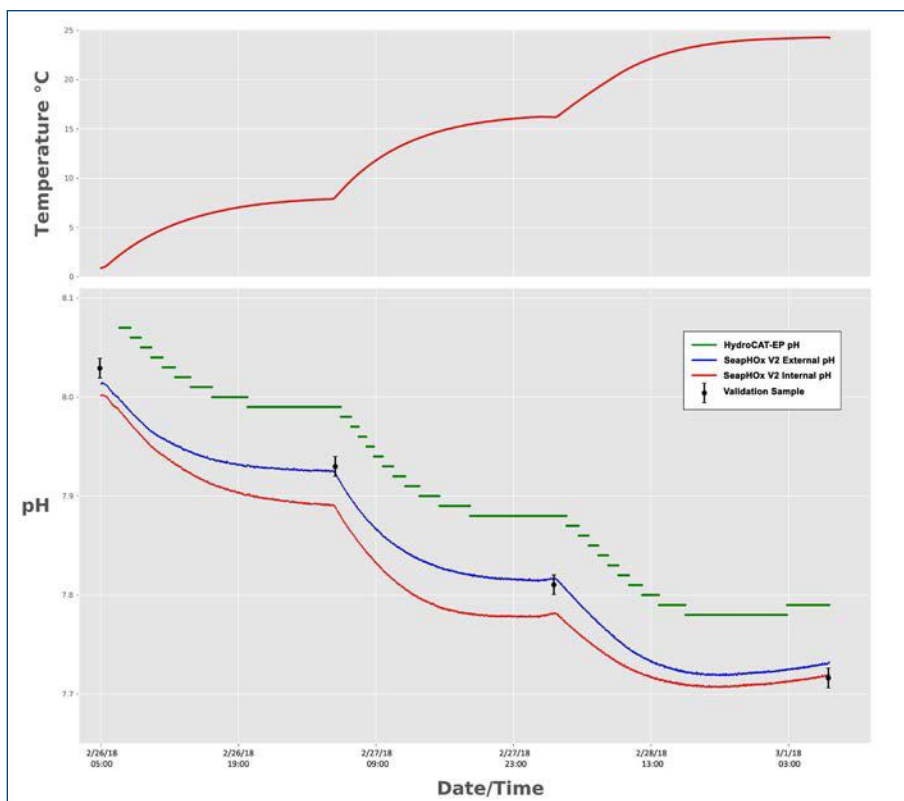
By Greg Ikeda

An ocean mooring is like a small community: clusters of sensors huddle together, each measuring the ocean's pulse in a different way, sometimes chatting with one another about what they've seen. As the world's oceans become more acidic, it's becoming increasingly clear that pH sensors should be vital members of this community. However, the prevailing technology—glass-electrode pH sensors—is notoriously unstable in seawater, necessitating frequent calibration, reducing reliability of the sensors during long-term deployments.

Enter the Sea-Bird Scientific SeapHOx V2: part pH sensor, part CTD. It consists of the SeaFET V2, measuring pH with an ion-sensitive field-effect transistor (ISFET), and corrects data with temperature and salinity input from an SBE 37-SMP-ODO CTD. Unlike glass electrodes, the SeapHOx V2's ISFET and solid-state reference sensors do not undergo significant changes to their internal chemistry, allowing them to retain accuracy for long-term deployments without recalibration.

The bath test of a SeapHOx V2 and a HydroCAT-EP. The test bath contained chilled natural seawater and retained a stable salinity of 36.63 to 36.90 psu. Temperature was increased at approximately 24-hr. intervals to stimulate changes in pH. Four pH validation samples were taken and analyzed on a spectrophotometer before each temperature change—the accuracy of this method with pure dye is approximately ± 0.01 pH, as shown by the error bars on the figure.

As part of ongoing efforts in pH sensor development, Sea-Bird Scientific conducted a basic comparison of pH data from the SeapHOx V2 to a HydroCAT-EP, a multiparameter moored CTD that uses a standard glass-electrode pH sensor. Simultaneously deployed in a stable test bath for approximately 72 hr., the response from the SeapHOx V2's ISFET sensor and the HydroCAT-EP's glass-electrode sensor highlighted the different capabilities of each sensor technology. While this test provided a snapshot of sensor performance under controlled, salinity-stable conditions, an experiment in a test bath is not an ideal test to characterize sensor differences: It fails to simulate rapidly changing field conditions and is not long enough



to capture drift rates of either pH sensor. Nonetheless, the experiment provided a useful baseline from which to evaluate the SeapHOx V2's overall accuracy and resolution relative to the prevailing glass-electrode technology.

To better characterize the SeapHOx V2's ability to withstand and perform in the field, Sea-Bird Scientific field scientists also deployed a Deep SeapHOx V2 in Puget Sound, a large estuary connected to the Pacific Ocean, with regular validation samples to determine sensor accuracy and drift over time.

The SeapHOx V2

The SeapHOx V2 is an upgrade of the original Satlantic SeapHOx pH sensor, consisting of a SeaFET V2 pH sensor physically and electrically integrated with an SBE 37-SMP-ODO CTD. It measures pH with an ISFET as the primary sensor, providing two pH outputs from two sep-

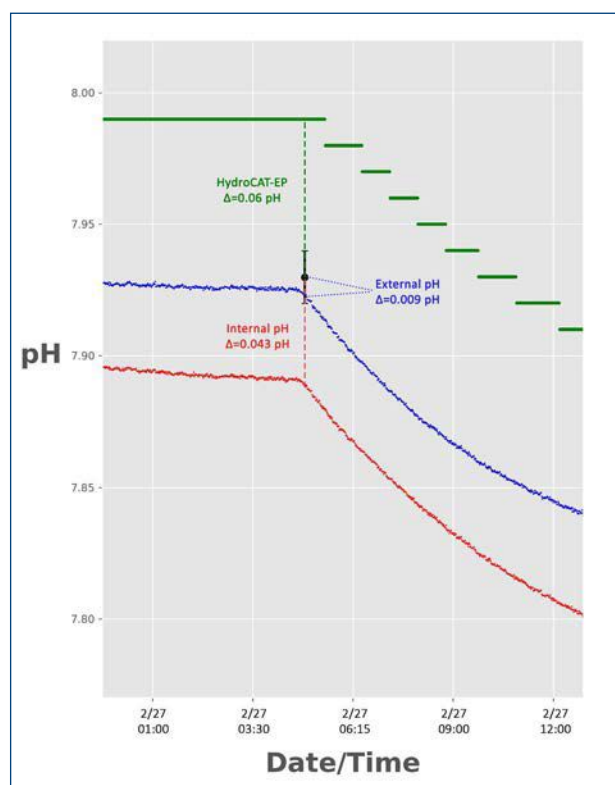
arate reference electrodes. The internal pH value references an internal electrode submerged in saturated KCl solution. The external pH value references an Ag/AgCl electrode next to the ISFET. Unlike the internal electrode, this external electrode is directly in contact with seawater. Because this electrode is sensitive to chloride ions in seawater, it requires accurate salinity measurements from the CTD for proper corrections of the pH. Each output has unique sources of error, but external pH is generally more accurate when salinity data are available to correct pH data. The initial accuracy of both pH outputs is rated to 0.05 pH, expected to drift less than 0.003 pH/month.

The physical and electrical design of the SeapHOx V2 provides the ability to deploy the ISFET pH sensor in marine environments. Unlike the glass electrode, the ISFET and accompanying reference electrodes do not undergo rapid change in seawater, opening doors for long-term deployment of moored pH sensors.

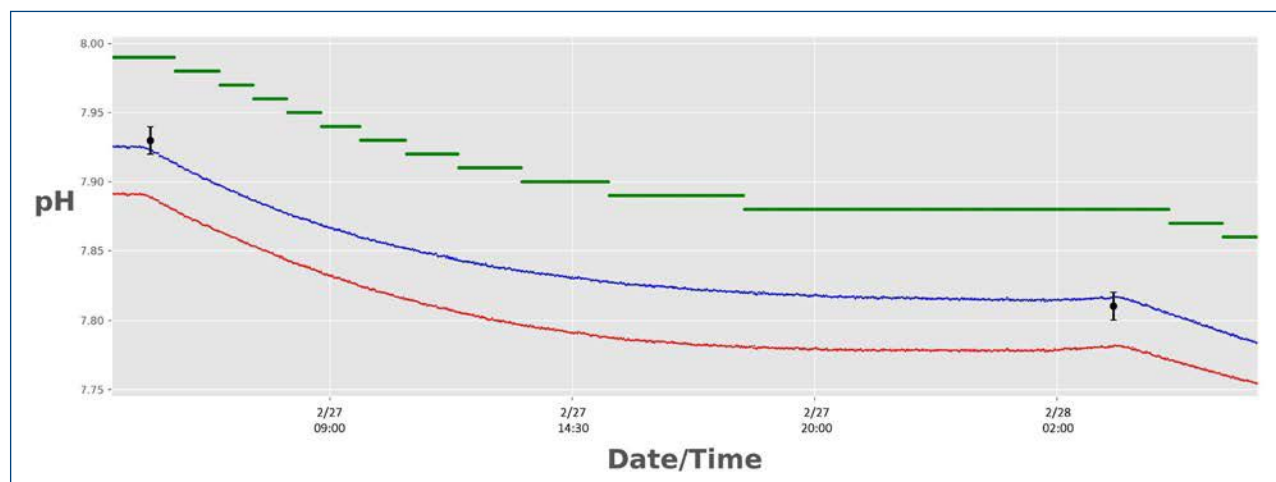
The HydroCAT-EP

The HydroCAT-EP is a multiparameter moored CTD based on the SBE 37 CTD. It is capable of measuring temperature, conductivity, pressure, dissolved oxygen, pH, fluorescence and turbidity with integrated sensors. The HydroCAT-EP's "HC-pH" pH sensor is a standard glass electrode optimized for longer deployments, accurate to 0.1 pH and expected to retain accuracy for approximately 90 days.

Like all glass-electrode sensors, the HC-pH is subject to changes in internal chemistry that cause sensor drift over time. As such, it benefits from frequent recalibration. While useful for coastal monitoring applications,



(Left) Enhanced view of the second validation sample, with the difference between pH from each sensor and the pH of the validation sample (Δ). All sensors are within their expected initial accuracy specification. (Bottom) Enhanced view of the second and third temperature changes, demonstrating how the HydroCAT-EP's pH resolution changes only in 0.01 pH increments. This is due to the pH sensor's resolution—it is unable to resolve changes below 0.01 pH. The SeapHOx is able to resolve very small changes in pH, producing a smooth line as pH drops.



frequent recalibration is often unfeasible for long-term, open-ocean deployments where equipment is largely inaccessible and accuracy is paramount. Accuracy of the glass-electrode pH technology is often insufficient for ocean acidification research.

The Bath Test

A SeapHOx V2 and HydroCAT-EP were deployed simultaneously in a test bath in Sea-Bird Scientific's facility in Bellevue, Washington, February/March 2018. The bath contained clean, natural seawater from Hawaii and a chiller for temperature control.

At roughly 24-hr. periods, the temperature was increased to stimulate slight changes in pH. Salinity remained stable at approximately 36.63 to 36.90 psu.

To determine sensor accuracy, four pH validation samples were collected before each temperature change using standard pH indicator dye spectrophotometry (with an accuracy of ± 0.01 pH).

The SeapHOx equilibrated to the test bath for 72 hr. prior to the experiment for optimal data quality and the HydroCAT-EP's pH sensor was calibrated before entering the bath.

Accuracy

As expected, the internal pH and external pH from the SeapHOx V2 were both significantly more accurate than the HydroCAT-EP. The SeapHOx V2 measured an average difference from the validation samples of 0.0108 pH (external) and 0.0253 pH (internal)—well within the rated accuracy spec of 0.05 pH—while the HydroCAT-EP retained an average difference of 0.062 pH from the validation samples (within the accuracy spec of 0.1 pH).

The improved accuracy of IS-FET-based pH sensors is important for several applications, including ocean acidification research. Previous research that required accuracy finer than 0.1 pH generally relied on spectrophotometer analysis of water samples or glass electrodes

that are extremely well designed and maintained. While spectrophotometer analysis still provides the greatest accuracy, reliance on analytical chemistry yields sampling challenges and lacks the speed and convenience of an in-situ sensor.

Resolution

Superior resolution from the SeapHOx V2 was immediately evident; it was capable of tracking minor changes within 0.002 pH, producing a smooth line as pH changed in the test bath. The HydroCAT-EP's pH sensor could only resolve changes of 0.01 pH, resulting in "stepwise" changes in pH data.

The resolution of the HydroCAT-EP's pH sensor is typical of glass-electrode pH sensors. Better resolution has obvious advantages for tracking ocean acidification, especially in deep-ocean environments where pH changes may be relatively small yet important to track.

Test Bath Conclusion

Overall, both the ISFET and glass-electrode pH sensors performed as expected in the test bath, with the ISFET achieving approximately three times better accuracy and five times better resolution than the glass electrode in a controlled seawater bath. However, as mentioned earlier, a comparison in a stable bath is not a strong representation of how each sensor will perform in the field. Rather, it verifies that each instrument is meeting its expected accuracy and resolution, and the SeapHOx V2 specs are indeed superior to the glass-bulb electrode on the HydroCAT-EP.

Field Deployment

In October 2017, Sea-Bird Scientific deployed a Deep SeapHOx V2 in Shilshole Bay Marina in Seattle, Washington. To benchmark the performance of the Deep SeapHOx V2, a Shallow SeaFET V1 was deployed simultaneously, plumbed to the exhaust outlet of the Deep SeapHOx V2 to ensure the instruments sampled the same parcel of water. Bottle samples were taken approximately twice a week, and the pH

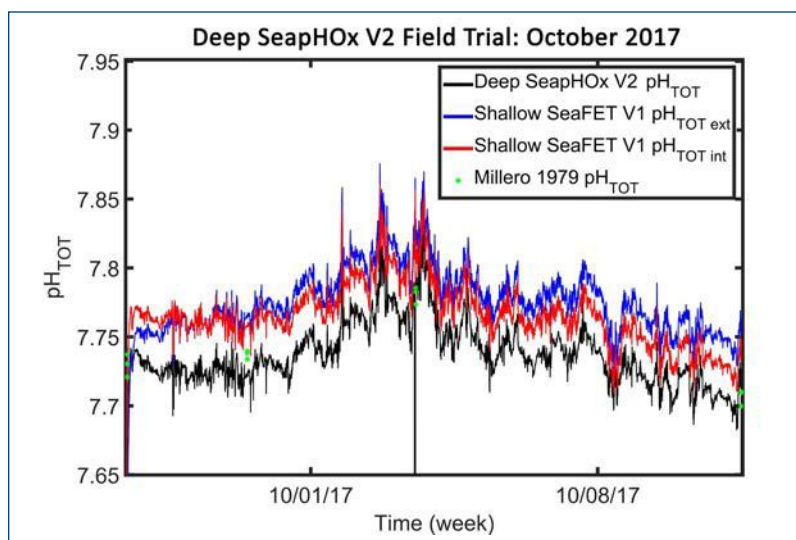
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A two-week time series of pH from a Deep SeapHOx V2 and Shallow SeaFET V1, deployed at Shilshole Marina in Seattle, Washington, October 2017. The black line is the pH from the Deep SeapHOx V2. The blue and red lines are the predicted pH from the external and internal reference of the Shallow SeaFET V1, respectively. Green represents the pH bottle samples.

was measured using standard seawater pH spectrophotometric methods. The instruments recorded two weeks of data and then were returned to Sea-Bird for data analysis.

The resulting accuracy of the Deep SeapHOx V2 was found to be 0.0077 pH after salinity corrections, which was at least two times better than the Shallow SeaFET V1 and five times better than the current accuracy specification of 0.050 pH. After characterization and validation at Sea-Bird, the Deep SeapHOx V2 was redeployed in November 2017 for one week, with bottle samples at the beginning and end of this deployment. The resulting accuracy of the Deep SeapHOx V2 was found to be 0.0072 pH, approximately the same as the previous deployment.

This result demonstrates the excellent reproducibility of the new Deep SeapHOx V2. After the deployment, the Deep SeapHOx V2 performance was evaluated at

Sea-Bird in seawater test baths. The post-field deployment accuracy of the instrument was found to be 0.0021 pH, three times better than the field performance.

The culmination of the results from these deployments demonstrates the improved accuracy of the Deep SeapHOx V2 in the field. **ST**

Greg Ikeda is the content development manager at Sea-Bird Scientific. Originally starting on Sea-Bird's technical support team, he brings a background of field experience and technical knowledge to assist with scientific projects and content development. He has a B.S. in oceanography from the University of Washington.

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CLEAN GULF



The CLEAN GULF Conference and Exhibition is the premier annual event for industry and government to

come together and discuss planning, preparedness and response issues for oil and hazardous materials spills. It brings together all parties responsible for prevention and response operations from North America and beyond to hear best practices and build relationships vital to a successful response on land or water. The main focus of the conference sessions are case studies, best practices and lessons learned, and the exhibit hall is filled with products and services for prevention and response.

This year, CLEAN GULF will take place November 13 to 15 in New Orleans, Louisiana. The conference agenda planned for 2018 covers many of the most pressing issues facing today's environmental professional, and the sessions are led by experts in their field. Not only

do the conference sessions provide need-to-know information, they give attendees an outlet to activate that information via net-

working and knowledge-sharing with their peers. In addition to the robust conference agenda, CLEAN GULF hosts an exhibit floor filled with more than 150 exhibitors ready to answer attendee's questions and provide solutions to their unique challenges.

Show Program

Eight concurrent tracks will take place at CLEAN GULF: Emerging Trends; Information/Response Technologies and Research; Response; Planning and Preparedness; Inland Preparedness and Response; Training and Exercise Best Management Practices; Subsea and Dispersant; and Solutions. The conference will kick-off on Tuesday, November 13, with training workshops covering



Comparative Risk Assessment (CRA) of Response Options for a Deepwater Oil Well Accident; Mexico: Navigating Offshore Oil Spill Response Challenges and Opportunities; and Homeland Security Challenges Including Terror Threats.

In the afternoon, conference sessions will cover Technology Innovations; Planning Tools to Improve Response Strategies and Tactics; and Rail Response Plan Requirements. The day concludes with the State and Federal Updates and the CLEAN GULF Welcome Mixer.

On Wednesday, November 14, the day will begin with the keynote address and welcome, delivered by Louisiana Governor John Bel Edwards and Lt. Governor Billy Nungesser.

Conference sessions will be held throughout the day, including International Challenges and Lessons Learned; Oil Spill Response Science and Technology: Bridging from Research to Response; Salvage and Marine Firefighting Case Studies and Lessons Learned; Impacts of Wildlife Regulations; In-Situ Burn Case Studies; MC-20 Insight into the Longest Running Active Unified Command in Response History; Mexico Exploration and Production; Detection of Submerged Oil; Lessons Learned from Hurricanes Irma and Maria Vessel Removal

Operations under ESF-10; Meeting Compliance Challenges; Pre-Planning for the Inland Zone; How to Meet Expectations Through Best Management Practices; Case Study: Stone Energy Subsea Dispersant Injection (SSDI) Application - API 4719; The Human Element; Surface Oil Surveillance and Detection; In-Situ Burn: A Historical Perspective and Advances in Technical and Regulatory Framework; Wildlife Response Updates for Planning; Case Studies in the Inland Zone; Regulatory Expectations for Training and Exercises; and Subsea Dispersant Injection (SSDI) - Comparing Relative Risks; Setting Expectations; and Managing Data.

The day will conclude with the opening-night reception on the exhibit floor.

On Thursday, November 15, the day will consist of conference sessions, including Risks and Security in a Digital World; Surveillance and Visualization Technologies; Response Community: Past, Present and Future; Response, Natural Resource Damage Assessment (NRDA) and Restoration; Exercise Success! Train Like You Fight and Fight Like You Train; Well Containment Companies - What Is Their Future?; Response Research; Shoreline Assessment and Response: The Future of SCAT; Regulatory Updates; Response Competency Processes; Subsea Oil Release Modeling; Strategies and Lessons Learned from Major Natural Disasters; PREP 2016.1 - An Update on Proposed Changes; Right Sizing the Incident Management Team for Exercises and Real Events; and the Consideration of Environmental Management.

The Exhibition

The CLEAN GULF exhibit hall will feature top products and services for prevention, emergency response, cleanup, remediation, fire and salvage, aerial surveillance, disaster recovery, crisis management and more. Attendees will have the opportunity to meet face to face with all of the exhibitors to discuss their unique challenges.

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Analysis of RTK Positioning Methods

Comparative Study of Single-Baseline and Network RTK

By Dr. Reha Metin Alkan • I. Murat Ozulu • Dr. Veli Ilci

In order to eliminate the disadvantages of conventional relative positioning and make the process more convenient and simple, a high-precision, real-time kinematic surveying method called conventional real-time kinematic (RTK), using corrections for rover users from a fixed reference station, began to be in use in the 1990s. In this method, single baseline is used to obtain 3D coordinates in real time, thus, it is also referred to as single-baseline RTK. This method makes GPS/GNSS a very efficient tool for land, air, marine and numerous other applications where precise real-time positioning is required. In this method, the rover should be within a 10- to 20-km radius from its base station, a limitation caused by distance-dependent biases, such as orbital, ionospheric and tropospheric biases that deteriorate the positioning accuracy.

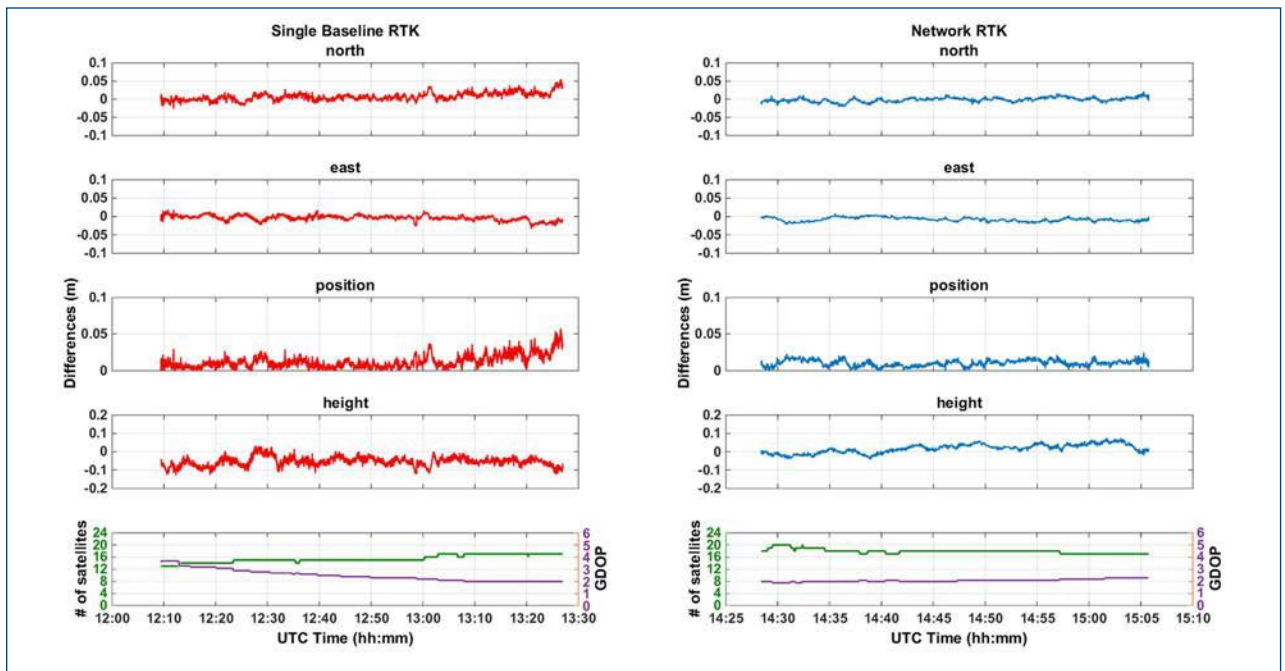
In the early 2000s, RTK positioning was extended from a single baseline to multibaseline in order to minimize the effect of distance-dependent errors, as well as to determine positioning with higher accuracy and reliability.

This was done by adding real-time kinematic positioning ability to the Continuously Operating Reference Stations (CORS) Network. The use of CORS Networks has become more prevalent in providing positioning services all over the world in the last couple decades. From this arose a method known as network RTK that has been widely used in various real-time surveying applications as an accurate and reliable RTK positioning method.

Network RTK employs GNSS raw data gathered from several spatially distributed base stations like the CORS Network in order to create models that can mitigate errors in the network coverage area. When compared to single-baseline RTK, the distance-dependent errors in the network RTK method mentioned above are modeled properly for long baselines, i.e., several tens of kilometers. This provides homogenous accuracy and improves reliability of positioning over extended distances.

In Turkey, there are a great number of single-baseline/network-based RTK systems that many different author-





ities, such as government facilities, municipalities, universities and the private sector have begun to utilize. A comparative study was carried out in Turkey in order to assess the accuracy performance of single-baseline and network RTK in dynamic environments. Two kinematic experiments were conducted.

Çorum Municipality Single-Baseline RTK

A single-baseline RTK was established in, and operated by, Çorum Municipality in Turkey to disseminate the RTK position corrections for Çorum province. The single-baseline RTK station MUNI was located on the roof of the municipality building of Çorum in 2012 and equipped with TOPCON GB-3 receiver with TOPCON PG-A1 geodetic-grade antenna. The TOPCON GB-3 multifrequency receiver has tracked the L1/L2/L5 C/A and P-code and carrier data from GPS and GLONASS satellites and E1/2/5a and L1 from GALILEO, including WAAS/EGNOS capability. The static positional accuracy is given as 3 mm + 0.5 ppm (for horizontal) and 5 mm + 0.5 ppm (for vertical) when using L1 + L2 observations. The real-time data format is in RTCM 2.1, 2.2, 2.3, 3.0, CMR, CMR+ and TPS protocols.

The corrections are sent to the users via internet communications and GSM network by using VRS correction method. The reference station not only disseminates the RTK correction, but may also log the static GNSS data for later use. Çorum Municipality intends to increase the number of reference stations and establish a CORS network with RTK capability within a few years.

Turkish RTK CORS Network/CORS-TR

In Turkey, establishment of a multibaseline RTK network was completed and has been used by civilians since 2009. This network is called TUSAGA-Aktif (or Turkish RTK CORS Network/CORS-TR) and consists of two control stations (master and auxiliary) and 146 reference stations, having an average spacing of 70- to 100-

Differences between post-processed differential solution (known coordinates) and RTK-derived coordinates (left: single-baseline RTK; right: network RTK).

km interstation distances covering almost all of Turkey and the Turkish Republic of Northern Cyprus.

In this system, VRS, FKP and MAC and differential GPS (DGPS) techniques are implemented. Users of MAC and FKP solution methods cannot use GLONASS data because network-related message types for GLONASS satellites are only available for VRS, not for FKP and MAC. The communication between the control center and rover(s) is provided by RTCM 3.0 and higher protocols and, thus, GSM, NTRIP over GPRS/EDGE and radio links are utilized. The coordinates can be realized in ITRF96 datum and 2005.0 measurement epoch. In addition to the RTK correction, all the reference stations can also log the GNSS data. Users can download 1 sec.-interval data with a limited fee and 30 sec.-interval data freely via the service's website, <http://rinex.tusaga-aktif.gov.tr>.

Kinematic Test Measurement

In order to make an accurate assessment of the single-baseline RTK operated by Çorum Municipality and the network GNSS RTK, CORS-TR operated by the General Directorate of Land Registry and Cadastre of Turkey in a dynamic environment, two different kinematic test measurements were carried out October 20, 2015. The test area was located at Obruk Lake Dam in Çorum, which has a water surface area of approximately 50 sq. km.

The test measurements were carried out with a vessel equipped with the GNSS receiver and a geodetic-grade antenna along several survey profiles, and 4,632 measurement epochs (approximately 80 min.) and 2,241 measurement epochs (approximately 40 min.) were recorded during the first and second trial, respectively. The data were collected at 1-sec. intervals from all visible sat-

ellites with 10° elevation mask. The coordinates of each measurement epoch were determined in real time by using the single-baseline RTK approach in the first trial and network RTK approach in the second trial with VRS correction technique by using all visible GPS and GLONASS satellites. All coordinates were obtained as a fixed solution. The average distance from the single-baseline RTK reference station to the test area was about 28 km.

In these test studies, ProFlex500 GNSS receivers with its geodetic-grade antennas were used. The ProFlex 500 is a 75-channel receiver (GPS L1 C/A L1/L2 P-code, L2C, L1/L2; GLONASS L1 C/A, L2 C/A code, L1/L2) with the maximum capacity of 20 Hz of raw data and position output.

While RTK-derived coordinates were determined, GNSS raw data were also recorded on the vessel in kinematic mode in order to obtain reference trajectories (i.e., known coordinates of each measurement epoch). This allows us to make a precise assessment of attainable accuracy of single-baseline and network RTK methods. Simultaneously, the same type of GNSS receiver was occupied at a known geodetic point on the shore, and data were collected in static mode.

The coordinates of this geodetic point on the shore were computed in ITRF datum with centimeter-level accuracy by using the static data from two of the reference stations of the TUSAGA-Aktif Network. The necessary data collected at the reference stations were retrieved from the TUSAGA-Aktif website. Then, the precise coordinates of each measurement epoch were calculated with carrier-phase-based relative method by using both the GNSS data collected on the vessel and at the geodetic point on the shore. All the data were post-processed and coordinates were calculated with Leica Geo Office commercial software. The computed coordinates for each measurement epoch were compared with the reference coordinates (assumed as known coordinates) for north, east and 2D position and height components.

When the obtained results are examined, it can be seen that the differences in 2D position reach up to 5.7 cm as a maximum value for single-baseline RTK-derived coordinates and 2.5 cm as a maximum value for network RTK-derived coordinates. The differences for height components reached to about 12.7 cm for single-baseline RTK and about 7.6 cm for the network RTK. These results imply that the network RTK method performs better than the single-baseline RTK. In general, the results show that network RTK provides homogenous, high accuracy and reliable positioning.

Conclusion

This study aimed to assess the accuracy performance and usability of single-baseline RTK and network RTK using the CORS-TR Network in a dynamic environment.

Results of the kinematic trials demonstrated that, although the network RTK method produced more accurate results than those achieved from the single-baseline RTK, both of them provided continuous real-time positioning within centimeter to decimeter level of accuracy with a reliable and cost-effective manner when the fixed

solution was established. In general, the result implies that both of the RTK techniques can be used for many marine applications, such as precise hydrographic surveying and mapping, navigation, marine engineering and geodesy, dredging, attitude control of ships, buoys and floating platforms, cable and pipeline laying, port operations, offshore exploration and exploitation, automatic docking, oceanography, coastal resources management, and marine and seafloor monitoring.

The results are also sufficient for many international hydrographic surveying standards. Currently, it is a strong alternative to the conventional differential methods that require expensive and time-consuming field and office studies.

Although RTK systems have become an efficient tool for surveyors with its several advantages, they have many disadvantages and restrictions, including distance limitation, data communication requirement between the rover and its base station, requirements of RTK-capable GNSS receivers, communication cost, and dependency on coverage of GSM carrier service. These systems need high-cost network installation and maintenance, as well as more complex hardware and software. If GSM coverage restricts the use of this technique in an area, users are forced to adopt the conventional approach or use a radio-modem device for broadcasting the differential correction using a single station. Also, in some countries such as Turkey, subscription requires a cost.

References

For a list of references, contact Professor Dr. Reha Metin Alkan at alkanr@itu.edu.tr. **ST**

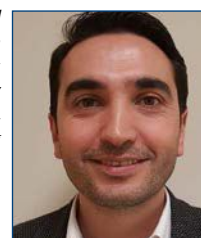
Dr. Reha Metin Alkan is a professor in the Geomatics Engineering Department at Istanbul Technical University (ITU) in Istanbul, Turkey. He holds an M.S. and Ph.D. in geodesy and photogrammetry from ITU. His research focuses on satellite positioning and navigation.



I. Murat Ozulu graduated from Yildiz Technical University (YTU). He obtained an M.S. degree from Anadolu University, Turkey in 2005. He is currently a Ph.D. candidate in YTU and a lecturer at the Hitit University in Turkey. His areas of research include geodesy, GNSS, engineering surveying and geodetic documentation studies at archeological sites.



Dr. Veli Ilci graduated from Istanbul Technical University. He obtained a Ph.D. degree from Yildiz Technical University, Turkey in 2017. He is currently an assistant professor at Hitit University in Turkey. His areas of research include geodesy, GNSS, indoor positioning, engineering surveying and GIS.



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International Water Conference

The International Water Conference (IWC) is the world's premier conference for understanding and dealing with the technical and business challenges of industrial water treatment.

The IWC is moving to a new location this year. It will be held November 4 to 8 at Talking Stick Resort in Scottsdale, Arizona.

As the preeminent international technical forum in the field, the IWC brings together end-users, researchers, practicing engineers, managers, educators, suppliers and contractors.

Attendees come to learn unbiased details about the latest applications available in the industry, get educated on current technology, and hold wide-ranging discussions with their peers active in water treatment.

Keynote Session

The IWC keynote session is the official start to the 2018 conference on Monday, November 5 at 11:15 a.m.

Joel Beauvais, who is a partner in the Washington, D.C., office of Latham & Watkins LLP and a member of its Environment, Land & Resources Department, will be the 2018 keynote speaker.

In addition to the keynote speaker, there will be a presentation of the annual awards, including the IWC Award of Merit, the Paul Cohen Award and the Joseph A. Levendusky Memorial Scholarship (sponsored by Epicor Inc. and the International Water Conference).

These awards are given to an outstanding individual in the field of industrial water technology; an author from the previous International Water Conference; and an undergraduate student in mechanical or chemical engineering, respectively.



Workshops

Conference attendees will learn the latest about new applications available in the industrial water treatment industry. The IWC Continuing Ed Workshop program is designed to provide practical information that includes a basic understanding of the topic, as well as detailed case studies. These are presented by experts in the field and are loaded with technical content, instead of sales information.

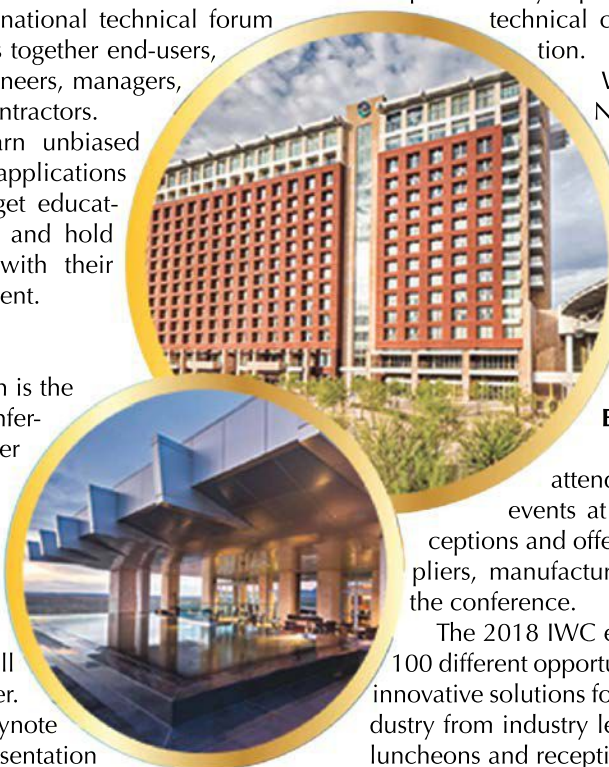
Workshops will start on Sunday, November 4 at 1 p.m. Each workshop will provide an opportunity for a technical exchange between the students, the instructor and other workshop participants. Once the workshops finish on Sunday, the exhibit hall will have a welcome reception starting at 5 p.m.

Exhibit Hall

The exhibit hall is the hub of all attendee gatherings and networking events at IWC; hosting luncheons and receptions and offering the chance to meet with suppliers, manufacturing companies and more during the conference.

The 2018 IWC exhibit hall will feature more than 100 different opportunities to learn about practical and innovative solutions for the industrial water treatment industry from industry leaders. Networking coffee breaks, luncheons and receptions will be hosted throughout the exhibit hall, giving attendees plenty of opportunities to continue their learning experience in between technical sessions.

Attendees can participate in Exhibit Hall Bingo as they network. Attendees that visit each booth on the bingo card will be eligible for a prize drawing. These well-timed networking breaks also afford exhibitors an opportunity to attend technical sessions along with other attendees.



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“The International Water Conference (IWC) is the world’s premier conference for understanding and dealing with the technical and business challenges of industrial water treatment.”

Social Events

There are new and exciting events planned for this year’s conference. The 2018 IWC will host a Golf Outing and TopGolf Outing, an outdoor exhibition hall and more.

For more information, visit the IWC website at www.eswp.com/water or check out the IWC App in the Google Play Store and the App Store.

Education

Overall, the IWC has always been a strong educational conference. Attendees come to learn about the latest applications available in the industrial water treatment industry, educate themselves in current technology and applications through attendance in IWC workshops, and network heavily with their peers active in water treatment in the IWC exhibit hall.

This year, more than 75 technical papers and 24 continuing education workshops are scheduled. All are carefully peer reviewed for quality and to ensure no commercial aspect is evident. Each paper presentation at the IWC is followed by a prepared discussion—a thoroughly

considered, different perspective on the topic, followed by an open-floor discussion when all audience members and presenters can fully interact by asking questions, seeking clarification and raising alternative viewpoints.

Sponsorship

The IWC program would not be possible without sponsors that show their commitment to the advancement of the water industry.

Sponsorships are available in Platinum, Gold, Silver and Bronze levels, plus additional à la carte opportunities.

These include recognition at the sponsored event, acknowledgment at the opening session, discounts for multiple sponsorship and advertising opportunities. Furthermore, sponsors will receive a listing of the company name and description in the IWC on-site program guide, website and app, plus complimentary IWC registrations for Platinum, Gold, Silver and Bronze Sponsors.

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Sustainable Ocean Summit

The Sustainable Ocean Summit (SOS), organized by the World Ocean Council (WOC), will take place in Hong Kong, November 14 to 16. For this year's show, the theme is "Ocean Sustainable Development – Connecting Asia and the World."

The event will provide a platform for leadership companies and organizations to advance the development and implementation of industry-driven solutions for ocean sustainability challenges.

The conference, taking place over two-and-a-half days, will bring together leadership companies from the ocean business community including members of the shipping, aquaculture, tourism and renewable energy industries to explore topics such as marine pollution, climate change and sustainable fishing.

Overview

Since 2010, the SOS has been a unique gathering of the world's ocean industries focused on the sustainable development, science and stewardship of the global ocean.

SUSTAINABLE OCEAN SUMMIT

The focus of the SOS 2018 will be on: the major role that Asia plays in the global economy through trade and maritime transport; the size and growth of the economies and population of Asian countries; the national, regional and international importance of key ocean industries in Asia,

e.g., shipping, shipbuilding, fisheries, aquaculture; the global interconnectedness of the ocean, the ocean economy and the ocean business community; and the need to address ocean sustainable development and the U.N. Sustainable Development Goals (SDGs) at a global scale with all ocean business sectors.

The SOS brings together leadership companies from the diverse ocean business community: shipping; oil and gas; fisheries; aquaculture; seabed mining; tourism; renewable energy; ports; dredging; mining; submarine cables; marine science, engineering and technology; the maritime legal, financial and insurance communities; and others.

In addition, the SOS also gathers ocean stakeholders from the governmental, intergovernmental, academic and environmental communities.



“Since 2010, the SOS has been a unique gathering of the world’s ocean industries focused on the sustainable development, science and stewardship of the global ocean.”

Draft Program

The SOS 2018 draft program includes: the Ocean Executive Forum: The Signature SOS Multi-Sector Panel of CEOs; Asian Shipping: Leadership and Challenges in Connecting Asia and the World; Asian Ports and Sustainable Development; Shipbuilding for Sustainability: The Role of Shipyards and Vessel Construction in Supporting Sustainable Development; One Belt, One Road, One Ocean: Ensuring the Maritime Silk Road Leads to a Sustainable Destination; Women in Ocean Industries: Leadership and Sustainable Development; Ocean 2030: Ocean Industry Projections and the Future of the Ocean Economy; The Digital Ocean, Big Ocean Data and the Ocean Cloud; Ocean Investment Platform: Financing Ocean Sustainable Development in Asia; Marine Pollution: Plastics and Ocean Cleanup Vessels, Plastics and Port Reception Facilities, Marine Sound, Biofouling and Invasive Aquatic Species; Ocean and Climate: Ocean Negative Emissions Technologies, Port Resiliency and

Extreme Events, Arctic Sustainable Development; Food Security: Addressing Illegal Fishing, Sustainable Aquaculture in Asia; Ocean Knowledge: Smart Ocean-Smart Industries for the Arctic, Seabed 2030; and Ocean Governance and Planning: UN Law of the Sea, Wind Energy and Fisheries Interactions, Marine Spatial Planning.

Workshops this year include one for young ocean professionals and one on maritime clusters for sustainable development.

The social program will feature the CEOcean Club, a networking reception for SOS 2018 C-Suite and VIP participants.

The full draft program is available at <https://tinyurl.com/y7fghjyx>. Parties interested in participating in the SOS 2018 program as session organizers, moderators or speakers are encouraged to contact the WOC at info@oceancouncil.org.

To register for the event, visit <https://sustainableocean.summit.org/registration>. **ST**

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Fugro Performs Hydrographic Survey In Arctic Norwegian and Barents Seas

Fugro has been awarded a hydrographic survey contract valued at NOK 44.7 million by the Norwegian Hydrographic Service. The survey is part of the MAREANO seabed mapping program, which is financed by Norway's Ministry of Trade, Industry and Fisheries and the Ministry of Climate and Environment. Fugro has successfully completed numerous surveys for the program since 2006, collecting more than 100,000 sq. km of data.

UK Hydrographic Office Performs LiDAR Survey to Update Charts

The most comprehensive seabed mapping survey of the seas surrounding the Turks and Caicos Islands is currently being conducted by the UK Hydrographic Office (UKHO). The bathymetric LiDAR survey consists of a specially modified light aircraft fitted with state-of-the-art sensors, which use a laser to accurately measure the depth of the water. The survey data will be used to update navigational charts.

Danish Agency Uses Bathymetry Data for Safety

The Danish Geodata Agency (GST) has selected Bathy DataBase as its new system for depth data management to increase efficiencies and optimize the maritime production chain from survey to chart. GST is responsible for surveying and charting the waters around Denmark, the Faroe Islands and Greenland to ensure safe passage at sea. The project includes software deployment and migration of existing data, to be completed in spring 2019.

Marine Sediment Sampling Project Aims To Improve Scottish Bathing Water Quality

CMS Geotech supported SOCOTEC on a ground investigation project for Scottish Water at Portobello Beach in Edinburgh, Scotland. The investigation helped develop options to improve bathing water quality by determining the geotechnical and chemical properties of the seabed deposits, as well as the underlying superficial soils and bedrock. SOCOTEC deployed a 215-t, 18-m modular jack-up barge constructed for the project. CMS collected marine sediment samples to 6 m below bed level using a high-powered vibrocoring unit.

Australia Rejoins Ocean Energy Program

The Australian government has issued its intent to reinstate its membership in the International Energy Agency's Ocean Energy Systems Technology Collaboration Program (OES).

This has been made possible via the Australian Renewable Energy Agency (ARENA) International Engagement Program, which supports projects that advance renewable energy technologies.

The contracting party nominated by the government is the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

Autonomous Electric Container Ship Due in 2020

The world's first autonomous and electric container vessel is one step closer to launch as YARA signs a deal with VARD worth approximately NOK 250 million to build the vessel. VARD will deliver *Yara Birkeland* for launch in early 2020, and the vessel will gradually move from manned operation to fully autonomous operation by 2022. The project was initiated in an effort to improve the logistics at Yara's Porsgrunn fertilizer plant and move transport from road to sea to reduce emissions.

California Company Donated Diving Masks To Thai Soccer Team Rescue

A company selling high-quality diving masks in California sent its products to the scene of a rescue effort in Thailand this summer. The victims were a boys' soccer team, and rescuers requested diving masks that would fit children. According to an article in *The San Diego Union-Tribune*, the California company Ocean Reef Group worked with employees in Italy, the U.K. and Germany to speed up the process of getting the masks to Thailand. The G.divers full-face diving masks that the company donated are worth \$600 each.

StormGeo Acquires Nautisk for All-in-One Maritime Chart Service

StormGeo has entered into an agreement to acquire Nautisk, a supplier of maritime charts and publications to the merchant marine, from NHST Media Group. The combination makes StormGeo the first to integrate routing and weather services with state-of-the-art charts and publications. The all-in-one platform will provide optimized routing, chart retrieval and voyage planning without switching between disparate systems, integrating navigational information with weather intelligence and route optimization algorithms.

Transocean Acquires Ocean Rig

Transocean Ltd. and Ocean Rig UDW Inc. entered into a definitive merger agreement under which Transocean will acquire Ocean Rig in a cash-and-stock transaction valued at approximately \$2.7 billion.

The transaction has been unanimously approved by the board of directors of each company.

Ocean Rig's fleet is comprised of nine high-specification ultradeepwater drillships and two harsh environment semisubmersibles, as well as two high-specification ultradeepwater drillships that are currently under construction.

Unique Group Gains Load-Testing Equipment

Aberdeen-headquartered load-testing equipment provider Water Weights has been acquired by Unique Group. Both companies will share their network of partnerships and distribution agreements at regional bases around the globe, complemented by integration with other Unique Group business units.

Unique Group produces its buoyancy and ballast products at a state-of-the-art facility on the Isle of Wight.



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General Oceanics, Inc. introduces its **new model 8050 autonomous pCO₂ monitoring system**. Continuous measurement, recording and transmission of sea surface CO₂ levels.

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New Design for Foundation Piles via Grant

Ocean Hydraulics, a company based in Redruth, Cornwall, is the first business to receive grant funding through the new Rapid Innovation Grant scheme. Ocean Hydraulics is owned by freelance engineer Mike Curnow, who created a new way of anchoring seabed foundation piles. His alternative drilling method is expected to bring benefits in safety and stability and be more cost-effective to implement.

Maritime Additive Manufacturing Processes Now Have Rules and Incubator Space

DNV GL has released the first approval-of-manufacturer scheme for additive manufacturing producers. Additive manufacturing includes industrial processes that create 3D objects by adding layers of material, including 3D printing, rapid prototyping, direct digital manufacturing, layered manufacturing and additive fabrication. This year, DNV GL opened the Global Additive Manufacturing Centre of Excellence in Singapore, a testbed for the oil and gas, offshore and marine sectors.

LNG Custody Transfer Requires Precise Measurement to Avoid Risk

Trelleborg's marine systems business and the Australasian engineering consultancy Synertec announced a partnership to meet demand for more accurate and efficient LNG custody transfer, which has long involved fiscal risk due to significant uncertainties in tank measurement. Synertec's automated custody transfer system uses a skid-mounted module.

Improved Satellite Bandwidth for Ships

Communications and technology company Navarino will now offer SES Networks' global managed mobility service, based in Ku-band, to support its delivery of connectivity to global shipping companies. SES has more than 70 satellites in two different orbits. Navarino is the developer and distributor of INFINITY, a maritime bandwidth management and optimization solution that can be used on vessels equipped with any type of IP-based satellite communications system.

Sea Machines Expands to Waterfront Test Lab

To support the growing interest in Sea Machines' autonomous controls and advanced perception technology in European markets and ensure success in its upcoming commercial product release, the company moved its Hamburg, Germany, team to a larger, waterfront work space. The new location more than triples the company's space, provides dockage for its test vessels, and provides a new commercial workshop and test lab.

French Shipyard Rebrand Reflects New Activity

Compositeworks is changing its name to MB92 La Ciotat, a rebranding that follows the company's acquisition by the MB92 Group last year and their subsequent takeover of the Blohm+Voss La Ciotat activities this summer. The La Ciotat, France, location is the site of a future 4,000-t ship lift. **ST**

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Ocean Business and Tech Grows in L.A. with Additional Funding and Space for Incubation

AltaSea at the Port of Los Angeles has raised more than \$8 million to build the first phase of its 35-acre center for ocean-focused science research, STEM-based education and sustainable business incubation. Three warehouses with deepwater dock access will be enhanced into space for ocean-oriented technology and business tenants. AltaSea initiatives have helped attract Boeing, the Jet Propulsion Laboratory and SpaceX to the waterfront to create a cluster of science, business and education and establish the port as a blue economy leader.

Riptide Expands into Canada

Riptide has made its first international expansion with the creation of Riptide Autonomous Solutions Canada. Headquartered in Halifax, Nova Scotia, Riptide Canada is being established to support the increasing demand in Canada and abroad for affordable, flexible AUV systems. Riptide Canada plans to establish development, production and support capabilities in the Halifax area and add staff to meet growing product demand.

Acoustic Zooplankton Fish Profiler Award Used to Study Prey-Predator Relationships

ASL Environmental Sciences announced the winner of the third annual acoustic zooplankton fish profiler (AZFP) award. Dr. Lilian Lieber, research fellow at Queen's University Belfast, will use an AZFP for her proposal entitled "Drivers of Predator-Prey Coherence in Energetic Environments." Lieber will conduct her study in the Narrows, an energetic tidal channel located in Northern Ireland. The project aims to understand tidal processes that result in foraging by top predators.

OceanGate Chooses Island Offshore to Provide Vessels for Deep-Sea Exploration

OceanGate Expeditions selected Island Offshore as its preferred partner for deep-sea exploration, and one of its ships will be used as the primary topside support vessel for the 2019 *Titanic* Survey Expedition. OceanGate will grant first right of refusal to Island Offshore on all deep-sea expeditions over the next five years that require a commercial-grade and classed support vessel. Island Offshore will provide suitable ships, offshore crew and personnel to OceanGate.

Node-Based Seismic Survey Company Expands its Products and Services

Fairfield Geotechnologies has launched a multiyear growth and investment campaign to enhance its core business by expanding its node inventory and associated system capacity to better serve the increasing global demand for node-based acquisition services. The company is working to expand the market for node-based seismic surveys through multiple sales channels and innovative commercial models. It is also extending its product and

services platform for data acquisitions, reservoir management services and multiclient data through targeted acquisitions and strategic partnerships.

Unmanned Survey Successfully Completed

ASV Global and TerraSond announced successful completion of a hydrographic survey for charting off the coast of Alaska. The 10,649-km survey used an ASV Global C-Worker 5 unmanned vessel alongside the Q105 survey ship acting as the mother vessel. The C-Worker 5 was remotely monitored using the ASView control system from a station on the mother ship.

The system used exported .dxf survey lines from the survey planning system to autonomously execute the survey.

Robotic Technology Will Collect Data for NOAA

Kraken Robotic Systems Inc. has signed a cooperative research and development agreement (CRADA) with NOAA's Office of Ocean Exploration and Research (OER). The data are used to enhance ocean research, inform policy and management decisions, develop new lines of scientific inquiry, and advise NOAA and the U.S. on critical issues. The CRADA partnership will explore the application of Kraken's underwater sensor and robotic technologies to NOAA's ocean observation charter.

Newest FRC Delivered To US Coast Guard

Bollinger Shipyards delivered the 154-ft. USCGC *Robert Ward*, the 30th fast response cutter (FRC) to the U.S. Coast Guard. The vessel is named after Coast Guard Hero Robert Ward. During the invasion of Normandy, Ward served as coxswain of a landing craft in the landing operations against the enemy on Cotentin Peninsula. Robert Ward was awarded the Silver Star for his conspicuous gallantry despite continued shelling and mortar fire.

Phoenix Successfully Assists Stranded Bulk Carrier in Mississippi River

After a collision with an obstruction in the Mississippi River, a fully laden bulk carrier suffered a flooded forepeak tank and was unable to continue transit. Phoenix was able to deploy a team within hours to assist the stranded vessel. Phoenix divers were able to open the tank top and assess the extent of the damage in zero visibility, formulating a repair plan that would allow the vessel to pump out the flooded tank.

Patent Awarded to Sulfur Oxide Scrubbing Tech

EnSolve Biosystems earned a U.S. patent for its EnScrub technology, which addresses contaminants from the aqueous effluent of sulfur oxide (SOx) scrubber systems for ships and oil refineries. The company says that due to high demand, it is looking to accelerate the commercialization process and is open to options such as strategic partnerships or exclusive licensing of the technology. **ST**

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New Pressure Test Facility For Marine Tech Development

Woods Hole Oceanographic Institution's (WHOI) Center for Marine Robotics kicked off its fourth annual Entrepreneur Showcase and Leadership Forum with the official opening of a new pressure test facility that will help researchers and companies better develop innovative marine technologies. The new facility will allow WHOI to replicate the pressure of the deep ocean in an onshore facility, which will more than triple the project capacity of its existing manually operated system, allow for unattended 24/7 operations, and expand the ability of researchers and private firms to test their marine robotics and sensor systems.

The pressure test facility is the second piece of infrastructure constructed under a \$5 million dollar award to WHOI's Center for Marine Robotics from the Commonwealth's Collaborative Research and Development Matching Grant Program, an effort managed by the Innovation Institute at the Massachusetts Technology Collaborative (MassTech).

The launch of this new R&D test facility will help accelerate WHOI's ability to support entrepreneurs, small and medium-size businesses and established marine robotics technologies, fueling innovation and growth in the sector and in Massachusetts's economy.

The new facility replaces an aging 50-year-old pressure test vessel, incorporating increased precision, programmable, computer-aided controls and safety.

According to "The Massachusetts Robotics Cluster" report sponsored by MassTech and published by ABI Research, global revenue for unmanned underwater vehicles was \$2.2 billion in 2015 and is expected to grow to \$4.6 billion by 2020.

Smartrak on Sabertooth For Underwater Survey

A new way to hunt down and survey buried submarine pipelines, energy cables and communication cables comes as Innovatum teams up its Smartrak magnetic sensor system to a Saab Seaeye Sabertooth autonomous robotic vehicle. Smartrak is a small survey system that enables high-quality data at a much lower cost.

Skimming just 2 m off the seabed in shallow turbulent waters typical of installation sites, Sabertooth can handle the outriggered Smartrak with its iCON intelligent control system. Sabertooth with Smartrak navigates autonomously to the target pipeline or cable, follows it, measures its position and records its depth of burial.

Such data are essential for installation contractors, owners and regulatory authorities to ensure that pipelines and cables are properly buried and not in danger of being exposed to damage.

In the future, Innovatum plans to fit its Smartsearch UXO system to the Sabertooth for hunting down unexploded ordnance. The company already operates Smartrak on three of Saab Seaeye's ROV models. **ST**

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Salish Sea Survey Expedition

SeaDoc Society and the OceanGate Foundation have partnered in support of deep exploration and research in the Salish Sea. In September, three teams of researchers were scheduled to dive to depths as great as 200 m (650 ft.) in Cyclops 1, a manned submersible owned and operated by OceanGate Inc.

During the week-long expedition, scientists could directly observe two important components of the Salish Sea food chain—the feeding strategies of deep-dwelling red urchins and the behavior of Pacific sand lance, which hide in deep sand wave fields—and collect data to assess the costs/benefits of scientific trawling.

The scientists will make the resulting data available to the public with the goal of informing future policy decisions related to the effects of scientific trawling and the management of the Salish Sea environment.

Warming Could Affect Fish More than Coral Bleaching

Research published in *Nature* has found that fish respond to warming seas more strongly than they do to bleaching of corals. Griffith University researchers played a key role in the study, which was led by the University of Tasmania and included researchers from James

Cook University. It analyzed data on fish, invertebrates and corals that were collected across the Great Barrier Reef and Coral Sea before and after the 2016 ocean heat wave. It identified important changes in reef animal communities that may affect the resilience of coral reefs, potentially reducing the capacity of corals to rebuild after mass bleaching.

Recent mass coral bleaching on the Great Barrier Reef has devastated large areas of coral, and corals are a key habitat for many types of fish. But fish also respond directly to warming waters. The fish that live on the Great Barrier Reef play a crucial role in its ecosystems, the tourism industry and fishing industries.

There were broad regional changes in fish communities that were consistent all the way from the far northern reefs to the southern reefs. Fish are cold-blooded organisms, so there are certain temperatures that suit them best. One of the groups of fish that responded strongly to the heat wave were herbivorous fish that eat algae, which assists coral recovery following bleaching. The study found herbivorous fish declined on the northern reefs, most likely because waters became too warm for them. They may have increased slightly at cooler southern reefs.

The team relied on extensive data on corals and fish provided by the Reef Life Survey (RLS) citizen science program.

The observations suggested that recovery processes would depend on functional changes in reef commu-

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nities, which in turn depended on how temperatures changed the makeup of fish and invertebrates that lived on the reefs.

These findings underscore the importance of building the reef's resilience through local management actions.

OSIL Multiple Corer For Antarctic Projects

Ocean Scientific International Ltd. has delivered a 12-station multiple corer to Colorado-based ASC, a support contractor to the U.S. National Science Foundation (NSF), for use in Antarctic waters.

The corer will be deployed by upcoming projects in the International Thwaites Glacier Collaboration, a joint project of the U.K.'s Natural Environment Research Council and NSF's Office of Polar Programs, which manages the U.S. Antarctic Program.

The corer will be used to investigate the role of the Southern Ocean biological pump in regulating atmospheric carbon dioxide and to determine the sediment-water fluxes of dissolved compounds in West Antarctic Shelf sediments.

Wirewalkers for Study of Monsoon Development

Six vertically profiling Del Mar Oceanographic Wirewalker vehicles were operated successfully in the Bay of Bengal as part of a joint U.S.-India experiment. The Wirewalkers were deployed in a free-drifting, 1.5-km linear horizontal array during the first two weeks of June under the southwest summer monsoon.

The "lead" Wirewalker carried an RBRconcerto CTD, Nortek Aquadopp acoustic current meter, and chlorophyll and turbidity sensors. Nearly 2,500 profiles from the surface to 100 m were obtained at 10-min. intervals.

Trailing Wirewalkers, separated at 300-m intervals by a submerged tether, profiled to 30 m at 3-min. intervals.

The focus of the experiment is on small-scale features that are formed as the freshwater from India's major rivers mixes with oceanic waters. Understanding the influence of these processes on air-sea exchange is a key step in predicting the development of the monsoon, which directly affects more than a quarter of the Earth's population.

All Wirewalkers were successfully recovered, and data analysis is underway.

New Great Lakes Studies Center

Construction has launched for the \$13.2 million Center for Freshwater Research and Education at Lake Superior State University (LSSU). The project builds on LSSU's 40-plus years of Great Lakes fisheries development and management. The center will integrate hands-on learning opportunities so students can apply knowledge to real-world problems. The threats to the Great Lakes include increased demand from population growth, emerging contaminants such as from algal blooms, and invasive species like quagga mussels and sea lamprey that have changed the food web; a wild card is climate change. The construction should finish by summer 2020. **ST**

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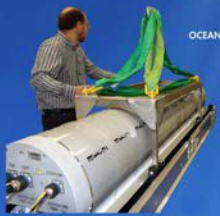
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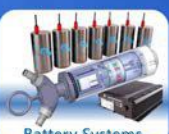
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Wireless Drone Power System



A wireless power system enables fully autonomous recharging of DJI Matrice 200 and 210 drones using software, APIs and cloud-based tools. Ground-based transmitter components as well as onboard charging components are included. The system is compatible with the PowerPad drone landing pad. Wi-Botic.

MCBH Adapters and Connectors

MCBH connectors are available with a 1/2-in. diameter hole through the glass sphere wall. The MCBH

adapter, G-180, extends the threaded connector and increases the load-bearing footprint inside the O-ring. The design was tested to 18,000 psi. Global Ocean Design LLC.

Water Quality Sensors

A new line of fluorometers is compatible with Aqua TROLL 500 and 600 multiparameter sondes and includes rhodamine WT, chlorophyll-a, phycocyanin (BGA-PC) and phycoerythrin (BGA-PE) sensors, ideal for lake and river monitoring and coastal studies. In-Situ Inc.

Water Sample Collection System

A range of ROV tools rated to 6,000 m now includes the instrumented water sample collection system, an undisturbed sediment sampling system, an instrumented pressure-acti-

vated camera system and a deep-sea solenoid actuator. The systems can be linked together to create a network. OSIL.

Bathymetric LiDAR System

RAMMS (Rapid Airborne Multibeam Mapping System) uses push-broom laser technology in a compact design for rapid deployment on small aircraft, including unmanned, fixed-wing aircraft. It includes rapid processing and data transfer capabilities. Fugro.

Cyber Threat Detection



Cyber Detection monitors all outbound and inbound network traffic for 50 threat categories on any satcom technology used to connect the ship, whether VSAT or MSS. A new security operations center offers threat management support, and a cyber dashboard provides real-time alerts. Marlink.

Low-Distortion Optics System

The Rayfin UltraOptics system has ultrawide-angle, 120° dome port rectilinear optics with a digital PTZ within a 21-megapixel sensor. The software-defined camera system uses region-of-interest binning of the high-resolution camera sensor. SubC Imaging.

Subsea-Qualified Modem

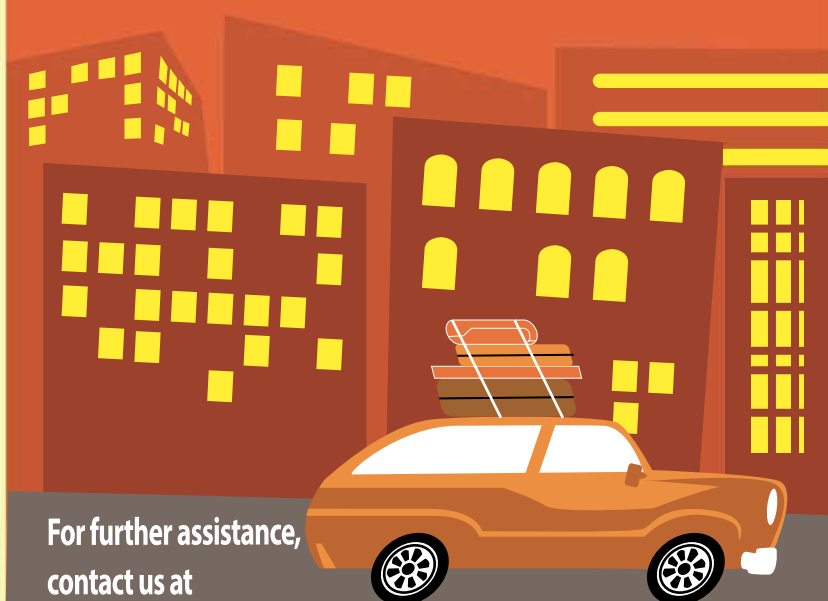
The latest addition to the series of optical and copper communications products for subsea oilfields, Model 922-DSLH, is a combined DSL and optical fiber modem with integrated Ethernet switch and serial gateway. Moog Focal.

Electronic Logbook

NAPA Logbook is now available as a monthly service solution, and it integrates with NAPA Mobile for smartphone logbook entries. The tamper-proof logbook allows for multiple logs and record books in-

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Split-Head Parametric SBP

The SeaKing split-head parametric sub-bottom profiler is ROV/AUV mountable and allows the transducer and electronics housing to be mounted separately. It comprises a 200-kHz echosounder to penetrate the seabed up to 10 m, effective at altitudes of 1 to 30 m from the seabed. Triton International Ltd.

Small Vessel Email Solution

SeaMail is designed for barges, fishing vessels, inland cruisers and leisure craft, allowing shoreside management of emails. It is optimized for communications at reduced satellite bandwidth usage, for high-latency circuits and for multiple connection management. GTMaritime.

Subsea Control Fluid

Transaqua SP control fluid for subsea systems is compatible with a range of elastomers, plastics, metals and completion fluids while helping transfer power, lubricate, deal with contamination and reduce equipment degradation in a range of temperatures and pressures. Castrol.

Hybrid Propulsion Systems



MTU Series 2000 engines combined with electric motors, each with 150 kW of electrical output, will be launched in 2020, with a power range of 1,000 to 2,200 kW per power train. The portfolio will extend in 2021 with systems with up to four electric motors. Rolls-Royce Power Systems AG.

Marine Digital Platform

Available on desktop and mobile devices, ShipSure 2.0 allows access to safety, operational and crew data from a single digital platform. It enables

analysis and sharing of compliance, operational performance, procurement, HR and real-time financial data. V.Group Ltd.

IoT Service for Shipping

The Fleet Data service enables shipowners and managers to access and analyze real-time onboard data through a dedicated, bandwidth-inclusive service and a sensor-agnostic platform. Inmarsat.

Dynamic Positioning System

The Ability Marine Pilot Control system helps automate navigational tasks with algorithms for the optimal execution of a control command in any operational situation. It allows for joystick control. ABB.

Diver Navigation System

Aid-to-Navigation is an operating system using the Shearwater DiveCAN digital communications protocol. A single screen provides heading, tank pressure, depth and compass information, as well as distress, assist, recall and send-to-target commands. New features include send-return-home and send-assist. Diver6.

VR Motion Control Subsea Drone

The Nemo ROV can be used for diving, fishing, yachting, salvage and rescue, ship inspection, scientific exploration, research and education. It offers 4K HD video, VR motion control with a joystick, and automatic hover. Aquarobotman Science & Technology Co. Ltd.

Triaxial Charge Accelerometer

Model EX356A73 is designed for high temperatures up to 900° F and has a frequency range up to 4,000 Hz with a $\pm 5\%$ tolerance. It has a nickel alloy, hermetically sealed housing with coaxial jacks and uses a UHT-12 sensing element. PCB Piezotronics Inc.

New Wave Instrument Features

Improvements to wave and tide instruments include a 300-m rating for shallow-water housing; anodized aluminum 3,000-m housing; and integrated internal pressure sensor. Falmouth Scientific Inc. **ST**



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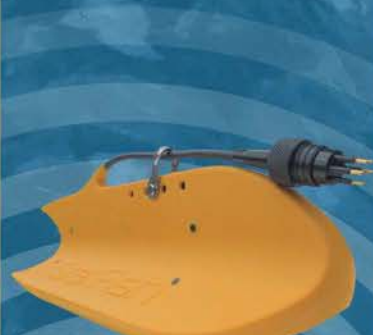
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Successful Testing of Wave Energy Converter

The European Marine Energy Centre (EMEC) Ltd. has issued a performance statement following dry testing of CorPower's wave energy converter (WEC), C3, in Stockholm. The testing involved CorPower's power take-off (PTO) on the hardware-in-the-loop (HIL) test rig, designed to test the PTO onshore as part of the Wave Energy Scotland (WES) funded Hi-Drive project.

The purpose of the HIL rig is to enable onshore testing and provide verification of WEC machinery subsystems before deployment. The rig emulates loads and motions representative of a complete range of expected sea states.

The dry test program performed over seven months included 708 registered test runs, with 378 signals being measured providing more than 1 TB of data on the equipment.

Each specified function was tested, starting with gentle loading, allowing safety and machine control to be verified while stabilizing the operation. Having built confidence at low sea states, the loading was gradually ramped up, verifying the performance on the range of operation up to full-range storm waves. The WaveSpring phase control method was verified, with subsystem efficiency of 99 percent at rated loading. The test campaign was finalized with a two-week noninterrupt test.

Following the dry tests in Sweden, C3 was transported to Orkney. The half-scale WEC was deployed in January 2018 at EMEC's scale test site at Scapa Flow in Orkney with support from the Interreg_NWE FORESEA program.

C3 tests were scheduled to end this summer, leading into the development of the next-generation WEC technology.

New OTEC Concept Eliminates Pipes, Pumping

A small start-up in France has secured a patent for ocean thermal energy conversion (OTEC) technology using phase-change materials (PCM). The technology involves filling a container with material in a liquid state that has a solidification temperature that varies according to the composition of the material. The container filled with PCM is lowered by ballasting to a depth where the water is sufficiently cold.

When the PCM becomes solid and enough cold accumulates, the container is raised by deballasting to the surface where the water temperature is warmer. The cold material in the warm surface environment then allows the production of electricity by a thermal machine. This technique eliminates the need for pipes and pumping of seawater from the depths to the surface.

This invention is based on the principle of latent heat, which enables separation of the power plant producing electricity from the con-



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tainers filled with PCM, allowing a continuous production of electricity by synchronization of several containers alternating at depth and on the surface.

This technology, yet to be tested, could provide electricity, water and hydrogen far from the coast. Repurposing obsolete oil platforms for this technology is a possibility.

More information is available at <https://bit.ly/2MTPFTK>.

Geotechnical Investigation At Hornsea Two

Fugro has commenced marine site characterization work at the Hornsea Two offshore wind farm. The contract, awarded by renewable energy company Ørsted, covers geotechnical site investigation and follows other contracts awarded earlier this year for the site.

The geotechnical data acquired by Fugro will support the development of the ground model, assist design activities for the turbine foundations and inform cable route design at the Hornsea Project Two and Hornsea Project Three sites. Fugro's workscope includes seabed and downhole geotechnical investigations that will be undertaken using state-of-the-art equipment from Fugro's specialist vessels.

Fugro will deliver this offshore project using its new SEACALF MkIV system for seabed cone penetration testing.

Another Tidal Turbine Deployed in Nova Scotia

Cape Sharp Tidal has deployed for the second time an in-stream tidal turbine and connected it to the power grid at the Fundy Ocean Research Center for Energy (FORCE) site in Nova Scotia's Minas Passage.

Cape Sharp Tidal's first demonstration turbine was deployed and grid-connected in November 2016 and recovered in June 2017.

The turbine is now undergoing initial commissioning, with operational and environmental monitoring device testing being conducted by the OpenHydro team.

The project team used the previously deployed turbine and environmental monitoring devices

to inform upgrades to the turbine technology and the environmental monitoring program.

'Dig-It' Starts Work At Borkum-2

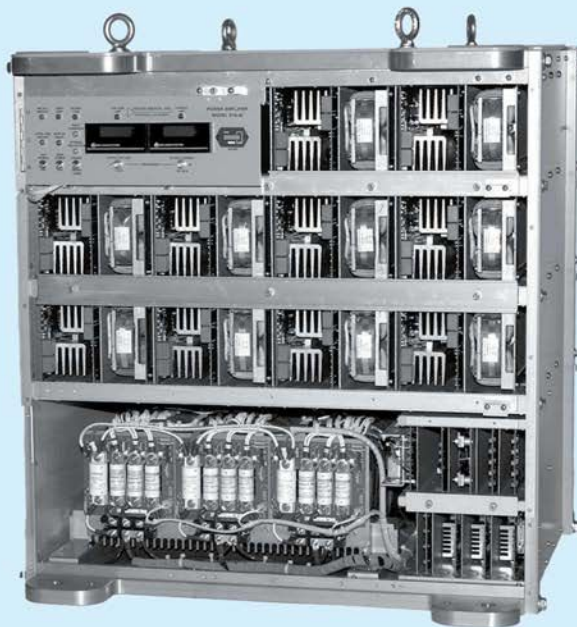
Soil Machine Dynamics Ltd. (SMD) announced that the QTrencher 1600 and its associated deck equipment package were delivered to Van Oord, and it has commenced its first job at Borkum-2 wind farm.

Van Oord's deck equipment for the QT1600, Dig-It, included a 48Te launch and recovery system (LARS) with A-Frame, cursor docking head, umbilical winch with snatch limiter and hydraulic power unit ensuring safe and reliable deployment of the QTrencher 1600 in higher sea states.

The Borkum-2 offshore wind farm, to be ready in 2019, is located 54 km off the coast of Germany. **ST**

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contracts

Oceaneering International Inc., Houston, Texas, will provide a resident, battery-powered electric ROV system to support subsea inspection, maintenance and repair activities. The system is expected to be deployed in water depths up to 1,000 m on the Norwegian Continental Shelf. Equinor ASA.

NSSLGlobal, Redhill, England, signed a service agreement to offer the Iridium Certus L-band service as part of its portfolio of maritime satcom, both as a standalone L-band service and in conjunction with VSAT IP@SEA. Iridium Communications Inc.

Soil Machine Dynamics Ltd., Wallsend, England, will supply a QTrencher 500 cable maintenance ROV and a 12.5-Te wide-angle A-frame that is operational in sea state five, as well as an umbilical winch with a steel armored umbil-

ical for operation in 2,500 mwd. TE SubCom.

Aleron Subsea, Aberdeen, Scotland, announced its first contract for its new hybrid TRACKROV technology. With a six-figure investment in research and development, the vehicle, designed to operate on the seabed, will carry out UXO surveys on a wind farm route.

Techano AS, Kristiansand, Norway, secured a contract for two rail-mounted service units and an offshore crane for the world's largest floating aquaculture construction, Havfarmen, which is designed for exposed waters and aims to make use of new areas for aquaculture. Nordlaks.

Kongsberg Maritime, Kongsberg, Norway, will deliver a real-time monitoring and advisory solution for the *Noble Tom Madden* drillship, an order that reflects a growing need for technology integration on drilling platforms and ships with data-sharing between ship and shore. Noble Corp. **ST**

November 7-8—Naval Submarine League Annual Symposium, Arlington, Virginia. 703-256-0891 or www.navalsubleague.org/events/annual-symposium.

November 13-15—CLEAN GULF, New Orleans, Louisiana. <http://2018.cleangulf.org>.

November 14-15—Design Sciences Series Workshop on Modular Adaptable Ships, Washington, D.C. 703-836-6727, asnehq@navalengineers.org or <https://bit.ly/2GFvcih>.

November 14-16—Offshore Wind R&D Conference, Bremerhaven, Germany. <https://bit.ly/2qdXkCf>.

November 14-16—Sustainable Ocean Summit, Hong Kong, China. summit@oceancouncil.org or <https://sustainableoceansummit.org>.

November 18-20—Pacific Marine Expo, Seattle, Washington. 207-842-5666, cdimmerling@divcom.com or www.pacificmarineexpo.com.

November 20-22—Australian Ocean Renewable Energy Symposium, Crawley, Australia. aor2018-oceans@uwa.edu.au or <https://aor2018.com.au>.

November 20-22—Marine Renewables Canada, Halifax, Canada. 902-717-0716, amanda@marinerenewables.ca or <https://marinerenewablesconference.com>.

November 26-27—Maritime Information Warfare, London, England. +44 (0)20 7827 6000, events@smi-online.co.uk or www.maritimewarfare.com/seatech.

November 27-28—The Blue Innovation Symposium, Newport, Rhode Island. 401-341-2163, bias.stapleton@salve.edu or <https://salve.edu/blue-innovation-symposium>.

For an extended list of industry meetings, visit sea-technology.com/meetings. **ST**

meetings

NOVEMBER

November 4-8—International Water Conference, Scottsdale, Arizona. eswp@eswp.com or <https://eswp.com/water/overview>.

November 5-9—BlueTech Week, San Diego, California. 619-450-4600 or www.bluetechweek.org.

November 6-8—Esri Ocean GIS Forum, Redlands, California. 888-377-4576, Confregis@esri.com or <https://bit.ly/2JJVwML>.

November 6-8—Seawork Asia, Shanghai, China. +44 1329 820492, marketing@mercatormedia.com or www.seaworkasia.com.

November 7-8—OPITO Global, Kuala Lumpur, Malaysia. +44 (0) 1224 211045, events@bigpartner-ship.co.uk or www.opito.com/opito-global.

Statement of Ownership, Management & Circulation filed with USPS, Form 3526-R, October 1, 2018 for <i>Sea Technology</i> , September 2018 issue, publication number 647500, 12 issues published annually at \$60 per year with offices at 4600 N. Fairfax Dr., Ste. 304, Arlington, VA 22203. Publisher: C. Amos Bussmann; Editor: Aileen Torres-Bennett, both of Arlington, VA. Owner: Compass Publications, Inc., Arlington, VA. Stockholders holding one or more percent of the total amount of stock: C. Amos Bussmann, Arlington, VA. Known bondholders, mortgagees and other security holders owning or holding one percent or more of the total amount of bonds, mortgages or other securities: None.		
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Falcon to Support Norway Aquaculture

Norway's growing aquaculture industry will see the Saab Seaeye Falcon robotic vehicle take on an extended role following the merger of two major aquaculture support companies, KB Dykk and AQS.

With 23 service vessels and more than 60 divers, the new enlarged grouping becomes the second biggest aquaculture support organization in Norway and the country's largest diving operation.

World's Second Largest Reef Off UNESCO 'Danger List'

The Belize Barrier Reef Reserve System, the world's second largest coral reef system after the Great Barrier Reef, has come off the UNESCO List of World Heritage in Danger, following the advice of the International Union for Conservation of Nature (IUCN).

For the past 10 years or so, the World Heritage site has been facing threats from potential oil activities and unsustainable tourism development. However, Belize recently announced a ban on oil drilling in its entire marine territories and reinforced the legal protection of its mangroves, which reduce the risk of disasters associated with climate change, keep the waters pristine and support local fisheries from harmful developments.

The Belize Barrier Reef Reserve System was inscribed on the World Heritage List in 1996. The site's pristine waters and abundant marine life provide social and economic benefits. Tourism and fisheries employ about half of Belize's population and highly depend on the site's healthy marine ecosystems.

The reef system is increasingly exposed to climate change, with impacts such as coral bleaching, rising sea levels, beach erosion and hurricanes.

Monitoring Red Tides for Mussel Health

Chile is the world's fourth largest producer of mussels. Mussel health is of paramount importance to the economy and human health. Environmental consultants Planc-ton Andino (Chile) are using a CTG FastAct Laboratory FRRf System to monitor red tides as part of the Bivalve Molluscs Health Program.

Red tides, or harmful algal blooms (HABs), are natural events occurring around the world. Since first being reported in Chile in 1972, in the Strait of Magellan, HABs have increased in both frequency and geographic coverage. HABs are highly toxic and problematic for human health and the local economy.

The CTG FastAct and the new Act2 FRRf systems consist of a multi-wavelength fluorometer that excites a sample with blue, green and orange light. HABs typically absorb light more strongly at green/orange wavelengths.

Food Web Study of Two Arctic Marine Species

The Central and Arctic Division of Fisheries and Oceans Canada will deploy an array of three ASL En-

vironmental Sciences multifrequency (38, 125, 200 and 455 kHz) acoustic zooplankton fish profilers (AZFPs) in the Amundsen Gulf in 2018.

The data, along with winter and summer net sampling programs, will enhance the understanding of the early life history of Arctic cod and the zooplankton copepod *Calanus spp.*, keystone species in the Arctic marine food web.

Because the instruments are battery powered and enclosed in pressure cases, they can be deployed and record data continuously for a year. These long-term data sets will allow for the detection of fish and zooplankton movements during the data-poor winter spawning season. **ST**

people



Paul Smith has been appointed group managing director at UTEC Survey. Since joining Acteon in 2011, Smith has undertaken a variety of commercial and operational roles. He was instrumental in the merger of UTEC with NCS Survey in 2015 and was most recently responsible for management of UTEC's operations worldwide.

Sonardyne announced the appointment of **Stephen Auld** as its new global business manager for subsea asset monitoring. Before joining Sonardyne last year, Auld was business development manager at Liquid Robotics Oil and Gas, a joint venture between oilfield services company Schlumberger and Liquid Robotics Inc. He was previously managing director at CodaOctopus.



The Woods Hole Oceanographic Institution has selected **Samuel C. Harp** as its first vice president for advancement and chief marketing officer. Harp has spent much of his career in academic, technology and research institutions and was chief marketing and communications officer for the Harvard T.H. Chan School of Public Health.

Greensea has appointed **Regina Yopak** as applications engineer and service manager. Yopak has extensive at-sea experience through several tours as lead navigator and mapping specialist on board EV *Nautilus* for the Ocean Exploration Trust.

Humphree USA named **Brett Marshall** director of technical sales and **George Lewis** as southeast regional sales manager. Marshall previously served as business development manager for Mack Boring and vice president of sales and marketing for the Luhrs Marine Group. Lewis was previously a tenured naval architect at Sea Ray. **ST**

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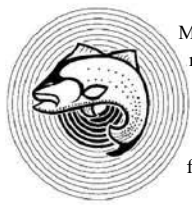
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Beyond the Horizon: Using Transparency to Protect the Oceans—Beth Lowell

Beth Lowell has dedicated her career to conservation. She has worked to protect and restore the oceans for more than 13 years. Lowell is Oceana's senior director of illegal fishing and seafood fraud in the United States. Oceana is the largest international advocacy group working solely to protect the world's oceans. Lowell served previously as the policy director for the Endangered Species Coalition.



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Our oceans provide us with numerous benefits—from offering a source of food and employment to being home to countless marine wildlife. More than 3 billion people rely on seafood to provide almost 20 percent of their protein, and almost 60 million people around the world work to catch or harvest seafood. How can we balance protecting the oceans today so they are healthy and productive for generations to come?

From locations across the globe, Oceana campaigns to protect and restore the world's oceans through improving fisheries management. Responsible fisheries policies such as scientifically based catch limits, protecting nursery areas for fish to rebuild and reducing the incidental catch of marine wildlife in commercial fishing can ensure that we have abundant oceans into the future.

But these advancements are undermined by illegal, unreported and unregulated (IUU) fishing, which ignores laws, operates off the books, and competes with legally caught fish in the market. It is estimated that global losses due to IUU fishing amount to \$10 billion to \$23 billion annually.

How can we begin to tackle IUU fishing when much of it is out of sight, far beyond the coast and hiding on the high seas?

To better protect our oceans and help fight illegal fishing, we need to

see what's happening beyond the horizon, and technology can help.

This need for transparency was the motivation behind Oceana partnering with Google and SkyTruth to create Global Fishing Watch, www.globalfishingwatch.org, and build a mapping platform using big data, machine learning and cloud computing to analyze the activities of large commercial fishing vessels worldwide. This interactive map empowers anyone to view or download data and investigate global fishing activity in near real time, for free.

Global Fishing Watch uses publicly broadcast automatic identification system (AIS) data that provide key information such as a vessel's speed and direction. Initially developed as a safety mechanism to prevent vessel collisions at sea, AIS can be used to locate, identify and monitor vessels around the world. The International Maritime Organization requires large vessels to carry AIS, however, governments can decide if—and to what extent—these requirements apply to fishing vessels. Currently, more than 70,000 fishing vessels are visible on the Global Fishing Watch map.

AIS signals are picked up by satellites and the time-linked position data are run through Global Fishing Watch's fishing detection algorithm. The mapping platform displays when and where vessels are likely fishing, and can be used by governments, researchers and citizens to track commercial fishing activity on a global scale.

Global Fishing Watch tracks fishing vessels even when they are operating far from shore. This improved oversight enables greater accountability of vessel behavior and can help to deter illegal fishing.

Oceana analysts use the technology to investigate suspicious behaviors at sea, such as fishing in off-limit areas and gaps in AIS transmissions. This potentially unscrupulous practice is when vessel

operators appear to turn off their AIS or “go dark” to public maritime tracking systems. Though justified if there are valid concerns for the security of the ship, turning off AIS can jeopardize the safety of a vessel and its crew and may indicate that a vessel is intentionally avoiding detection to hide suspicious or illegal activities.

One of Oceana's investigative reports used Global Fishing Watch's mapping platform to highlight examples of commercial fishing vessels that “went dark,” appearing to turn off their AIS suspiciously near marine protected areas closed to commercial fishing or near the national waters of developing countries.

One Panamanian ship appeared to switch off its AIS at the west side of the Galápagos Marine Reserve, a protected area known for its abundance of fish and sharks, where industrial fishing is prohibited. Fifteen days later, it reappeared on the park's opposite border. This gap in AIS transmission raises questions for further investigation.

In another example, over the course of 1.5 years, a Spanish vessel appeared to go dark repeatedly as it approached the national waters of The Gambia, a small, developing country in West Africa with limited resources for fisheries monitoring and enforcement. Global Fishing Watch's mapping platform can help such countries.

Transparency at sea can support efforts to protect and restore the world's oceans. Continually broadcasting AIS improves safety at sea for fishing vessels and deters illegal fishing, which undermines fishermen who play by the rules. Fishing vessels should use AIS, and governments should require their fishing fleets to continually transmit AIS. Transparency is critical to preserve the ability of our oceans to thrive, support coastal communities and provide a valuable food source into the future. **ST**

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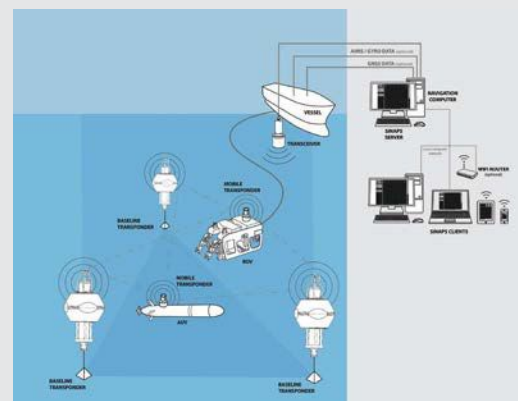
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