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September 2016

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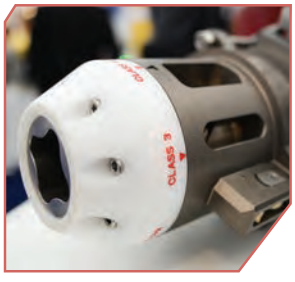

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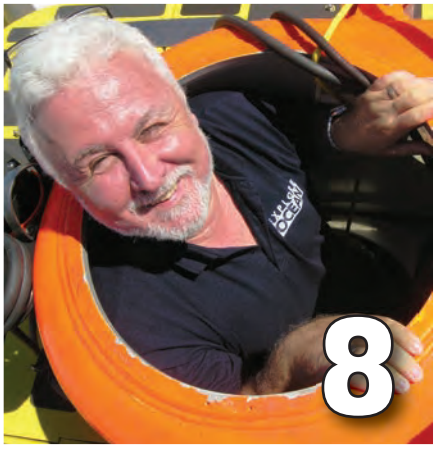

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FLORIDA
215 NW 3rd St., Boynton Beach, FL 33435
Tel: (561) 732-4368; Fax: (561) 732-6984

PUBLISHER
John C. O'Malley
jomalley@marinelink.com

Associate Publisher & Editor
Gregory R. Trauthwein
trauthwein@marinelink.com

Web Editor
Eric Haun
haun@marinelink.com

Contributing Writers
Kira Coley, United Kingdom
Capt. Edward Lundquist, USN (Ret.)
Claudio Paschoa, Brazil
William Stoichevski, Norway

Production Manager
Irina Vasilets
vasilets@marinelink.com

Production & Graphic Design
Nicole Ventimiglia
nicole@marinelink.com

Corporate Staff
Manager, Marketing
Mark O'Malley
momalley@marinelink.com

Accounting
Esther Rothenberger
rothenberger@marinelink.com

Manager, Information Technology Services
Vladimir Bibik
bibik@marinelink.com

Circulation
Kathleen Hickey
mtrcirc@marinelink.com

Advertising
Vice President, Sales and Marketing
Rob Howard
howard@marinelink.com
Tel: (561) 732-4368 • Fax: (561) 732-6984

Advertising Sales Manager
Mike Kozlowski
kozlowski@marinelink.com
Tel: (561) 733-2477 • Fax: (561) 732-9670

Gregory R. Trauthwein
Associate Publisher & Editor
Email: trauthwein@marinelink.com

It is hard to believe that the dog days of summer are quickly giving way to the start of Autumn, and what promises to be another busy travel season starting now and running straight until the end of 2016. First on the agenda for many is Oceans 2016 in Monterey, California, September 19-23. Oceans is traditionally a strong launching point for new service and technology, and this year's event does not disappoint. A preview of the conference and exhibition, as well as the companies showcasing new technologies, starts on page 60.

Since we took over publishing this title in 2005, a recurring theme has been the demand to be more efficient and effective in conducting studies and business at sea. In fact, to this day I look back to an invitation from Dr. Robert Ballard to visit with him and his students at the University of Rhode Island (URI) as one of the most influential meetings in my MTR career. I spent the day at URI with Ballard and his crew to get insight and understanding of its Archaeological Oceanography Doctorate Program and how they were fast-forwarding 'telepresence' technology to help broaden and make more affordable access to subsea exploration and discovery. (See Marine Technology Reporter, January 2006: http://magazines.marinelink.com/Magazines/MarineTechnology/200601/flash/).

That mission continues today industry-wide in earnest, and I'm happy to share with you a feature from **Guy T. Noll** of ESRI on the use of aerial drones as "the next great leap in hydrography," starting on page 24. But the story is not simply about drones, or any one technology for that matter, rather it addresses the collaboration of technologies – from new software and apps to point-clouds and mosaic datasets – in the effort to make work and study at sea more efficient.

Speaking of collaboration, in her feature *"A United Front on Ocean Observation"* **Kira Coley** looks at the European Marine Board's efforts to forward a partnership of major national marine and oceanographic institutes in Europe to help close critical gaps within ocean observation and seafloor mapping. Kira's story starts on page 34.

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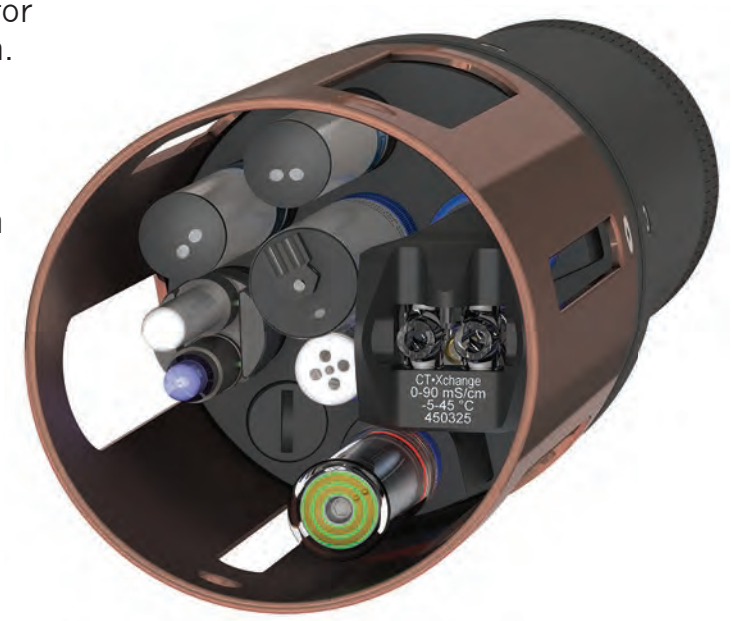

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Coley
Kira Coley is a freelance science writer and regular contributor to MTR. She is a lecturer in science communication and a PhD researcher.

Hartman
Chris Hartman's career experience includes working internationally for industrial oceanic companies, scientific and government agencies. Hartman commercially operates submergence vehicles and consults for said groups.

Noll
Captain Guy T. Noll is the maritime principal consultant at Esri. He has been the commanding officer for the NOAA Marine Operations Center-Pacific and the commanding officer of the NOAA ship Rainier. Captain Noll was involved in documenting best practices and specifying sonar acquisition systems for NOAA's fleet of mapping and surveying ships.

Paschoa
Claudio Paschoa is MTR's correspondent in Brazil.

Safer
Based in St. John's, Newfoundland and Labrador, Andrew Safer writes about ocean technology and arctic expertise in the province for the City of St. John's Ocean Technology Media Program.

Smith
Kathy A. Smith is a Victoria, BC-based maritime writer who has penned over 100 published trade articles.

Unterweiser
Paul Unterweiser is a retired U.S. Navy officer, USCG licensed master, ROV pilot and, for the last 10 years, president of Marine Simulation, a software company located in NC specializing in developing training simulators for ROV pilot schools and other marine industry applications.

Williams, Steinberg & Spain
David Williams is with the Australian Institute of Marine Science, Darwin, Australia; Craig Steinberg is with the Australian Institute of Marine Science, Townsville, Australia; and Peter Spain is with Teledyne RD Instruments, San Diego.

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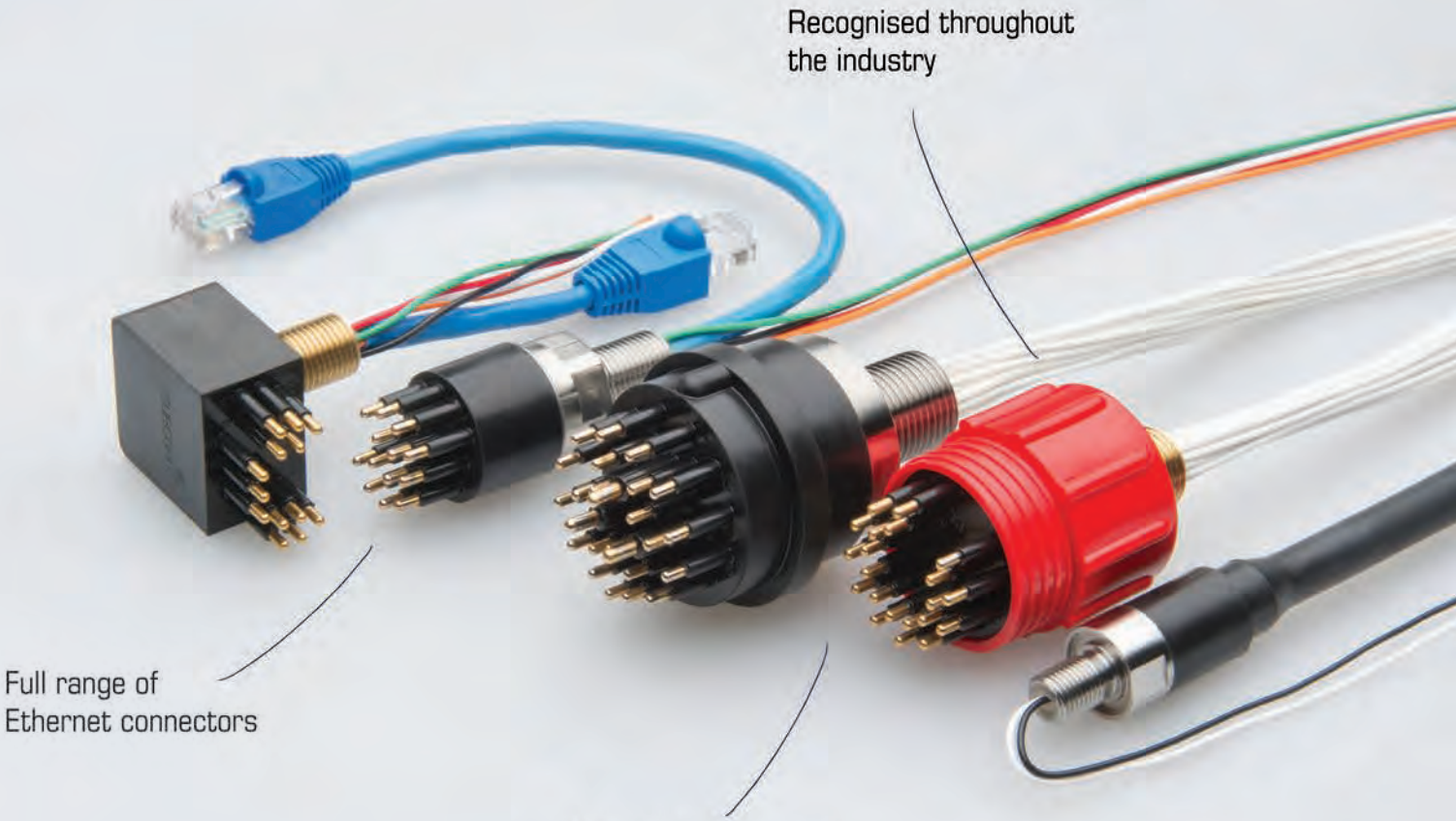

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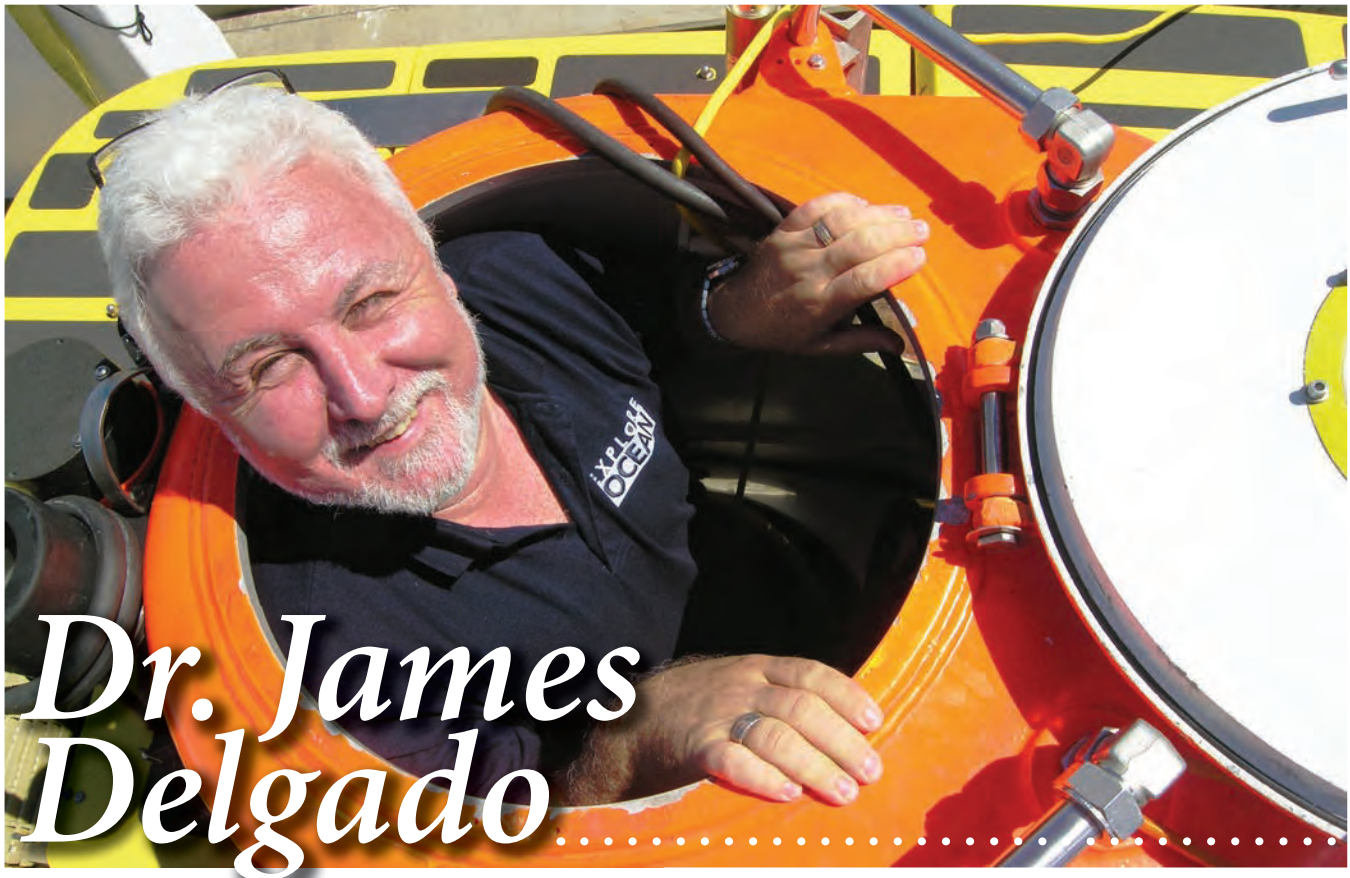

(Credit: James Delgado Collection)

NOAA's Director of Maritime Heritage

By Kathy A. Smith

Nearly a century ago, Lieutenant Ernest Larkin Jones was lost at sea. For decades, his surviving descendants, and the families of the other 55 seamen aboard the USS Conestoga had no idea what had happened to their loved ones. The ship that had left Mare Island, near San Francisco Bay on March 25, 1921 bound for Pearl Harbor, Hawaii had vanished without a trace.

Fast forward to March 23, 2016. NOAA (National Oceanic Atmospheric Administration) revealed to worldwide media that the wreck had finally been found – almost by accident – in the Greater Farallones National Marine Sanctuary in California. The announcement was made after several family members of the captain and crew had been personally notified – a job Dr. James Delgado, NOAA's director of maritime heritage and his colleagues, take very seriously.

Just a week earlier, arriving at the house of a woman whose grandfather had perished in the tragedy, Delgado prepared himself. He knew the meeting would be very emotional on both sides.

As he and his NOAA colleagues were greeted warmly by Diane Gollnitz, granddaughter of Lieutenant Jones, Delgado's mind flashed back to the moment he knew for sure the elusive wreck's identity – the encrusted barrel of a 3-inch/50-caliber single-fire naval rifle served as the proverbial "smoking gun" that solidified the sunken vessel's place in U.S. naval history.

Jones was the commanding officer of the ill-fated civilian coal-barge-towing tug, turned World War I supply transportation and convoy escort. Delgado soon learned from Gollnitz how the loss of Jones had taken a huge emotional toll on her mother.

It was a special career-defining moment for Delgado, who, very early on, had ambitions to become an astronaut. But that all changed when he was introduced to archaeology and his-

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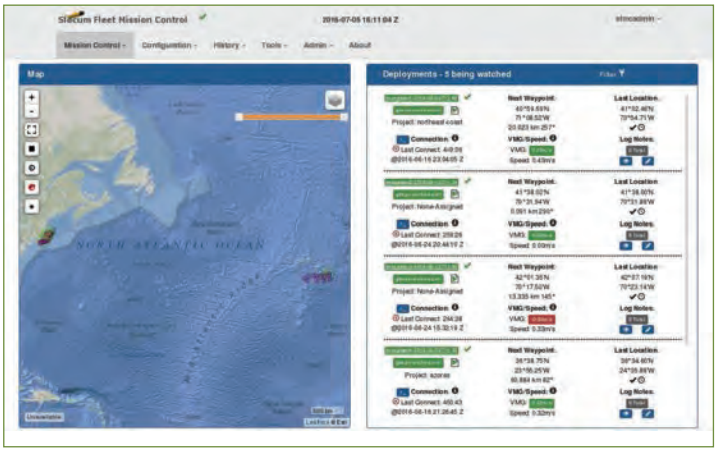

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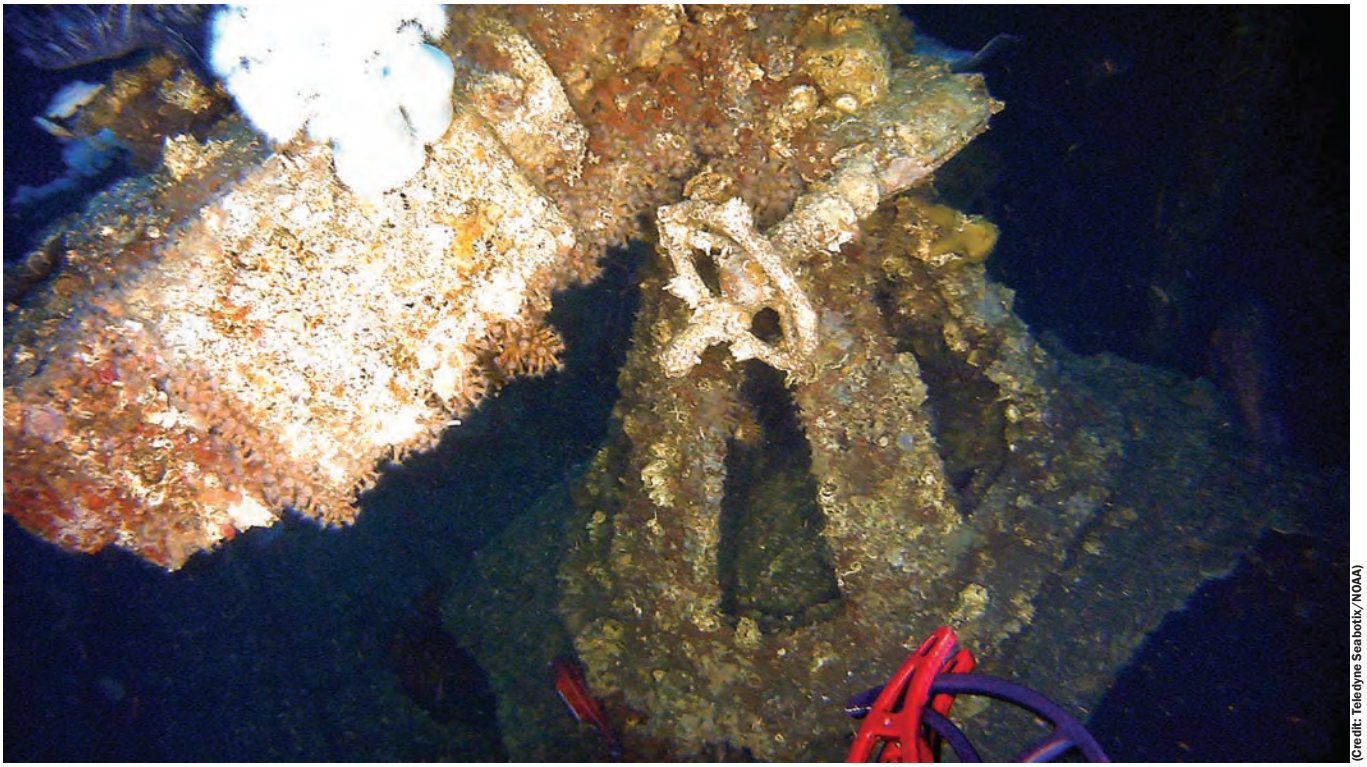

(Credit: Teledyne Seabotix/NOAA)

The "smoking gun" on the wreck of USS Conestoga, a single-purpose 3-inch/50 cal. naval rifle, lies dislodged and inside the ship.

tory at age 10.

Just four years later, growing up near the Santa Teresa foothills in San Jose, California (now famed as "Silicon Valley"), the 14-year-old with a love of the past talked his way onto a construction site where bulldozers were unearthing the burials and artifacts of the Ohlone people who had lived thousands of years ago in the area.

The outline of golden-stained ribs and the curve of a skull protruded, fossil-like, from the sidewall of a trench, he remembers, tantalizingly called him to his future path. He rescued more than 100 burials from destruction as well as many artifacts. The skeletal remains were reburied by the Ohlone descendants. Later, beginning in his junior high school years, he began working with local archaeologists, and at age 20, joined the National Park Service. There, he learned to scuba dive while working as an historian and archaeologist for the National Park Service in San Francisco.

Not surprisingly, his career has taken him all over the globe and to several hundred fathoms under the sea. He has been part of some of the world's most famous shipwreck investigations, 150 and counting, that range from wrecks dating from 2,700 years ago to ships of a bygone steamer era like R.J. Walker, the U.S. Coastal Survey sidewheel steamship (NOAA's predecessor organization) and Titanic.

Delgado actually made a trip to the unsinkable passenger liner in 2000 in a Mir submersible. Then in 2010 as chief scientist, he worked with a team of scientists responsible for documenting the wreck; together they created the first-ever 3-D map of her tangled and scattered remains. Preserving Titanic's legacy for future generations is, like all the work he's involved in, ensuring that the stories and the archaeological records live on.

In fact, as part of his personal decree to share his work with others, including scholars and the general public, Delgado has written more than 100 articles as well as 36 books and nearly 100 archaeological reports, in addition to giving numerous presentations worldwide. He recalls one of his fondest experiences was when he became the "talking head" and archaeologist on the popular National Geographic documentary TV series The Sea Hunters, which ran from 2001-2006, with a global audience of hundreds of millions.

Now, as he approaches the age of 60, Delgado has been steadily handing the baton to the next generation of historians, archaeologists and shipwreck explorers. The man who has spent more than 43 years immersed in the world of underwater archaeology says his work never gets old.

Always on the move, a late afternoon phone call found him in mid-transit on land, with a few minutes to generously give his views on the field he has poured his life's work into.

When Delgado began diving into the depths looking for history under the sea, there was no Internet, no cell phones, and mapping a wreck underwater was done by hand, by setting up grids, using tapes and writing notes on plastic slates covered with Mylar.

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How have things changed in the world of maritime archaeology?

Technology has changed so rapidly in the undersea world that I feel in some ways as if we have catapulted out of one century to another. Whether it's positioning with GPS and better satellite range, or robotic technologies such as remotely operated vehicles and autonomous underwater vehicles, we have the ability to move more quickly and efficiently with less expense. Additionally, more people have embraced the concept of multidisciplinary missions. It's more cost-effective and enables people to bring different elements to the table.

You say people no longer have to obtain a PhD to do the work you're doing. Can you explain?

Citizen Science recognizes that you don't need a PhD. There is so much that gets done by people who have the passion, who have understanding. I've worked on projects with people who didn't learn anything from a book. They know about historic sailing ships because they sail or they've sailed on replica vessels or they've worked with a certain tool. On a dig, you can learn from the person who has the degree but from others as well. That's the powerful part of it. It's the realization that most of this stuff happens with people who know something and step forward to do it.

What current wreck investigations are you working on?

I'm working with Bob Ballard (naval officer, professor of oceanography at the University of Rhode Island, and the scientist who led the team that found Titanic in 1985) to plan a deep-sea mission off the southern west coast of Canada, where we have an interest, as does the province of British Columbia, in a World War II wreck located in the Strait of Juan de Fuca. Later, I'll also be travelling to San Francisco where we'll be doing deep-sea exploration, including what will be the first time we'll be able to lay eyes on, and do a detailed map of, the wreck of USS Independence aircraft carrier that we did an initial sonar mapping of last year with The Boeing Company.

I've also recently been planning with the State of California's State Parks team and others to better map and understand the maritime cultural landscape north of San Francisco. This area, known as "the Redwood Coast," was part of California's lumber industry after the gold rush in the mid-19th Century. In the absence of a highway and railroad, small steamers would tuck into tiny little coves and load lumber. The ships would anchor at the end of a tower lowered in the water, and they would slide that lumber off the top of the cliffs and down onto the decks of these ships to be loaded. Those dog-hole ports as they're called, remain a powerful feature in the region. Other than archaeological traces, they are gone but not forgotten.

Of course, there are a number of things going on all the time with many of my colleagues around the world such as the team at Parks Canada and their ongoing work with HMS Erebus (one of two historic ships British explorer Sir John Franklin sailed to find the Norwest Passage in 1845; Franklin and his crew eventually died after the ships became ice-locked) to Hunley (an American Civil War submarine that made history as being the first sub to sink a war ship; her crew and the vessel disappeared shortly afterward). As the rust continues to be cleared away, the sub continues to be revealed as it once looked, telling us even more about this amazingly sophisticated early submarine lost in 1864.

How much more is there we don't know about shipwrecks?

We still don't have the very earliest ships. We still haven't gained a really clear sense of a fair amount of this when you consider that so much of our history is intertwined with the seas, the lakes and the rivers. The Uluburun (late Bronze Age) shipwreck has evidence of 12 different cultures within it, from equatorial Africa to the Baltic, all connected over 3,300 years ago by maritime trade. I think that in time we will understand more of what's in the oceans. I don't think that's going to happen anytime soon. But I think the fact that discoveries are made, sometimes in people's own backyards, is a reminder that not everything is done, that there are achievements yet to be made. And for young people in particular, that they can make a difference, that discovery can happen. I think as well, shipwrecks speak to powerful things in our history but they also connect to us personally.

Any final thoughts?

After meeting the granddaughter of a man who disappeared almost a century ago with the rest of his crew and seeing how that connected to her – it is the universality of our experience as human beings –that we suffer loss, that we prevail and we also experience triumph. I think shipwrecks speak to all of that. I think there will always be compelling stories to be told and people will continue to be curious. And as long as that happens and there is support for that, I think exploration will continue to happen. It's not just lost treasures. It's what it all speaks to in terms of mapping the human heart.

H38 deploying researchers.

(Photo: Brazil Navy)

A New Reef Biome
Under the Amazon Plume

By Claudio Paschoa

As extensive exploration of shallow and deep-water oil and gas plays along Brazil's Equatorial Margin (EM) progresses, a large and unique reef system has been discovered among offshore exploration and production blocks. In a research article recently published in *Science Advances*, a group of researchers from Brazil and the U.S. described the unexpected discovery they made in offshore shallow waters off the mouth of the Amazon River in northern Brazil. The international group of scientists, coordinated by Fabiano Thompson (UFRJ) and Carlos Rezende (UENF), which used research ships to study the offshore seabed, was immensely surprised when confronted by a large reef system under muddy water off the Amazon River mouth during hydrographic studies in the

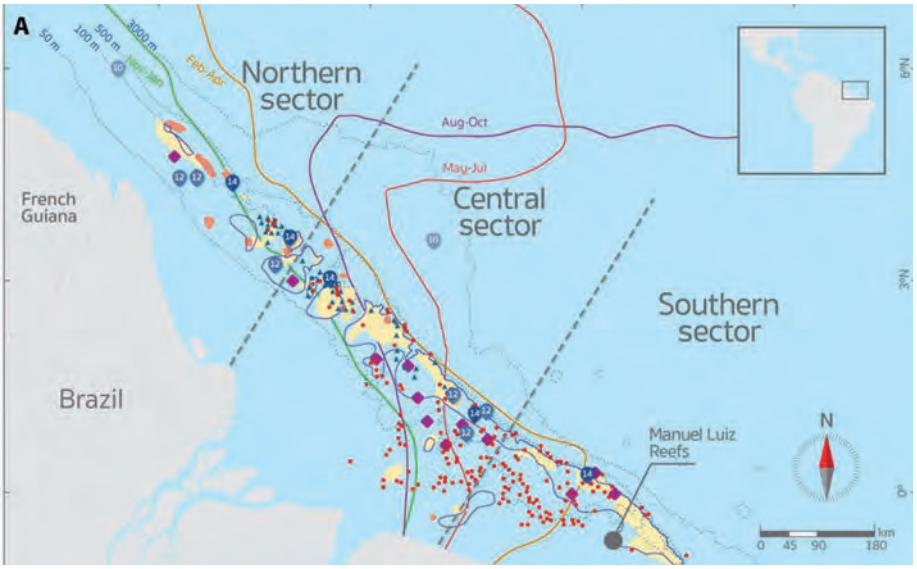
(Image: RSMAS)

North Brazil Current

region. During the multi-year research project, it was established that the reef system is at least 700 miles (1,126 km) long, ranging from around 25 to 120 meters deep, and approximately 45 to around 200 km offshore. Coral formations were detected from Brazil's border with French Guyana down to Brazil's northeast state of Maranhão. Although there were speculations of its existence for decades, the final discovery of the extensive reef system was still unexpected, because most of the great river mouths in the world produce major gaps in reef systems, when reefs are present along the river mouths. Reefs usually thrive in clear, sunlit saltwater, but the waters near the mouth of the Amazon River are very muddy, with huge quantities of sediments and nutrients washed downriver, no light and swept far out to sea. "Primary production to sustain the new biome benthic organisms appears to rely on chemosynthesis (i.e. microbes use minerals as energy sources) to make biomass and exudates instead of photosynthesis (i.e. microbes use light as energy source)," said Fabiano Thompson.

Astonishingly, this reef system is growing below the freshwater "plume", or outflow, of the Amazon River. Compared to many other reefs, it is relatively poor in fauna and flora diversity and quantity, nevertheless, the researchers found more than 60 species of sponges, 73 species of fish, spiny lobsters, sea stars and many other forms of reef life. The Amazon River has the world's greatest discharge basin, with an area over 7 million square kilometers and discharges about 209 thousand cubic meters of water per second (approximately 20% of all the freshwater discharge into the world's oceans), and accounts for roughly one-fifth of the world's total river flow. It is significant to note that the Amazon River is considered by many scientists to be the greatest river in the world. The reef systems encountered are also influenced by the fast flowing North Brazil Current (NBC), which runs east to west, toward French Guyana, and may have helped the reefs to grow.

This multidisciplinary research of the outer Amazon shelf took place between 2010 and 2014, comprising three voyages aboard different research vessels, and it discovered a unique carbonate reef system with a total area of around 9,500 square kilometers. Sampling was carried out onboard R/V Knorr (May 2010), R/V Atlantis (July 2012), both owned by the U.S Navy and operated by the Woods Hole Oceanographic Institution (WHOI) and the NHo Cruzeiro do Sul or H38, owned and operated by the Brazilian Navy (September 2014). The data was collected by a group of more than 30 researchers. The bottom topography data was obtained by a variety of means. 800 km of acoustic data was obtained using a Kongsberg EM122 Multibeam Echosounder in 2012. In



A map of the Amazon shelf showing the newly discovered reef structures in yellow.

(Image: Integration and Application Network, University of Maryland Center for Environmental Science)

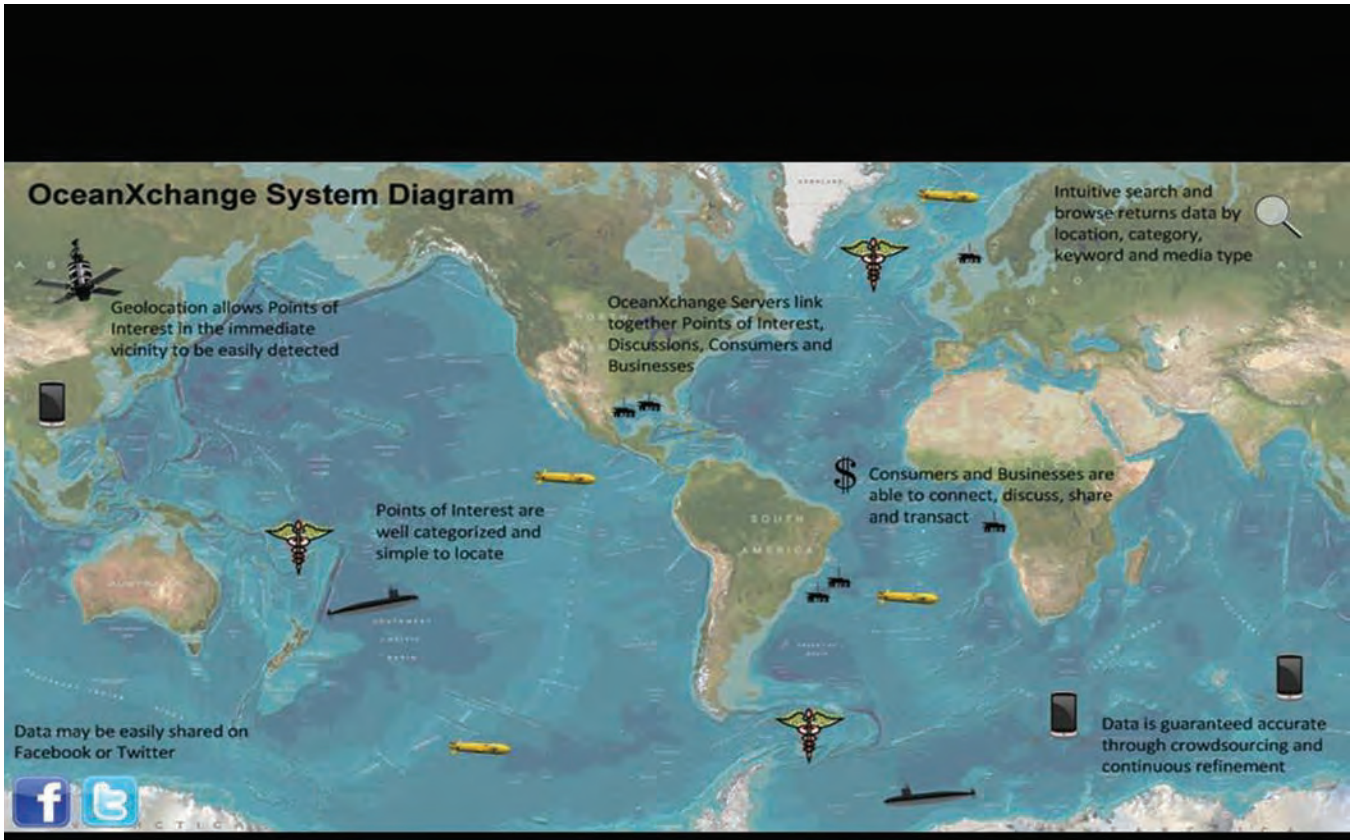
2014, 500 km was surveyed using two EdgeTech side scan sonars, model 4200 (100 to 400 kHz) and model 4100 (100 to 500 kHz). Both surveys were carried out with around 300 meter swath widths. Sonograms were processed with Sonar WizMap 5.03, converted into 1-m pixel images, and further vectored and submitted to supervised qualitative classification in a Geographic Information Systems (GIS) environment. Classification was based on backscatter intensity and indirect topography. The analysis of all the data took over a year to be completed and showed that the newly discovered reefs are in imminent danger, as there is ongoing oil exploration all along the reef and in 20 cases, oil production is being carried out right over parts of the reef system. The conclusions reached by the researchers are reported here in full. "In conclusion, the novel reef system off the Amazon River is extensive, is impoverished in terms of biodiversity, and presents unique functional attributes due to the plume influence. The system provides relevant ecosystem services and functions as a selective biogeographic corridor between the Caribbean and the South Atlantic Ocean, and may give important insights in

Patricia Yager from the University of Georgia oversees the deployment of a CTD Rosette sampler on board the RV Atlantis.

Photo: Lance Willis

terms of future scenarios for forecasting coralline reefs trajectories under acute climate changes. Remarkably, 125 exploratory blocks for oil drilling in the Amazon shelf were offered in an international auction in 2013, 35 of which were acquired by domestic and transnational companies. In the past decade, a total of 80 exploratory blocks have been acquired for oil drilling in the study region, 20 of which are already producing. These blocks will soon be producing oil in close proximity to the reefs, but the environmental baseline compiled by the companies and the Brazilian government is still incipient and largely based on sparse museum specimens. Such large-scale industrial activities present a major environmental challenge, and companies should catalyze a more complete social-ecological assessment of the system before impacts become extensive and conflicts among the stakeholders escalate. The feasibility of oil and gas operations may be assessed by considering environmental and social sensibilities, but even the extent of the overlap of exploratory blocks with sensitive areas remains unclear. The context of great proximity to international waters and to the French Guyana border adds complexity. It is relevant to consider further studies on regional marine spatial planning, the functioning of the new reef biome in face of global changes, and sensitivities related to the hydrologic cycle of the Amazon—where extreme droughts and floods are on the increase and will influence the functioning of this novel carbonate reef system."

Unfortunately, Brazilian institutions have neglected to examine more thoroughly the seabed and underwater environment along the deeper shallow waters off the Amazon River basin and the EM. Knowing this lack of hard data on the EM, the ANP, Brazil's National Petroleum and Biofuels Agency, states in its 11th round auction documents that environmental impact licenses for blocks in the EM may be impacted and even revoked depending on new data being acquired, which, with the unique reef discoveries along the Foz do Amazonas, Para-Maranhão and Barreirinha basins, may very well affect a number of operators with ongoing E&P projects at the EM. Funding for the research was secured through: Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Coordenadoria de Aperfeiçoamento de Pessoal de Nível Superior (CAPES),Fundação Carlos Chagas Filho de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ) Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP), and Brasoil. MCTI and the Brazilian Navy provided support with the NHo Cruzeiro do Sul in 2014. Expeditions in 2010 (R/V Knorr) and 2012 (R/V Atlantis) were funded by U.S. NSF. Additional support was provided by the Gordon and Betty Moore Foundation.



(All Images: Global Ocean Center)

Alaska's (Hidden) *Frontier*

By Chris Hartman

Terrestrial Alaska has been widely explored and economically understood for over a century. While we have a handle on this, we know little about what lies underneath the surface of sounds, seas, gulfs and oceans.

Regulated by U.S. law, the Exclusive Economic Zone extends 200 miles from shore, providing citizens access to use these waters, the seafloor and subterranean of the seafloor. This makes Alaskan waters one of the most comprehensive, dynamic and economically viable platforms to work with. The platform includes 45,000 miles of sophisticated shoreline, two oceans, three seas and the Gulf of Alaska. It also has the world's largest submarine canyon with depths to 24,000 feet, extreme tidal ranges with 16 knot currents known as tidal racing, ice-free ocean, frozen ocean and a seasonal mix of both.

Alaska is 53 miles from Russia, it boarders Canada, connects to the Arctic and is the northern gateway for Pacific Ocean maritime traffic. This makes Alaska an ongoing political, strategic and economic importance for the U.S. and international ocean commerce development. Its location makes the U.S. one of eight Arctic nations, putting the Nation in an unprecedented situation due to the rapidly developing commercial opportunities resulting from changing Arctic conditions.

Arctic shipping lanes are opening for new fuel saving intercontinental routes, and new areas for exploration and development are becoming accessible. This year the first Arctic passenger crossing from Seward to New York will take place, and the first subsea fiber cable is being installed across the Arctic, connecting Tokyo to London with fiber branching off to remote Alaskan coastal

towns. Aquaculture protein development will be another near term focus for commercial food sources as nutrients shift with seawater changes.

Never before have we seen what is happening now, yet Alaskans for the most part are only able to observe, unable to capture, prosper and utilize this platform. Why? There is no coordinated effort in place to help Alaskans harness prosperity in their backyard. Global Ocean Center (GOC) aims to change this, serving to bring world focus to oceanic initiatives, thereby elevating Alaska as a leader in ocean enterprise and innovation. NGOs, governments, universities and entrepreneurs will all be integral to GOC functions.

As the founder of GOC, Chris Hartman (the author) created this concept by utilizing decades of worldwide oceanic experiences ranging from energy development, medicinal discovery to working with government agencies. Hartman sees major opportunity for Alaskans and has dedicated a year in Alaska educating businesses, politicians, universities and citizens about the exceptional opportunities they could have available to them right now. "The community is encouraged and understands the potential of this project. The next step is securing proper capital to launch concept into fruition. Our goal is to provide opportunity to Alaskans from a base of operations in Alaska, easily accessible to all people who want to connect and collaborate with the development of ongoing local, national and international projects. GOC fulfills client needs by removing their roadblocks via application of innovative solutions."

Alaskan polar air cargo and polar maritime services will be utilized to support GOC functions. Utilization will also include international marine to rail transportation, connected by deepwater ice-free ports. These rail lines go to Anchorage and the city of Fairbanks which has direct road access to the Arctic Ocean. Furthermore, the marine highway system, com-

mercial fishing vessels, maritime service companies and other oceanic related entities may find economic inclusion within certain projects.

Future employment opportunities for ocean engineers will consist of teams with backgrounds in nanotechnology, aerospace, software, mechanical, electrical, acoustical, industrial, geological, chemical and applied. Employees will work in teams to provide solutions for the following types of projects;

• Provide 650 million people with clean water. The ocean can supply these people the water they need. An abundant supply of clean water strengthens people's health and prosperity. Building and installing subsea desalination systems in the most needed areas will make up for this shortage.

• Discover medicinal cures from ocean specimens. There is no major effort to discover new cures for the most lethal and debilitating diseases, even though past subsea discoveries have proven to successfully cure diseases. The challenge is finding and collecting approximately 5lbs of the unknown specimen to determine its medicinal viability. Once the organic chemistry is understood from the specimen it can then be infinitely replicated without ever having to collect more of that specimen.

• Clean the five ocean gyres. Most discarded buoyant trash in the ocean is collected within these giant gyres. There is no effective and efficient reclamation method to separate

this trash from the oceans. Furthermore, there is an estimated 3 million shipwrecks and chemical dumps on the seafloor needing hazardous material handling and extraction solutions.

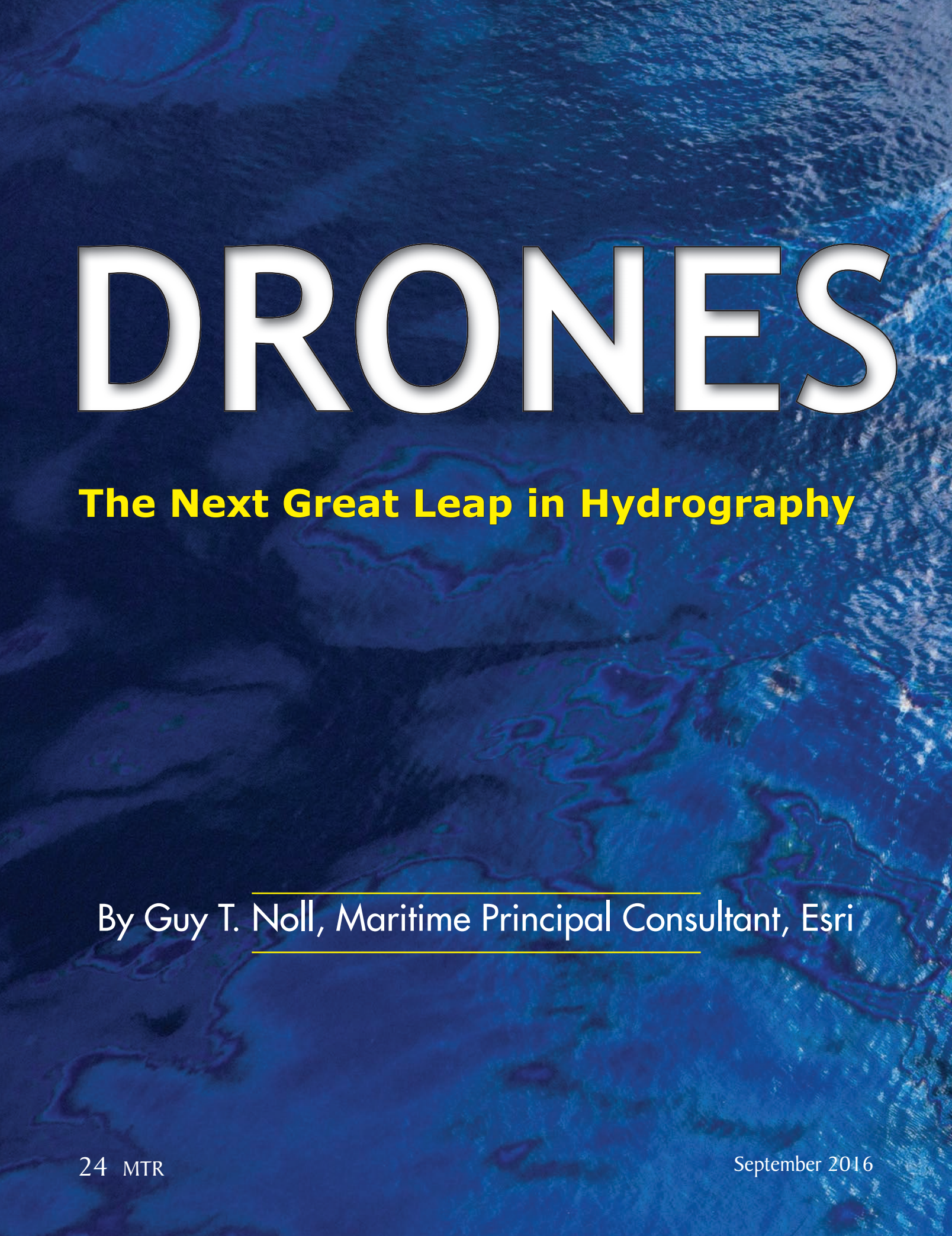
- Build an online ocean community with a unique database and a proprietary taxonomy for organizing oceanic data and tailoring it for users as diverse as energy explorers, shipping, commercial fishing, scientists, military and recreational use. (Define "community": As a resource center for companies, universities, governments, entrepreneurs and scientists currently fractured from one another, while in the same pond.) Replace the fractured model with a deeply interactive data and search tool in real-time. Secure critical information for these entities to make more effective and reliable forecasts.
- Make a detailed map of the ocean floor. The technology is now available to thoroughly map the ocean floor in HD3D. We have little to no idea what our planet looks like underwater or what it's made of. The goal is to determine the most viable and expeditious way to map the ocean floor in detail, then complete the task.
- Design and manufacture submarines for humans to be transported and functionally interact with the oceans at any depth. The first published prescription for a human occupied submarine was over 435 years ago. After four centuries of development there is still no utilitarian sub that can safely, dependably and economically transport humans through liquid mediums, while providing adequate endurance and tools.
- Design and manufacture disposable autonomous underwater smart vehicles with configurable sizes and interchanging capabilities to handle multiple devices. The vehicle will adaptable to a variety of missions, self-charge and be programmable when submerged.
- Transfer tidal forces into usable energy. Capture this consistent and reliable energy source, providing feasible energy for end-users. Prove apparatus, design it for replication and offer it to markets where tides will cost effectively provide and distribute energy.

• Commercialize emerging opportunities from Arctic ice melting that is opening new ocean territory and changing protein development environments. Assess this rapidly developing opportunity and define the best commercial practices for the Arctic Ocean. Implement policy, technology and services that will be ready for the increase of near future demands.
• Test the limits of engineering capabilities by attempting to build an untethered, full ocean depth haptic humanoid diver. Modern-day haptic systems have limitations because of the restraining tether. The goal is to remove the tether, allowing for full operating freedom at any depth.

The overarching goal is to develop GOC - Alaska into a comprehensive ocean enterprise company that will have the capability to capitalize and privatize the $24 trillion ocean economy. Hartman is seeking investment from U.S. based financiers to build this center.

About the Author

Chris Hartman
Chris Hartman's career experience includes working internationally for industrial oceanic companies, scientific and government agencies. Hartman commercially operates submergence vehicles and consults for said groups.



DRONES

The Next Great Leap in Hydrography

By Guy T. Noll, Maritime Principal Consultant, Esri

Oil spill recovery:
Drone technology can aid disaster response effectively as in oil spill cleanup.

(Photo: GettyImages/ESRI)

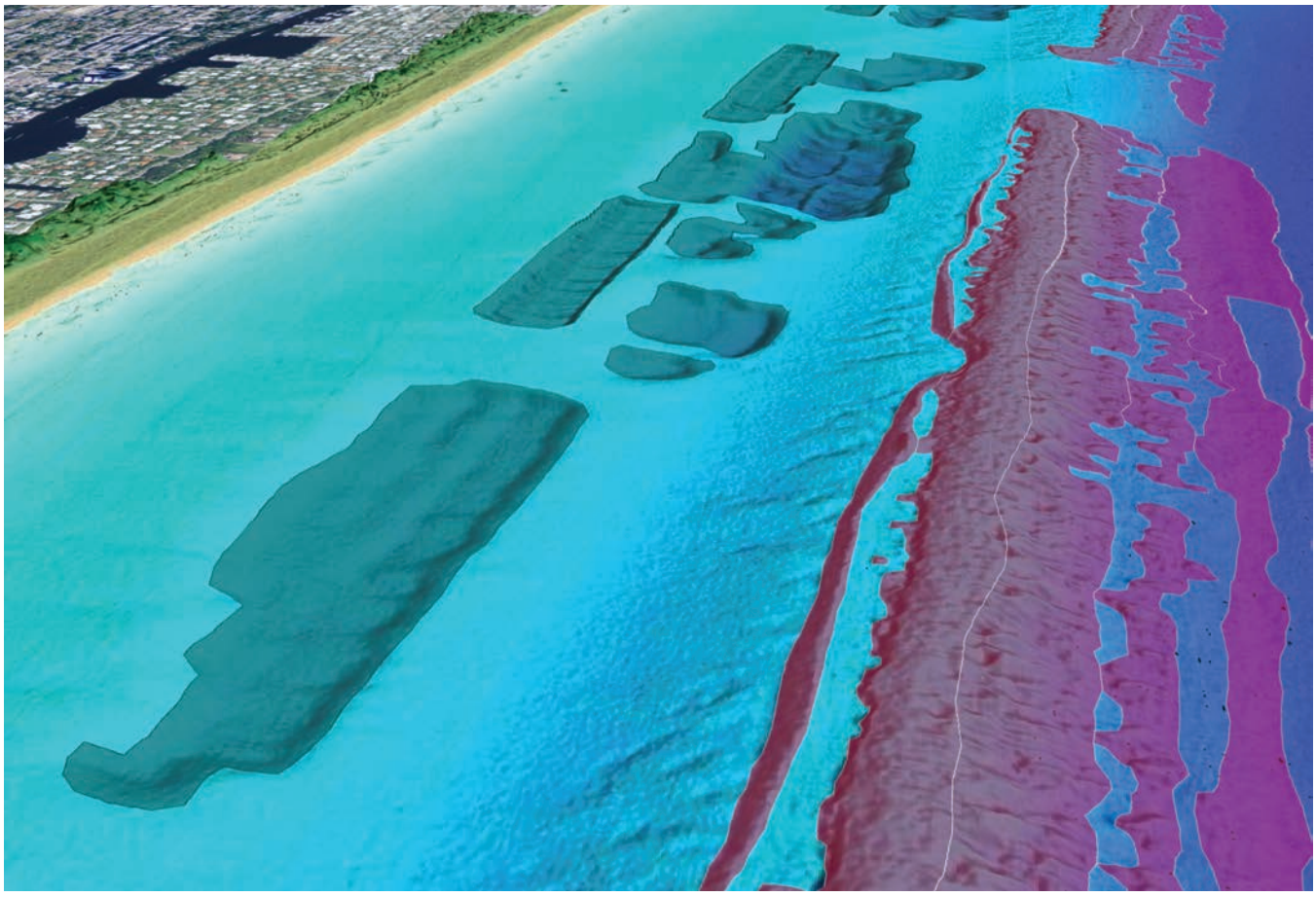
Hydrographic charting is becoming more important outside the world of shipboard navigation as both industry and conservation have gone offshore to meet the increasing demands of a growing global population. By 2020, the subsea sector of oil exploration and extraction is expected to account for 20% of total crude oil production. In addition, global marine fisheries, which provide 15% of all animal protein consumed by humans, have been steadily collapsing for the last half century. As the needs of developed economies grow, so too must the tools to understand the new marine environments from which humanity seeks to satisfy those needs. Hydrographic surveys will become more valuable information resources as the survival of the planet and global prosperity become increasingly tied to the geography and ecosystem of the sea.

A Flawed Workflow

While the demand for hydrographic resources to assist emerging enterprises has increased dramatically over the last 30 years, the rate at which this data becomes available to key stakeholders has remained rooted in an outdated workflow that creates inefficiencies and delays. The construction of a hydrographic chart is a twofold process consisting of bathymetric readings taken from the surface and the complex step of gathering a shoreline compilation coordinated with the tide. Almost all surveys near coastal regions have typically been preceded by a coastal mapping effort.

The purpose of this was to provide a frame of reference for the ocean data the hydrographer gathered at sea and also to establish and identify objects in the nearshore region that might be dangerous. However, up to now, there have only been two ways to obtain this crucial step in the creation of a topobathymetric dataset. A hydrographer might physically observe critical shoreline points with the aid of ellipsoidal-referenced bathymetry at high water or use an airplane with lidar to fly over the shore and take readings—called point-clouds—in clear waters or at low tide where possible. The first approach is slow and riddled with the potential for unsafe operations due to human error, and the second can be prohibitively expensive. Airplanes are also limited by where they can take off, airspace regulations and maneuverability. Shoreline areas that are remote, not easily accessible and which have rough terrain present obstacles for both ground-based and airborne shore mapping efforts. Additionally, if there is a change in the foreshore, such as manmade infrastructure, it can take months to observe again and correct inaccurate products.

Coastline 3D: ArcGIS 3D imagery of the coastline and nearshore area.



(Image courtesy of Keith VanGraafeiland, Esri.)

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A Seamless Integration

Drone technology itself has progressed over the past decade, allowing aerial photographic observation to become more accessible at a fraction of the cost of chartering aircraft for the same purpose. Fuel expenses alone can be an obstacle to obtaining aerial data. Drone integration with geographic information system (GIS) technologies has existed for several years. Using drones has proved to be a cost-effective and safe way to collect aerial data, with applications commonly used for fighting fire, monitoring environmental changes and managing rights-of-way vegetation. However, when users bring drone data into GIS, they exponentially increase the value of that data. And thanks to new innovations in drone technology, maritime users can exploit that integration in new and exciting ways. A seamless topobathymetric surface is now available to hydrographers interested in a more efficient and economical workflow.

Esri has just released the Drone2Map for ArcGIS app, which transforms high-resolution drone imagery into ready-to-use aerial data in the GIS platform. Users can bring point-clouds, mosaic datasets, 3D meshes and orthomosaics directly into the platform in near real time without any third-party application. This is a huge leap in hydrographic technology because users can instantly produce new observations to update nautical charts and topographic maps. Simple photographic data obtained from a miniature camera mounted on a drone can be used for point-cloud collection, rather than rely on airborne lidar. Additionally, a geospatial platform stores and manages Drone2Map data, provides authoring and publishing tools and streams live and authoritative data for rich situational aware-

Solo flying on sea:

Drones are uniquely suited to maneuver difficult coastline terrain.

(Image courtesy of 3DR.)

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ness. Maritime organizations can see data on real-time maps and as 3D digital visualizations. Working in the online Esri platform, users can share drone datasets, maps and analyses with other departments and agencies as well as the public. The platform stores drone data for later use as well as creates 3D geospatial visualizations of the shoreline, piers and pipelines.

In addition to integrating point-clouds with bathymetric data, drone mapping is also applicable to incidents such as oil spill and chemical hazard response. For example, after an oil spill, drones capture situational imagery, and then GIS maps the affected area and uses oceanographic parameters—wind, currents, tide data—to project the spill's drift over time. Emergency Operations Center staff use these reconnaissance maps to plan contingency response and deploy resources, such as for determining boom placement around the spill.

Drone2Map offers a seamless topobathymetric workflow that government agencies have invested years of research and vast amounts of money into developing. The value of this technology is not just the accuracy of the data itself, but the fact that Drone2Map liberates hydrographers in several ways. From an economic perspective, an inexpensive and accessible method of obtaining point-cloud data is invaluable. Drones are also more capable of maneuvering difficult terrain and aren't limited by the same airspace standards as cumbersome aircraft outfitted with lidar. And drones also allow hydrographers to focus on their offshore bathymetry, as opposed to the additional risk of managing foreshore feature collection.

Why Improved Workflows Matter

This year, off the coast of Mexico, a Sistemas de Información Geográfica, S.A. de C.V. (SIGSA) boat was using multibeam echo sounder data collection to complement existing hydrographic survey data with detailed bathymetry. SIGSA spotted an uncharted buoy near a pier that would have posed a serious

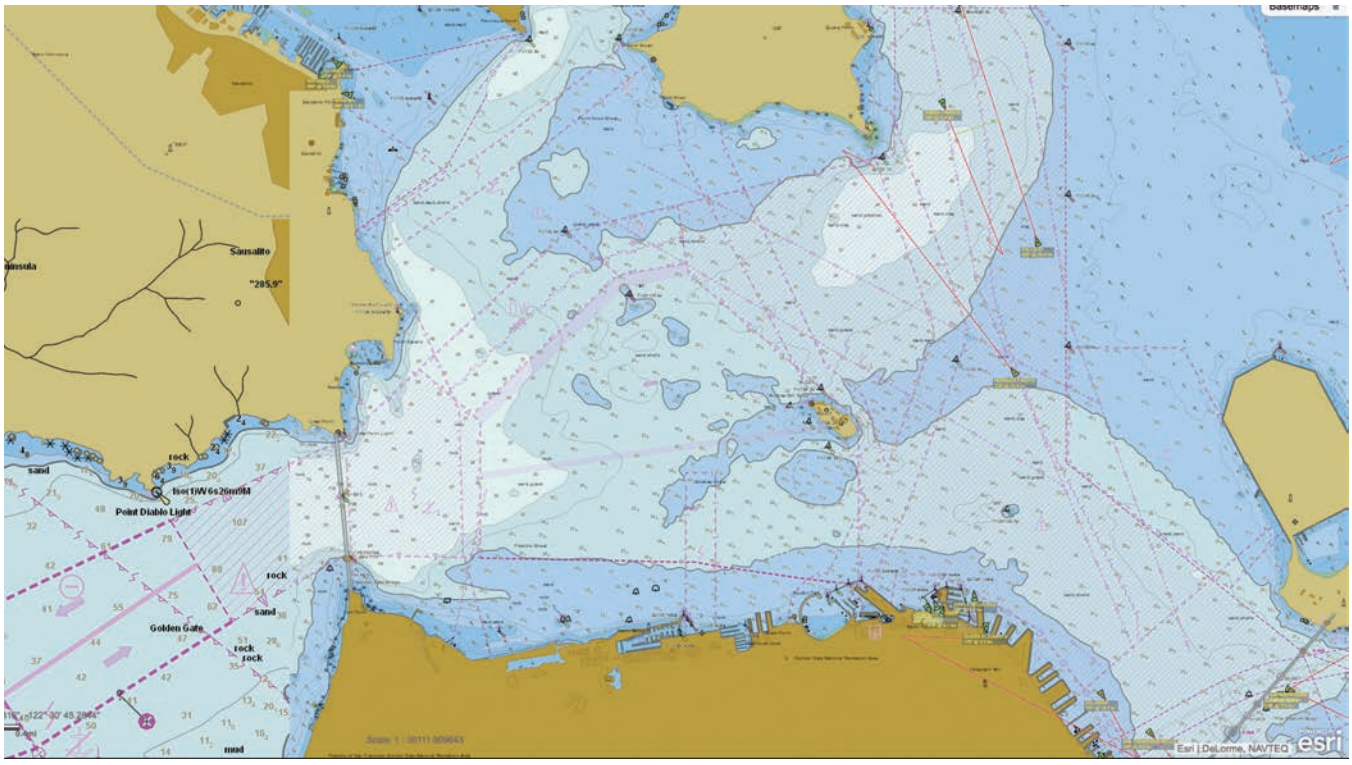
(Image courtesy of Steve Snow, Esri.)

Research ship:

Bathymetric data is collected from the surface and integrated with point-cloud data from drones.

Navigational Chart:

Integrated data is processed to create useful maritime resources like navigational charts.



navigational risk to anyone using these charts. However, using Drone2Map, the hydrographic team was able to quickly and easily position it, and, through ArcGIS Online, send it to the Cartographic Department to update the current chart. This is a real-time, ground truth example of how drone technology has revolutionized workflows for hydrographers. This example, which could also have been an uncharted rock, a semisubmerged container or a small iceberg, shows how Drone2Map could save lives by ensuring that mariners are aware of all dangerous obstacles in their vicinity.

Moving forward, gaining a more accurate picture of the foreshore seabed will be crucial for a number of reasons. Pre-engineering technical hydrographic surveys are a necessary part of constructing nearshore structures. A complete hydrographic survey is also an important source of information in determining pollution sources and sedimentation rates and their impact on essential fish habitats such as kelp or coral reefs. Since nonlivestock protein sources, such as fish, present a possible solution to the challenge of cattle production's effects on the climate, it is necessary to understand benthic and pelagic habitat impacts on recruitment rates in global fisheries. The increasing reliance on offshore energy such as wave generators and wind farms—which require cables to bring generated energy ashore—makes the need for fast and accurate nearshore hydrography imperative.

Drone technology opens up a world of possibilities in collecting data to complete a picture that was previously difficult and time-consuming to obtain and error-prone. With Drone2Map, shore-based information can be extracted very easily; and through ArcGIS Online, that information can be sent from the field to the office, and chart production can commence immediately. If there is any problem with the data, office-based team members can immediately send feedback to field technicians, who can resurvey without any delays. The valuable resource of hydrographic data is now more accessible and accurate. And it's all thanks to a solution that can launch from the trunk of a car or the deck of a boat.

Notes:

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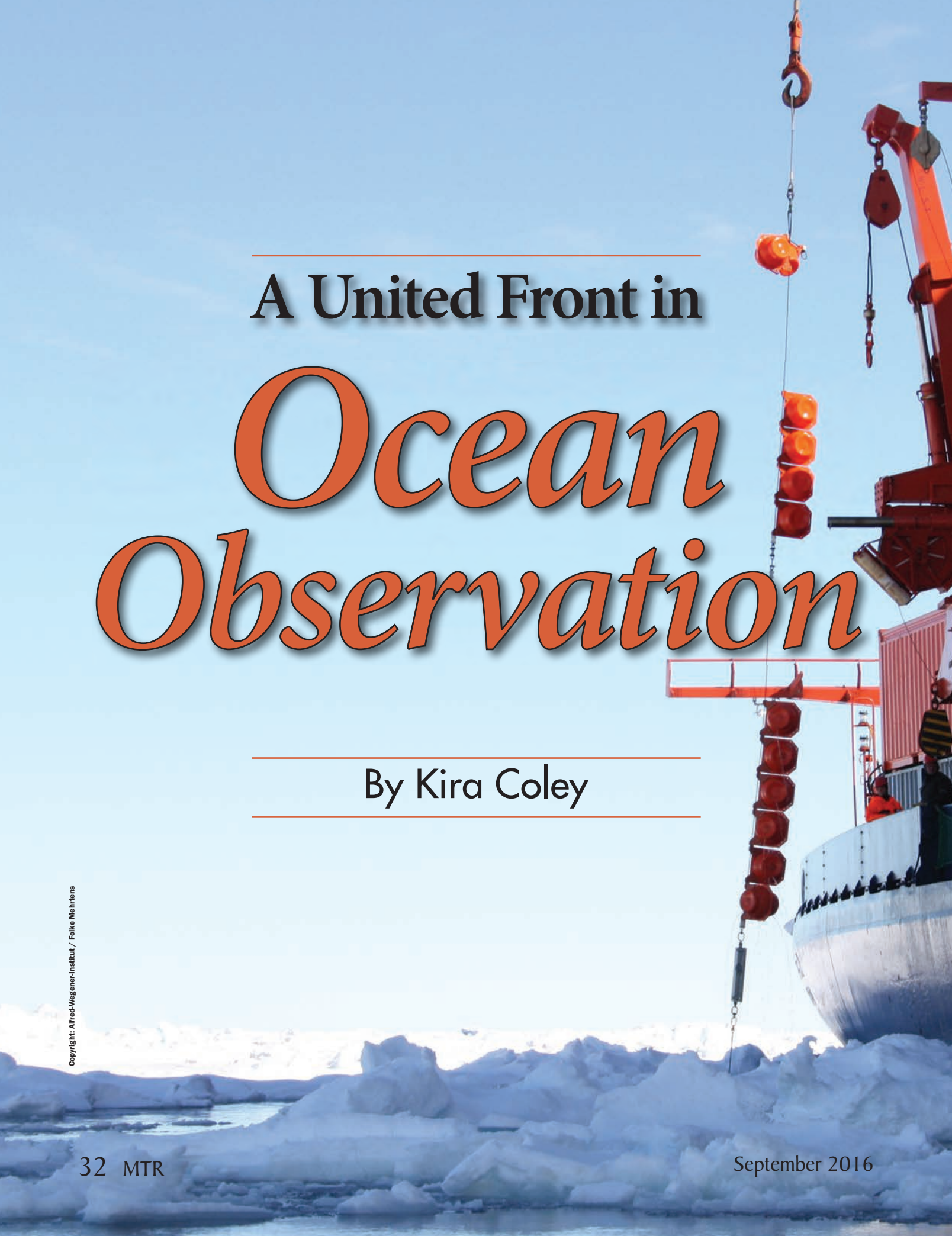
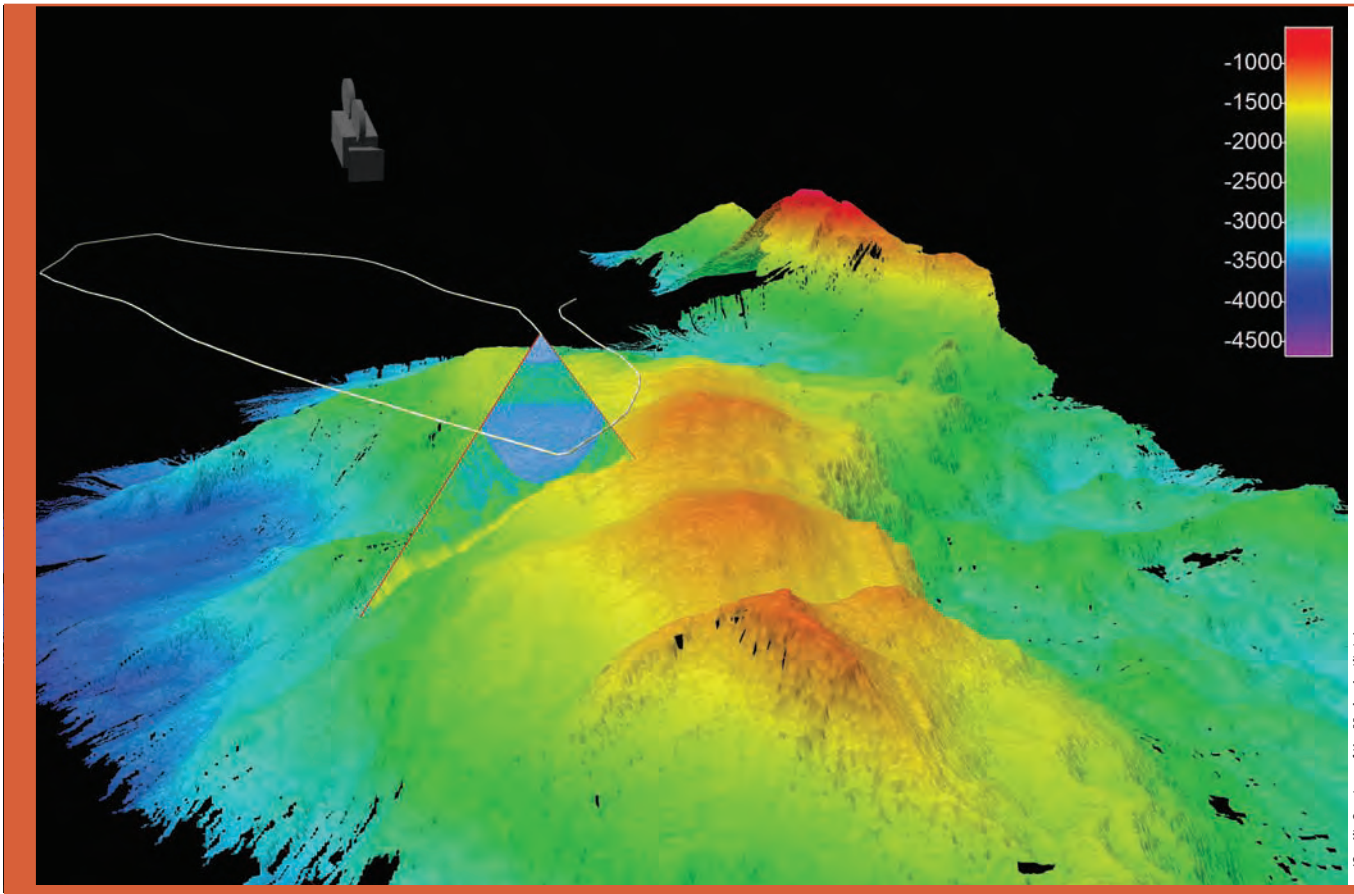
2Camilo Mora et al., Management Effectiveness of the World's Marine Fisheries, http://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.1000131 (Jun 2009).

A United Front in Ocean Observation

By Kira Coley





As the world's oceans become increasingly exposed to rapidly growing pressures, long-term data sets are fundamental for monitoring these processes and understanding the complex and vast oceanic environment. In July 2016, the European Marine Board (EMB), a partnership of major national marine and oceanographic institutes in Europe, identified critical gaps within ocean observation and seafloor mapping capabilities. Their mission, along with many organizations and networks, is to unite existing ocean observing capacity and launch Europe into a time of ocean erudition.

For 20 years the EMB has provided a unique platform for the successful development of marine research policy and strategy. The formation of partnerships and the birth of valuable networks has been a product of EMB activity, influencing marine research throughout Europe, and the world. Today, the EMB represents 35 member organizations and provides a united front enabling Europe to form a common vision and find solutions to address key global issues.

Deputy Director of Alfred Wegener Institute for Marine and Polar Research (AWI), Chair of Partnership for Observation of the Global Oceans (POGO) and EMB member Prof. Karen Wiltshire explains, "Observations are imperative for the earth systems future. The world is blue, so, therefore, the amount of knowledge that we require in order to survive and adapt to climate change is quite considerable. We cannot do this without ocean observations. Unless we know how our oceans are structured, which includes seafloor mapping, we can't come up with good strategies for moorings or governance. We still don't know what type of habitats we have in our oceans. It is because we lack this knowledge that we cannot yet know all the areas that should be observed."

EU directives and policies such as the Integrated Maritime Policy, the Marine Strategy Framework Directive, the Marine Spatial Planning Directive and the Common Fisheries Policy all rely fundamentally on marine observations, data and data products for their successful implementation. As most of the ocean lies beyond the jurisdiction of individual nations, coordinated international collaborations, such as the European Multidisciplinary Seafloor and water-column Observatory (EMSO) and Euro-Argo, are essential for developing and operating fit-for-purpose ocean observing systems and their integration into modeling and forecasting activities. The EU has also been active in implementing a Europe-wide effort to promote the accessibility and use by multiple sectors of marine data. The European Marine Observation and Data Network (EMODnet) is Commission action designed to implement the far-reaching strategic goals of the EU Marine Knowledge 2020 Strategy, which sets targets for vastly improved knowl-

3D animation of the largest feature mapped in the Charlie-Gibbs Fracture Zone, extending 3,708m above the surrounding seabed at the opening of the Atlantic Ocean. The shallowest depth is 979m below sea surface, with depths of 4,687m recorded at the base some 20km away.

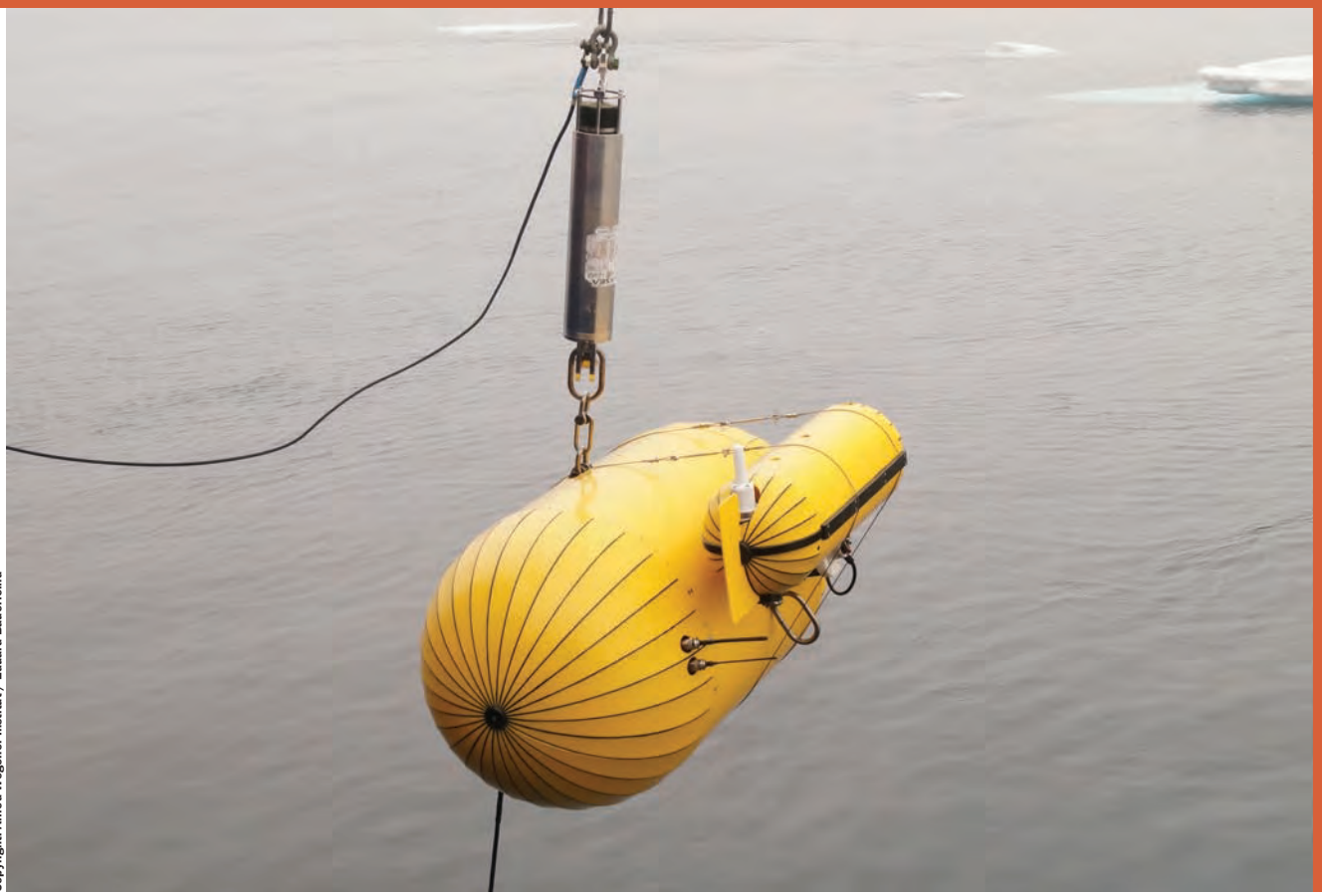
edge of Europe's marine territories.

Since its establishment, the EMB has advocated for a more coordinated and effective European effort to monitor and understand the state and variability of Europe's regional seas and the global ocean. The European Global Ocean Observing System (EuroGOOS) and the EMB are working together to promote and facilitate an overarching framework for advancing ocean observation across Europe, referred to as the European Ocean Observing System (EOOS). This comprehensive framework will connect more effectively the currently fragmented and complex ocean observing capacity and act as a single, well-organized voice for Europe.

Niall McDonough, Executive Secretary, EMB comments, "EOOS will not take ownership or control of ocean observing in Europe. Rather, EOOS will provide a light and flexible coordinating framework, making it more efficient and effective at different geographical scales and for different users. In this way, EOOS can help add value to existing observing efforts, empowering those who are already working to advance ocean observing in Europe, and catalyzing new initiatives in a strategic way, targeting identified gaps and communicating progress to a wide range of stakeholders."

Marine ecosystems are already under considerable pressure from global climate change and ocean acidification as well as localized stressors from human pollution and commercial activities. Although international efforts are underway to monitor the ocean and these impacts, only 5% of the seafloor has been surveyed to modern standards. There are also significant issues in terms of spatial coverage, the parameters being measured, the frequency of collection and the availability and ease of access to quality controlled data in real-time, or near real-time.

According to the EMB, particular emphasis must also be placed on biological observing. While a relatively advanced operational oceanography capability collects physical data at a global scale from both in situ and satellite systems, the collection of chemical, biogeochemical and biological data remains ad hoc and much less developed. There are few sustained biological observatories, a dwindling number of taxonomic experts and limited funding opportunities to increase observing efforts for biological or ecological characteristics. The EMB has recognized this as an urgent aspect to address and will begin work in late 2016 to produce a policy paper with recommendations on future biological observing needs.



"It will never be possible to have a full picture in time and space, so it is critical to ensure that all ocean observation efforts are maximized in terms of the use and relevance of data across multiple users including science, industry and government authorities.

This is why we need close cooperation and coordination," says McDonough. "From a scientific perspective, a particular emphasis must also be placed on long-term observing initiatives which deliver decadal time series, whether that be physical, chemical or biological. Understanding patterns of change and the impacts on marine systems is dependent on sustained operational observations."

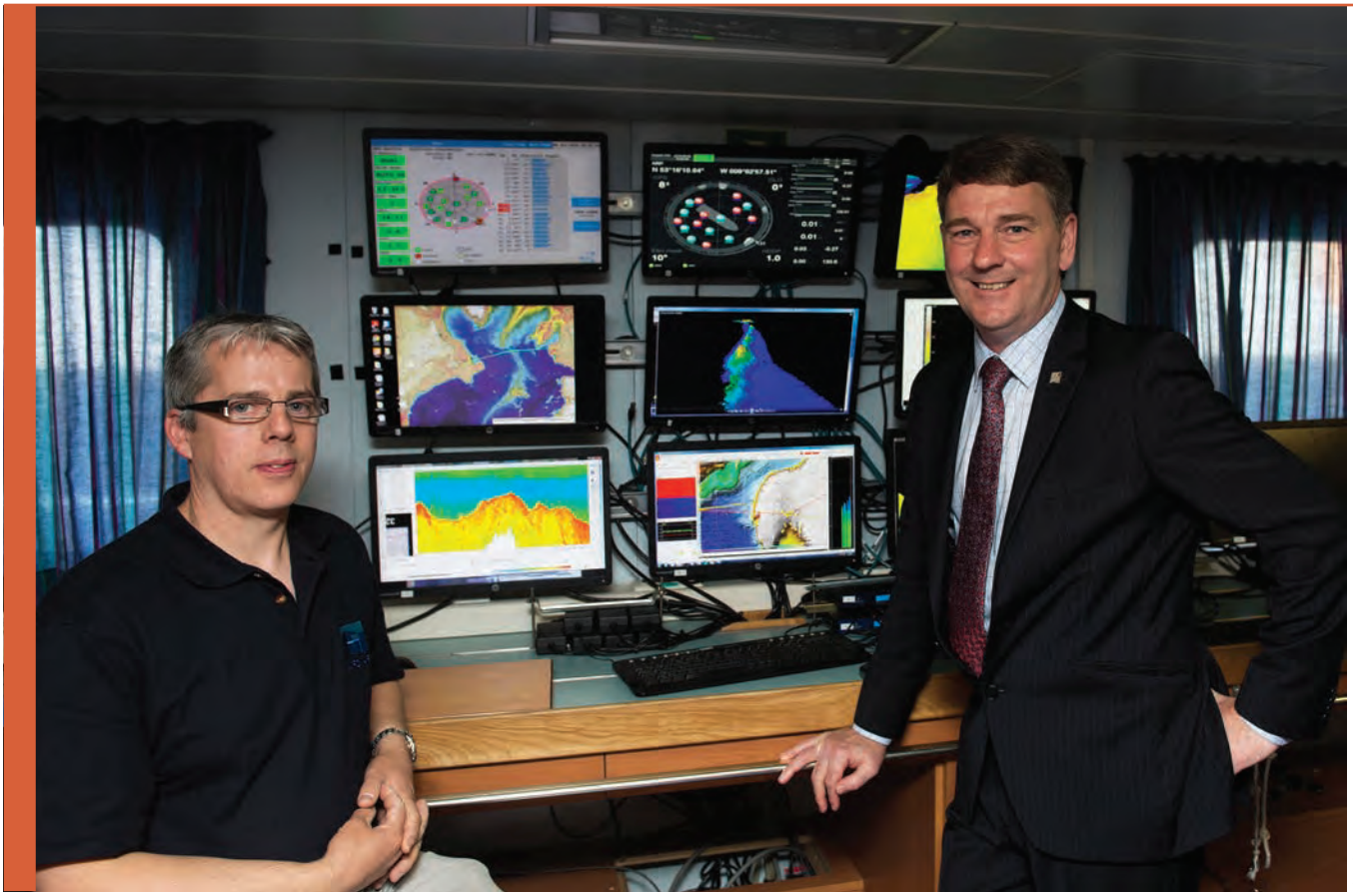
Geographically, there are still many areas which are in need of long term observation that has not long been realized. These gaps exist for several reasons including logistics, resources and funding, but also due to the evolving focus and shifts in modern concerns over time.

Wiltshire adds, "The Arctic is now an area of concern. Gaps in Arctic ocean observations have a lot to do with the evolution of needs of individual countries, such as transport and general governance questions. We also have a critical gap in the upper North Sea as it's very hard for us to get information as to how the water moves there. We have to model it and we also have to set up a few more long term moorings. Maybe 20 years ago, we might not have thought about the Arctic as we do now nor realized how important the inflow and outflow of the North Sea is. The more information we have, for example with climate change, the more we realize we might be missing bits. It's up to us to readjust some of our observation systems to current concerns."

Another key area within ocean observation, one EMB sees potential for immense opportunity, lies in the development of new observing sensors and platforms. Technology is advancing rapidly and with it the capacity for autonomous systems to be deployed for longer periods with lower energy demands. The support of innovation and advancement in future observing technologies will be key to achieving goals in ocean observation, both within Europe and globally.

Advancement through Unity

The EU Blue Economy provides over five million jobs and approximately 4% of Europe's Gross Domestic Product. New technologies, including underwater engineering and DNA sequencing, offer possibilities to increase the contribution between marine industry and science sectors. To capture this potential, the European Commission has launched a Blue Growth initiative which explores new ways to contribute to the EU's economy through technological, industrial and financial innovation while respecting the scarcity and vulnerability of marine resources.



(Credit: Andrew Downes, Xposure)

Industry collects considerable amounts of ocean data throughout the process of offshore development, oil and gas, fisheries and aquaculture and ocean energy. Through openly sharing expertise and the creation of new opportunities for knowledge and data transfer, the EMB believe the benefits will be felt by both industry and science, forming a strong foundation to achieving a data-rich future for all.

Peter Heffernan, Chief Executive of the Marine Institute, Galway, Ireland and EMB member, describes the opportunities created by linking industry and scientific resources, "Ireland has existing expertise across a number of the key enabling technologies required to develop products and services that will support growth in emerging areas of the global blue economy while creating efficiencies and supporting sustainability across more established markets. Expertise in areas such as sensors, platforms, communications, robotics, informatics, computer vision and advanced materials can be harnessed in new ways to drive innovation in global marine markets with high growth potential. This will also support the sustainable development of our significant marine resource that is uniquely situated on the European Atlantic seaboard and a potential hotspot for developments in areas such as renewable energy, fisheries, shipping, marine security and surveillance and marine biotechnology."

Against the Tide

The dream of an integrated ocean observation network, both internationally and across sectors will first need to overcome some key challenges. International cooperation is critical as is targeting appropriate funding in the right areas such as new biological sensors, training and reinvigorating Europe's declining taxonomic expertise. High-risk projects must also be supported in order to develop innovation.

There needs to be more opportunities which allow for marine data sharing collected by private enterprise to be utilized by science and public agencies. Data collected through publicly-funded initiatives, including research, must also be accessible and useful for industry in support of Blue Growth. Both these aspects, however, will first need to overcome the associated legal issues. The Commission is moving toward this goal for data generated through EC-funded research projects. From 2017, Horizon 2020 is adopting an open data policy for all projects funded through the program.

Finally, making the case to decision makers of the importance to investing in ocean observing systems and infrastructure requires better economic cost-benefit arguments.

Europe also lacks a 'seabed mapping research center of excellence'. Knowledge resources are spread across numerous agencies and research centers, and related expertise has not been mapped out to date. This is largely because seabed mapping programs have been nationally operated rather than international research focused, as is the case with ocean observation. Resource allocation to assess the current knowledge and expertise base, and encourage collaboration between operational entities is also required.

"Key seabed mapping data programs already in place don't

(L-R): Tommy Furey, Chief Scientist, and Dr. Peter Heffernan, CEO, Marine Institute, Ireland, review previously uncharted features on the Atlantic seabed, onboard Ireland's national research vessel, the RV Celtic Explorer.

necessarily involve the key operational agencies or researchers. Partnerships are often developed through historical programs and initiatives, rather than bringing together the most appropriate expertise. Resource allocation mechanisms to bring all strategic stakeholders together is required, such as a network of marine data centers or active seabed mapping organizations," explains Heffernan. "Ireland has built up considerable expertise in seabed mapping through INFOMAR, the national seabed mapping program carried out by the Geological Survey of Ireland and the Marine Institute. It is one of the largest civilian mapping exercises undertaken worldwide."

EMB has recently met through a high-level delegation with the EU Commissioner for Environment, Maritime Affairs and Fisheries, Karmenu Vella, to discuss needs and strategic actions to improve Europe's ocean observing system. While the meeting on July 8, 2016 produced a number of follow-up actions, the EMB will continue to work with the Commissioner and DG MARE to develop and shape the next actions to promote and expand Europe's ocean observing capacity.

Going forward, the EMB will continue to work with its partner network, EuroGOOS, to develop EOOS. A Roadmap for EOOS is currently in development and will be discussed at a special event in the European Parliament on September 8. This will be followed by an open consultation with all stakeholders on EOOS in autumn 2016.

"The global Ocean is facing multiple anthropogenic and natural stressors and consequently marine ecosystems are increasingly vulnerable to exceeding tipping points which may lead to irreversible change. Society will rely on scientific information to tackle these threats and potentially even turn challenges into opportunities A particularly important goal is to achieve a balance between protecting the marine environment and supporting Blue Growth," states McDonough.

Acknowledgements

Niall McDonough, Executive Secretary, European Marine Board

Prof Karen Wiltshire, Deputy Director of Alfred Wegener Institute for Marine and Polar Research (AWI) and Chair of Partnership for Observation of the Global Oceans (POGO)

Peter Heffernan, Chief Executive of the Marine Institute, Ireland

ADCP-based Monitoring System Aids Operations in Darwin Harbor

Near real-time data assist mariners navigating strong & complex currents

By David Williams, Australian Institute of Marine Science, Darwin, Australia; Craig Steinberg, Australian Institute of Marine Science, Townsville, Australia; and Peter Spain, Teledyne RD Instruments, San Diego

Introduction

Located in Australia's northern Top End, the port of Darwin has long been a strategic gateway to/from Asia. Founded in 1869, today Darwin is a major multi-modal port serving shipping and cargo markets. Ships range from container and general cargo to cruise and naval vessels. Exports include livestock and minerals as well as bulk liquids like LNG. As well, the port provides services for offshore oil and gas rigs.

Due to Australia's increasing trade links with Asian neighbors, the port and facilities have expanded for increased shipping and business. This expansion has seen a renewed focus on the interplay between the port's operational, maritime and natural environments. For example, a large tidal range of almost 8 m drives strong and complex currents, having speeds to 2 m/s. At times, maneuvering Panamax and LNG bulk carriers can be difficult. While aiding such port operations, marine observing systems can also help reveal processes that impact the sustainable use of these areas (e.g., sediment transport, water quality). To boot, these data can provide ground truth and boundary conditions for computer models used in the port's development projects.

Near Real-Time Ocean Observations

Australia's Integrated Marine Observing System (IMOS) includes a station at the entrance to Darwin Harbour. Information for currents, tides, waves, temperature, water quality parameters (e.g., Chlorophyll-a, turbidity), wind and rainfall are recorded. More recently, bio-geochemical instruments have been added. Updated every 30 minutes, various data summaries are available via the Internet in near real-time. While navigating ships in Darwin Harbour, pilots can use a smartphone to see the data. As well as supporting safe shipping, these near

Darwin is a major multi-modal port serving shipping and cargo markets. The port conveys a wide range of exports and provides services for offshore oil and gas rigs.

(Photo: Port Darwin)

real-time observations can aid the general public. Examples include recreational activities, improved safety from storm events, protections for public health and healthy ecosystems. For authorities, these data can also assist in emergency response operations and support.

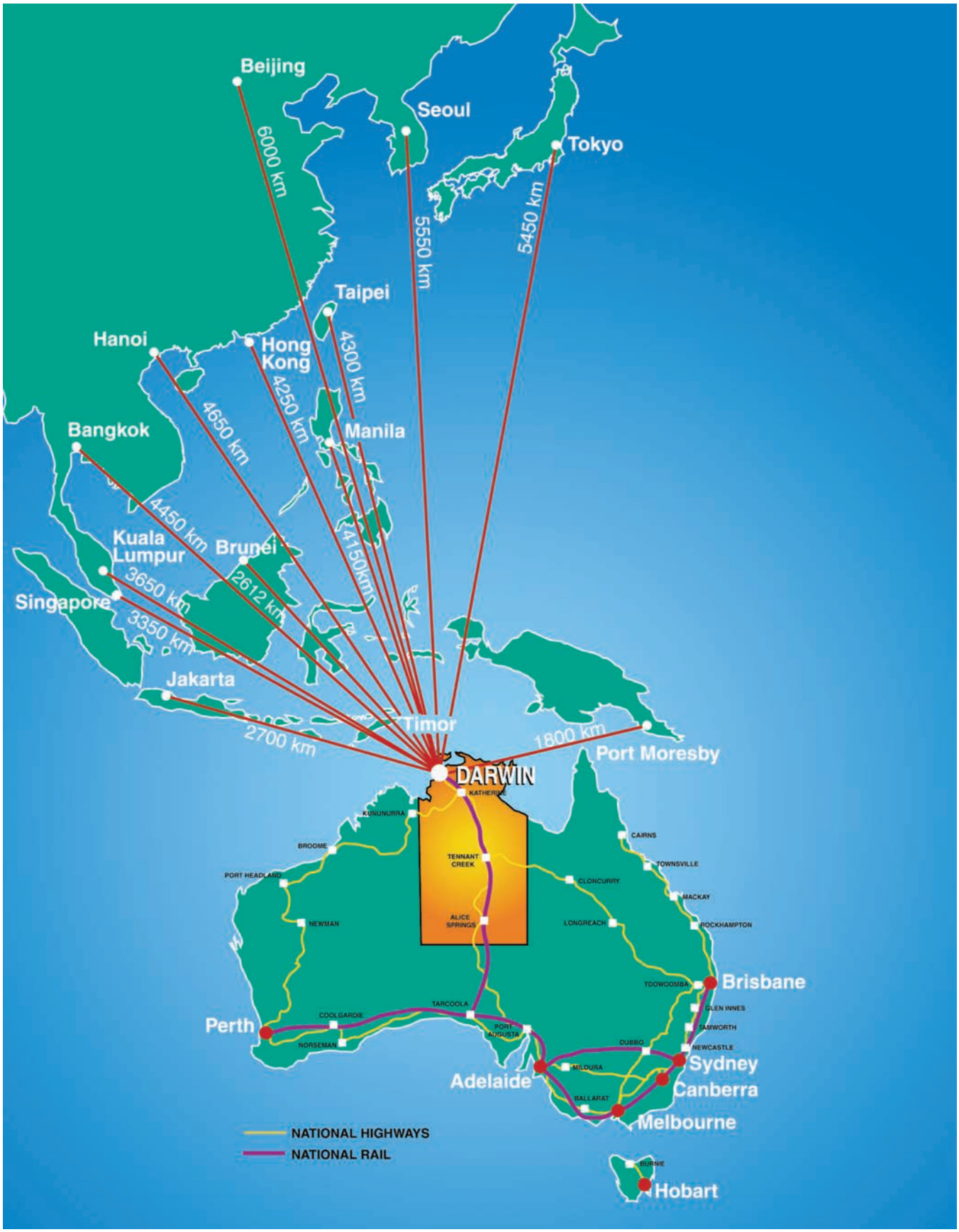
From Currents to Currency

The ADCP-based system in Darwin Harbour can have a direct impact on the port's efficiency and safety. Two parameters can be important for the economics of big ships in a port. One is the sailing window, which is the available time for safe passage. The second is the vessel draft, which limits the amount of cargo carried. Knowing the actual conditions for currents and waves can help operators to maximize these two parameters safely. Entry and exit to ports where shipping channels have bends can be challenging for big ships. Strong and variable water currents worsen the difficulties. Timely data about unpredictable water movements aid pilots navigating ships and berthing at docks. Knowing actual wave conditions can help reduce the possibility of ship groundings. This problem can arise in both along-ship and across-ship directions. For example, large ore carriers have flat bottoms; when rolling, they have less clearance than rounded hulls. Likewise, real-time information about wind loading on ships permits more efficient use of tugs. A less direct effect of water currents on port operations is via transporting sediments. Deposition of sediments drives the need for dredging. For port operations, this affects maintenance intervals. Plus it can require monitoring of how dredge spoils enter the surrounding environment. Currents can move sediments along the bed (e.g., sand waves in navigation channels) or in suspended mode (e.g., river effluent, dredging plumes). At certain times, the entrance to Port Darwin is restricted in depth through an area of sand waves. This restricts passage for Panamax-class ships during lower stages of the tidal cycle. Dredging a channel is planned to permit unfettered access to Port Darwin for big ships. As part of this effort, understanding how water currents move the sand waves will be essential.

ADCP-based current and wave monitoring

The marine National Reference Station at Darwin was installed by the Australian Institute of Marine Science (AIMS). The system was engineered by Dr. Paul Rigby of AIMS. Darwin Port Corporation provided an existing navigation buoy to support the observational instruments. Water motions are profiled with an ADCP-based system at 20 m depth. Recently a second mooring was added in the Beagle Gulf to extend seaward oceanographic observations.

Aboard the buoy, instruments are located at two heights. At 3 m are a weather station and radiometer whereas just below sea



(Photo: Port Darwin)

Located in Australia's northern Top End, the port of Darwin is a strategic hub for trade with Asia.

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IMA
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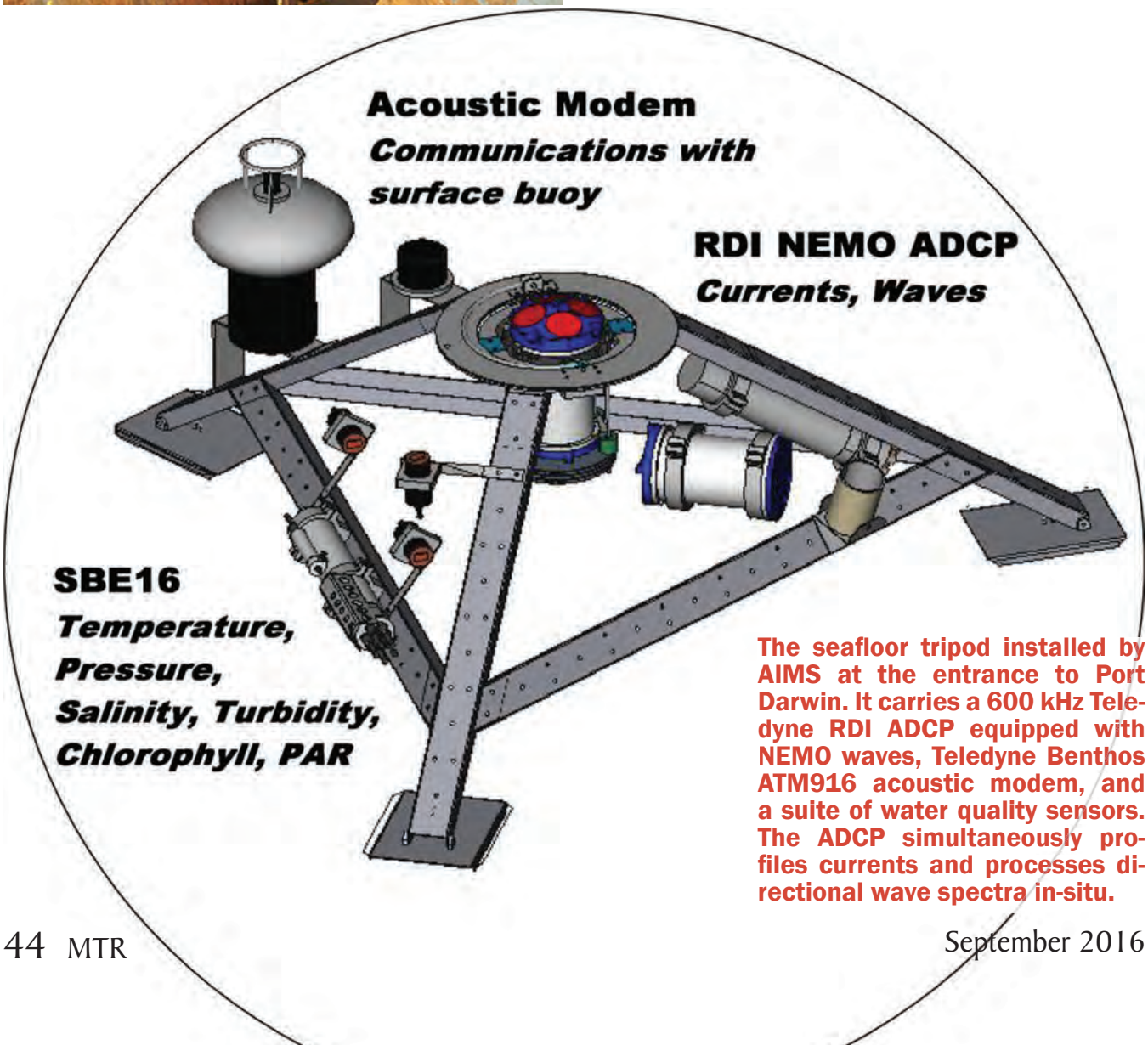
level are water quality sensors. On the seabed, about 100 m from the buoy, is a tripod. As well as water quality sensors, it carries a 600 kHz Teledyne RDI ADCP equipped with NEMO waves for in-situ processing. The ADCP simultaneously profiles currents and processes directional wave spectra in-situ. Combining both currents and waves in a single compact package simplifies operations. Using battery power allows the measurement of waves every two hours over a six-month deployment. Using a bottom-mounted ADCP for measuring waves, rather than a surface buoy, can have key advantages. It has been shown that ADCP wave measurements compare favorably with competing techniques. Mounted on the bed, the equipment is safe from damage due to collisions by shipping. Also AIMS avoids frequent maintenance trips to remove fouling by tropical birds. Both had been problems while using wave buoys.

Communication Links

Access to the seabed ADCP's data is achieved using acoustic telemetry through water to the surface buoy. The link is via a Teledyne Benthos ATM916 acoustic modem. Every 30 minutes, the near-surface modem polls the tripod

(Photo: Craig Steinberg)



The seafloor tripod installed by AIMS at the entrance to Port Darwin. It carries a 600 kHz Teledyne RDI ADCP equipped with NEMO waves, Teledyne Benthos ATM916 acoustic modem, and a suite of water quality sensors. The ADCP simultaneously profiles currents and processes directional wave spectra in-situ.

The navigation buoy provided by Darwin Port Corporation hosts metoc sensors and provides the surface link for sending near real-time data. Aboard the buoy, instruments are located at two heights. At 3 m are a weather station and radiometer whereas just below sea level are water quality sensors.

modem. This interval allows for six-month deployments when using battery power for the modem. The communication link from the navigation buoy to shore uses the NextG mobile phone network. Its primary use is the scheduled uploads of new marine data. Yet this link also allows full remote access to the station for software updates and maintenance. For the farther site in Beagle Gulf, real-time communications are via satellite. Besides helping operators understand what is influencing coastal systems, this site serves as an early warning system. It provides alerts of approaching weather to improve forecasts of waves and current at key sites along the shipping channel.

Back on the Beach

All transmitted data are published on the AIMS website. They are publicly accessible within 10-30 minutes of leaving the tripod. The web interface provides tools for exploring and plotting the data. Another simpler interface for smart phones delivers relevant readings to mariners.

Every six months, the instruments are recovered. This period is set to avoid bio-fouling issues with other sensors in the collective (e.g., pumps, optics). All raw data stored on each instrument are downloaded. Typically, these sets are more detailed than the real-time stream, which is limited by available bandwidth. The full data set is processed, controlled for quality, and then published on the IMOS Ocean Portal. Key contributions have been made by John Luetchford, Chris Bartlett, Shaun Byrnes and Jonathon Windsor of AIMS. Data from the ADCP show that currents are bi-directional to speeds of 1.5 m/s. Apparent too is a slight seasonal asymmetry in tidal motions. Net flux of sediment loads into Darwin Harbour has been estimated. This was done by coupling ADCP-based discharge measures with suspended sediment concentration (derived from optical instruments and ADCP backscatter data).

Looking Ahead

For some time, this ADCP-based monitoring system has assisted Darwin Port Corporation in different ways. Besides supporting ship handling actions, the ADCP's data contribute to managing less frequent activities: recurring events like dredging and occasional events like maritime accidents (e.g., ship groundings, oil spills). The data are also valuable for general public uses like recreational boating and trip planning. Data from the station are expected to feed into other key systems for Port Darwin. One will include accurate modeling and prediction of under keel clearance. This will help in optimizing the sailing window and maximizing the draft for any particular ship. Another is an operational forecast model for Darwin Harbour.

(Photo: Craig Steinberg)

Station-Keeping *In Ice*

By Andrew Safer

While substantial amounts of petroleum reserves exist in the Arctic—30% of the undiscovered gas and 13% of the undiscovered oil, according to the U.S. Geological Survey's 2009 estimates — there are hurdles that need to be cleared before oil and gas companies can efficiently operate there. A high priority is to be able to accurately predict the forces that nearby ice floes would exert on a vessel's hull upon impact, and have the ability to react to this information in a timely manner (see sidebar, page 48). A Dynamic Positioning (DP) system outfitted to operate in managed ice (following icebreaking) would satisfy this requirement. It needs to (1) be equipped with predictive capability, (2) be able to determine the counterforce that will be required to offset the force of ice collision, (3) "know" the limitations of the vessel's engine power and propulsion system, (4) recognize when ice loads will exceed these limits and provide a signal to the DP Operator, and (5) when the force of impact of ice loads is within the vessel's limits, automate the response from the thrusters and propulsion system required to maintain station. Such a DP system would be particularly valuable for a drillship when carrying out operations. When the system notifies the DP Operator that the vessel will be unable to maintain its position due to the magnitude of the ice loads, the operator would then ensure that the drill string and risers are pulled, there would be a controlled, safe disconnect from the

(Photo: National Research Council of Canada)

(R-L) Captain Chris Hearn, Director, Center for Marine Simulation and Maria Halfyard, Manager, Applied Research and Industrial Projects in the Offshore Operations Simulator which is outfitted with a DP system (controller is on the left)

seafloor, and the vessel would be moved. Since DP systems were designed to operate in open water, significant technology developments and modifications are required to enable operations in ice environments. Model testing and simulation—both in the development of an ice model and the visualization of mathematically based scenarios—are playing key roles in an applied research project underway in St. John's, Newfoundland and Labrador.

The Center for Marine Simulation (CMS) at the Fisheries and Marine Institute of Memorial University in St. John's, in partnership with the Government of Canada's National Research Council Ocean, Coastal and River Engineering (NRC OCRE) also in St. John's and Kongsberg Maritime Simulation Ltd., are conducting a five-year research project to address these issues. The funding totals $8.6 million ($C), including $1.8 million in in-kind contributions. The funders include Petroleum Research Newfoundland & Labrador, the Government of Canada through the Atlantic Canada Opportunities Agency, Research & Development Corporation of Newfoundland and Labrador and Kongsberg Maritime.

"If you can extend the weather window in the Arctic by one month, that would be huge," says Maria Halfyard, CMS' Manager of Applied Research and Industrial Projects, and Project Manager. "They're spending millions of dollars a day in time up there." Referring to recent restrictions on drilling in the Canadian Arctic post-Macondo, she adds that oil companies don't have enough time to drill two wells in one season. "If our technology allows them to do this, that would be significant for them." Since the kick start of this project in May 2014, Halfyard has spoken to half a dozen oil companies, all of whom have confirmed the high priority of developing DP capability in ice-infested waters.

One of the major challenges on the CMS side of the project is addressing the complexity of simulating ice. "Ice simulation is still in its infancy," says Halfyard. "Our aim is to develop the best ice simulation out there. We want it to look as realistic as possible, including fracture, colour, and floes responding to and bouncing off each other, and breaking."

The approach of the CMS project includes testing a fully instrumented model drillship in an ice tank at NRC OCRE, and sending the ice-ice and ice-ship interaction data to the numerical researchers and software engineers who are building an ice model, who then send scenarios to CMS where visualizations are created and simulations are run onscreen. Kongsberg Maritime will then assess the fidelity of the ice model and DP response and determine what modifications their DP system requires for integration.

At NRC OCRE, which boasts one of the world's longest ice tanks (90 x 12 m), a team of ice and software engineers are working on model testing and building a numerical ice model. Ice engineers have conducted tests with a DP-equipped model drill ship (1:40 scale) in the ice tank, which holds 76m of ice. Managed first-year ice up to two meters in thickness was specified. The testing began with the ice field designer coding each piece of ice to represent its geometry, toughness, type and thickness. The tests provided ice-ice and ice-ship interaction data, collected as the drillship proceeded across the tank. This information was passed to the ice modelers / software engineers who are analyzing the data and developing formulas (algorithms) to represent the measured forces. Based on this data, they are currently building the numerical ice model.

The physical model used for testing is self-contained, providing its own power to the thruster and data acquisition systems onboard. An optical six-degree-of-freedom system is used to track the position and orientation of the model. NRC OCRE's in-house DP system is used to maintain station and record forces and moments. A camera is mounted over the bow with the purpose of observing ice-ice and ice-hull interaction. There are three azimuthing podded propellers fore, and three aft. Since a wireless network is connected to the model, there is no need for a tether.

The ice produced in the tank—equivalent to first-year ice—was cut from a sheet into ¼-metre floes. Over the ensuing days, as a result of the impacts, variations in size and thickness developed, reports David Millan, OCRE System Engineer and NRC Project Manager, at which point the tank more closely resembled a real-world managed ice field. The ice thickness ranged from 15 millimetres to 32 millimetres to 50 millimetres. Millan's team conducted almost 40 days of testing, finishing up in March 2015. They used 17 full-tank ice sheets, and made 372 model test runs (three runs per length of the tank), which yielded terabytes of data.

Software engineers reformat the data to provide ice type and ice field characteristics, which is then fed into one of three algorithms that focus on collisions, loading and the motion of the ice. "The boat is moving through the ice," explains Millan. "According to how it's pressured by the ice, there's a response—a pushing back by the thrusters." Successive calculations produce realistic ice-loading information, based on data collected from the real-world tests.

The plan is for the OCRE team to send this data to the CMS team, who will represent the scientific information visually. Each piece of ice is specified according to type, shape (number of vertices), thickness and location. The information transferred to CMS will include ice field, ship, wave and wind scenarios, and force interaction components. The embedded complexity of shapes and sophisticated rendering methods used by CMS will result in a very high fidelity look and feel to the simulation.

To create the visualization, the appropriate visual representation will be wrapped around the ice geometry. The CMS team will then display the 3D scientifically-based real-time visualizations on three 55-inch screens, arranged side-by-side with an angle between them representing a 150-degree horizontal view. A fourth screen will enable walking around different areas of the vessel and changing one's point of view (this is the screen set-up that CMS instructors currently use for DP training). The numerical ice model will then be tested on NRC OCRE's DP system. Once positive results are obtained regarding how the vessel responds in an ice field, that will validate that the integration of the numerical ice model and DP system is working well. The next step will then be to integrate this into a commercial DP Control System, which is where Kongsberg Maritime comes in.

By the end of the project, "we hope to have a prototype," says Halfyard. "There are people who are skeptical because ice is so unpredictable. They're saying, 'Can you really build a numerical ice model that is realistic for the type of ice conditions that we get? I keep telling them, 'Just think outside the box.' Let's push past what we know, and create something innovative. We can be the group that develops this new technology."

Evolving the prototype into a commercially available product will extend well beyond the life of the project, says Halfyard. The objective of this project is to develop a proof of concept that can be commercialized by a DP manufacturer. "It will likely take years to bring to market, as significant full-scale testing would need to occur," Halfyard observes. "But then again, innovation takes time and patience."

Station-Keeping in Ice: A Priority

After consulting with subject matter experts from oil and gas companies and other organizations / institutions with Arctic expertise, the Centre for Arctic Resource Development (CARD) in St. John's completed its Arctic Development Roadmap in 2012. The purpose of the Roadmap was "to identify, organize and prioritize key research and development issues that need to be addressed to fill gaps in the knowledge, technology, methodology and training associated with offshore Arctic oil and gas development."

The oil and gas companies that were consulted for the CARD Roadmap included Exxon Mobil, Suncor, Husky Energy, Statoil, Chevron, Imperial Oil, Shell and Conoco Phillips. Among the needs that were identified as high priority was station-keeping in ice using either mooring or dynamic positioning. The limiting case used for design was station-keeping during emergency response, which pointed to the need for "improved ice load models (and full-scale data) for floating platforms to guide the design of station-keeping systems."

A Rude Awakening

"When I first went to the Arctic in the early '90s, the statistics said there was a very small chance that there would be a vast ice floe," recalls David Millan, who was working for NORDCO of St. John's as the Engineering Project Lead. His mission was to collect and analyze data on a brand new digital radar system on board a 1,000-foot long icebreaking cargo ship (now MV Arctic). He climbed aboard in Antwerp and was heading for Nanisivik on Baffin Island. While travelling at 6 knots, the ship came to an abrupt halt. It had hit a massive ice floe. "It practically threw people off their feet," Millan recalls. "We waited three days for the Canadian Coast Guard's Sir John A. MacDonald to break us free. On the same trip heading south to North Sydney, the Arctic encountered 17-m seas close to the ice edge." One of the hulls cracked on the next voyage, which Millan figures was probably due to the impact and massive seas. Ever since, Millan has been aware of the need for superior ice detection capability and technology solutions that can make Arctic voyages safer.

Imagenex 881AL-GS
Gyro-stabilized Scanning Sonar

By Paul Unterweiser

The Imagenex model 881A-GS, 881L-GS (881A/L-GS) and 882-GS are gyro stabilized, high resolution scanning sonars. Manufactured in Canada, the 881A/L-GS is available in models built to withstand depths up to 10,000 meters and can scan and display targets from 0.2 to 200 meters away. Available with either an RS-485, RS-232 or Ethernet interface gives the user a wide range of options for integration into an existing underwater platform.

The principal benefit of a gyro stabilized sonar is that it can produce a clear sonar image regardless of how the host vehicle may be moving. That clear image is the key capability that allows the software controlling the sonar to incorporate more complex functionality. In the case of the 881A/L-GS, one advanced feature that proved itself invaluable (to be covered in greater detail later), is target focused scanning.

The package I received from Imagenex included the 881AL-GS gyro-stabilized sonar, four lead pigtail for integration into my ROV, software and documentation on a CD, and an RS-485 to USB interface (which is available as an option). It differs from the model 881A-GS or 881L-GS in that it is intended to be mounted horizontally which allows it to be used with smaller, low profile underwater vehicles such as ROVs and AUVs. The only other component I added was a voltage regulator to convert my ROV's nominal 14.8 volts to the 881AL-GS required 24 volts. Fortunately, the power requirements of the sonar were minimal (less than 7 watts) so a tiny off the shelf regulator was all I needed to complete the integration. The 881AL-GS size and shape are a bit different from other sonars I've used. The main housing is an aluminum tube with a red polyurethane transducer mounted at one end at 90 degrees. The entire unit is roughly 28 cm in length and weighs 1.6 kg (in air) and so needs to be mounted on a vehicle capable of handling a sonar of this size.

Mounting the sonar is straightforward but the mounting location must be chosen carefully, allowing both unobstructed sonar transmission while also protecting the transducer from damage. The sonar may be mounted transducer "up" or "down" providing more options when choosing a mounting location.

I divided my testing of the 881AL-GS into three parts: initial setup and bench testing, static testing in the water and fully operational testing at a dive site.

Bench test

Once I had all the components necessary to integrate the sonar, setting it up was straightforward.

Two leads of the sonar's pigtail supply power and the other two are for RS-485 serial communications. I installed the supplied software and drivers (initially on a 10" Windows tablet and then later on a laptop), connected the sonar to the serial/USB interface and supplied power to the sonar. I launched the software, selected the COM port, and a few seconds later it was working. I have to say that setting up the sonar was considerably easier than what I was expecting. The system automatically starts an initialization and calibration process as soon as it has power. A few seconds later it's ready to go. With the sonar running on the bench I took a few minutes to famil-

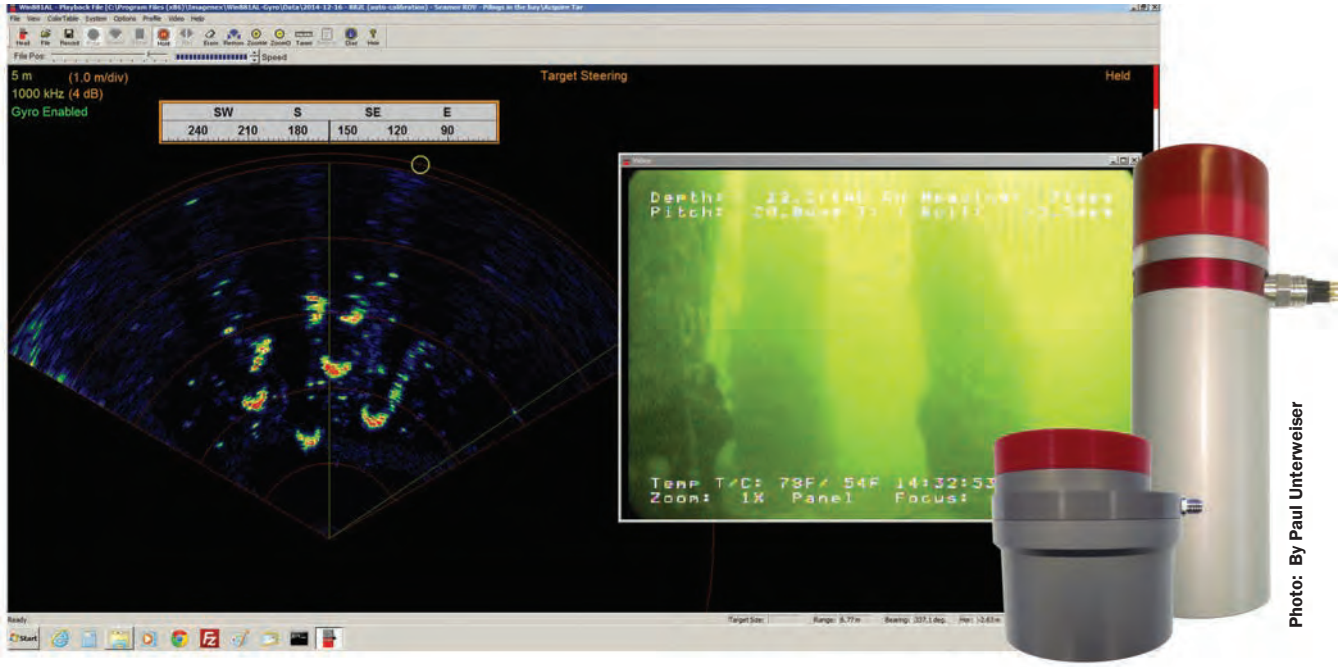


Photo: By Paul Unterweiser

iarize myself with the included software. The software interface, just like the integration, was straightforward and simple to use. At the top of the screen are icons and pull down menus. To the right are larger icons for the most frequently used functions (which just happen to be ideally sized for touch screen use as well) and the remainder of the screen is filled by the sonar display. There is an option in the settings for a separate video window so both video and sonar can be displayed and controlled via the same software interface.

Static test

My first "in the water" test was conducted in conditions typical for the coastal estuaries of North Carolina. The bottom was a combination of silt and weeds with a depth ranging from 0 to 10 meters. Visibility was less than 1 meter, making navigation without a sonar virtually impossible. Potential sonar targets ranged from soft sand banks to hard oyster beds and a variety of steel and wood pilings.

Although I used a 10 inch Windows tablet during the bench test, I decided that in the field a larger screen would be easier to see so used a 15 inch laptop instead. The 881AL-GS was mounted to the underside of our mini ROV and launched alongside a floating dock. My objective was to become familiar with the 881AL-GS and software while keeping the ROV as stationary as possible. The ROV was kept just below the surface and held in place using thrusters and tether tension. I ran the sonar at various ranges and levels of gain to get a feel for the submerged terrain and obstacles.

After letting the sonar run for a few minutes, I decided to give the "acquire target" feature a try. This feature allows the operator to select and direct the sonar's beam toward a contact on the display. The gyro-stabilization is then employed to track the selected target regardless of where the ROV (and transducer) may be pointing.

I picked what looked like a small oyster bed 30 meters from the ROV's position, selected the "Acquire Target" icon and then clicked on the oyster bed on the screen. The display then changed from full 360 degrees of sweep to a 120 degree sector centered on my oyster bed. I then pivoted the ROV while holding position and watched as the sonar sector on the screen matched whatever movement the ROV made. The smaller sonar sector and quick response of the gyro resulted in quick refresh rates of the painted target. I could immediately see that this could be an enormously useful tool in any application where a scanning sonar is required for navigation.

Operational test

Operational testing was conducted in similar conditions as the static tests. Visibility was less than one meter, so I navigated entirely with compass heading, depth and sonar.

Immediately after launching the ROV, I did a full 360 degree "polar" scan of the surrounding area out to 100 meters to help visualize the underwater terrain. Setting the sonar display to "Heading Up" I had a clear picture of the terrain and identified a series of wooden pilings roughly 10 meters away. I changed the sonar range to 10 meters and then flew the ROV to the piling. The gyro-stabilization did an excellent job of keeping the displayed image clean and understandable as I flew the short distance to the piling. The Imagenex software display includes a "yellow circle" that swings around the circumference of the polar display indicating the current heading of the ROV, in addition to a compass heading graphic at the top of the application window. This feature made flying toward the piling easy. I repeated the same scenario with targets at roughly 15 and 20 meters with similar results. Without gyro-stabilization I would have needed to stop every few minutes, allow the sonar image to stabilize and then re-

orient myself to the ROV's new position before continuing towards the contact.

The next mission took place near a highway overpass. Conditions were similar to the earlier mission with the addition of roughly half a knot of current caused by outgoing tide. Repeating the steps from earlier missions, I identified a concrete piling on the sonar roughly 50 meters away.

With the sonar in "Target Steering" mode, I clicked on "Acquire Target" and then clicked on the bridge piling. The display immediately switched from a full polar sweep to a 120 degree sector centered on the piling in the distance. Watching only the heading display and sonar contact while maintaining a depth of roughly 3 meters, I flew the ROV toward the contact. Every time the ROV turned, veered or pitched, the sonar display instantly responded with an equal, compensating movement on the display.

I did notice that, over a longer period of time, the target did seem to drift a degree or two, but this is expected of any gyro stabilized system. Although I didn't feel this small amount of drift required it, I could have simply selected "calibrate gyro" from the top, pull-down menu to eliminate any amount of drift that may have accumulated. Based on my field experience with the Imagenex 881AL-GS, I felt that as long as I was able to locate a target on the sonar I could navigate to that target regardless of what the ROV might be doing.

Overall I was very impressed with the performance of the Imagenex model 881AL-GS. Construction was excellent. Installation of the software and integration of the hardware into our ROV's system were both easy and straightforward. Using the 881AL-GS was equally straightforward and the included software provided all the features and information I needed. But what made the 881AL-GS really stand out was its gyro-stabilization. With gyro-stabilization, scanning sonar becomes a very effective tool with a number of key benefits, including: sonar targets are more easily identified; the ROV doesn't need to stop to stabilize the sonar image, thus transit time to a target is reduced; and bottom terrain and obstacles are more clearly defined and thus more easily avoided.

These benefits make the Imagenex GS family of gyro stabilized sonars ideal for any application where a scanning sonar is required, but would be especially suited to search and recovery (SAR) and operation in limited visibility.

Paul Unterweiser

Paul Unterweiser is a retired U.S. Navy officer, USCG licensed master, ROV pilot and, for the last 10 years, president of Marine Simulation, a software company located in North Carolina specializing in developing training simulators for ROV pilot schools and other marine industry applications.

Deep Ocean

Meet the Phantom T5 Defender

Homeland security, law enforcement, military and search and rescue organizations in every region of the United States recently attended demonstrations of the Deep Ocean Engineering Phantom T5 Defender underwater drone in various locations around the country.

This specially-equipped remotely operated vehicle (ROV) was developed in collaboration with Greensea Systems, Tecnadyne, Tritech and Nortek, specifically to provide security organizations with a new technology solution that enhances their ability to accomplish their missions, while at the same time, minimizing risk to personnel.

The Phantom T5 Defender is portable and deployable by two people. It can run on standard 110v or 220v power sources, and can reach a speed of 3 knots submerged. It is equipped with a 12 gauge "shotgun" explosive ordinance disposal (EOD) device that fires its disrupter at point-blank range to disable a potential threat.

The underwater drone has been under development for 18 months, tested in real-life situations by dive teams and marine units of federal, state and local law enforcement agencies, military bomb teams, search and rescue agencies and homeland security tactical units.

Utilizing the fully integrated Greensea system, the Phantom T5 Defender is piloted either manually with joysticks or automatically using waypoints that allow the drone to execute a preplanned mission. The drones' five Tecnadyne thrusters work in conjunction with a Tritech multi-beam sonar to easily identify and lock onto targets. With the Greensea system, once the target is identified, a pilot can click on the sonar to engage target-relative positioning of the drone, add hazard or "keep out" zones, automatically orbit the target, station keep on the target, while in current, and reacquire the target. In addition, video and sonar activities are fully integrated into one screen with the vehicle's navigation information. All vehicle information is georeferenced and recorded for further review at any time.

The Nortek DVL and Tritech Micron INS are fully integrated into the Greensea system and provide crucial information about the vehicle's position subsea. Using this information, the Phantom T5 Defender can perform the advanced vehicle control features described above. In fact, this combination of technologies allows the pilot operating the topside laptop to move the drone with a click of the mouse in increments as precise as 10cm. Deep Ocean Engineering offers a standard single-function manipulator on the Phantom T5 Defender, however, as an option, can be equipped with multi-function arms based on the needs of the end-user. The flexibility of the system allows interchangeability of cameras and lights, if the end-user requires it.

Most recently, the Phantom T5 Defender participated in a week-long series of tests conducted by independent homeland security evaluators at an undisclosed location. The tests were conducted in open water and in water tank environments, to evaluate performance in meeting specific criteria. The Phantom T5 Defender performed flawlessly, and in several cases, exceeded expectations.

Phantom T5 Specs:

Length: ..... 35"
Width: ..... 21.5"
Height: ..... 22.625"
Weight in air: ..... 150 lbs
Weight in water: ..... Trimmed to be neutral/slightly positive
Operational Depth: ... 300m (Note: Disruptor undergoing further depth tests. Reliably initiated at depths per the requirements of the application)
Operational Current: ..... 3 knots
Navigation Sensors: ..... Greensea INS with integrated compass and depth, Nortek DVL
Sonar: ..... Tritech Gemini 720is multibeam sonar
Cameras: .... Full HD 1080i camera, multi-camera option
Umbilical: ..... Falmat fiber optic
Power Supply: 85-265 VAC Single phase, Universal Power Supply, Any standard power source; primary power demands max 30 amps, auxiliary power expandable to user requirements
Manipulator: ..... Single function manipulator (grabber) with cutter blade

Stevens

Fugro Geoservices

Hughes

James Fisher

Gandhi

Unique Group

EdgeTech Bolsters Customer Support Team

EdgeTech promoted Dylan Lynch to Customer Service Manager. Lynch has worked with EdgeTech for over seven years, having traveled the globe supporting customers with hands-on experience working with various customer configurations from towed side scan sonars and sub-bottom profilers to AUV and ROV-based sonar systems offered by EdgeTech. He holds an Ocean Engineering degree. Adam Lipper has joined EdgeTech as a Customer Service Engineer. Lipper has more than 10 years in the industry with countless offshore trips helping customers with acoustic communication and related underwater equipment.

Fugro Geoservices Names Stevens MD

Ross Stevens has been appointed managing director of Fugro GeoServices Ltd. He is a chartered civil engineer who joined Fugro Seacore in 2007 after a decade in project management and civil contracting. In 2012, he was appointed deputy MD of Fugro Engineers BV based in the Netherlands. He returned to Fugro Seacore as a director in 2015, ahead of its integration in October 2015 as part of Fugro GeoServices Ltd. Stevens takes the reins from Marcus Rampley who has steered Fugro GeoServices through its integration of U.K.-based Fugro specialists, marking a 37-year career in geotechnics.

James Fisher Acquires Hughes

James Fisher and Sons plc has acquired specialist diving, subsea and marine project company Hughes Sub Surface Engineering Ltd (Hughes SSE), further enhancing James Fisher's subsea activities and, through the combination of complementary capabilities, creating a comprehensive portfolio of services focused in the oil and gas, marine renewables, power generation and marine civil engineering sectors.

Unique Acquires Oceanvision

Unique Group, through its subsidiary Unique Maritime Group (SEA) PTE Ltd, has acquired Singapore's Oceanvision PTE Ltd and Oceanvision Equipment Services PTE Ltd., marking the third acquisition Unique has made in the last nine months. One year ago the founder, chairman and CEO of Unique Group, Harry Gandhi, outlined his plan to grow his business, and this latest acquisition is a further execution of that growth strategy. Now part of the Unique Group of Companies, Oceanvision Pte Ltd manufactures and supplies imaging and intervention products for sub-ocean, marine, offshore and petrochemical industries.

SBM Offshore Nominates Wood as CFO

SBM Offshore has nominated D.H.M. Wood as a member of the management board and CFO to replace current CFO, P.M. van Rossum, who is set to retire. Wood will join the company October 1, 2016.

Scantrol Deep Vision Wins Nor-Fishing Innovation Award

Scantol's Deep Vision underwater camera and light system for fish measurement and sorting in the trawl has been awarded Nor-Fishing's Innovation Award. Minister of Fisheries Per Sandberg handed over the award at the official opening at Nor-Fishing. Currently used for research, the system can measured is being developed for use in commercial trawl fisheries where the skipper will be able to program the system to automatically sort for size and species of desired catch.

Survey Launched for Hawaiki Cable System

A marine route survey was launched on August 4, marking a significant stage in the deployment of the 14,000 km transpacific Hawaiki cable system scheduled for completion in mid-2018. Hawaiki will link Australia and New Zealand to the mainland U.S., as well as Hawaii, with options to expand to several

ROVOP

During a recent visit, SoS Greg Clark meets Steven Gray, ROVOP CEO; Callum Lamont, ROVOP's Graduate Trainee; and Douglas Young, ROVOP's Apprentice

South Pacific islands. The Route survey, launched by Hawaiki Submarine Cable LP and TE SubCom, follows the commencement of a supply contract in March and a survey of landing sites from May to July 2016.

ROVOP Sees Success

ROVOP won contracts worth more than $4 million spanning oil and gas and offshore wind projects in the North Sea, Gulf of Mexico, W. Africa and Europe with several new clients and include construction support, cable lay and protection, survey and inspection repair and maintenance (IRM). CEO of ROVOP, Steven Gray, said, "As a result of these awards, we are increasing our offshore workforce across both Aberdeen and Houston. It's clear that the market remains challenging, however ROVOP continues to win work by focusing on saving cost for our customer. The continued prolonged market downturn has been significant. However, this downturn will undoubtedly create opportunity for those companies who address the current challenges and adapt to the new market environment. This flexible approach, along with looking to increase cost efficiencies to clients should ensure we continue to be well positioned in our target markets going forward."

Med Excursion for Applied Acoustics' Deep Tow Sparker

The Applied Acoustics deep-tow sparker DTS-500 has recently been deployed in the Mediterranean Sea, off the continental slope of Majorca, working on a project with SOCIB, the Balearic Islands Coastal Observing and Forcasting body. Assisted by SOCIB's Oceanographic Instrumentation Technician, Carlos Castilla Álvarez, the DTS-500 was deployed in deep water, up to 500m, at a distance up to 1km from the SOCIB research vessel. The complete system consists of a rack mount surface console, cable and robust towfish, and easily interfaces with standard data-loggers.

SeaRobotics Delivers USV

SeaRobotics has delivered an autonomous 2.5 meter USV to the Center for Marine Science and Technology at NC State University. Funded by an award from the National Science Foundation's Marine Lab Facilities Program, the USV 2.5 is equipped with a suite of scientific instrumentation and will be utilized as an experiential-based teaching tool and to conduct basic and applied research in lake, river, estuary and costal environments. Equipped with side-scanning and bathymetric sonars, a high-frequency sub-bottom seismic system, a RoweTech SeaPROFILER acoustic Doppler current profiler and sensors that record the temperature and conductivity of the waters being surveyed. The USV was delivered with a fully integrated Edgetech 6205 multi-beam echo-sounder, motion reference unit, dual antenna RTK GPS, sound velocity probe and HYPACK software.

ESS Doubles Scope of Wikinger Offshore Work

Ecosse Subsea Systems (ESS) was awarded a contract last year by main contractor Prysmian Group to carry out pre-cut seabed trenching, prior to cable laying, on Iberdrola's 70-turbine wind farm offshore Germany. The initial contract has now doubled in scope with the award of route clearance and seabed preparation work on the 350MW Wikinger development. ESS's SCAR Seabed System will perform first pass and multi-pass trenching in preparation for Prysmian's installation and burial of 81km of submarine cables which will connect the turbines to the offshore substation.

Multiple Corer for Taiwan

Ocean Scientific International Ltd (OSIL) has built and equipped a 12 station Multi Corer system for use by the

National Taiwan Ocean University (NTOU).

The hydrostatically damped Multi Corer is capable of collecting up to 12 undisturbed 600mm long samples (including the overlying supernatant water). The corer is constructed from stainless steel and features detachable core assemblies, which enables the core tubes (or if necessary the entire core tube assembly) to be detached from the corer for analysis or storage.

Fugro Collects Metocean Data for Hess Ghana

Fugro has completed a 33-month period of metocean data acquisition for Hess Ghana Exploration Limited. Measurements were made at three locations in an area offshore western Ghana known as the Deepwater Tano/Cape Three Points block, in water depths of approximately 2,400 meters. The data are to be used by Hess in support of its operations in Ghana.

Wave Gliders Delivered to the Japan Coast Guard

Liquid Robotics and its Japanese partner, Hydro Systems Development (HSD), have delivered a fleet of eight Wave Gliders to the Japan Coast Guard for providing autonomous observation and situational awareness of ocean currents, wave activity and weather along Japan's coastlines. According to Liquid Robotics, this is the first ocean observation network in Japan's history that will provide comprehensive and economical monitoring of Japan's ocean conditions.

Return to HMS Hampshire

U.K. warship HMS Hampshire sunk in 1916 after hitting a mine off the Orkney Isles. Now 100 years later, a Saab Seaeye Falcon ROV operated by Roving Eye Enterprises went down to survey the wreckage. Although there have been two previous surveys of the ship, this is the first extensive mapping of the wreck site since it sank. Sandra Henry, a marine archaeologist from the Islands Archaeology, said that the remote survey has provided many new insights into the sinking and wreck, adding that ongoing work will continue to develop the knowledge base, revealing new information as they continue to gather and process data.

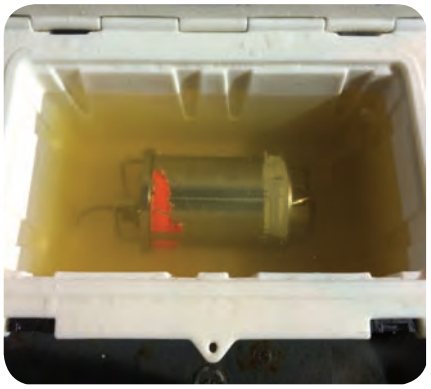
Thales to Take Role in 'Exercise Unmanned Warrior'

Thales is set to play a key role in Exercise Unmanned Warrior, a U.K. Royal Navy exercise in October that will bring together 40 organizations from defense, industry and academia, as well as more than 50 vehicles, sensors and systems from across defense and industry, to gauge how unmanned systems might add operational capability in a military maritime environment.

Thales will showcase its capability through the Watchkeeper Unmanned Aircraft System, Halcyon Unmanned Surface Vehicle and its collaborative work in the field of unmanned command and control research.

Unique Group Sells Two Dive-ROV Systems

Unique Group's Diving & Life Support team has received orders for two of its HYRDA ABS Nitrox Surface Dive-ROV Systems from its client in Nigeria. The systems sold each comprise a Dive-ROV control and chamber container, machinery container, air and nitrox 10ft HP gas storage containers, two single basket LARS and a SRP boat. The systems will be ABS Classed and compliant with the latest IMCA, OGP and ExxonMobil requirements. The systems will be delivered by the end of October 2016.



El Faro voyage data recorder in fresh water on the USNS Apache.

Phoenix Assists in Recovering El Faro's VDR

Phoenix International Holdings, Inc., under the operational direction of the U.S. Navy's Office of the Supervisor of Salvage and Diving (SUPSALV), recovered the voyage data recorder (VDR) from the sunken cargo vessel El Faro. Working aboard USNS Apache (T-ATF 172), Phoenix operated the U.S. Navy's Remotely Operated Vehicle (ROV) CURV-21during a single 13 hour dive to identify and recover the VDR from a water depth of 15,000 feet. Following the recovery, the VDR was transferred to National Transportation and Safety Board (NTSB) investigators onboard USNS Apache.

El Faro went missing on October 1, 2015 while operating in the midst of Hurricane Joaquin near Crooked Island in the Bahamas. In late October 2015, Phoenix, under the direction of SUPSALV, located the sunken ship using the U.S. Navy's deepwater side scan sonar search system Orion. The Phoenix team then launched CURV-21 to verify and visually inspect the wreckage.

www.phnx-international.com

Custom ROV Solutions for Stinger Technology

Stinger Technology AS has taken delivery of a custom Seaeye Falcon ROV to be used under a contract from Dong Energy for environmental sampling and inspection inside the oil storage tank of the Siri offshore platform, located in the North Sea about 220 kilometers off the Danish coast. The storage tank measures 50 x 66 meters and is 17.5 meters high, with a designed storage volume of 50,000 cubic meters. It is split internally into 16 compartments, some of which are only accessible through a 10-inch jumper pipe. Therefore, Stinger has opted to use the Seaeye Falcon ROV to carry a VideoRay vehicle small enough to enter the tank's compartments. A tether management system (TMS) has been mounted under the Falcon for carrying the VideoRay umbilical. The Falcon's add-ons include additional power and electric motor for driving the TMS. MacArtney supplied an extensive spare parts package, FAT and a technical training course.

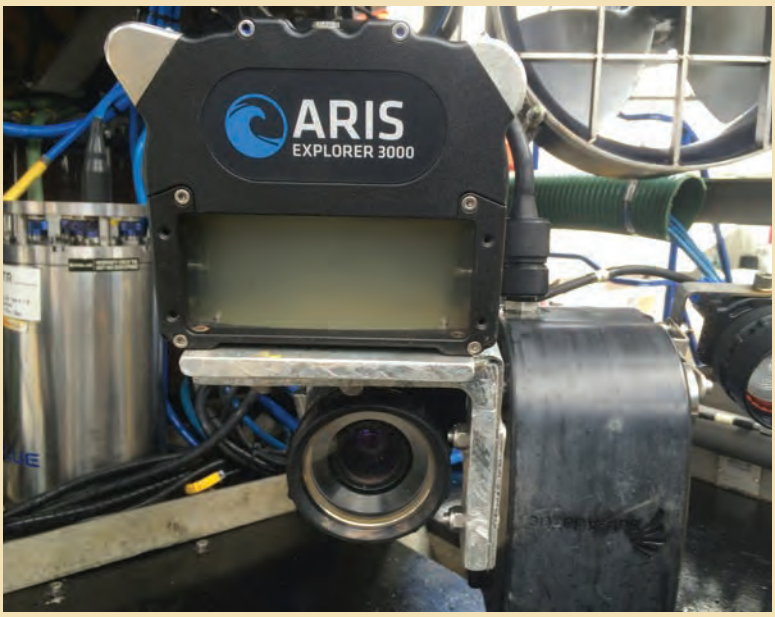
www.macartney.com

MacArtney

ARIS Explorer Aids UXO Identification Mission

Sound Metrics has supplied an ARIS Explorer 3000 to help identify unexploded ordnances (UXO) along the coastline of the North Sea. The sonar's clarity and high-resolution imaging in zero-visibility waters offered the detail critical to identifying the UXO, and the team successfully gathered information on the target's dimensions, characteristics and location, found to be consistent with a highly explosive German LMB Ground Mine. Due to the successful identification of the target, the team could effectually evaluate risk and carry out a plan of action to protect seafarers.

www.soundmetrics.com



Sound Metrics

Ocean Sensor Systems

New Sonic Wave Sensor RV

The Sonic Wave Sensor RV from Ocean Sensor Systems, Inc. can measure fast submillimeter to large waves in polluted, fresh, salt, soapy, oily or muddy waters. The wave sensor combines an ultrasonic sensor circuit, low power microprocessor and anti-aliasing filter in an IP67 resistant to water submersion package. Available in three versions with different signal outputs, it can be powered with any voltage from 4.5 volts to 45 volts.

www.oceansensorsystems.com

Rockland: MicroCTD Estuarine Turbulence Profiler

Rockland Scientific releasd the MicroCTD Estuarine Turbulence Profiler, designed in consultation with estuarine physicists for turbulence measurements in the unique operating environments of tidally influenced shallow waters. The profiler is shortened in length so that it can be easily handled on small vessels, e.g. Zodiac, while maximizing the profiling range in the water column. The MicroCTD uses the same microstructure sensor suite as the conventional VMP series of profilers. This includes velocity shear, fast-response thermistor and micro conductivity probes as well as a standard oceanographic reference conductivity-temperature sensor (JFE Advantech). Optional compound fluorometer/optical backscatter and fast-response optical DO sensors are available. Pre-production testing of the MicroCTD included an experiment, led by the University of Florida Gainesville Civil & Coastal Engineering Department, in which the profiler was used to examine flood-to-ebb asymmetry of mixing in two Florida estuaries with contrasting stratification. In total, 420 full-water column profiles were acquired with the MicroCTD, with a majority of the measurements reaching the bottom boundary layer.

www.rocklandscientific.com

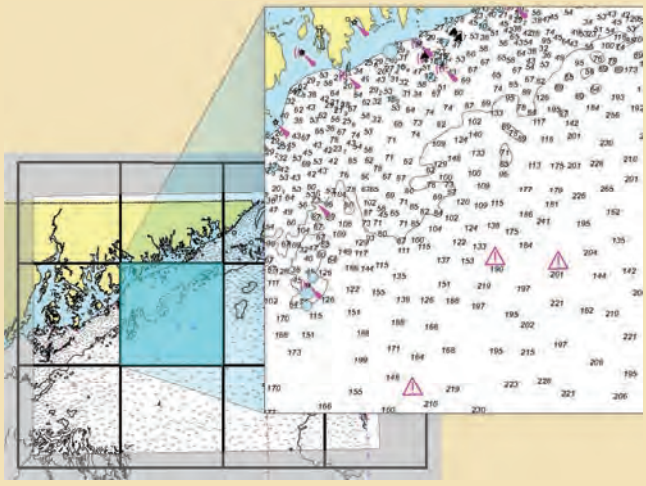
Rockland Scientific

Tidal Observation Solution

Valeport's tidal observation solution TideStation offers pressure, radar and hybrid tidal observation techniques coupled with interfaces to other meteorological, telemetry and third party systems. The unit includes all infrastructure required to maintain power to the tide and meteorological equipment and communications system within. Data from water level equipment is recorded locally and broadcast to a chosen command and control point. This can be enhanced with the addition of Port-Log.net from Oceanwise. Internal battery power is provided along with options to do this externally via solar panels or ac mains.

www.valeport.co.uk

Valeport



Teledyne CARIS

Teledyne CARIS Updates HPD

As part of the CARIS Ping-to-Chart solution, Teledyne CARIS has released its Hydrographic Production Database (HPD) 3.2, which offers an integrated suite of products for managing data in a seamless database, providing simultaneous data compilation by multiple users. New features allow users to implement new workflows and leverage an expanded the range of products that can be generated.

www.caris.com

Valeport Debuts rapidCTD Automated Profiler

Designed initially to operate autonomously with the Teledyne OceanScience rapidCAST automated underway profiling system, Valeport's new rapidCTD profiler with Bluetooth technology is targeted at the shallow water survey market as an evolution of the Valeport fastCTD and rapidSV that makes underway profiling work faster and more efficient. The profiler includes a conductivity cell designed for optimum flow-through, a fast responsive thermistor sensor and a 0.01 percent accuracy pressure sensor, synchronously sampling at up to 32Hz. Valeport said the rapidCTD will include an optional Fluorometer sensor and an enhanced, rechargeable battery later this year.

www.valeport.co.ukx

Valeport

Buoy System Based on Campbell Scientific Dataloggers

Construction upgrades at Costa Rica's port of Limon required monitoring of sea-surface meteorology, including wind speed and direction, air temperature, barometric pressure, humidity, water column currents, sea-surface temperature and turbidity. Contractor RDSEA designed a buoy system using a Campbell Scientific CR6 datalogger and sensors that included a Campbell OBS501 turbidity probe and a Teledyne ADCP. The buoy was deployed in March 2016 and immediately began transmitting wet-data daily via Campbell's LoggerLink app on the project lead's smart phone until the initial phase of the monitoring project was completed.

www.campbellsci.com

Campbell Scientific

AutoNaut

Autonomous Boat Monitors Ocean Noise

Plymouth University Marine Institute scientists are working with AutoNaut and its nearly silent 5m wave-propelled USV, which tows a Seiche Ltd passive acoustic monitoring array, on a project studying how increasing levels of manmade noise in the sea is affecting marine life. Two days of initial trials of the autonomous concept were completed in July, and PAM data will now undergo a technical analysis.

www.autonautusv.com

New ROTV System to Aid German Naval Research

WehrTechnische Dienststelle (WTD 71) has acquired a MacArtney FOCUS 2 ROTV system installed with Raytheon ProSAS for testing SAS sonar technologies for German Navy mine detection.The FOCUS 2 has a number of off-the-shelf products, including MacArtney LUXUS compact low light cameras, ORE Trackpoint 3 USBL transponder, Valeport MiniSVS sound velocity sensor and Imaginex FL forward looking sonar. Additionally, the FOCUS system has been prepared for installation of Raytheon ProSAS synthetic aperture sonar, Reson multibeam sonar and Kearfott INS, and a special interface has been developed for integration of a range of WTD 71 developed sensors.

www.macartney.com

MacArtney

CTG Algae Monitoring System for United Utilities

United Utilities has chosen the Chelsea Technologies Group ALGAE-Wader Pro and ALGAE-Station Pro systems to aid real time assessment of algae levels in their water sources feeding into a number of Water Treatment Works. The CTG Algae monitoring systems were chosen after an extended trial period which demonstrated the use of the TriLux fluorometer, from which these systems are based, in detecting chl-a, Phycocyanin and Phycoerythrin levels.

www.chelsea.co.uk

CTG

Dr. Cathy Rushworth with the CTG ALGAE-Wader Pro.

Novacavi

Novacavi Hybrid Cable Passes Pressure Test

Specialist cable manufacturer Novacavi reports that its 22XM413 custom transmission data and power hybrid cable has passed endurance tests for hydrostatic longitudinal water tightness. The cable test was performed in Novacavi facilities for two hours at water pressure of more than 2 bars, and saw no leakage and no slippage of cores.

www.novacavi.it

Monterey's Breakwater Cove
(Photo: City of Monterey)

Oceans 2016

What: Oceans 2016
When: Sept. 19-23, 2016
Where: Monterey, Calif.
www.oceans16mtsieeemonterey.org

Each year the Marine Technology Society and the IEEE Oceanic Engineering Society cosponsor a joint annual conference and exhibition that focuses on advances in marine science, engineering, technology and policy. This year's running, Oceans 2016, is set to take place September 19-23, 2016 in Monterey, Calif. at the Portola Plaza Hotel and the Monterey Marriott, with plenary sessions at the Golden State Theatre.

According to its organizers, the annual event typically draws some 2,000 attendees from industry, academia and government; more than 500 professionally reviewed technical papers and 130-plus exhibitors showcasing some of the latest products, services and technological advancements; as well as a wide spectrum of plenary sessions, tutorials, workshops, demonstrations, professional field trips, networking opportunities and more.

Soundnine

Soundnine Inc. (S9), manufacturer of inductive modems, sensors with inductive telemetry and real-time data buoys will display its new Ulti-Buoy turnkey real-time T-chain buoy system at Oceans 2016 in Monterey.

Ulti-Buoy delivers high accuracy temperature profiles in real time for long maintenance-free deployments. Economical and easy to use, Ulti-Buoys transmit data via cellular or Iridium telemetry. S9's cloud-based data server delivers data directly to the users' desktop or smart phone.

Ulti-Buoy consists of a small robust spar buoy with solar powered buoy controller, cellular or Iridium modem, GPS, mooring wire and XTP Temperature, Pressure (optional) and tilt sensors. The XTP sensors sample simultaneously at programmed intervals and transmit their data to the Ulti-Buoy controller via inductive telemetry.

Just deploy the buoy and view data within minutes. It's that easy.

Ulti-Buoy is typically delivered preprogrammed with telemetry and data service activated. Free software provides access to your raw data, data parsing control, automatic customized report creation and forwarding, and a communication link with cellular connected buoys. The cloud data service is included free for three years. Cellular or Iridium telemetry service can also be provided by Soundnine, creating a total single-source solution.

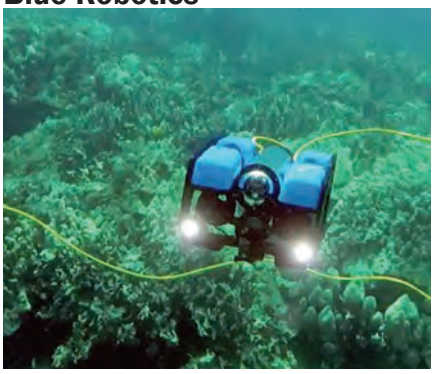
Booth: 603 (Monterey Marriott)
www.soundnine.com

Blue Robotics

Blue Robotics Inc. in Torrance, Calif. has developed a line of marine robotics products including thrusters, sensors,

Soundnine

Blue Robotics



EdgeTech

lights and enclosures targeted towards commercial, research and hobbyist applications. Its recently released BlueROV2 brings these products together into one of the most affordable and capable subsea vehicles on the market. Featuring six thrusters in a vectored configuration, HD video streaming, a 100m depth rating, and open-source software and hardware, the BlueROV2 is suited for inspection, research, aquaculture and many more applications. More than 100 units have been sold in the first two months since release. In the coming months, Blue Robotics will release a number of accessories, sensors and features for the BlueROV2 in a continued effort to make it the most capable vehicle on the market.

Booth: 604 (Monterey Marriott)
www.bluerobotics.com

EdgeTech

EdgeTech is celebrating "50 Years in Underwater Technology" this year, and the company will be exhibiting many of its well-known products and solutions at Oceans 2016. The company is known worldwide for its high quality products which include side scan sonars, sub-bottom profilers, bathymetry systems, AUV, USV and ROV-based sonar systems, combined and customized solutions. In addition to the full line of underwater survey products, EdgeTech provides reliable USBL systems, transponder beacons, deep sea acoustic releases, shallow water and long life acoustic releases and customized underwater acoustic command and control systems.

Booth: 41 (Portola Plaza)
www.edgetech.com

Schmidt Ocean Institute

On August 15, 2016 Schmidt Ocean Institute completed its sea trials in Guam, testing its new ROV SuBastian, which is designed to go to depths of 4,500m and will be used by scientists to investigate the ocean, deploying and recovering equipment as well as conducting photomosaicing, sample collection, seafloor mapping and seawater characterization. The ROV weighs 6,500 lbs. and has two 4K ultra-high definition pan-zoom-tilt cameras designed for performing scientific video acquisition, which will get live-streamed via YouTube. The ultimate goal is to provide critical data that is open-sourced and free to the public. Schmidt Ocean Institute plans to return to Guam in November with research vessel Falkor and ROV SuBastian for a one week science verification cruise led by a team of expert biologists and geologists. The verification cruise will be followed by the first research cruise with the ROV. This expedition will return to the Mariana Back-Arc with SuBastian to collect samples and investigate geologic activity on hydrothermal vents that the institute discovered last year.

Booth: 605 (Monterey Marriott)
www.schmidtocean.org

Seafloor Systems

Seafloor Systems, Incorporated, a provider of specialized survey equipment to the Hydrographic and Geophysical Survey community, will conduct live demonstrations of its EchoBoat-ASV with integrated multibeam echosounder during the Oceans '16 Exhibition.

The customizable, portable, autonomous and remotely controlled EchoBoat-ASV survey vehicle will be integrated with a NORBIT iWBMBc—Compact Widebeam Multibeam Sonar, with integrated INS/GNSS and real-time sound velocity probe.

Seafloor's EchoBoat-ASV includes the proprietary AutoNav, an auto pilot module which allows the user to preplan survey waypoints, upload via RF to the vehicle and have it automatically carry out the mission without user input. The system also provides the ability to manually override auto pilot mode as well as a return to base function.

The boat features dual-DC motors for ease of control and redundancy, noncorrosive materials, an integral transducer well and multi-sensor payload capability. It allows the hydrographic surveyor to reliably and effectively tackle multibeam surveys in shallow waters or difficult to reach areas when conventional survey boats are not an option.

Booth: 404 (Monterey Marriott)
www.seafloorsystems.com

Polymer Corporation

Polymer Corporation, based in Rock-

Schmidt Ocean Institute

Seafloor Systems

TE

land, Mass., is a manufacturer of high-performance, difficult-to-produce plastic parts and assemblies for surface, underwater and deep sea use. Its parts are tough, lightweight, don't corrode or rust, and meet a wide variety of mission-specific performance requirements.

Polymer has extensive knowledge of materials for marine use and continues to extend its repertoire of custom-formulated, application-tailored materials. It can machine precision parts quickly in any of these materials. Furthermore, its liquid resin casting process is ideal for many marine applications—thick walls for extreme depth pressures, no-leak windows and sensor zones, design freedom to reduce potential leak paths, low-cost tooling and fast time to first article. Polymer often encapsulates delicate electronics, GPS modules, antennae and other critical components.

Polymer now is leading the way in the use of additive manufacturing, or 3D printing, to advance production possibilities for fully functional plastic parts. No tooling, no long wait, tough parts that perform. It recently produced the propeller shown for an underwater defense propulsion application, going from an engineering part design file to a finished, vehicle-ready part in an hour. The future imagined and delivered.

Booth: 73 (Portola Plaza)
www.polymercorporation.com

TE Connectivity

Exhibiting at SEACON booth, TE Connectivity will showcase many products, including its SEACON 55 dry-mate connector series. These connectors have been developed for a variety of applications, including remotely operated vehicles, umbilicals, underwater cameras and diver communications. The SEACON 55 series benefits from a design incorporating features, such as gold plated contacts with contact band interface technology. The product line also boasts industry standard compatibility and reliable sealing technology.

Booth: 504 (Monterey Marriott)
www.te.com

HYDROSPACE Group

Hydrospace Group specializes in the design and manufacture of engineering systems developed for the harsh environment of subsea, space and terrestrial applications. Hydrospace pressure vessels, windows and lenses for manned and unmanned systems are certified in accordance with ASME Pressure Vessels for Human Occupancy (PVHO) for hyperbaric, subsea and space applications (including subsea instrumentation). Hydrospace electric motor systems increase performance capabilities through our custom designed and manufactured propulsion systems (innerspace thrusters), hydraulic power units (HPU), pump drives, wheel drives and battery systems for underwater vehicles. This includes brushless DC servo motors ranging from 1 to 50 HP with custom control software for analog or networked system instrumentation. In addition, Hydrospace has a wider range of pressure tolerant ICTINEU Li-Po batteries rated to 3,00-6,000m. The Hydrospace line of precision rotary actuators offers electric drive pointing systems for cameras, sonars and instruments.

Booth: 107 (Monterey Marriott)
www.hydrospacegroup.com

Rockland Scientific

Rockland Scientific will introduce the new MicroPod-EM flow sensor, designed for integration on gliders and other autonomous underwater vehicles. The MicroPod-EM works on the principle of electromagnetic induction and measures directly the axial speed of the vehicle, U, through the water.

The axial speed of a glider is an important quantity affecting the flight dynamics of the glider, as well as the accuracy of certain oceanographic observations. For example, accurate knowledge of U is required when converting measurement points from time-domain spacing to spatial-domain spacing. Some sensors, e.g., turbulence shear probes, require U for proper scaling or measured signal. While U can be estimated from hydrodynamic models, a direct measurement of the axial speed is useful and preferred in many applications.

The MicroPod-EM can also be used in laboratory flume settings to measure flow speed independently of the presence of acoustic scatterers, eleminating the need for seeding of the flume installation. The MicroPod-EM is also available as a modular unit integrated in Rockland's MicroRider turbulence payload system.

Booth: 45 (Portola Plaza)
www.rocklandscientific.com

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EvoLogics GmbH
Ackerstrasse 76,
13355 Berlin, Germany

tel.: +49 30 4679 862-0
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sales@evologics.de
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