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EXPLORE

The 2019-2020 collection of Global Underwater Explorers featured diving projects

WRECKS CAVES, AND REEFS

FRANCE
THE HIDDEN RIVER

EGYPT
MYSTERY STEAMSHIP

MEXICO
TIP OF THE ICEBERG

SCAPA FLOW
THE GRAND SCUTTLE

SWEDEN
MARS – STILL MAGNIFICENT

DIVING WITH A PURPOSE
COLLABORATIONS

WANT TO JOIN A PROJECT?
MAKING THE CUT

METHODS & MOTIVATIONS
TEAM DIVING

30+ GUE projects in 15 different countries

GLOBAL Underwater Explorers

PHOTO JESPER KJØLLER

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PROJECT COORDINATOR AMANDA WHITE
EDITING & LAYOUT JESPER KJØLLER

PREFACE

As Global Underwater Explorers (GUE) dives into its 21st year, I am pleased to present our 2020 exploration report, showcasing a broadly diverse selection of GUE's world-wide diving activities. This year's edition not only features articles on our large expeditions but also focuses on a range of smaller projects spanning both cave and ocean environments. Also included are a variety of unique conservation initiatives, as well as the smaller community events that cultivate teams of volunteers and refine the skills that make all these activities possible. The activities featured in these pages are not meant to be exhaustive. They do, however, provide an overview of the breadth of GUE activities and will hopefully inspire you to form your own projects and submit the results to this magazine for publication in next year's edition. Unique to this year's report, we have also included three novel articles designed to help guide existing and future project organizers.

Among the more well-known activities within these pages, you will find the latest updates for several of the world's most elaborate expeditions. These include featured articles on *Mars the Magnificent*, the Mexico Cave Exploration Project (MCEP), the Red Sea Wreck Exploration Project, and the Woodville Karst Plain Project (WKPP). Most of our readers will be aware of these projects but are still likely to enjoy the detailed accounts of the most recent exploits. These endeavors continually establish a new bar with techniques and deliverables that redefine what is possible by coordinated underwater teams. Partly through expanded use of technology and partly through ongoing dedication by high capacity, team-based initiatives, these divers are able to develop highly sophisticated documentation during deep water and/or remote exploration activities. The deliverables from such projects are shared with leading governmental and non-governmental research institutions, universities, and conservation-focused entities.

Signature expeditions are a critical way to refine important tools for underwater discovery but should not overshadow our many other global projects with their new discoveries and their role in expanding our understanding of the obscure world nestled below the earth's watery surface. Some examples from this issue include Battle of The Egadi Islands, Capo Noli, The Grand Scuttle, Battle of The Convoys, Estremenho Karst Massif, Sardinian Caves, and Hidden River. The range of projects showcased in this magazine demonstrates how sustained dedication to building well-trained communities that are committed to exploration and conservation activities can make nearly anything possible. These articles showcase elaborate documentation of new discoveries, exploration of unique environments, honoring wrecks of historical significance, and success at preserving unique historical data.

Despite our natural attraction to large-scale expeditions or complex projects, we should never lose sight of the critical role played by fun-filled weekend activities. Over time, these activities can grow into important initiatives, which is one of the most exciting aspects of the GUE organization. We see the realization of globally diverse GUE communities developing their own locally relevant initiatives while expanding awareness of and consideration for the unique underwater world. In these pages we see divers rehabilitating reefs, studying marine species, exploring Arctic caves, capturing historically significant war planes, modeling a newly discovered steamship, memorializing Norwegian shipwrecks, and much more. In these many endeavors we see the success of the GUE community-driven model writ large across the full spectrum of important aquatic initiatives. From joy-filled weekend events to large scale expeditions and everything between, GUE is helping redefine the connection between divers and the aquatic realm. We hope you will enjoy the following pages and that they help inspire your own personal diving activities.

Dive safe and have fun!

Jarrod Jablonski
Founder and President
Global Underwater Explorers

GLOBAL Underwater Explorers
DIVE CENTER 2020

FIND YOUR COMMUNITY EVERYWHERE YOU GO

PREMIUM DIVE CENTERS

Deepstop – Schwetzingen, Germany
Dive Centre Bondi – Bondi, NSW, Australia
Duikcentrum de Aalscholvers – Tilburg, Netherlands
Eight Diving – Des Moines, WA, USA
Extreme Exposure – High Springs, FL, USA
Living Oceans – Singapore
Living Oceans Malaysia – Kuala Lumpur, Malaysia
Plongée Nautilus – Quebec City, QC, Canada
Portofino Divers – Portofino, Italy
Qiandaohu Diving Center – Hangzhou, China
Scuba Academie – Vinkeveen, Netherlands
Silent Bubbles – Stockholm, Sweden
Tech Korea – Incheon, South Korea
Zen Dive Co. – Pasadena, CA, US
Zero Gravity – Quintana Roo, Mexico

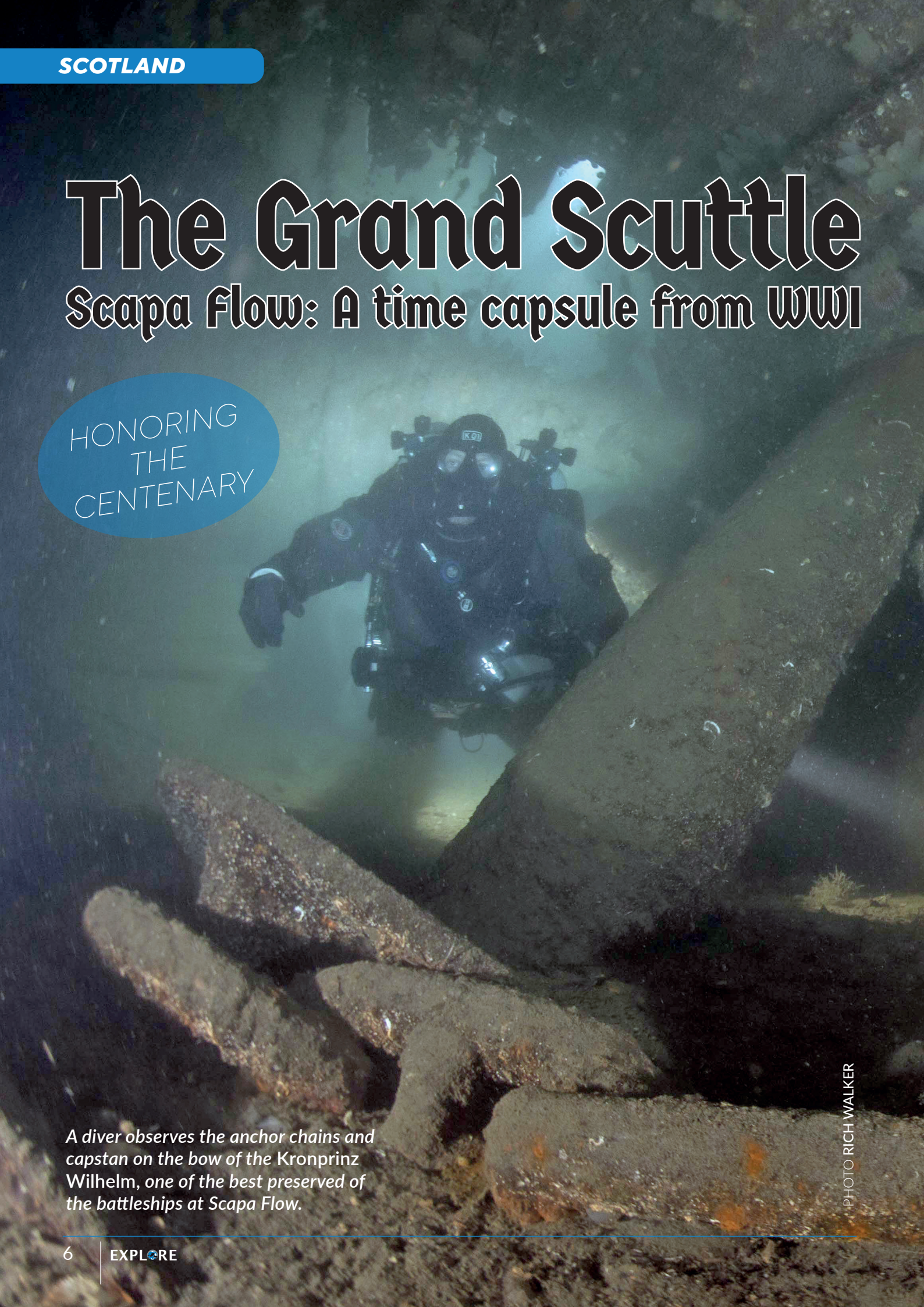
DIVE CENTERS

Acuatic Tulum Dive Center – Tulum, Mexico
Buddy Dive Resort – Bonaire
Dive Alaska – Anchorage, AK, USA
Diveolution – Kessl-Lo, Belgium
Faszination-Tauchsport – Sauerlach, Germany
Freestyle Divers – Fujairah, United Arab Emirates
Hollywood Divers – Los Angeles, CA, USA
Islas Hormigas – Cabo de Palos, Spain
Kasai Village Dive Academy – Cebu, Philippines
KrakenDive – Tossa de Mar, Spain
Krnicadive – Krnica, Croatia
Moby Tek Dive Centre – Pahang, Malaysia
Ocean Blue Wave – Bangkok, Thailand
Red Sea Explorers – Hurghada, Egypt
Scuba Seekers – Dahab, Egypt
Tauchen und Freizeit – Wuppertal, Germany
Tauchservice Münster – Münster, Germany
Tech Asia – Puerto Galera, Philippines
Werner Lau – Sinai Divers Tek – Sharm el Sheikh, Egypt

The Grand Scuttle

Scapa Flow: A time capsule from WWI

HONORING THE CENTENARY



A diver observes the anchor chains and capstan on the bow of the Kronprinz Wilhelm, *one of the best preserved of the battleships at Scapa Flow.*

PHOTO RICH WALKER

TEXT RICH WALKER
PHOTOS KIRILL EGOROV & RICH WALKER

One hundred years ago, in 1919, the German High Seas Fleet sank to the bottom of Scapa Flow. To mark this event, a team of GUE divers visited this historic site and dived the seven remaining warships.

On June 21, 1919, Admiral Ludwig von Reuter of the German Imperial Navy gave an order that led to the sinking of over 50 German warships to the bottom of Scapa Flow in the Orkney Islands, Scotland. But why were these ships in Scotland? After all, the hostilities of World War I had ended on November 11, 1918, when the armistice was signed.

The terms of the armistice required that the entire German High Seas Fleet should surrender to Admiral Beatty of the Royal Navy, whereupon they would be taken to Scapa Flow, the base of the British Grand Fleet. The fate of these ships was to be decided at the Paris Peace Conference in Versailles. The deadline for the decision was June, 21, 1919.

PARAGRAPH ELEVEN

On the morning of June 21, no information on the fate of his fleet had been given to von Reuter. Unbeknownst to him, the deadline for agreement had been extended. In the absence of any information, he made the understandable decision to prevent his ships from falling into the hands of the enemy (the British). His ships had no ammunition and were working on skeleton crews, so he would have been unable to fight. He decided to scuttle all 72 ships. He issued the order "Paragraph Eleven, confirm" to every ship in his fleet, and the scuttling began. Sea cocks were opened and smashed. Flood doors had previously been welded open. Tools to close valves were thrown overboard. By midday, all the ships were on their way to the seabed, and the British could do very little about it. Over the following years, many of the ships have been salvaged, but seven remain fully intact for divers to visit. Other sites, called "scrapyard sites," are there as well, where visitors can still see some of the remains of various parts of the ships.

The seven ships are of two different classes. There are three König class battleships and four light cruisers. The battleships are 175 m/575 ft long and displaced nearly 26,000 tons. The cruisers are smaller at 150 m/500 ft long and displaced 5,600 tons. The battleships lie at a depth of around 40 m/130 ft of water, while the cruisers are slightly shallower at 24-38 m/80-125 ft at the seabed. The wrecks stand high from the seabed, so even on the deeper battleships, a dive can be done at a depth of less than 25 m/80 ft. There are few currents in Scapa Flow, meaning it's possible to dive the wrecks at any state of the tide. Visibility is generally better than 10 m/33 ft, and water temperatures are typically between 8-12 °C/46-54 °F, depending on the time of year.

CENTENARY CELEBRATION

The valuable components from the ships have been salvaged, such as condensers and turbines, but they remain recognizable as fighting ships. The guns, armor, and fittings of these leviathans have remained mostly undisturbed for 100 years. Today they serve as a monument to the sailors who fought and died in the war.

In June 2019, a team of GUE divers from across the globe arrived in Scapa Flow to board the liveaboard dive vessel MV *Halton*. The goal was to mark the centenary of this historic event by diving all of the seven ships, plus some other related sites.

The encrusted bow of the SMS Cöln.

PHOTO RICH WALKER

SMS *CÖLN*

The *Cöln* lies on her starboard side, decks vertical. The main 15 cm/5.9 in. guns have been removed from the bow, but the mountings where they sat remain. The armored control tower still has the remains of a rangefinder attached. This structure would have been used to direct gunfire from the light cruiser while in battle and is a repeating navigation feature.

Cöln is relatively intact, except for the salvage work that was carried out in the engine room area. This makes her easy to navigate and gives an excellent introduction to this class of ship. She lies at a maximum depth of 36 m/120 ft, with the shallowest point being around 20 m/65 ft. As she is on her side, this means an average depth of around 27 m/90 ft is normal on this dive.

SMS *DRESDEN*

The sister ship of the *Cöln*, the *Dresden*, is a very similar dive. She lies on a slight slope, with the bow at 25 m/82 ft and the stern at 38 m/125 ft. She lies on her port side, with the decks again vertical, allowing an average depth of shallower than 30 m/100 ft if the diver is careful.

The control tower is a notable feature, as always, but the rangefinder is not in place. Divers can see into the tower through this port and get some impression of how it would have been to be inside this vital piece of the ship during an engagement.

The deck at the bow of the ship has begun peeling away from the hull, which allows access to the heart of the ship. Divers can follow the anchor capstans and their shafts down into the hull of the ship. The engines that drove these shafts are visible, along with the manual wheels that could be used in the event of a mechanical failure. One can begin to imagine something about life on board these ships.

Toward the stern, the accommodation quarters can be found, and below the super-firing 15 cm/5.9 in. guns, you can see a bathtub, probably from the officer's quarters.

SMS *BRUMMER*

The SMS *Brummer* was again salvaged around the engine room, and much of the rest of the ship remains very intact. She lies between 22-36 m/72-120 ft depth and on her starboard side.

The feature of interest on the *Brummer* is the bridge area. Ships of this type did not have the enclosed, heated bridges that we know today. They were open to the weather with a simple railing around the edge. There may have been a canvas tarpaulin attached to it, but the bridge would not have been a comfortable place to be. This is very visible

PHOTO RICH WALKER

Gearing systems for rotating the 30 cm/12 in. gun turret from the SMS Bayern.

on the *Brummer*, and the criss-cross structure of the bridge supports and the railings are clearly visible. On the seabed a few meters away lies the iris of a signalling lamp. This is 1.5 m/4 ft in diameter and would have had a powerful lamp behind it. The iris would have been opened and closed rapidly for signalling. It is also thought that these lights were used to blind enemy spotters when fighting at night.

SMS *KARLSRUHE*

The SMS *Karlsruhe* rests in shallower water, on her starboard side. She lies at a maximum depth of 25 m/82 ft. She was heavily salvaged, and her shallow depth may well be one of the reasons why. The result of this salvage work is that she is much more broken than the other three light cruisers.

But this broken-up nature gives divers an opportunity to see much more about the construction and layout of these ships. In fact, if divers become familiar with the more intact cruisers, it will help them to "rebuild" the *Karlsruhe* in their mind as they float through her. It will also help them find things on the other ships that might not have been immediately obvious.

SMS *KÖNIG*

The battleships are some of the most dramatic ships sunk in Scapa Flow. Due to the heavy armor and the weight of the guns, these ships turned upside down when they sank. However, a combination of the salvage work and the effects of time means that there is much to see on these wrecks.

The SMS *König* was the first of this class of ship, giving her name to the "König class" battleship. She was of a dreadnaught design, with all of the main guns on a centerline, allowing them all to be brought to bear for a broadside of ten 30 cm/12 in. shells. She was also the lead ship in the line at the Battle of Jutland and represented the "state of the art" of battleship design at the time.

The salvage work saw a large amount of the heavy belt armor removed from the ship, as well as much of the non-ferrous components. This means that she is more broken up than the other ships and can be confusing to navigate. However, this can also be an advantage, as it allows divers better access to some more interesting areas of the ship.

SMS *MARKGRAF*

wwThe SMS *Markgraf* was the third of the König class battleships. She also saw significant action in the Battle of Jutland, being the third ship in the German line. The salvage work on the Markgraf was much more precise than some of the other ships.

The colossal breech of a battleship gun.

She was one of the later ships to be salvaged, probably due to being sunk in deeper water, meaning that the techniques had been better developed by the time the salvors got to her.

She lies in approximately 45 m/150 ft of water. A spectacular feature of the *Markgraf* is the bow. This beautiful, curved, sharp line ascends from the seabed up toward the surface, and one cannot help but imagine this ship slicing through the waves at high speed on her way to battle the Royal Navy.

SMS *KRONPRINZ WILHELM*

The *Kronprinz* is perhaps the best preserved of the battleships at Scapa Flow. She was the fourth ship of the König class and also fought at the Battle of Jutland. The König class battleships had an armament of ten 30 cm/12 in. guns, mounted in five turrets. Two forward turrets, two aft, and one midship turret made the König class a formidable fighting ship. They also carried fourteen 15 cm/6 in. casemate guns, surrounding the central armored citadel.

For most divers, the favorite aspect of this dive is the opportunity to see the 30 cm/12 in. gun turrets at both the bow and the stern. Even though the *Kronprinz* lies upside down, she is on a slight angle, allowing divers to swim under the wooden decks and to look up to see huge gun barrels emerging from the turrets where German sailors would have loaded, aimed, and fired these colossal weapons. The bow guns also have the added feature of the anchor chains. When the *Kronprinz* sank and turned upside down, the bow anchor chain became wrapped around the port side forward gun. It is also possible to swim from the bow to the stern and identify

PHOTO KIRILL EGOROV

> **"THIS IS AN UNUSUAL DIVE, BUT IT HELPS TO EXPLAIN HOW AND WHY BATTLESHIPS INVERT WHEN THEY SINK.**

each of the seven casemate guns that would have surrounded the armored citadel, which gives another aspect to this dive and reinforces the stupendous size of the ship.

BAYERN TURRETS

The SMS *Bayern* was salvaged in 1934, but the four 38 cm/15 in. gun turrets remain inverted on the seabed. This is an unusual dive, but it helps to explain how and why battleships invert when they sink. The guns and armor on these ships are so heavy that when sinking, their tendency is to turn over. Also, the gun turrets are not fixed in place, so while they can rotate to aim their fire, nothing locks them down. When the hull of the SMS *Bayern* was recovered to the surface, the gun turrets simply remained on the seabed. It is now possible to see these incredible pieces of engineering from the lower end of the ammunition elevators, right through to the breeches of the huge 28 cm/15 in. guns.

THE FINAL EVENT

In June 2019, GUE divers visited these wrecks to mark the 100 years since they were scuttled. The team comprised a very wide level of experience, from new Tech 1 divers to experienced GUE Technical instructors. Each evening, they discussed the historical context of the wrecks, the events leading up to the scuttling, and the different yet strangely similar views of the British and German navies about what was effectively the final event of World War I.

NORWAY

TEXT & PHOTO **BELÈN ANDRÈS**

CAVING ABOVE THE ARCTIC

At the end of the Plurdalen Valley in central Norway, a 35 m/115 ft wide river rises out of the ground, and it is here that one can find the jewel of Norwegian cave diving, Plura cave. Just 45 minutes from there is Litjåga cave, smaller and tighter, but with a few turnarounds. These caves, characterized by narrow bands of limestone and marble, are two of the most famous caves in Nordland, a karst area in Norway. Even though both caves have been explored, due to the harsh conditions in them, some parts of the survey are still missing, and very few people visit them every year. Each summer, Plurauka is organized by Norsk Grottedykkerforbund (Norwegian Cave Diving Association), and that is when cave divers and cavers from Scandinavia as well as abroad meet in Plura Valley. During the summer of 2019, GUE Norway and GUE Spain began documenting both caves with the goal of generating a new survey map, including all the side passages on both caves. Along with the effort of documentation, photos, 3D models, and videos were taken. Some effort was also put toward creating a detailed map of sidemount passages and the less-visited areas.

TEAM *GUE Norway & GUE Spain*

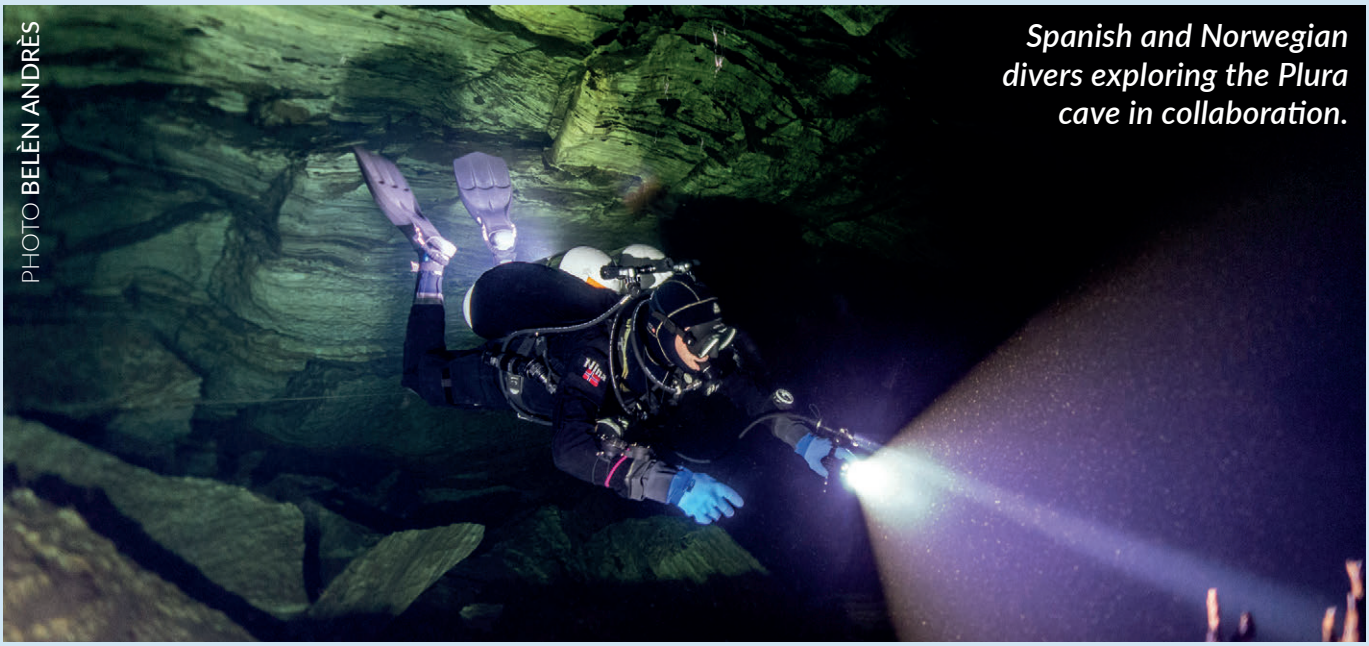


PHOTO **BELÈN ANDRÈS**

Spanish and Norwegian divers exploring the Plura cave in collaboration.

USA

TEXT & PHOTOS **KEES BEEMSTER LEVERENZ**

PB4Y PRIVATEER

In 2018, our local dive community completed a 3D model of a flying boat in Lake Washington called the PBM Mariner. After that success, we decided to try 3D scanning our crown jewel: the wreck of a four-engine U.S. Navy patrol bomber. Our goal was twofold: first, to document the wreck and second, to share it with the diving and non-diving community in Seattle.

Our target was a *PB4Y Privateer* (a variant of the famous B-24 bomber) that crashed in 1956. Fortunately, there were no fatalities, as the plane landed relatively softly. Soon after the crash, the U.S. Navy attempted to salvage the wreck. In the process, they moved and damaged the plane. As a result of the damage incurred during the salvage attempt, the plane was abandoned.

EXQUISITE CONDITION

While the U.S. Navy considers the plane damaged, most divers recognize the wreck as being in exquisite condition. Both wings and the tail are attached, the nose and tail turret are in place, and the airplane's serial number and insignia are still easy to read. The *PB4Y* now lies in 45 m/150 ft of fresh water.

Photogrammetry in Lake Washington is challenging as a result of poor visibility, limited light,

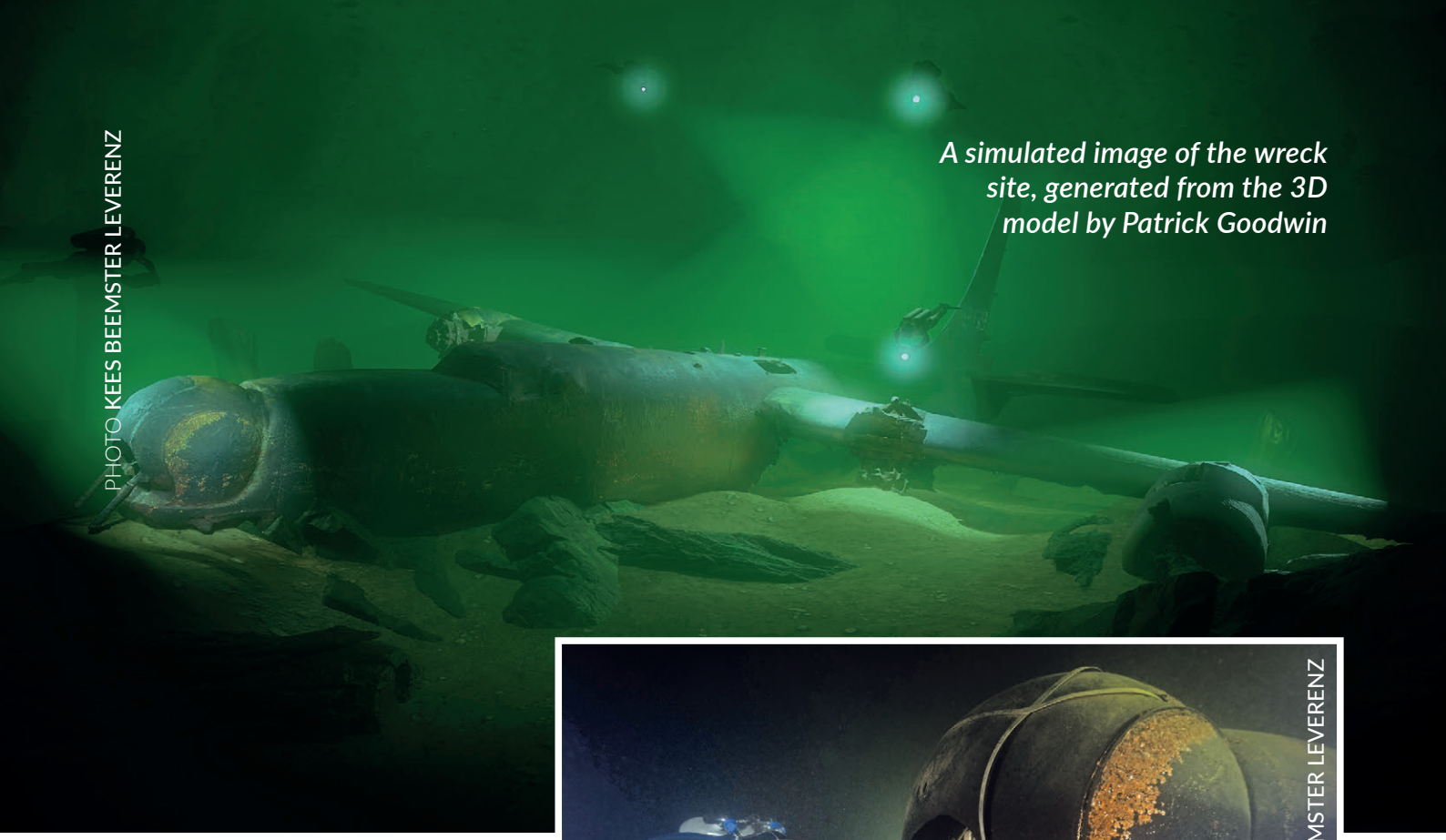


PHOTO KEES BEEMSTER LEVERENZ

A simulated image of the wreck site, generated from the 3D model by Patrick Goodwin

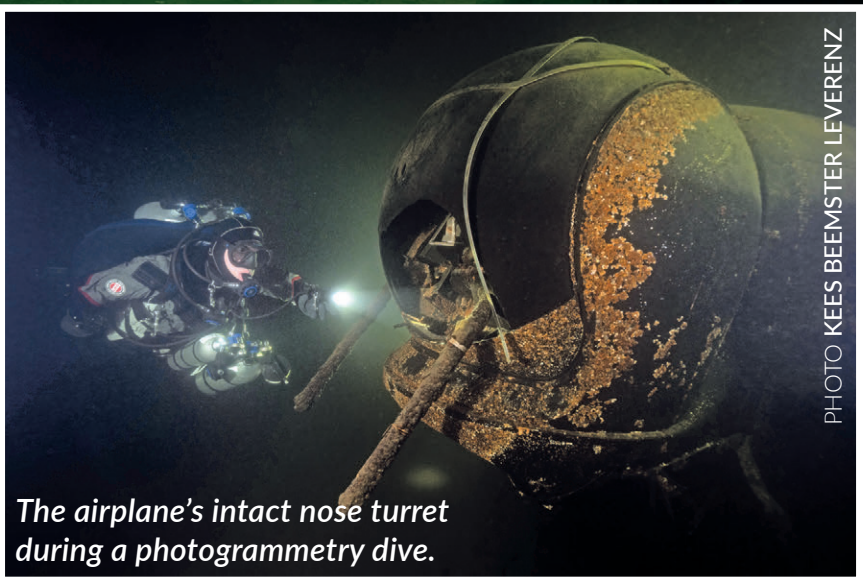


PHOTO KEES BEEMSTER LEVERENZ

The airplane's intact nose turret during a photogrammetry dive.

and significant fine sediment that covers nearly everything. However, since our team had experience with these conditions, we were able to apply our lighting and photography skills to this new wreck. The intact nature of the wreck actually made the project even more challenging. For example, the undersides of the wings needed to be photographed by pointing the camera directly up while swimming horizontally, and 3D photogrammetry relies on a photographer taking photos precisely!

UNLIMITED VISIBILITY

Fortunately, the project went smoothly, and we completed the model over the course of six dives. The plane was broken into five major chunks, each of which was photographed separately and brought together using Agisoft Metashape. Most of the airplane came together on the first attempt, although several particularly complex areas needed to be scanned more than once.

After completing the model, we worked with a 3D artist, Patrick Goodwin, who was able to clean up the model significantly. He also rendered an underwater scene that shows the airplane as if it were in unlimited visibility, a situation that simply does not occur in real life.

This wreck is particularly charismatic, so we garnered some media attention during the process of creating the 3D model and after we published the final product as well. Ultimately, members of the team presented the project at the local science museum, online on DigitalTrends, on New Day Northwest (a local morning show), and on KIRO 7 (evening news). The final piece was particularly meaningful, as we were able to do an interview with John Madden, one of the crew members who was on board when the plane crashed. The data collected is also being forwarded to the Naval History and Heritage Command (NHHC) so they can monitor the condition of the wreck. Overall, the project was a great success both from a documentation and public outreach perspective.

TEAM *Alex Adolfi, Bert Brezicha, Itai Rosenberger, Jay Olsen, Patrick Goodwin, Kees Beemster Leverenz, Mike Bearda & Rebekah Marshall*

ISLAS HORMIGAS

TEXT **RICARDO CONSTANTINO** PHOTO **JANVIER FERRER**

One of the landmarks on Islas Hormigasis the 50 m/170 ft lighthouse built in 1862. Divers can expect to find clear water teaming with marine life.

Islas Hormigas (Island of Ants) is the name of the Marine Reserve created in 1995 in the Spanish province of Murcia. It is the home of abundant kelp prairies and coral bottoms and has been consistently voted as the best diving destination in the Mediterranean. From the coast to the off-shore island, there are six bajos (pinnacles) that form the regulated diving spots within the marine park. They normally start between 6-12 m/20-40 ft depth and drop down to 25-30 m/80-100 ft. Divers can expect to see big groupers, shoals of barracuda, moray eels, and much more, with visibilities that can exceed 30 m/100 ft. Water temperatures vary from 16 °C/60 °F in the winter months to more than 25 °C/77 °F at the end of the summer.

The Calas, or beaches, constitute the breeding ground for the rich sea life, with their extensive kelp prairies. A project conducted by Project Baseline in 2017 created a survey of the rock formations lining one of the Calas (Cala Escalerica), and work is underway to integrate this survey map with stations managed by the Spanish Oceanographic Institute, which monitors the state and health of the kelp prairies.

NON-INTRUSIVE 3D MODELING

In 2019 we started tracking the growth of two large fissures that are breaking apart the *Naranjito* wreck, which lies just outside the border of the marine reserve. We are using non-intrusive 3D modeling techniques to measure and track the growth of the fissures. A temperature logger has also been deployed inside the wreck to gather information for the institute.

2020 will see the start of a large and ongoing project to survey the floor and artifacts of the Bajo de Fuera pinnacle lying on the furthest reaches of the marine reserve. The pinnacle rises up to just below the surface and has been a frequent cause of many notable shipwrecks in the region; the slopes of the pinnacle are covered in artifacts from multiple wrecks. This project will employ traditional survey techniques using MNemo devices, integrated with specialized 3D modeling software (Blender).

PHOTO JANVIER FERRER

DECO RESEARCH

TEXT & PHOTOS SERGIO RHEIN SCHIRATO

GUE divers work together with researchers from DAN Europe and the University of São Paulo at the Y-40 swimming pool in cutting-edge decompression research.

In April 2019, in an event organized by Mario Arena, GUE divers, DAN Europe Foundation's Research Division, and a team of researchers from the University of São Paulo convened at the Y-40 swimming pool in Montegrotto Terme for four days of integrated research and training. The event consisted of two experimental dives with different decompression schedules interspersed with a DAN Instructor Training Course. This format resulted in the instatement of four new DAN instructors at the end of the week.

The event integrated two different research protocols, allowing the research team to maximize the data collected from each experimental dive.

THE RESEARCH

DAN Europe Foundation's Research Division has been studying the association between different dive profiles and post-dive venous gas emboli production by utilizing echocardiographic monitoring for a period of up to two hours after the end of the dive. Researchers from the Laboratory of Theoretical Physiology of the University of São Paulo have been working on the association between heart rate variability and physiological stress related to decompression. The protocols were synchronized in a manner that allowed both teams to work with the volunteers in different time windows in a very efficient way. DAN researchers monitored for venous gas emboli production for two hours, in an interval of 15 minutes beginning at the end of the dive, and in between the measurements, the team from Brazil recorded electrocardiogram data from each volunteer. Pre- and post-dive venous blood samples were also obtained and sent to Brazil for flow cytometry analysis, where different markers of inflammatory and oxidative processes were identified.

HEART RATE VARIABILITY

Electrocardiogram recordings were converted into intervals between two R waves. Each of these was then subdivided into non-overlapping windows of 256 consecutive R-R intervals. Subsequently, different estimators of heart rate variability were obtained from each R-R window. Heart rate variability is usually measured in time domain indicators and in frequency domain indicators, where the measurements estimate the distribution of absolute or relative power into different frequency bands. Alterations in heart rate variability are linked to a huge spectrum of physiological processes and might correlate with different levels of decompression-induced inflammatory and oxidative processes.

TEAM *Mario Arena, Manuela Schoch, Sven Nelles, Peter Gaertner, Sergio Rhein Schirato, DAN Europe research and training team, and University of São Paulo research team*

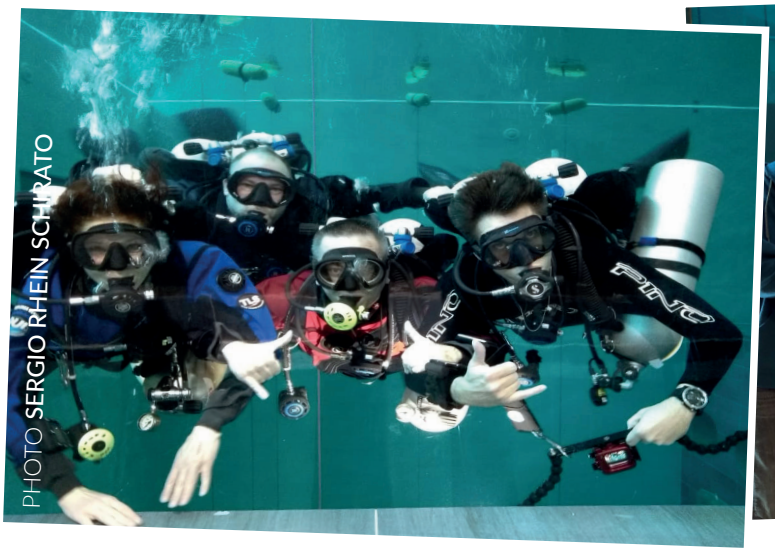


PHOTO SERGIO RHEIN SCHIRATO

PHOTO SERGIO RHEIN SCHIRATO

PROJECT RECOVER

TEXT & PHOTO
KEES BEEMSTER LEVERENZ

In late 2019, my friend Megan Lickliter-Mundon contacted me to discuss a new diving project. Megan and I had worked together in 2018 on the PBM Mariner Project, which aimed to 3D scan a rare airplane that had sunk in Lake Washington for display in the Pima Air Museum. The PBM Mariner Project was a success, so I was excited to hear her plans.

Megan was working and representing Project Recover as their project archaeologist. Project Recover is a long-established organization whose goal is to enlist 21st century science and technology in a quest to find and repatriate Americans missing in action since World War II. The first step in this process is to locate and identify downed American military aircraft, a process they are quite good at.

However, up until 2019, Project Recover had not sent divers to crash sites that couldn't safely be reached with conventional single-tank scuba equipment. My friend Megan had contacted me to ask if I'd be interested in working for Project Recover to assist them in documenting several potential aircraft crash sites in Portugal, Croatia, and Italy. I was delighted to say yes!

I quickly got to preparing, as the project was ambitious: dive, document, and investigate crash sites and potential sites in three countries over the course of three weeks. Our targets lay in depths from 20 m/65 ft to 107 m/350 ft, meaning we'd need both open-circuit gear and rebreather equipment to get to the sites. We'd also bring Project Recover's diver-held side-scan sonar to assist in locating artifacts and camera gear for documentation purposes. Needless to say, we were not traveling light.

SIMILAR PROCEDURES

We planned to use a combination of Project Recover's experienced dive team and GUE divers for recreational-depth dives and GUE rebreather teams on the deep dives. I sent out an email to GUE's Quest mailing list asking if any experienced and qualified GUE divers would be interested in supporting the project. Within 24 hours, I received dozens of replies. These local divers were indispensable in ensuring the team had access to the niche gear required to support deep rebreather diving on an incredibly tight schedule.

As the project progressed, it was fascinating to discover that both organizations had organically developed similar procedures. For example, Project Recover's pre-dive checklist contains nearly all the same items as GUE EDGE (GUE's pre-dive checklist). Of course, this makes sense, as both Project Recover and GUE are both focused on safely supporting complex dives in remote parts of the world.

The team made 13 dives over the course of the three-week project, ranging from 45 minutes to four hours. Visibility varied from well over 30 m/100 ft to effectively zero visibility. However, thanks to the safety procedures put in place, we were able to accomplish our primary goal: stay safe. We also accomplished our secondary goal of investigating all potential crash sites and documenting three known airplane sites with video and 3D photogrammetry.

PHOTO KEES BEEMSTER LEVERENZ

TEAM *Aldo Costigliolo, Charlie Brown, Giulia Napolitano, Kees Beemster Leverenz, Luca Palezza, Marcus Newbold, Maurizio Grbac, Megan Lickliter-Mundon, Mike Raible, Patrick Scannon, & Valerie Thal-Slocum*

If you or your local dive community is aware of (or has discovered) an American aircraft, please consider contacting Project Recover at media@projectrecover.org.

CUEVAS DE ESPAÑA

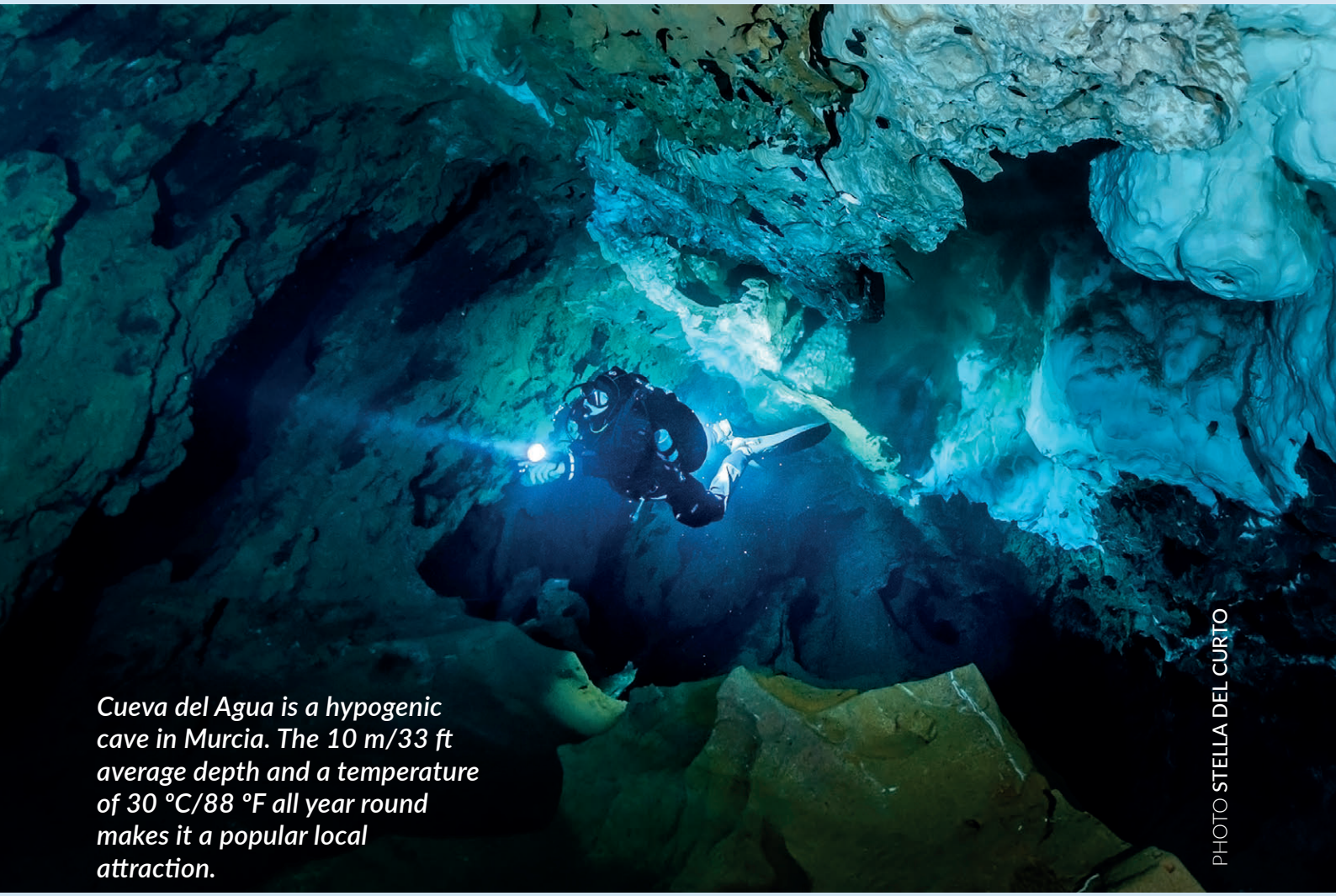
TEXT **RICARDO CONSTANTINO** PHOTO **STELLA DEL CURTO**

This is a two-pronged project targeted to local and visiting cave divers: We want to document key cave locations in Spain through a photographic record, and secondly, we hope to challenge divers to get involved in survey and cartography-based projects. This project is open to all Cave 1 and Cave 2 divers and runs all year long.

In 2019, we started a Project Baseline initiative targeted at the caves in Spain. With this project we would like to record, through photographs, key locations in the most popular caves in Spain and track their changes over time. The objectives are to:

1. Record the environmental changes with divers who are engaged to do so.
2. Help strengthen a conservation culture through concrete, personal actions within the cave diving community.
3. Track and monitor changes to the caves.
4. Build a team and capacity to tackle other data collection programs (3D, temperature).
5. Build a repertoire to engage institutes and universities for further collaboration.

In addition, there is a long-term plan to survey some of these caves. Besides the standard and important uses of the cave maps, this project is also pioneering an open approach to process and data sharing. The survey process guidelines, standards, and all the resulting survey data and tools are already available for all interested divers to consult (and update). The project integrates multiple visiting divers to the caves, exposes these divers to the importance of the survey work, and allows for active holistic project participation spanning diving and data processing.



Cueva del Agua is a hypogenic cave in Murcia. The 10 m/33 ft average depth and a temperature of 30 °C/88 °F all year round makes it a popular local attraction.

PHOTO **STELLA DEL CURTO**

WHAT'S THE PLAN?

TEXT **RUSSELL HUGHES**
PHOTOS **ANDREW D, LOUISE G, XAVIER V, MADDY J, TYLER U, DIVE!TUTUKAKA, JACK A & GDNZ**

Arriving in New Zealand, we needed support in order to develop. I wanted to intern while Louise wanted to get in the water, and immediately we were greeted by members of the community. Gradually, opportunities fell into place—volunteering on some project diving in the Blue Creek resurgence, being introduced to contacts within the dive industry, and progressing our own personal training. As we grew to be a part of this group, it gave us the opportunity to reflect on what could benefit it moving forward.

WHAT DO WE NEED?

It seemed GUE in New Zealand was often affiliated with more advanced technical challenges, but opportunities for non-technical diving had potentially been overlooked. For example, a Fundamentals-trained diver had very few opportunities to be involved in project-focused work (which usually involved overseas travel at a cave or trimix level). In essence, Fundamentals was viewed as a technique class with nowhere further to go.

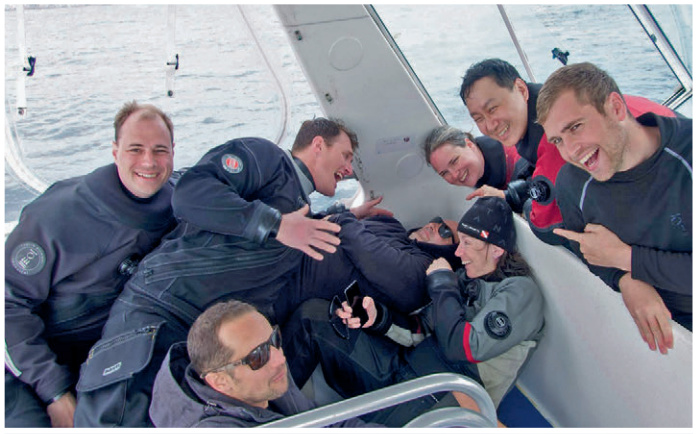
SEARCHING

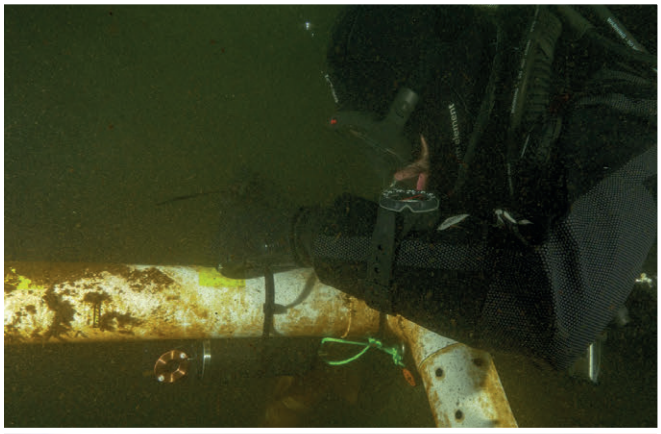
I was mentored to identify critical areas that could be developed, but also cautioned to avoid rushing to build something that was not sustainable. As an example, during survey work in Mexico it was obvious when exploration had started only to find its support, funding, or commitments fail, causing the project to stall.

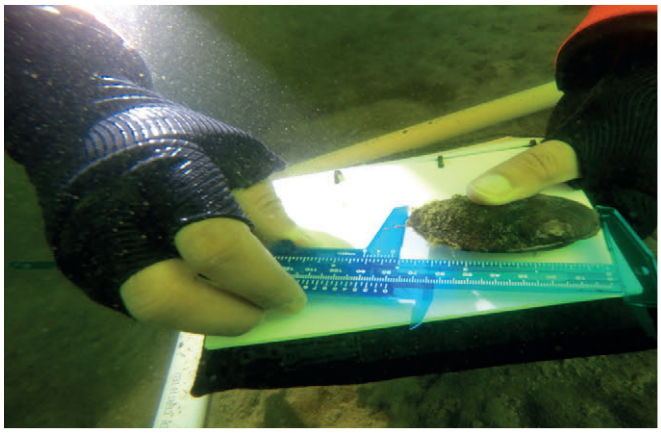
Through discussion and mutual connections, we settled on two core components: the first was community-focused diving events on a monthly basis; the second was an ongoing project initiative domestically which was accessible to Fundamentals-level divers.

DIVE DAYS

The importance of nonprofit in a business-driven space cannot be overlooked. Often, the dive industry culture is to create a trip for profit in order to sustain a business interest. Our approach was to avoid this and build a relationship with a charter operator with whom members could book directly for the events they wished to access, as the operator would be running anyway! Dive Tutukaka had the fleet resources to afford us spaces from two divers to 20-plus. The event is not exclusive, and the only restrictions are no solo or deep air diving.







The events have been running now for four years, and the flexibility of booking and set date structure means divers with busy schedules can forecast their interest. Nobody from the community is making money from the endeavor, so this also helps to create a relaxed environment, and we get to support others in turn.

FUNDIES PROJECTS?

A tougher nut to crack was how to collaborate with a valuable initiative domestically. Project Baseline offered us this pathway, but we needed to connect it with wider interests.

Not everybody wants to help. One very valuable lesson learned here is that when you find someone valuable and committed, don't let them go! We found ours with Ebi Hussain, an Environmental Scientist at Auckland Council. Ebi and his team had a need to collect data, and there was no budget available for diving operations.

Through discussion, we saw that credible data could be collected by skilled volunteer divers, and interested third parties could utilize it if applicable. To date, the project has collaborated with NIWA, the Cawthron Institute, and Auckland Council, all of whom are key players in science and environment here.

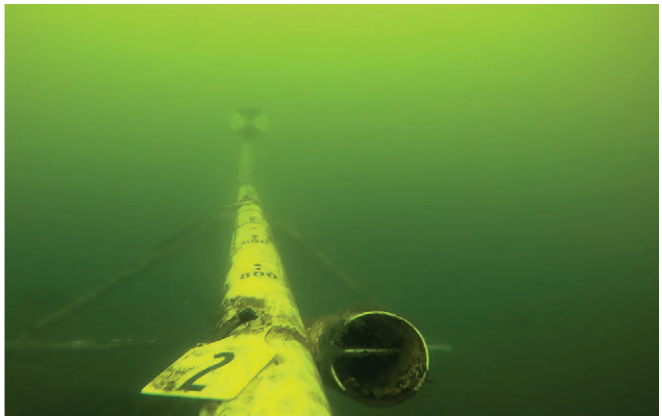
Through the work with Project Baseline Lake Pupuke and Lake Rototoa, this initiative has evolved to be rolled out across all freshwater bodies in the Auckland region—be it sampling, photography, or survey, all can be achieved with a solid Fundamentals skill set.

WHAT DO WE WANT NEXT?

It is great to see that our approach seems to be working; our numbers are growing, activities are becoming more diverse, and teams seem to have more opportunities than ever to explore, collaborate with exciting initiatives, and to interact in important non-diving social activities around the country. Our process is still ongoing, and community organizations seem to be gaining more credibility to assist alongside important environmental work.

One great example here is Ghost Diving NZ, who maintain that their primary recovery teams all have Fundamentals-level training. A consistent supporter of GUE's standardized principles, they continue to go from strength to strength.

Next in the pipeline would be to help develop a few more instructors that can operate throughout different regions of New Zealand and to better evolve links between professional, scientific, or research bodies while creating more exciting outlets for graduates of GUE different programs.



EXTREME ARCHAEOLOGY

MARS – STILL MAGNIFICIENT

TEXT JESPER KJØLLER
PHOTOS JESPER KJØLLER, KIRILL EGOROV,
KEES BEEMSTER LEVERENZ & OCEAN DISCOVERY

The discovery of the Swedish warship Mars Makalös, which sank in 1564, is arguably one of the most important wreck finds in the world. Richard Lundgren's childhood dream resulted in finding Mars in 2011, some 447 years after the sinking. Every year since the discovery, divers and scientists have engaged in a fruitful collaboration to expose Mars' secrets with advanced digital archaeological methods.

July 2019 is a wet, cold, and windy affair on the Swedish Baltic Sea coast. Over a few days, the dive team arrives from many parts of the world. They immediately begin equipment preparation and set up the tent that makes up the *Mars* Expedition headquarters.

Gradually, the diving shed is also ready, the compressor is set up, the diluent cylinders for our JJ-CCR rebreathers are filled with 12/65 trimix, the deco cylinders are labelled, and a charging station for the huge amount of batteries that feeds our lights, cameras, and drysuit heating systems is set up. We are ready for the first *Mars* dive of the year, but the weather forecast is not promising. The normal daily rhythm—an early morning dive and an afternoon spent preparing for the next day—is disrupted by the weather gods. Consequently, we adopt a mindset of constant alertness in order to be ready to dive at short notice when a sufficiently promising weather window appears in the forecasts. *Mars* is situated a 60-minute cruise due east of the port of Böda at Öland in a relatively exposed area. A typical *Mars* dive lasts up to three hours, and with a one-hour cruise back and forth, we need a five-hour window with fairly calm winds.

The 2019 dive team consists of a dozen specially selected divers. Everybody is trained by GUE on the JJ-CCR rebreather. The team is made up of divers with extensive project experience who can dive under difficult conditions while being productive and efficient, and, above all, safe. Most are experienced underwater videographers or photographers.

PHOTO JESPER KJØLLER

GUE Instructor Kirill Egorov is one of the veterans on the Mars project.

PHOTO JESPER KJØLLER

Every afternoon the scientists and divers meet in the HQ tent to discuss the results of the day and plan the next.

PHOTO KIRILL EGOROV

In a world of ultramodern photogrammetry, making measurements with a folding rule still has its place.

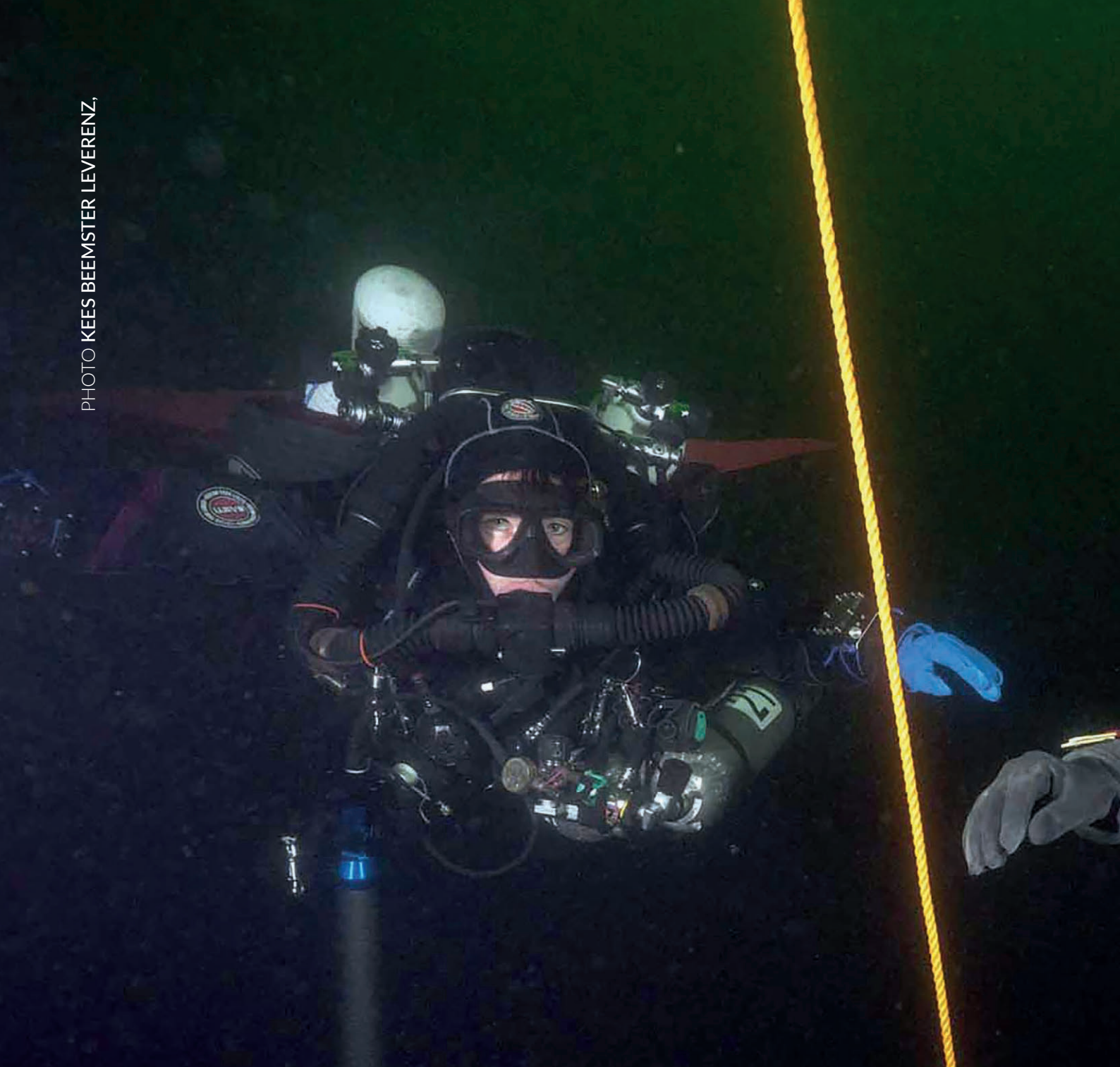


PHOTO KEES BEEMSTER LEVERENZ,

ROOKIE

I had already been warned that the first dives on *Mars* can be somewhat confusing, and they are! I am overwhelmed by the grandeur as well as the complex nature of the wreck. At this depth in the Baltic, it is always pitch black, and you can only see what you can illuminate with your dive light. At first glance, the wreckage resembles a lumber yard gone berserk or a giant game of Mikado. The 4 °C/40 °F water, the darkness, and the inevitable narcosis add to the challenge. Frankly, I am a little intimidated by it all. After all, as the rookie on the team, I want to be able to contribute positively to this year's expedition. But, eventually, I begin to recognize details, and after getting a few reference points, my situational awareness improves and I feel more at home.

The wreck is spread out over 500 m/1,600 ft, and it is actually possible to follow the last hours of the battle step by step by following the tracks it has left on the seabed. Cannonballs, parts of the hull and masts, as well as personal artifacts bear testimony to the brutality of the sea battle. The main wreck itself, including both hull sides, are relatively intact in the middle of the wreck area, where guns of various dimensions and calibers are sprinkled across the seabed in an unprecedented quantity.

THE DEEP FREEZER

After 40 minutes on the bottom, about two hours of decompression awaits. As soon as we rise just a few meters above the wreckage, the visibility suddenly becomes clear as gin. On the other hand, the

Nobody wants to stay on the deco stops in the "deep freezer" longer than absolutely necessary.

"THE LAST STOP AT 6 M/20 FT LASTS ABOUT AN HOUR, AND I USUALLY JUST TRY TO TURN THE BRAIN OFF AND ZONE OUT WHILE THE MINUTES TICK AWAY.

temperature drops to just 2 °C/36 °F, and we can think only about moving quickly through the freezer while spending as little time as possible on the deeper deco stops.

After the first hour in the water, the effect of our heated Santi drysuits begins to wear off. There is still juice on the battery pack, but the body has been cold for a long time. It can be hard to grasp the fact that still almost two hours of decompression time is looming. Fortunately, the rebreather technology is on our side. On open scuba, you breathe cold, compressed gas, which is heated in the lungs and then breathed directly into the water. It's a big waste of heat energy. Rebreather divers, on the other hand, inhales their own warm and moist exhalation gas, which even has added heat energy from the process that takes place when the carbon dioxide in the exhalation gas is purified in the rebreather's scrubber material.

Around 30 m/100 ft, the decompression stops begin to get longer and the temperature increases accordingly. On the last shallow stop the visibility gets worse again, and we move closer to the ascent line. It is important not to lose it and have to shoot a bag. The last stop at 6 m/20 ft lasts about an hour, and I usually just try to turn the brain off and zone out while the minutes tick away. Granted, the surface water is around 17-18 °C/62-64 °F, but at this point we are all cold. It helps some to visualize the barbecue that we all will be enjoying in a few hours.

PHOTOGRAMMETRY

After the discovery of *Mars* in 2011, a special law was quickly declared to protect the wreck site. It is illegal and impossible to dive *Mars* without special permits, and the area is monitored 24/7 by the Swedish Coast Guard. It is prohibited to fish, stop, or use sonar in a circular area with a diameter of one nautical mile.

However, each year a special permit has been granted to a small, select group of divers who, in collaboration with international and Swedish researchers and experts during the 14 days the permit lasts, conduct field studies at the unique archaeological site.

The first few years, the main focus was to map the wreck site and to get an overview. The iconic mosaic image, created from 640 images that were painstakingly put together in Photoshop, went around the world and was on the cover of several magazines, including *National Geographic*.

The mosaic assembly, which visualized *Mars* in a way no one would be able to see in reality, introduced a new approach to underwater archaeology. It was clear from the start that salvaging the wreck was out of the question. Bringing it on land and preserving it would be almost impossible and too costly. In addition, the oxygen-poor, brackish, and ice-cold Baltic Sea at a depth of 72 m/235 ft is in fact the optimal location to store ancient woodwork. The absence of wood worms in the almost fresh water offers the best possible environment.

Instead of salvaging objects from *Mars*, the Lundgren brothers and their team began developing and refining digital documentation techniques, such as 3D scanning and photogrammetry. The *Mars* exploration began parallel to the maturing of technologies that achieved a precision that supports serious scientific studies. But it is one thing to do photogrammetric documentation of smaller objects in the controlled environment of a photo studio, and something completely different to document large shipwrecks at 72 m/235 ft depth in pitch-dark conditions. GUE divers are specialized in working efficiently with documentation methods, and photogrammetry techniques are now part of the GUE course curriculum.

DIGITAL EXCAVATION

On the basis of the photogrammetric 3D models, the ship can be digitally rebuilt, and the models provide a fantastic overview of the entire wreck site, which allows researchers from all over the world to participate in the archaeological studies of this battlefield frozen in time. For example, an expert in historic weaponry can study the digital models and make measurements with great accuracy. Scientists or experts can discover contexts or details that divers can't see with the naked eye underwater. And scientists can participate in the research without ever leaving their office. Photogrammetry also makes it possible to reconstruct or 3D print artifacts such as small guns or make scale models of the entire wreck.

It has been claimed that *Mars* is one of the world's most significant wreck finds, and the series of parallel scientific projects focusing on many different aspects of *Mars* is proof of that. Life on a warship in the 16th century, shipbuilding techniques, metallurgy studies of cannons, and the role of warships in society are just a few examples of these ongoing scientific projects. *Mars* sank with more than 800 soldiers and sailors on board. Those remains and the artifacts left behind allow today's experts to reconstruct and describe life on board, thus providing insight into life in the 16th century. *Mars* is an undisturbed time capsule that can provide many answers to an ever-growing number of questions.

NAT GEO

We know that in a few days, our camp will get a visit from a British production team that is working on an episode for *National Geographic*'s series "Drain the Oceans". Although I usually take still photos while diving, I am tasked with recording video sequences on *Mars* that NatGeo will use as additional material for the show.

Otherwise, the most important result of the 2019 expedition is the expansion of the mapped area around the wreck itself. Many more details are added, but much work remains to be done if we want to cover the entire fallout area around *Mars*, where numerous effects and their relative placement can provide important information to the researchers. If it is decided to salvage more objects at some point, it is also vital to document their location and context before moving those objects. The mapping is done by a photogrammetry diver swimming steadily above the bottom and shooting multiple images with a certain overlap, which is then digitally assembled into a 3D model.

But this laborious work could be done far more efficiently with a remote-controlled underwater video robot (ROV) that does not have to decompress after 30-40 minutes on the bottom. This is expensive equipment, but efforts are currently underway to obtain funding through sponsorships, so we divers can concentrate on more specialized tasks. See how you can support the *Mars* Project on the next page.

SUPPORT THE *MARS* PROJECT! MAKE A DONATION.

The *Mars* Project seek funds to advance the field of maritime archeology by developing methods, techniques, and technology suitable for the underwater world.

Your contribution will not only secure the ongoing scientific documentation of the *Mars* wreck site, but it will also advance the field of maritime archeology.

Your contribution will directly contribute to:

- Project logistics
- Remotely operated vehicle (ROV) rental
- Technological development
- Method development
- Support vessel rental

Read more and make a donation at ***www.mars-project.org***

PHOTO KIRILL EGOROV

It is mandatory to use CCR units when diving the historic wreck. Open-circuit exhaust bubbles and oxygen may impact the fragile environment.

DIVE TEAM – MARS 2019
Kirill Egorov (Russia), *Jesper Kjøller* (Denmark), *Kees Beemster Leverenz* (USA), *John Kendall* (UK), *Rachael Kendall* (UK), *Oleksiy Sverdlov* (Ukraine), *Marcus Newbold* (UK), *Su Eun Kim* (Korea), *Kyungsoo Kim* (Korea) & *Richard Lundgren* (Sweden)

TEXT ANDREA MARASSICH PHOTO STELLA DEL CURTO

SARDINIAN CAVES

During summer 2019, more than 50 GUE divers gathered in the town of Cala Gonone in western Sardinia. With GUE qualifications ranging from beginner cave divers to seasoned cave instructors, the team had plenty of talent to put toward the project goals. The most ambitious and difficult of these objectives included the 3D photogrammetry of Bel Torrente cave and pushing the exploration in Cala Luna cave, continuing the survey, 3D modeling, and cartography. Also included were the ongoing scientific efforts regarding sediment/water sampling and surveying paleontological remains.

The main objective was to capture 3D photogrammetry of the entire Bel Torrente first sump, more than one kilometer. To make this challenging goal even more difficult, the Bel Torrente cave has a mixture of salt and fresh water, halocline, air spaces, and silt. The passage geometries also range from a couple of meters wide to 20-plus. And no one has ever before attempted to create such a 3D model on this scale. The project concept started a year earlier with discussions between Andrea Marassich and John Kendall about the possibility of 3D mapping a cave. They rapidly brought Peter Brandt on board, and they came up with a plan for the 3D scanning. This then required designing and building appropriate rigs for scanning the cave.

In the months leading up to the project, Peter and John accumulated the necessary cameras and lights for the 360-degree camera arrays. The first was made up of 12 cameras, the second of eight, with both rigs utilizing eight wide-angle video lights. To mount these onto the Suex XK1 DPVs required a whole lot of 3D printing, as well as some inventiveness. The final build also required quite a lot of duct tape and zip ties.

Each day ran pretty similarly: We had two boats, and the rebreather teams would leave first and get into the cave first. They had the longest run times, and it was important for the photogrammetry not to have other divers working the same areas. The OC divers would then follow 30 minutes or so behind. This worked well and gave everyone space in the cave to achieve their goals.

At the end of the project, more than 1 terabyte of imagery had been created by the two teams. Processing had started, the cave was surveyed to the end of sump 2 in every passage, and everyone had fun and learned stuff.

3D MODELING

During the project weeks, it was planned to use state-of-the-art survey techniques in close contact with the inventor of MNEMO and programmer of Ariane's Line software to implement new routines and bring the software features to a new degree of development. Peter Gaertner spearheaded the efforts, trying to create new in-water survey protocols.

Key steps were as follows: defining a starting point of the survey in open water to be measured by GPS, installing markers on every tie off, ensuring a continuous guideline throughout the cave, and, finally, initiating the first step of our survey. The basic line survey was done using the MNEMO. As a result, the polygon representing the cave grew fast, and with this further tasks could be assigned, such as measuring wall-to-wall and floor-to-ceiling distances (LRUD coordinates) with tape measurements and taking photos. In order to get the proper shape of the cave, the strobe was fired between two plastic lids to get a ring-shaped flashlight, illuminating only the cross section of the cave just at the correct angle in respect to the station.

HIGH-TECH SURVEY

The photos and the measurements were processed into the software, and together with Sebastian Kister, located in Mexico, a new feature was added: At every station of the polygon, a photo could be added, together with the measured LRUD coordinates.

A spline curve in the software allows the shape of the cave to morph in a much more accurate way than a classical diamond shape does, in that it is possible to add a number of anchor points to the curve. This allows one to literally draw the cross section. Moreover, inclination of the plan on both vertical and horizontal axes can be adjusted to better represent the cave and to show specific spaces in the model that would otherwise not be as clearly understood. This permits more accurate modeling of the cave and the ability to take precise measures of the void area, e.g., flow and water distribution can be modelled by scientists.

Daily tasks were assigned during the week based on the results of the day, and the divers were able to alter between varied

order to gain experience in different fields. The newly graduated Cave 2 divers were able to gradually increase their comfort levels as they explored different sections of the cave. Surveyed were 5,529 m/18,000 ft of the cave, 772 stations, eight major loops, with error under 3%.

EXPLORATION

The aquifer beneath the eastern Supramonte Plateau (which includes the caves Su Palu, Su Spiria, and Su Molente, which is connected to Bue Marino), discharges much of its water into the sea through multiple springs, with Cala Luna spring receiving a large volume of water during heavy rain and flooding. Dye trace experiments by local cavers have shown that inland cave systems connect to both the Bel Torrente cave system and Cala Luna, though these connections have not been confirmed by divers underground.

Unfortunately, despite sometimes presenting a strong flow that makes it impossible to dive, Cala Luna is characterized by increasingly smaller passages with complex navigation, multiple restrictions, and collapsed areas. As a result, explorers looking to connect to inland cave systems have failed to find the missing lead.

PROMISING LEAD

During an early dive in spring 2019, Rob Neto quickly found a promising lead in a collapsed area toward the end of the mapped section. About 30 m/100 ft further, and in shallower water, at the edge of the collapse, a restricted vertical crack in the middle of two solid, sheer, white slabs of rock stopped the exploration. After multiple divers assessed the passage various times in the subsequent month, we realized the only feasible option was to push it with a no-mount configuration. Considering the shallow depth, the crystal-clear water, and the fact that the restriction was a long, simple corridor, we finally decided to go for it.

After the divers cleared the restriction, they could gear up again in a relatively comfortable room, from which the cave continues west toward the inland systems, with the passages ultimately dictating the direction of exploration.

The diversity of this cave is amazing, as it changes from shallow, restricted, and silt-free to about 15 m/50 ft wide at 30 m/100 ft of depth, and a mixture of sand and tiny gravel covers the bottom of the phreatic cross section. Big passages led to rooms with apparently no ongoing passage, and smaller conduits led the teams inland and to open passages. This pattern repeated a few times throughout the cave.

The team managed to explore and survey more than 1.4 km/0.9 miles of underwater passages as well as some short, dry sections during six dives.

SIX-HOUR DIVE

There are multiple areas past the restriction where divers surfaced and checked the dry parts, hoping to encounter other sumps. In some areas the teams checking the dry sections needed rope and single rope technique (SRT) caving gear.

As with many European caves, what poses the greatest challenge to the explorer is not the fact that there is a restriction, but rather where the restriction rests, as many times it is a fair distance from the entrance. In this case, it is about 600 m/1,970 ft from the entrance. This required a team of divers able and willing to carry safety cylinders, stages, DPVs, and extra stages and caving gear across the restriction.

Even though the dives were as long as seven hours, shallow depths rendered decompression manageable. The main variable that needed careful management was coordination with the boat and surface crew, as they provided access to the cave. Weather and sea condition changes required efficient communication between divers and surface support. This resulted in a plan of a six-hour dive time and the staging of two mobile phones in a predetermined location in the event of worsening weather and team separation.

TEXT RICARDO CONSTANTINO **PHOTO** JOÃO RODRIGUES

ESTREMENHO KARST MASSIF

Since 2007, GUE divers have been documenting and exploring the cave labyrinth located in central Portugal named Estremenho Karst Massif. In 2019, the team consolidated sensor data from previous years, and in January 2020, opened some leads for further exploration with RB80 and sidemount configurations.

The Estremenho Karst Massif (EKM) is located 100 km/60 miles north of Lisbon, Portugal, and is home to some of the main caves in the country. The Portuguese Speleological Society (www.SPE.pt) has been actively exploring and studying the vast network of caves for over 70 years. We started a project in close collaboration with the geologists of SPE in 2007 to extend the studies into the submerged sections of the sinks and springs. Initial project activities involved building a local team and augmenting team competencies to undertake detailed UW cave survey tasks and removal of enormous quantities of old (broken) nylon line and rubber elastics (snoopy-loops) from the caves.

With the creation of Project Baseline, we started monitoring specific points in the different caves; data collected included photographic documentation and temperature data logs from various cave locations.

Photographic documentation over ten years of sampling has allowed us to compile an impactful snapshot of the change that one specific site has undergone during this period.

EXPLORING NEW PASSAGES

The detailed and long-term water temperature logging has revealed a number of interesting effects that geologists continue to study. We deployed stand-alone temperature and water level loggers in five different caves/locations to provide new data for the scientists to analyze. To the surprise of the geologists, we found that the water temperature drops in some caves with rising water levels (rains), while it decreases in others. Also, by comparing the variations in-water temperature over a complete hydrological cycle between three passages in two of the terminal springs of the aquifer, we found that a temperature profile can be associated with each major conduit and that there is a possibility of a correlation between the depth of the conduit and the temperature variation profile.

During the latest expedition in January 2020, we started exploring new passages in the Moinhos Velhos cave system, using both RB80 and sidemount configurations. These new leads open up the possibility of a connection to the nearby Contenda cave. The next exploration is planned for the end of September 2020.

This project has motivated the writeup of two articles for GUE's *Quest* journal. See: *www.gue.com/quest/10/2* & *www.gue.com/quest/11/2*

Alviela is a major spring in the Estremenho Karst Massif, the largest in Portugal.

PHOTO JOÃO RODRIGUES

TEXT & PHOTOS **BELÈN ANDRÈS & HYE JIN KIM**

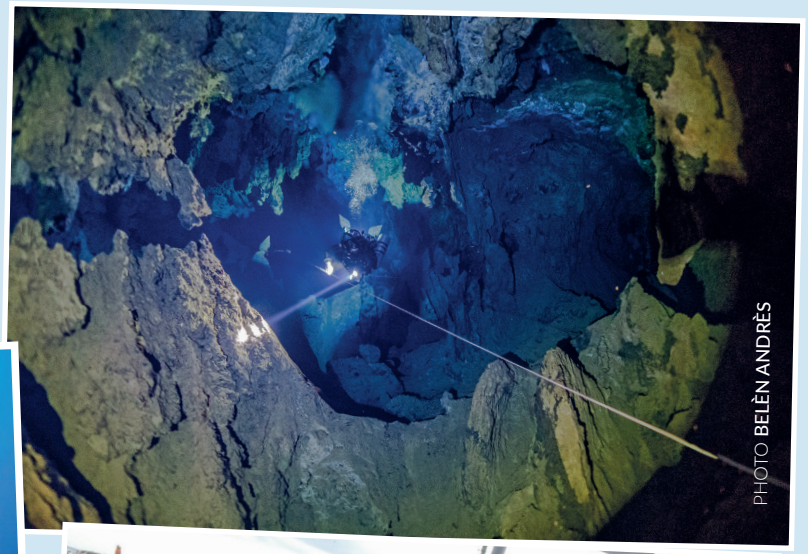
OPPOSITE WORLDS

We were a community of divers gathering in opposite parts of the world, which made us a global team. In September 2019, GUE Spain visited GUE Korea, where the team organized all the diving. We were eager to become acquainted, as we came from very different cultures above the water. But, despite our cultural differences, we were all the same underwater. The Korean team showed their ocean floors and introduced some of their Ghost Diving projects in the pinnacles on the East Sea. The bottom of this area is 30 m/100 ft, with pinnacles coming up to 10 m/30 ft. Here we were able to experience some magnificent, colorful formations that made us want to stay forever.

In November of the same year, GUE Korea repaid the visit back to Spain! The group enjoyed one week of diving the shipwrecks in Cabo de Palos marine reserve, which ranged from recreational to Tech 2: a WWI wreck, the SS *Stanfield*, which sits upright at 110 m/360 ft in good condition; the *Carbonero*, lying on a sandy bottom at a maximum depth of 45 m/148 ft; and the *El Naranjito*. We also dived Cueva del Agua, an hypogenic cave at 29 °C/84 °F, which is still in exploration with more than 4 km/2.4 miles surveyed and continuing. This cave is a real labyrinth, and you can spend days without seeing it all. We will never forget the laughs we had and the food we enjoyed while these two communities from opposite sides of the world met up and dived together.

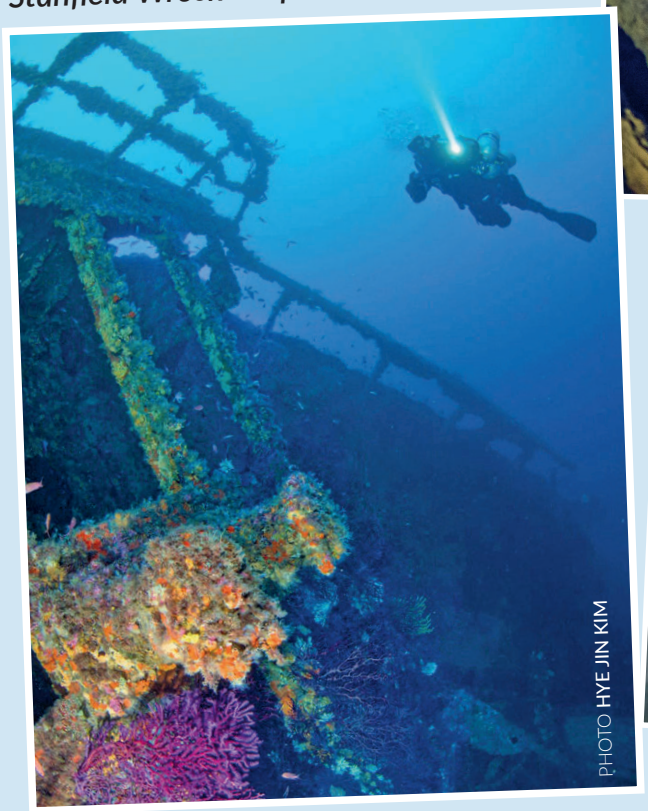
TEAM *Belèn Andrès, Juan Carlos Farra, Julio Cepeda, Taejin Kwak, Yura Kim, KyungBing Kan & Sangseon Ang*

SPECIAL THANKS TO
Islas Hormigas Club de Buceo & GUE Tech Dive Korea



Cueva del Agua cave in Spain.

Stanfield Wreck in Spain.



Lunch with the team.

CAPO NOLI

TEXT & PHOTOS **MARCO COLMAN**

More than six years have passed since a group of divers discovered a one-pound cannon on the seabed of Capo Noli.

GUE divers have dedicated more than three years of diving activity and research, assisted by Superintendency of Cultural Heritage of Liguria archaeologists and by the historian Alessandro Garulla, to identify with extreme accuracy the origin of the various artifacts found.

Over the years, historical studies and research have led to the creation of a team that also made use of the close collaboration with the COMSUBIN departments of the Italian Navy. Thanks to this partnership, it was possible to hold the first archaeological excavation in which two GUE divers were able to participate actively by diving during the excavation operations.

NAPOLEON

The news of the discovery and all the history that has been carefully reconstructed was covered extensively by the media, and as a result, the 1795 Foundation was responsible for organizing and setting up an exhibition at the Oratorio dei Disciplinati in Finale Ligure. The theme of the exhibition was 1795, which is considered to be the beginning of Napoleon Bonaparte's conquest of Europe.

The exhibition was divided into three areas: the first is dedicated to the post-French revolution period with unique objects from the private collection of the historian Alessandro Garulla; the second is dedicated to the artifacts found at Capo Noli with historical details and written testimonies of the battle; and a final part, illustrated by multimedia, supports all the phases of the saturation excavation carried out in July 2018. At the inauguration on March 30, 2018, the general staff of the Navy of La Spezia and the COMSUBIN were present, as well as the direct heir of Napoleon Bonaparte, Charles Bonaparte. Also present were Lilly Style for Horatio Nelson and Paolo Caracciolo, a pupil of Admiral Caracciolo, who embarked on the Minerva vessel belonging to the Duchy of Naples and whose figurehead is visible in the Navy Museum of La Spezia. New research activities are planned for the current year in collaboration with the departments of the Italian Navy and excavation and research activities with GUE divers.

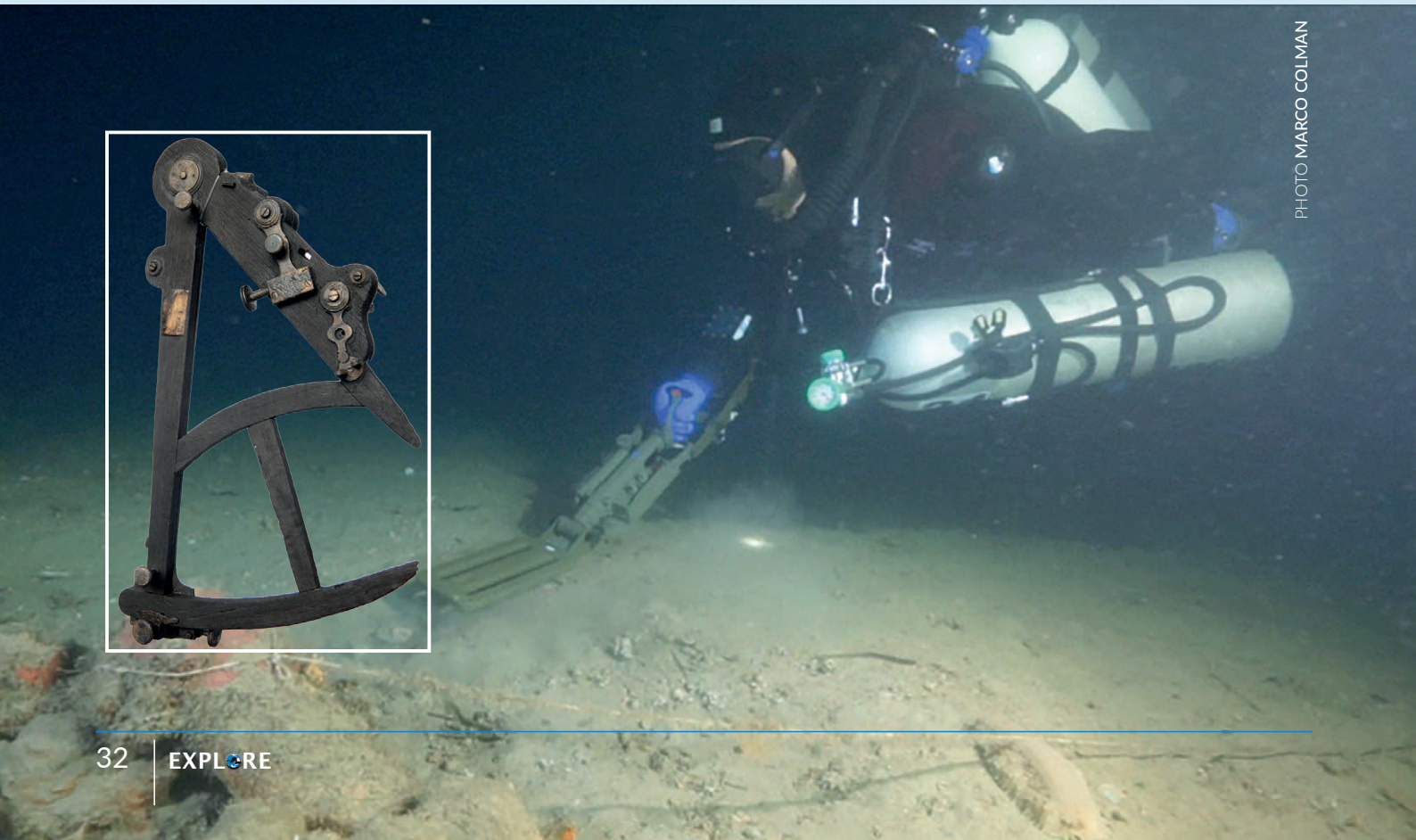


PHOTO MARCO COLMAN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RED SEA CREATIVE TRIP

Any picture ever taken is a momentary snapshot of a story. When producing a large amount of media content, high quality can be a challenge. This is the story of how a colorful mix of community members undertook this challenge.

TEXT **KENZIE POTTER STEPHENS & PETER GAERTNER** PHOTO **PETER GAERTNER**

In October 2019, for the second time in GUE history, *C Avenue* of the fleet of the Red Sea Explorers headed out to sea with a team of highly motivated GUE community members. Those on board came from eight different countries with backgrounds ranging from highly experienced exploration divers, GUE instructors and interns, and everyday GUE divers all the way to novice divers who had never jumped off a boat before.

All had traveled from various ends of the world and were brought together by one shared goal: to create material that exemplifies our mission, our purpose, and our philosophies. Of course, added bonuses would be to connect with friends yet unknown and enjoy a wonderful week in the hot sun and cool waters of the Red Sea.

It sounds almost like a luxury cruise, and it promised to be that—once the day's work had been completed. As with all good dives, our success would depend on solid planning, adaptability, and a bit of humor along the way. Together, Jarrod Jablonski and Dorota Czerny cunningly mixed and matched the individual teams, forming them into potent work groups, and thus the fun and hard work began.

The Red Sea, with its endless visibility and sunny weather, is a magnificent location for such an undertaking, yet it brings its own unique challenges. Photographing and filming, a task that already requires exacting skills on land, transforms into an even greater science and art beneath the water's surface. Currents can push one model out of position while the other is safe behind the wreck's bow, and the photographer is left bravely back-kicking and trying to get into an advantageous position, all the while adjusting the camera settings to the ever-changing environment.

THE VIEW THROUGH THE LENS

The goal of the trip was to produce picture and video material to be used throughout the year for publications, training materials, and product presentations. Therefore, before jumping in, lists of desired shots, locations, and surroundings were compiled. Again, when it comes to creating pictures and videos of value and high quality, it all starts with a sound plan. However, things don't always go as planned. First, before departing from the home port, Hurghada, three team members became stuck in Istanbul, Turkey, transforming their diving mission for the day into exploring Turkish land instead of the waters of the Red Sea. So, plans were rearranged, and people adapted.

The next day around midnight, the missing team members and their equipment were dispatched by speedboat to the waiting dive boat, allowing the project week to begin.

Then, after we arrived at the dive locations that were planned for the first few project dives, we discovered that the current had picked up speed significantly, causing a drift-and-shoot procedure to be developed and applied.

The first unintended consequence of this change in plans was that since the surrounding environment had interfered, we had to make adaptations while still underwater. Because even though the photos taken did not meet the photographer's expectations, the project members formed ideas for new ways to use them in the debriefing that followed. Even better, fresh ideas were proposed for the following days of diving.

LET'S TALK TACTICS

Of all the project members on board, we had two photographers and one videographer. In order to prevent an overlap in the pictured themes, the tasks were divided by desired content between the two photographers. For example, one photographer was tasked with pictures for Rec 1 educational material, while the other focused on pictures with specific stories to tell.

At the same time, the models also rotated between the two photographers. Of course, the downside to this is that communication becomes a challenge. Each photographer has their own specific style and set of signs with which they position their subjects. After a few dives, models learn the sign language of one photographer and can predict where they need to be, which can be the exact op-

PHOTO PETER GAERTNER

posite of what the second photographer wants. Still, the upside to this rotation lies in the variation it allows. As a photographer, I know that after a good number of shootings, the pictures begin to resemble themselves more and more, as the people working in front of and behind the lens become one unit. While this makes the process more efficient, the pictures are less diverse. And, as said before, mistakes can be a great source for creativity.

Each day would begin with the sunrise in order to make good use of the daylight. As the sun wandered west, the divers wandered off as well—back onto the boat, gathering here and there for small briefings. And each day would end late as it became dark, when—after a dinner each more delicious than the last—the entire project team would gather for a group review of the pictures. So basically, we lived by the rhythm of the sun, which was a wonderful experience on its own!

CREW IS CRUCIAL

Besides our loyal friend the sun, the project week was accompanied by an amazing boat crew spearheaded by the fleet's captain, Faisal Khalaf. Unparalleled, the members of the crew were always present to lend a hand, even before we knew we needed help ourselves. Skilled with the zodiacs, attentive with the handling of dive gear and divers alike, quick to spot risks and tricky situations, ready with a fruit platter or freshly pressed mango smoothies, and absolutely phenomenal cooks to boot, Faisal and his guys never failed to amaze us. They are among the unsung heroes of our project week. From the 5 o'clock early morning dive until the late-night dive, from wrecks to coral reefs, and from the simplest request to the seemingly most bizarre questions, the crew and Faisal's ever-present joyfulness were our rock through it all.

MORE THAN JUST PROJECT MEMBERS

Throughout our days of salt in our hair, sweat in our dry- and wetsuits (and wet drysuits!), sun in our eyes, and fruit in our stomachs, what truly connects us to this day are the bonds that we built. How amazing it is to open your educational material and see a photo that shows you and your good friends doing what you love the most. Eight countries are now forever connected by the friendships we have formed and the success we were able to gain as a team. A girl, fearful of taking a "giant stride" off the boat, is now on her way to becoming a diver. Strangers have become family, and experiences have been immortalized into a wide palette of video- and photographic material to support GUE's mission.

TEAM *Jarrod Jablonski, Dorota Czerny, Faisal Khalaf, Lauren Fanning, Sameh Sokar, Dimitris Fifis, Peter Gaertner, Manuela Schoch, Julian Mühlenhaus, Olga Martinelli, Kasia Puchalska, Kenzie Potter, Nigar Asadova & Shabnam Amirova*

MAKING THE CUT

TEXT RICHARD LUNDGREN
PHOTOS JULIA GOLOSIY & KEES BEEMSTER LEVERENZ

Few GUE projects have external funding, and the participants are uncompensated for their time and effort. Yet they work tirelessly, exhibiting values such as solidarity, reciprocity, mutual trust, a sense of belonging, and individual and team empowerment. But how can YOU join?

QUALIFYING FOR A GUE PROJECT

For many divers, participation in a GUE project or expedition is where the efforts of their training and experience culminates into a life goal. Member participation is the backbone of GUE and is realized in several ways. This article describes the three types of GUE activities: expeditions, projects, and events. We will define the volunteer roles and responsibilities needed to drive the activity, describe the certifications and qualifications needed for a high-profile project or expedition, and finally, we will let you know how to connect so you can get involved!

MULTIPLE ROLES

An example of expedition goals, desired outcomes, and deliverables: *Mars*. The *Mars* Project is an exciting example of a scientific, goal-oriented GUE expedition. The *Mars* Project is an all-volunteer maritime archaeological expedition that sets out to explore the *Mars* wreck site, to investigate its surroundings, and to examine this legendary wreck.

The *Mars* Project is usually conducted annually over a two-to-three-week period in the summer. During this time, more than 40 highly qualified and dedicated individuals are involved in the expedition. Scientists from different disciplines participate together with professional surveyors, divers, ROV pilots, technicians, boat crew, and support crew. On average, 200+ man dives are performed, documenting the site using 4-8K video cameras, still cameras, and sonar systems. A tremendous amount of data is generated for the scientists, all of which has allowed for the production of scientific reports, magazine articles, TV documentaries, social media postings, virtual reality applications, 3D models, digital elevation models, orthomosaic maps, photomosaics, and photo/video archives.

In last year's expedition, for example, the 12 divers, six boat crew/captains, and eight scientists all played multiple roles. The 12 divers also acted as safety divers and filled gas. One of the divers doubled as the media officer, and the scientists also helped out with logistics. Since only a limited number of people can participate due to boat regulations and accommodation logistics, the expedition relies on highly qualified and multi-talented participants with a willingness to wear many hats and assume different roles.

VOLUNTEER REQUIREMENTS

Applicants must be aware that participation in expeditions and projects demands a huge commitment of time, as well as an intense desire to make a difference.

Applicants must possess and demonstrate unique skill sets, verifiable qualifications, and the suitable experience to match the expedition or project goal and its proposed outcomes.

EXPEDITIONS, PROJECTS, AND EVENTS - A DEFINITION

EXPEDITIONS

Expeditions are the most rigorous of the three GUE member activities and require the largest commitment of time and expertise. Expeditions are highly sophisticated projects that take place in a demanding environment with carefully articulated goals and deliverables. Expeditions are usually recurring efforts to reach a multitude of often multidisciplinary scientific goals. The goals are dynamic and evolve over time. The results are often ambitious and help drive science forward as new techniques and methodologies are invented and adopted as the requirements increase. GUE expeditions often have support from corporations as well as governmental research institutions, museums, or universities. The *Mars* and Egadi expeditions are two great volunteer-driven examples of GUE activities with international fame and repute.

PROJECTS

Projects are volunteer-driven as well. However, projects are usually not recurring and don't require collaborative efforts with partners. Projects are technical or recreational diving activities oriented around a specific outcome; however, they tend to be less scientific in nature, and have fewer and less complicated results. This includes GUE-oriented technical diving excursions to remote areas like the Bikini Atoll. The results of projects often include magazine articles, TV documentaries, 3D models, and social media content.

EVENTS

Events are usually fun occasions organized by member volunteers in support of a community diving activity. They are inclusive, social, and oriented around enjoying your time underwater or spending time with your local dive community.

PHOTO JULIA GOLOSIY

Only experienced GUE CCR divers are selected for the yearly Mars *expeditions.*

PHOTO JULIA GOLOSIY

The ideal participants in any GUE expedition or project are multitalented and able to assume many different roles.

Diver applicants must have certifications matching the project requirements. If practical, one level beyond any depth and deco limit is desirable. If a project target is at 45 m/150 ft, a Tech 1 rating may be the minimum requirement, but often a Tech 2 or CCR 1 or 2 rating is desirable. Some activities are limited to rebreathers due to gas logistics and/or sensitive environments.

There are other dive certifications that may be desirable or required depending on the activity. Often DPV, Gas Blender, Documentation; and Scientific Diver increase the likelihood of being selected.

Project leaders always acknowledge and prioritize applicants with medical and first aid skills, therefore any DAN (Divers Alert Network) certificates or similar are great. The gold standard, apart from being a professional, is the DMT card (diver medical technician). For specialized operations, chamber operator and attendant certifications are very useful.

EXPERIENCE AND RECENCY

Applicants must present solid dive experience at the level or beyond the project target. This most likely also involves environmental experience. As an example, activities in the Baltic Sea may not require experience dealing with strong currents but demand profound experience diving in cold waters with reduced visibility. The amount of experience is hard to establish, as it is individual and is based on the quality of the dives.

As a reference for expeditions and projects, a volunteer's diving skills should be solid and effortless, allowing the diver to focus entirely on safety, awareness, and the objectives of the mission at hand.

Diving recency is of profound importance. As an applicant, you should be sure to undertake numerous dives during the months leading up to the event. There will be little time for more than one or two checkup dives during the actual event. You need to be ready!

SAFETY

The number one priority and most desirable goal of any GUE activity is safety. All GUE events follow a "safety first" doctrine whereby all participants are responsible for ensuring that every activity is as safe as possible and, according to the event, that they follow GUE's standard operating procedures. It is understood and agreed upon that all divers participate on a volunteer basis and at their own risk.

All participants are responsible for their own and the team's safety on land and in the water. These responsibilities include, but are not restricted to, diver's medical and physical fitness, recent experience, training, proficiency, equipment, preparations, and planning. All participants are responsible for bringing their own equipment and for the preparation and function and servicing of that equipment according to manufacturer guidelines.

FIT TO DIVE

Applicants should submit a fit-to-dive medical with the application. In general, for expeditions and project activities, the applicant should be in very good physical condition, i.e., a BMI less than 30 and solid cardio endurance. The concept of "train hard, fight easy" applies, and the participant is expected to not only perform as a very capable diver, but also function well under duress and rough conditions that may well involve rescues. A physical fitness overcapacity is recommended and often required.

Applicants must submit proof of full insurance coverage for the dive activities, including third party liability release. Without insurance, the application will be denied.

APPLICATION

If you've decided you want to be a part of a GUE expedition, you can find the application and the contact information on the GUE Events calendar. The application should be submitted via email with the required attachments to the project leader or administrator.

Unfortunately, any application may be denied without an extensive rationale or explanation. If your application is rejected, it will probably be recommended that you consider strengthening your CV or your diver capacity, and dive experience or recency. GUE remains grateful for all applicants' continued interest in and support of our work.

ACCEPTANCE

The moment has finally come. Congratulations! You have been selected as a member of the team. On its own, this is a great personal achievement, but it is only the beginning of the adventure! This is when the fun, but also hard work and challenges, begin. Usually, participants for projects and expeditions are selected up to a year before the activity begins. As a team member, you will be expected to donate your time and efforts in driving the activity toward its success. The associated costs shared by the participants will be collected months before the project is initiated in order to secure all the required logistics. At this time, for obvious reasons, the participation fee is not refundable. Please apply only if you know you are able to commit and will be able to follow through. Late cancelation can put the entire activity at risk and prevent you from being considered for projects and expeditions in the future. Let the adventure begin!

See more
www.gue.com/events & www.mars-project.org

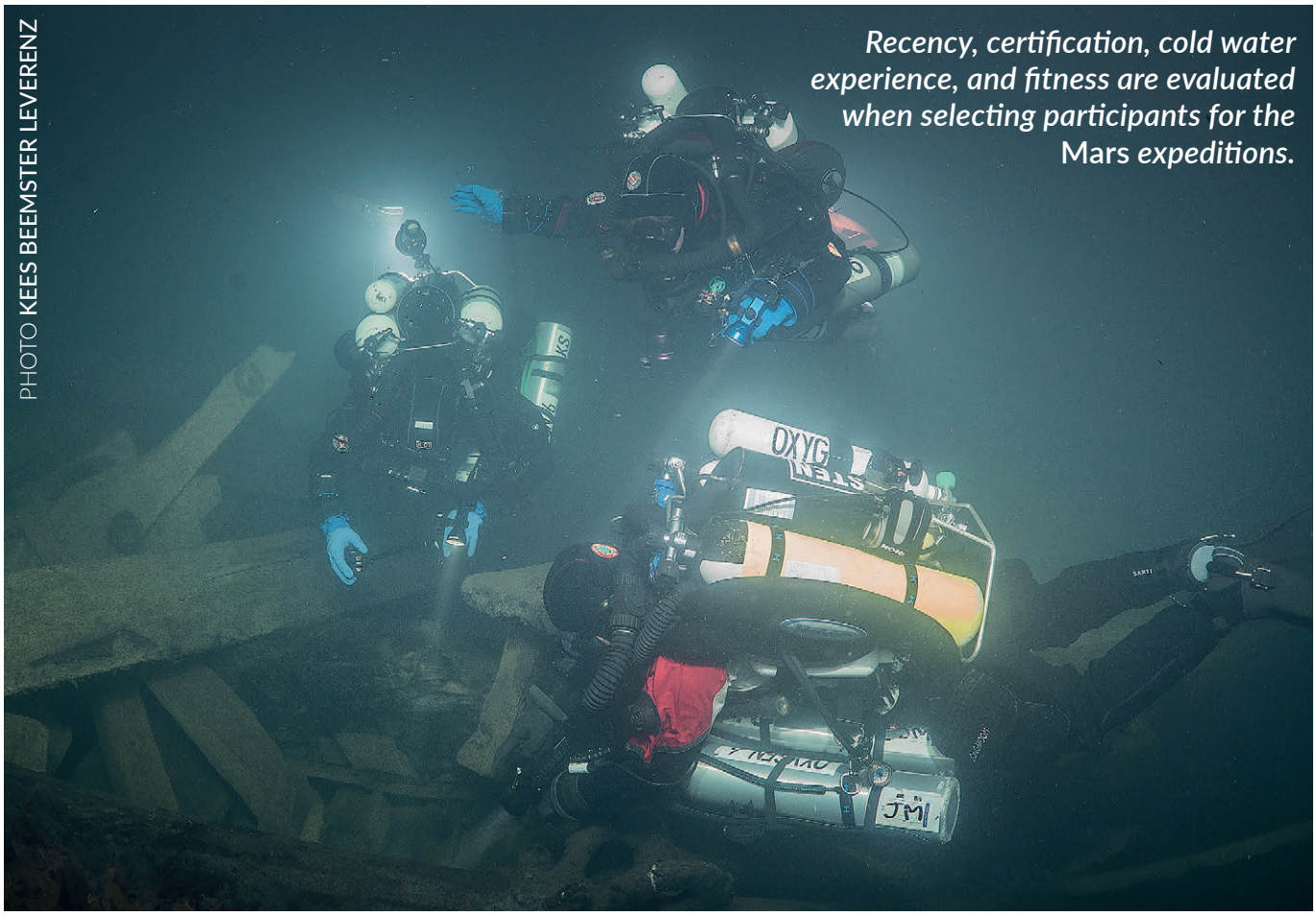
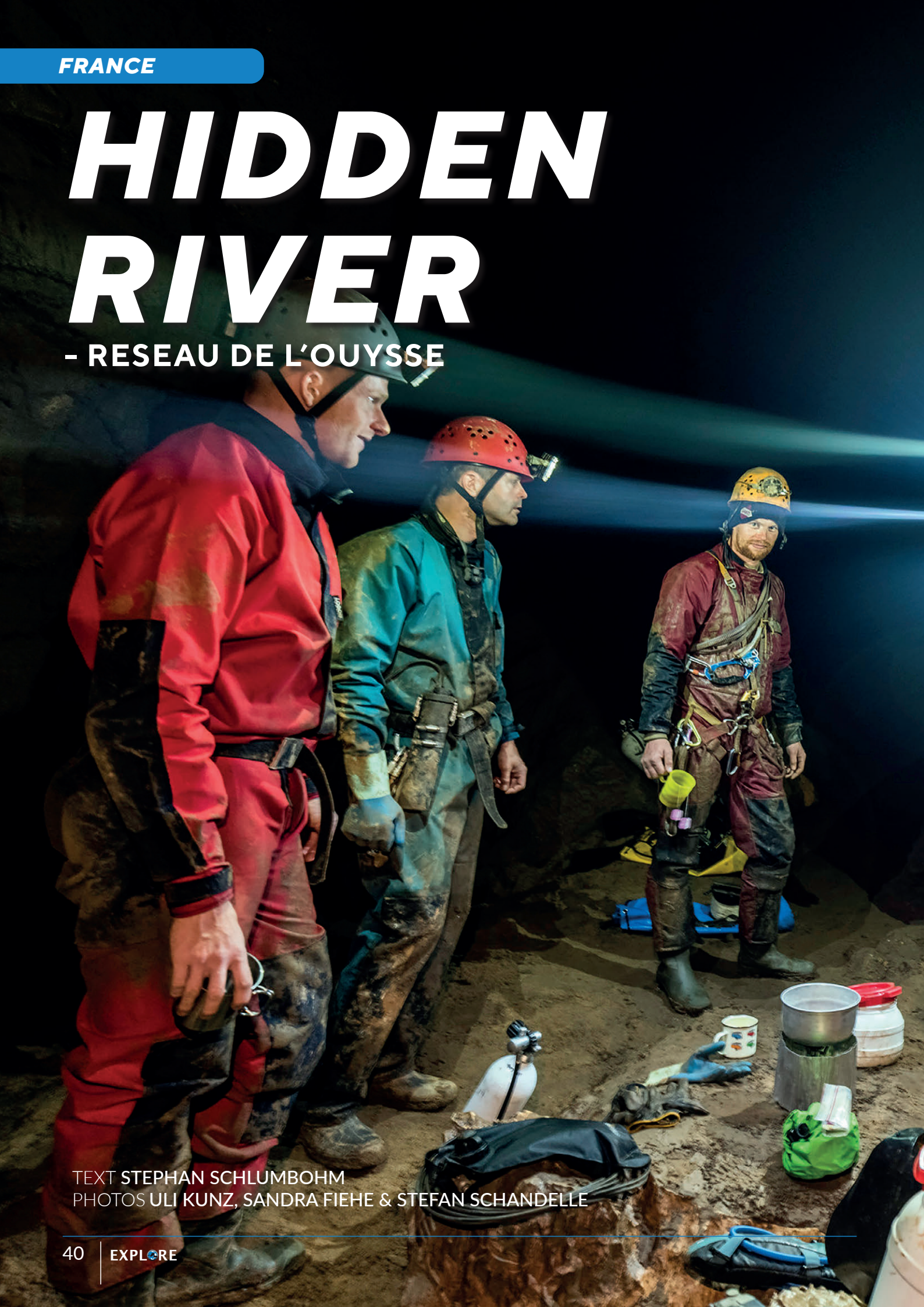


PHOTO KEES BEEMSTER LEVERENZ

Recency, certification, cold water experience, and fitness are evaluated when selecting participants for the Mars expeditions.

HIDDEN RIVER

– RESEAU DE L'OUYSSE



TEXT STEPHAN SCHLUMBOHM
PHOTOS ULI KUNZ, SANDRA FIEHE & STEFAN SCHANDELLE

The Hidden River project team explored and extended the end of the line at Réseau de L'Ouysse. The team has been exploring and documenting the cave known as the diving sites Gouffre de Cabouy and Gouffre de Pou Meyssen in the department Lot since 2009.

PHOTO ULI KURTZ

The bivouac team discussing dive planning at sump 3.

The end of the line at Réseau de L'Ouysse was set by Rick Stanton in 2005. In 2019, after years of exploration and documentation of the cave, the Hidden River Project team extended the end of the line into the third sump. In the years between 2005 and 2019, the team had built their skills to a level that would allow for safely diving and exploring the cave. This is how it happened:

FIVE DAYS OF BIVOUAC

In 2019, calling on the previous six years' experience, the project team established a bivouac in the massive air bell between the second and third sump of the cave for five days. In order to get to the bivouac, cave divers entered the dive site Gouffre de Cabouy, crossed the first sump at a distance of 2 m/7 ft, swam across a lake inside the cave, climbed steps in the air bell for another 500 m/1640 ft, and dived through the second sump for another 100 m/328 ft. In order to dive the third sump, all necessary gear was carried over a distance of 600 m/1968 ft across several challenging sections of the dry cave. The gear was transported the last few meters into sump 3 in a cable car.

Two dive teams, each consisting of two divers, stayed in the cave for five days and conducted, in total, three dives in sump 3. During the first dive, dive team #1 checked the state of the line up to the deep section and evaluated options for climbing into the newly discovered air bell above the collapse. Dive team #2 explored and extended the cave down to 125 m/410 ft total distance in a five-hour dive. A third dive was then conducted by dive team #1 in order to explore the collapse. All four divers used RB80 rebreathers. In addition to the three dives in sump 3, several team members further explored and documented the long, dry section of the south passage beyond sump 2 using single-rope techniques.

SIX YEARS OF DATA COLLECTION

The Hidden River Project team has been collecting and evaluating the sensor data—depth and temperature—for over six years. The data from all three sensors was collected, and a new, fourth sensor was installed in the second sump of the cave, the data from which is freely available upon request. In addition, the map of the cave has been extended further by the exploration and survey data collected during the 2019 issue of the project.

The cave still offers several options for further exploration and documentation, and the Hidden River project team is planning to follow up in 2020.

For more information, videos, and pictures, please visit *www.facebook.com/thehiddenriverproject* or contact us at *info@thehiddenriverproject.org*

TEAM *H. Amecke, D. Beiert, S. Bertelmann, M. Buchs, C. Bühler, M. Eickhoff, S. Fiehe, O. Gobara, I. Homberger, M. Isigkeit, J. Medenwaldt, M. Miethke, U. Roschanski, R. Rosenberger, S. Schandelle, M. Schernbeck, S. Schlumbohm, T. Schnitter & C. Schüle*

> **"THE HIDDEN RIVER PROJECT TEAM HAS BEEN COLLECTING AND EVALUATING THE SENSOR DATA ALREADY FOR OVER SIX YEARS.**

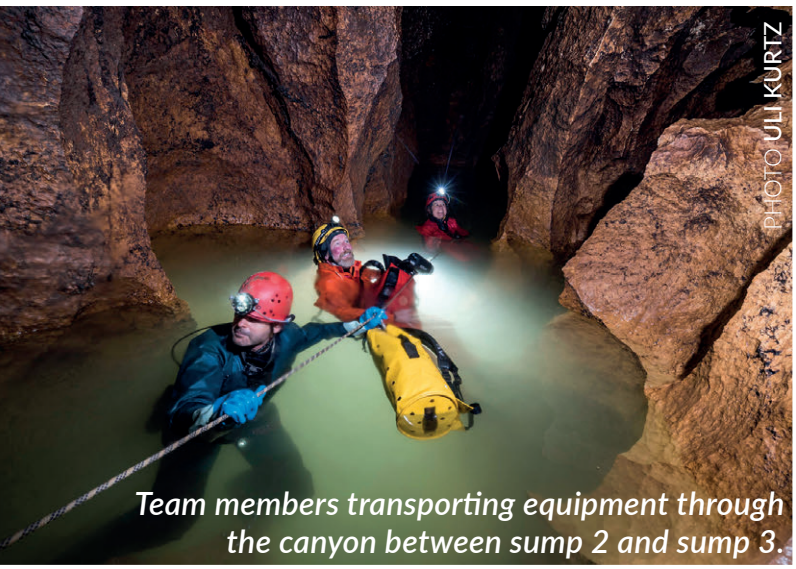


PHOTO ULI KURTZ

Team members transporting equipment through the canyon between sump 2 and sump 3.

PHOTO STEFAN SCHANDELLE

The 2019 Hidden River Project team.

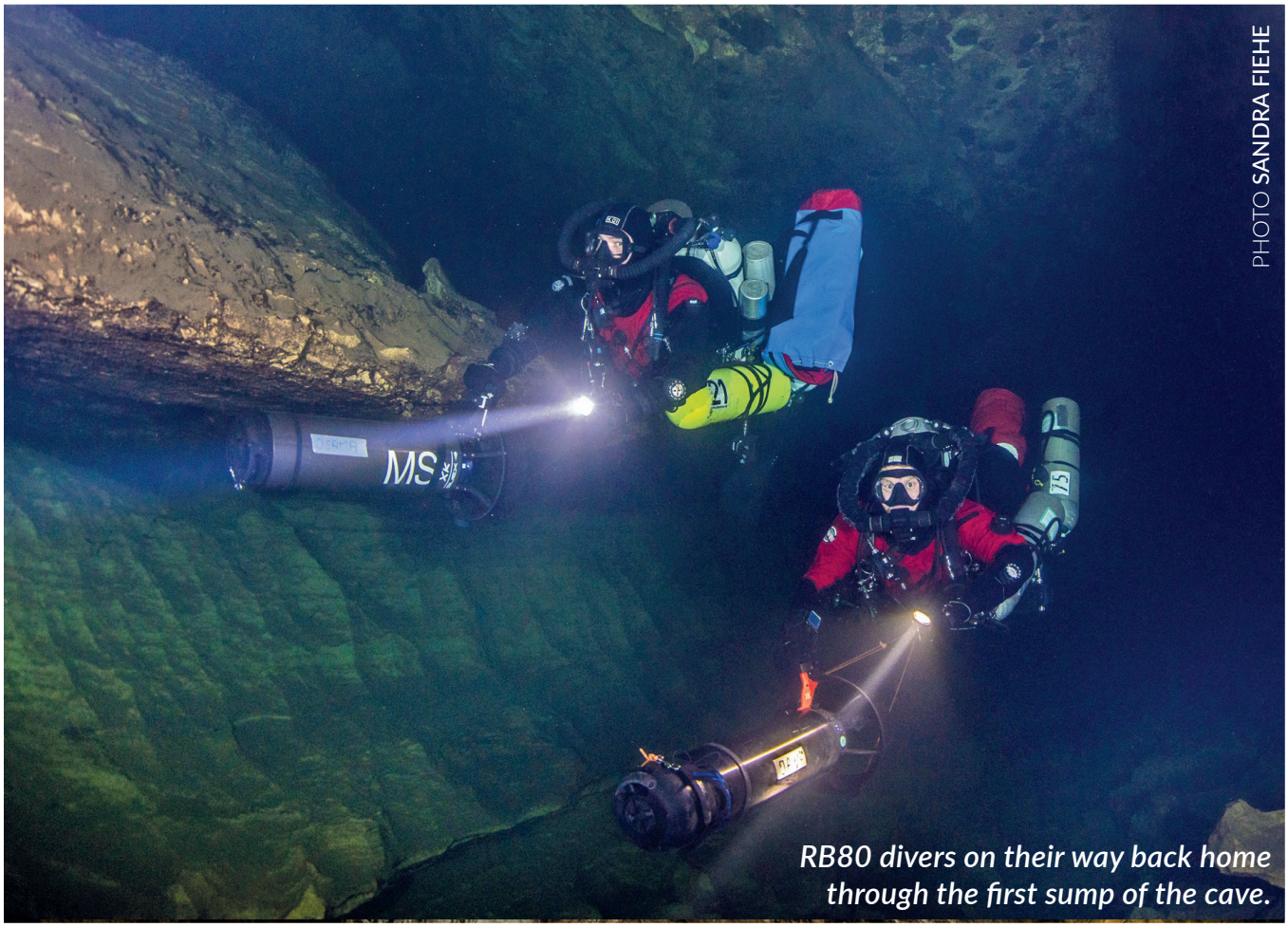
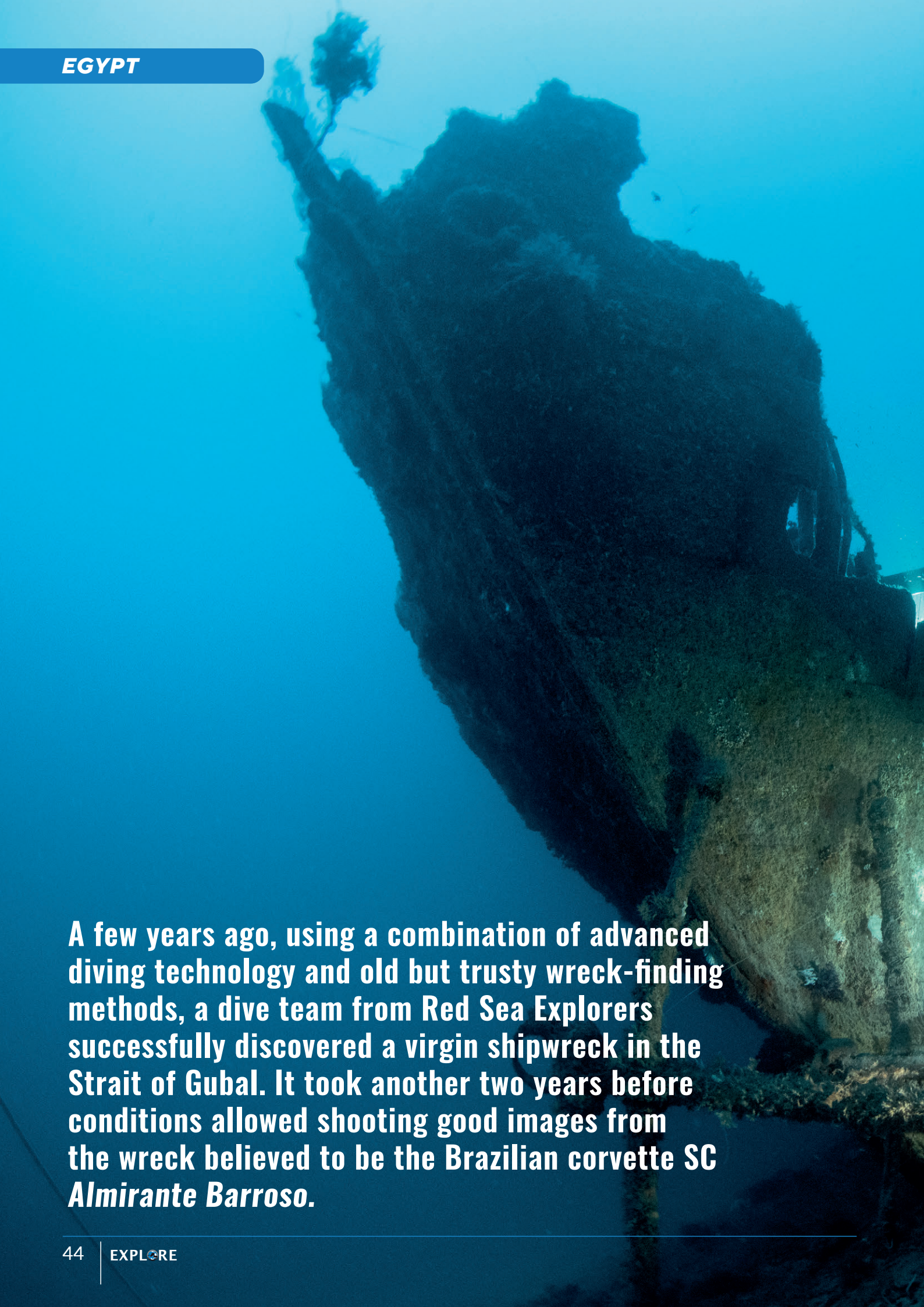


PHOTO SANDRA FIEHE

RB80 divers on their way back home through the first sump of the cave.

PHOTO ULI KURTZ

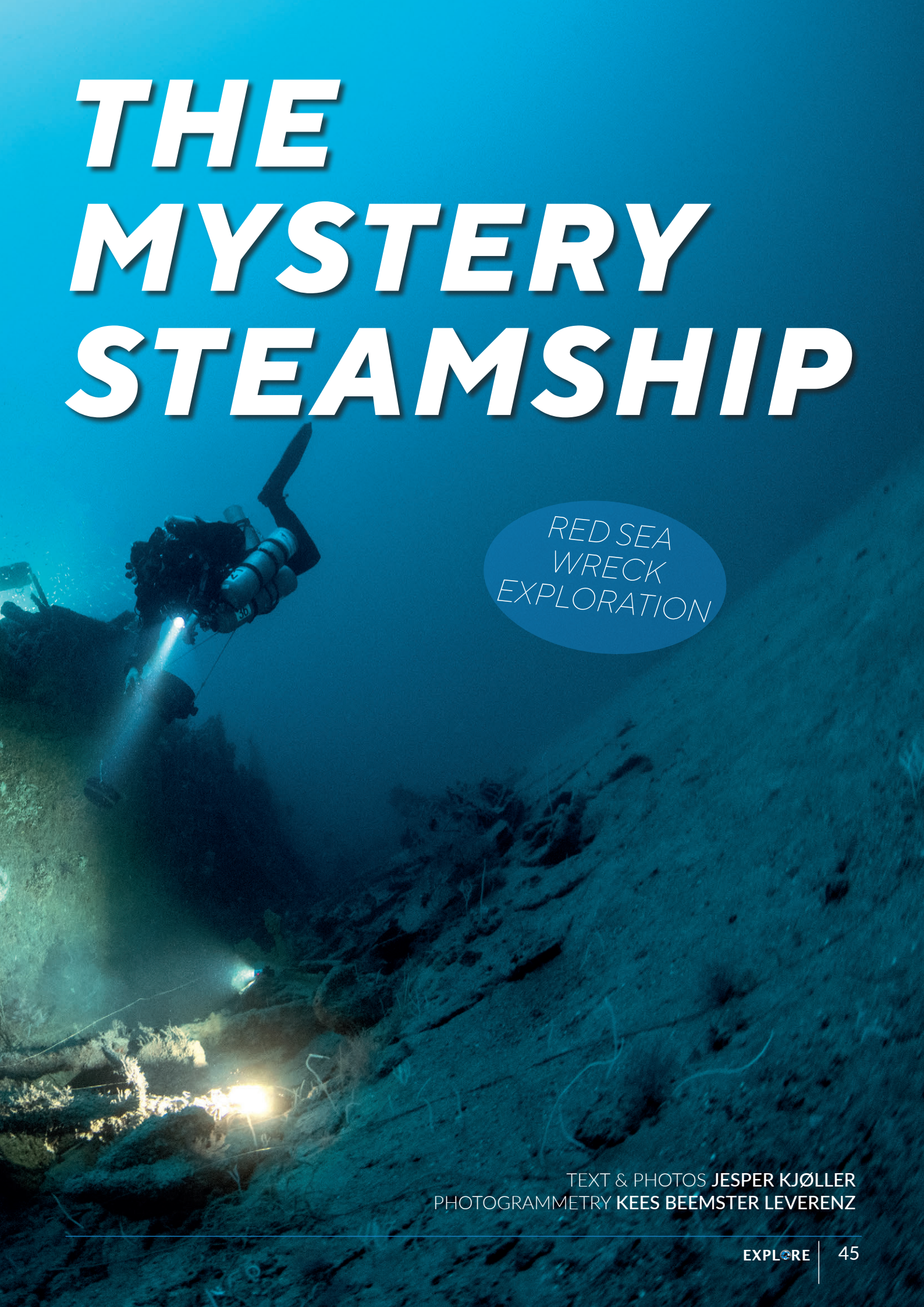
Huge halls between sump 2 and sump 3.



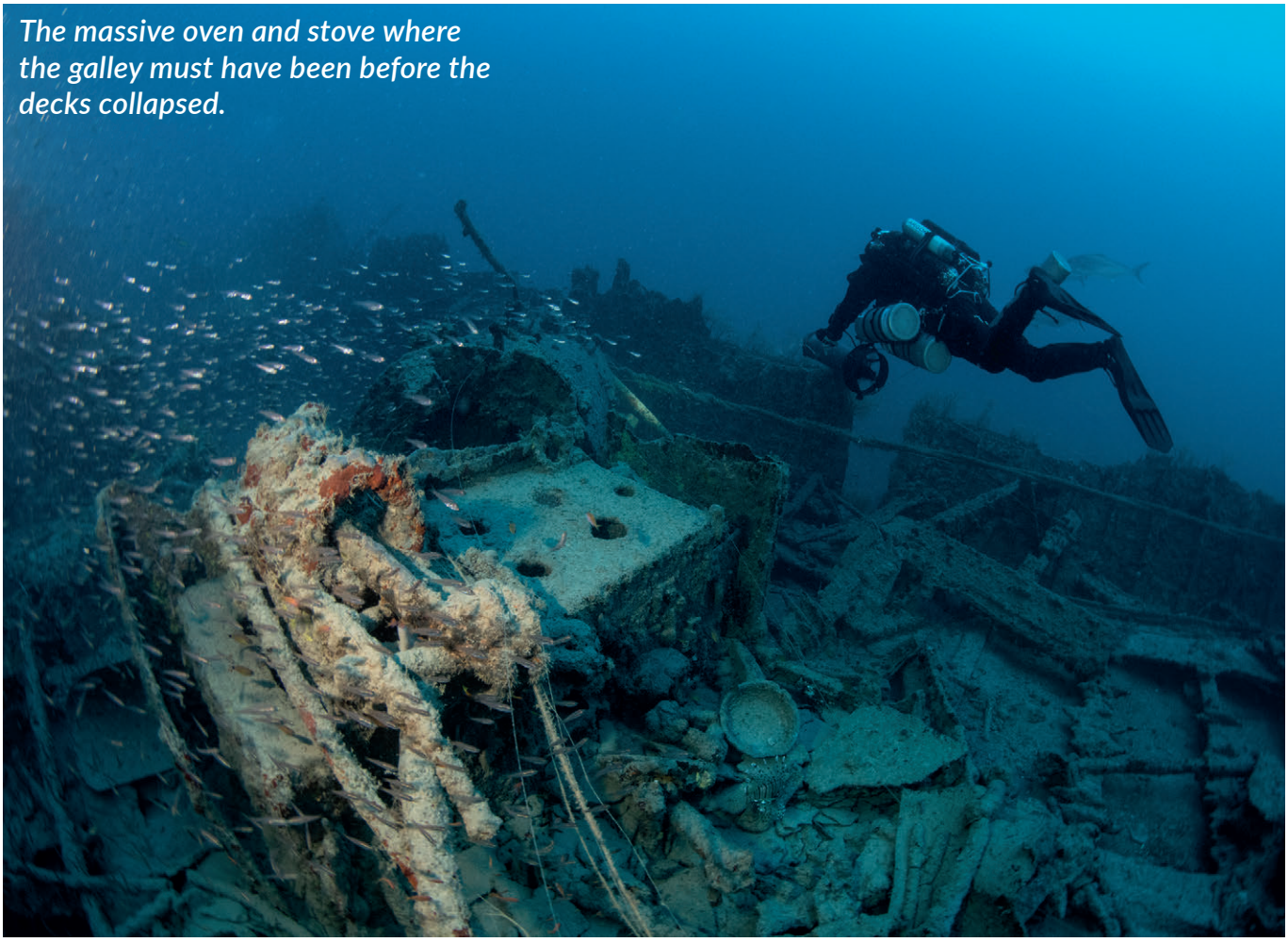
A few years ago, using a combination of advanced diving technology and old but trusty wreck-finding methods, a dive team from Red Sea Explorers successfully discovered a virgin shipwreck in the Strait of Gubal. It took another two years before conditions allowed shooting good images from the wreck believed to be the Brazilian corvette SC *Almirante Barroso*.

THE MYSTERY STEAMSHIP

RED SEA WRECK EXPLORATION



TEXT & PHOTOS **JESPER KJØLLER**
PHOTOGRAMMETRY **KEES BEEMSTER LEVERENZ**



The massive oven and stove where the galley must have been before the decks collapsed.

Wow! I can't believe our luck. We anticipated a ripping current, but the thick rope that was dropped by the crew on our mothership, M/V *Nouran*, is leading straight down into the unusually clear water. Did we break the code and figure out how to time the dive in relation to the tidal charts and weather forecasts? Full of anticipation, I let myself fall through the water column a few meters away from the rope, and for a moment I even contemplate preparing my camera and begin to unfold the strobe arms in the tranquil environment on the way down. But then, at around 50 m/160 ft, I notice that the rope begins to shiver and shake. I look down and discover a sharp bend on the rope below me, indicating that the current is picking up further down.

I realize that I've drifted too far away from the rope now, so I keep the scooter at full speed and I fin as hard as I can. I tuck my head in between my arms to make me more streamlined, but I'm not moving closer, and the current is really strong now. I remind myself to be careful not to overexert myself to avoid carbon dioxide build up—hypercapnia is the rebreather diver's number one enemy. Now I can see the contours of the wreck below me, and I realize that down on the seafloor, the hull of the wreck will create a shelter from the current.

My buddy Daniel is smarter than I am, and he has apparently been holding on to the rope during the entire descent. Also, he does not have the added drag of my big camera system. I am confident that he is in control of the situation and that he will continue his descent along the rope, so I decide to scooter straight down toward the ocean floor at 80 m/260 ft rather than fight against the unforgiving current to catch the rope again. As soon as I am sheltered behind the wreck, I can quickly make my way to the ship with the scooter at full speed along the ocean floor to reunite with Daniel. We arrive at the wreck at the same time but through different means. Lesson learned: Do not lose the rope!

SMOKING GUN

The downline from the *Nouran* is situated just a few meters in front of the bow of the wreck, where the two large anchors are lying. Perfect drop! Daniel immediately positions the video lights to illuminate the bow and the anchors, and he assumes a good position for modeling. We have had a couple of days

“I REALIZE THAT I’VE DRIFTED TOO FAR AWAY FROM THE ROPE NOW, SO I KEEP THE SCOOTER AT FULL SPEED AND I FIN AS HARD AS I CAN.

Daniel Schelvis posing above a winch of some sort.

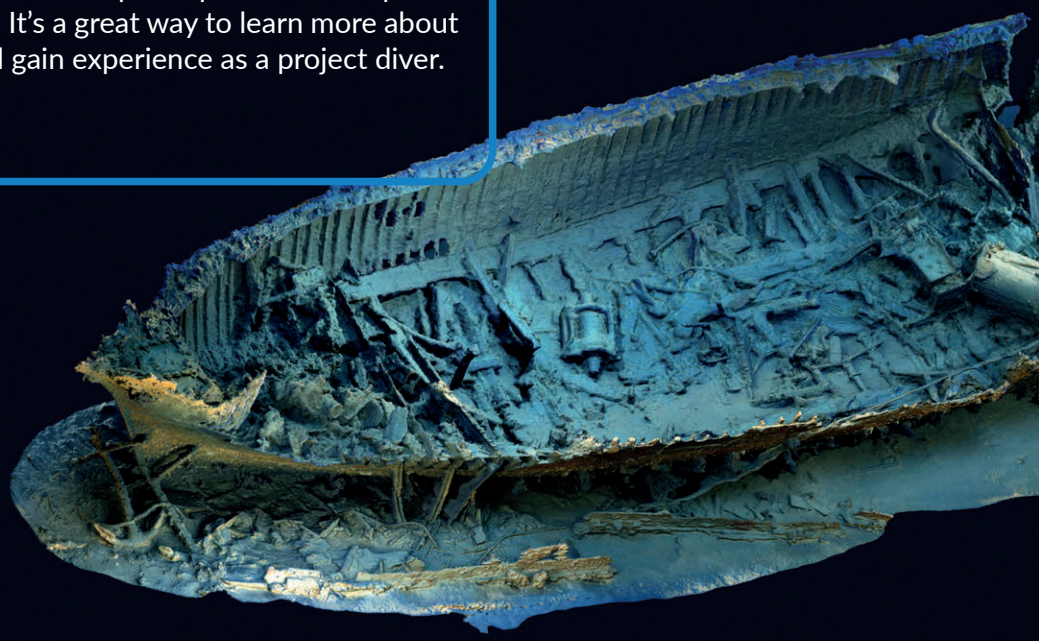
RED SEA EXPLORERS WRECK EXPLORATION PROJECT

As the name implies, Red Sea Explorers are dedicated to exploring and protecting the wonders of the Red Sea, and they have been doing so during the last 15 years as one of Egypt's most popular and successful liveaboard dive operations.

The Wreck Exploration Project is an ongoing endeavor that dedicates a couple of weeks every year to finding and exploring new shipwrecks.

Even if you are not able to do long and demanding decompression dives at great depths, you can still participate in the Exploration Projects as a support diver. It's a great way to learn more about technical diving adventures and gain experience as a project diver.

www.redseaexplorers.com



to practice both technique and communication on easy wreck dives in the region (Abu Nuhas and *Thistlegorm*), so we can work fast and efficiently. The visibility is really good, and the ambient light is nice, even if we are deep and it is only around 10 a.m. The current is a small price to pay for the clear water.

After the shots at the bow, we venture inside the open hull to explore and shoot more images. The other half of our four-man dive team, prominent Italian GUE instructors and wreck explorers Mario Arena and Stefano Gualtieri, are already immersed in looking for clues that can support a 100 percent positive identification of the wreck. We believe that the ship is the Brazilian steam-powered sailing corvette *Almirante Barroso*, but we still need the smoking gun to prove it.

Mario Arena, being one of the most experienced wreck explorers on the planet, knows where to look and he is searching for clues. A boilerplate with the name, a serial number on an engine part, or a ship's bell would be the typical things to look for, but he draws a blank and is not able to find anything conclusive.

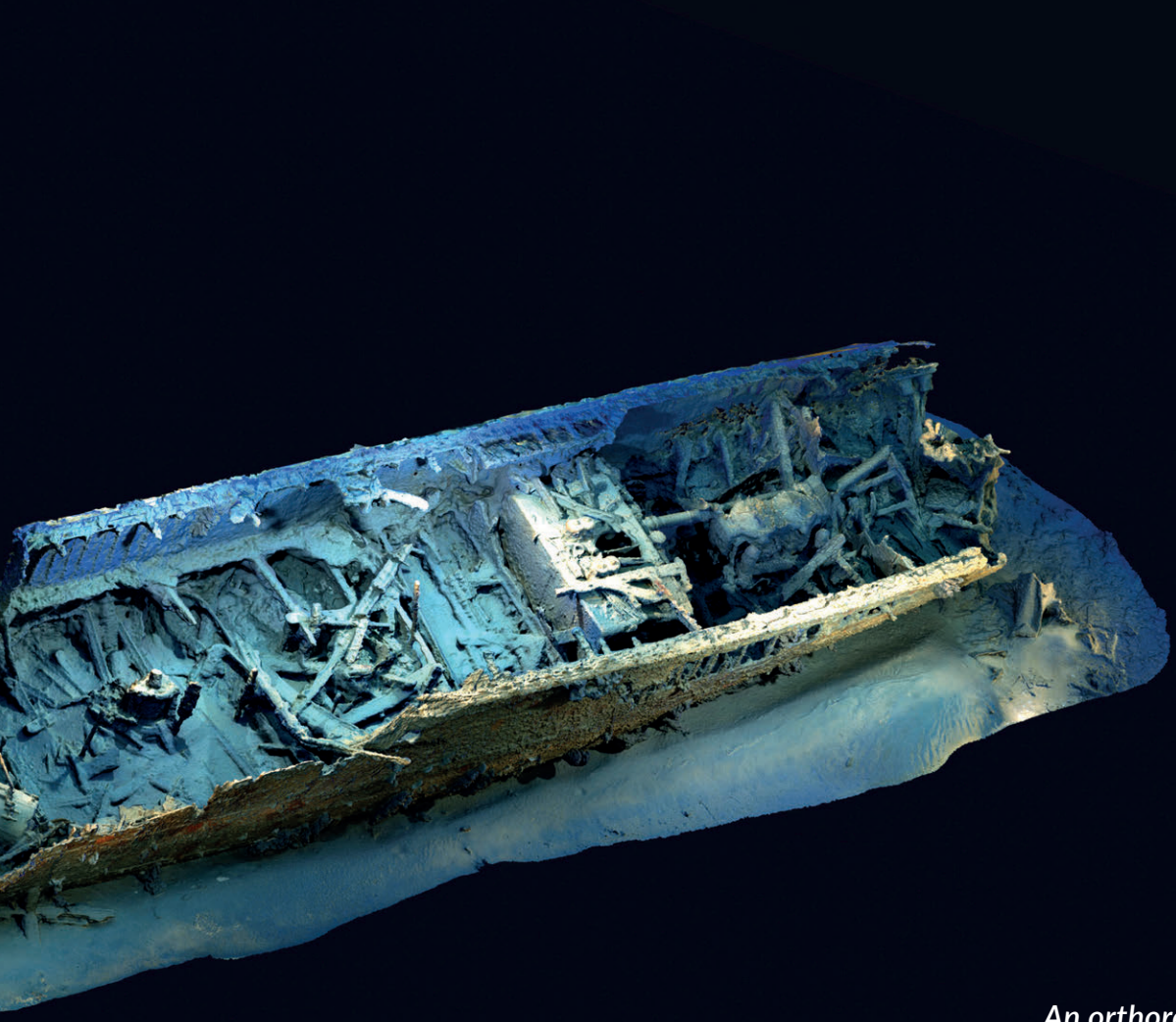
OCCAM'S RAZOR

Scientists often refer to a problem-solving principle called Occam's Razor when trying to figure out complex problems. This principle suggests that the simplest solution to a problem is most likely the right one. Occam's Razor declares that when presented with competing hypotheses, one should trust the one that is based on fewest assumptions.

The *Almirante* went down in 1893, and we have found a wreck that looks like her from that period. If it is not her, there should be a similar ship missing, and the *Almirante* must lie somewhere else in the vicinity. Occam's Razor suggests that we have found the *Almirante Barroso*, but we still need to prove it.

I ask Faisal Khalaf from Red Sea Explorers about the identification process. "None of the items found on the wreck thus far provide 100 percent identification. However, the size, location, and different characteristics of the wreck make us quite certain of its identity," Faisal says.

"For example, there is damage to the hull where the rigging used to connect. Items such as pulleys and blocks used in sailing rigs are further evidence



PHOTOGRAMMETRY KEES BEEMSTER LEVERENZ

An orthorectified model of the Almirante Barroso *based on photogrammetry.*

that she is a tall ship. The question as to where the superstructure has gone is answered by the fact that this is a sailing ship and there was limited or no superstructure. The missing parts were likely made of wood that has since disintegrated".

"Our mission now is to continue to document and catalogue all the parts of the wreck in order to conserve it for further research. Using different technologies such as photogrammetry and video documentation, we aim to keep a thorough record of what was discovered. We will also search for items that might be buried in and around the wreck. This is a long-term project, and lots of dives will be conducted on the wreck as part of the Wreck Exploration Project," Faisal ends.

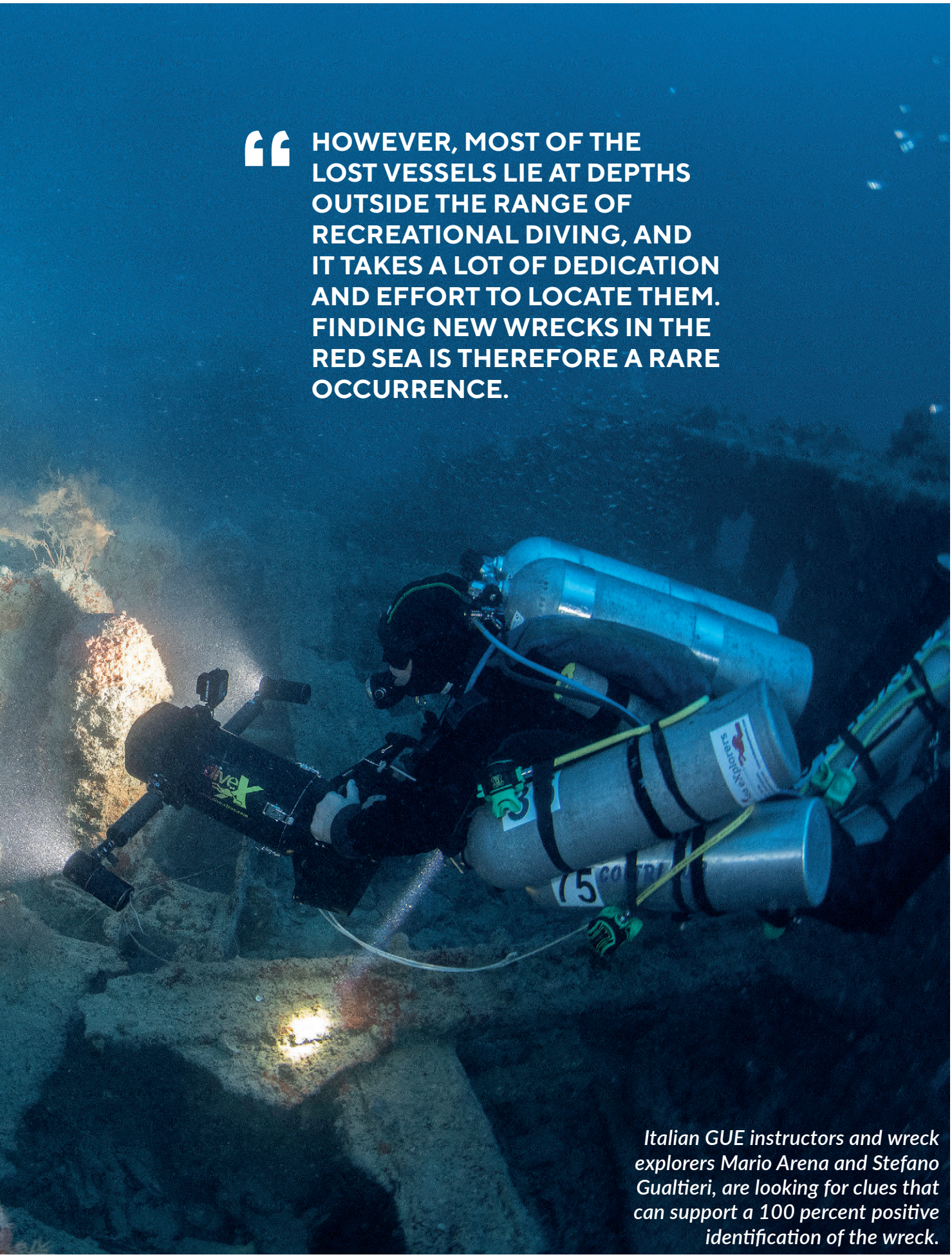
OLD AND NEW METHODS

Without a doubt, the Egyptian Red Sea is one of the planet's most dived oceans. You would think by now that all its secrets have been revealed and that all areas were fully explored. On the other hand, the Red Sea is one of the busiest sailing passages in the world, so it is no wonder that a lot of ships have ended up on the bottom of the Strait of Gubal since the inauguration of the Suez Canal in 1869. However, most of the lost vessels lie at depths outside the range of recreational diving, and it takes a lot of dedication and effort to locate them. Finding new wrecks in the Red Sea is therefore a rare occurrence.

> **"USING DIFFERENT TECHNOLOGIES SUCH AS PHOTOGRAMMETRY AND VIDEO DOCUMENTATION, WE AIM TO KEEP A THOROUGH RECORD OF WHAT WAS DISCOVERED.**

Nowadays, most new wrecks are found with modern technology, but Egyptian law prohibits the use of sidescan sonars. So, Faisal reverted to old, trusty methods and teamed up with a local fisherman, Hamdi. He had a small handheld GPS with hundreds of promising positions where his col-


NINJA



> **HOWEVER, MOST OF THE LOST VESSELS LIE AT DEPTHS OUTSIDE THE RANGE OF RECREATIONAL DIVING, AND IT TAKES A LOT OF DEDICATION AND EFFORT TO LOCATE THEM. FINDING NEW WRECKS IN THE RED SEA IS THEREFORE A RARE OCCURRENCE.**

Italian GUE instructors and wreck explorers Mario Arena and Stefano Gualtieri, are looking for clues that can support a 100 percent positive identification of the wreck.

Team: Mario Arena & Stefano Gualtieri (Italy), Daniel Schelvis (Spain) & Jesper Kjøller (Denmark)

leagues had lost trawls or noticed resistance when pulling in their nets. The fishermen were promised 2000 euros for every position that turned out to be a virgin wreck, and so far, half a dozen new wrecks have been located.

The fishermen have an impressive knowledge of the positions and can describe details of the wrecks purely on the basis of the pieces of debris pulled up by their angling tools.

The wrecks are found using old methods, but they are divided with new technology. When diving in deep water surrounded by huge container ships in a busy sailing lane, it is essential to use the safest and most reliable gear. We use trimix-based CCRs and powerful underwater scooters—two technologies that have recently reached a level of maturity and that make it possible to do safe exploration of areas that were inaccessible 10-15 years ago.

PICTURES OR IT DIDN'T HAPPEN

I'm thinking back on our inaugural dive on the wreck in February 2018. The first attempt to reach the wreck was aborted; the current at the bottom made it impossible. After 20 minutes scootering at full throttle against a ripping current while following a horizontal line on 65 m/210 ft, we had to give up. I was desperately holding on to the line with my left hand and operating the scooter with the right. We were moving slowly but with great effort, and it became clear that it was not sustainable, so the dive was aborted. We never reached the wreck, but the sonar image on the bridge of M/V *Nouran* was so tempting and alluring that it was decided to make another attempt later the same day, hoping that the current had lessened and conditions improved by then. We still did not know what was waiting for us. A wreck? A lost container? A hull-shaped reef? Or maybe just MS *Sand*—the largest wreck in the world.

Imagine the thrill we experienced when we reached the bottom at almost 80 m/260 ft and discovered that the shot line was just a few meters away from a structure that turned out to be the wreck of a large steamship. Unfortunately, the visibility was bad, and because of the difficulties

we experienced on the first attempt, I had left my big camera system on the surface. We only had a scooter-mounted GoPro to document the dive, and you can clearly hear our joyful screams on the video.

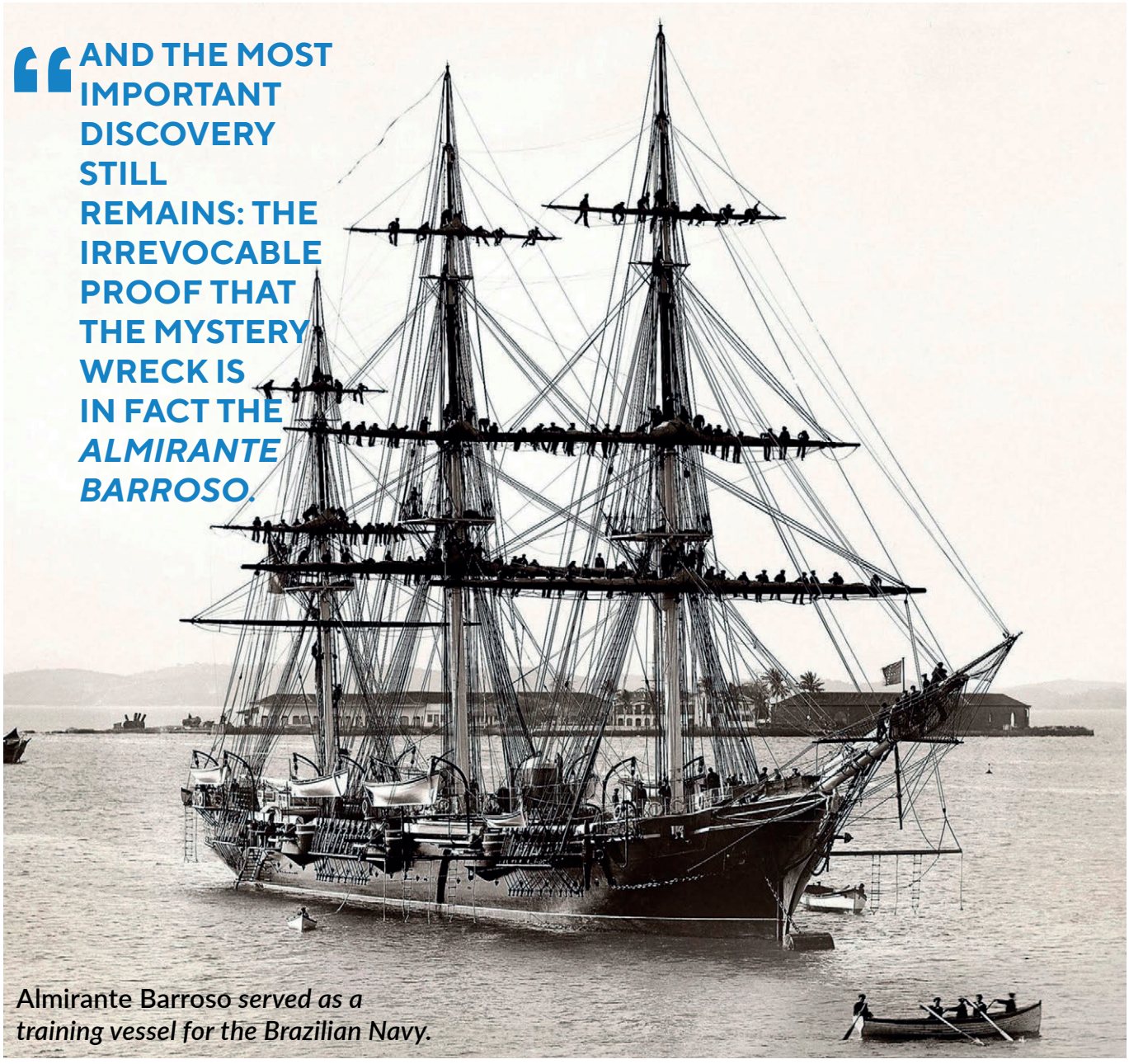
The marine life on the wreck was spectacular. There was very little protection against the strong current on the sandy bottom around the site, so the wreck offers a shelter that makes the marine life thrive. The hull was filled with glass fish chaperoned by enormous groupers and lionfish. Large giant trevallies were roaming the area and they were visible even on the sonar. No wonder the area is an attractive fishing ground!

We were ecstatic with our new discovery, but we only had sparse GoPro documentation, so we wanted to go back. It would take two years until I had a chance to dive the *Almirante* again. In the meantime, a few other dives were made, and a handful of artifacts were recovered.

MYSTERY WRECK

Lots of questions need to be answered. Where are the cannons? What was the cargo and where is it? Maybe the ship was turned upside down before landing upright on the seafloor and everything spilled out? What reef did it hit, and is there a debris field leading to it? And the most important discovery still remains: the irrevocable proof that the mystery wreck is in fact the *Almirante Barroso*.

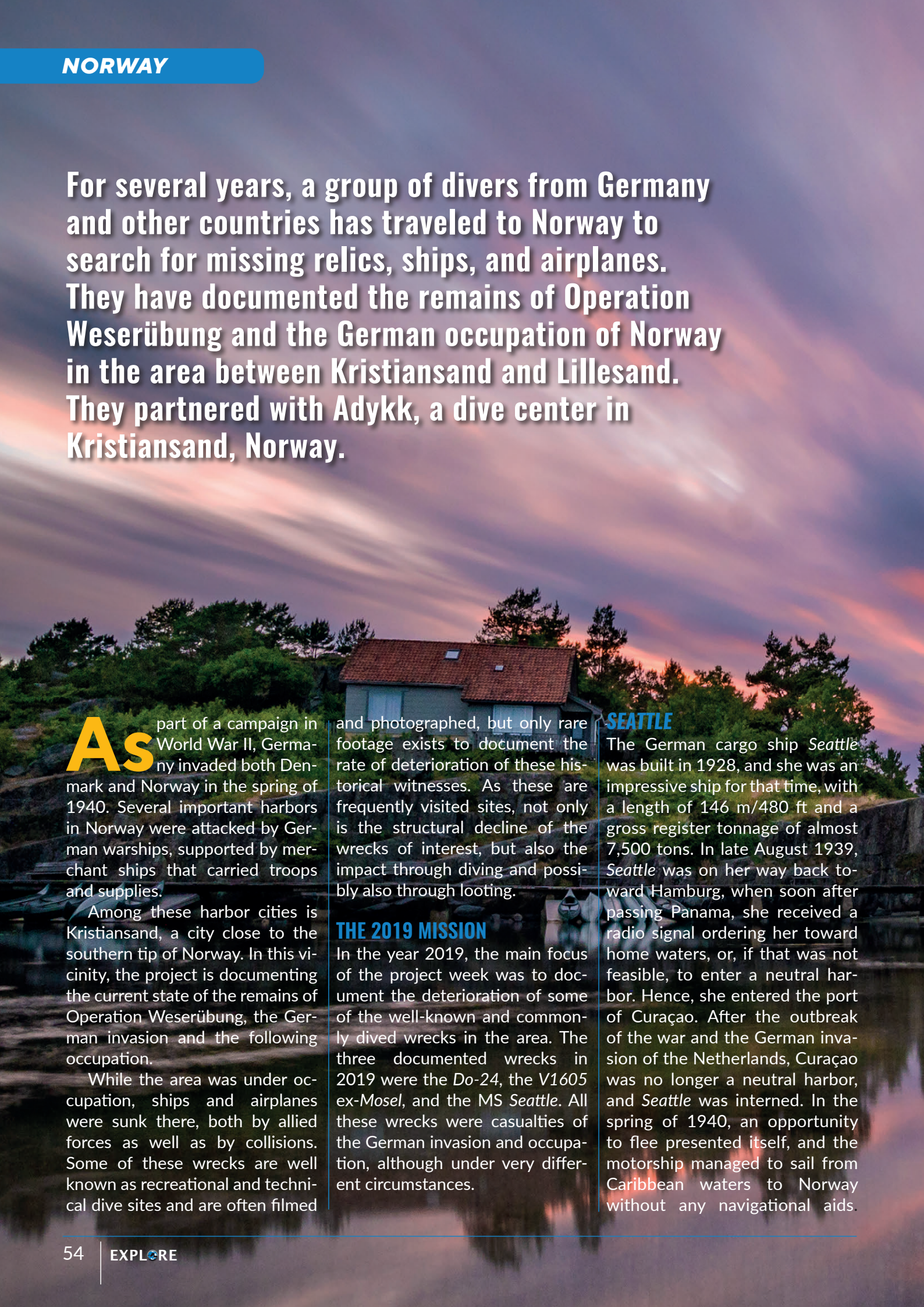
All these questions will be answered during the ongoing wreck exploration weeks that are planned every year.



"AND THE MOST IMPORTANT DISCOVERY STILL REMAINS: THE IRREVOCABLE PROOF THAT THE MYSTERY WRECK IS IN FACT THE *ALMIRANTE BARROSO*."

Almirante Barroso *served as a training vessel for the Brazilian Navy.*

For several years, a group of divers from Germany and other countries has traveled to Norway to search for missing relics, ships, and airplanes. They have documented the remains of Operation Weserübung and the German occupation of Norway in the area between Kristiansand and Lillesand. They partnered with Adykk, a dive center in Kristiansand, Norway.



As part of a campaign in World War II, Germany invaded both Denmark and Norway in the spring of 1940. Several important harbors in Norway were attacked by German warships, supported by merchant ships that carried troops and supplies.

Among these harbor cities is Kristiansand, a city close to the southern tip of Norway. In this vicinity, the project is documenting the current state of the remains of Operation Weserübung, the German invasion and the following occupation.

While the area was under occupation, ships and airplanes were sunk there, both by allied forces as well as by collisions. Some of these wrecks are well known as recreational and technical dive sites and are often filmed and photographed, but only rare footage exists to document the rate of deterioration of these historical witnesses. As these are frequently visited sites, not only is the structural decline of the wrecks of interest, but also the impact through diving and possibly also through looting.

THE 2019 MISSION

In the year 2019, the main focus of the project week was to document the deterioration of some of the well-known and commonly dived wrecks in the area. The three documented wrecks in 2019 were the *Do-24*, the *V1605* ex-*Mosel*, and the MS *Seattle*. All these wrecks were casualties of the German invasion and occupation, although under very different circumstances.

SEATTLE

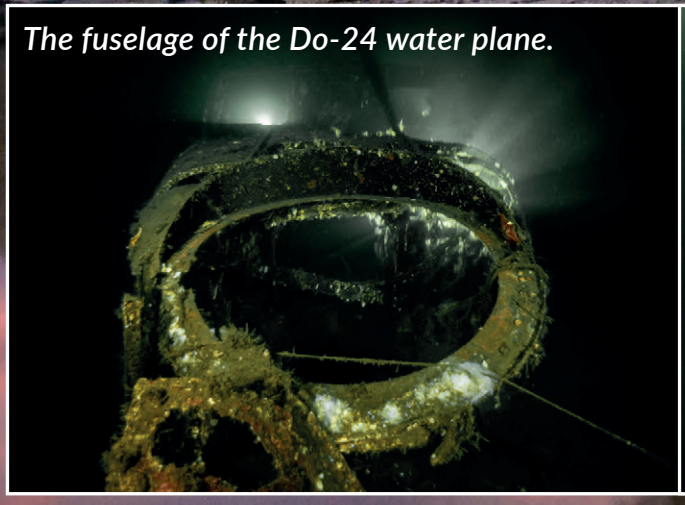
The German cargo ship *Seattle* was built in 1928, and she was an impressive ship for that time, with a length of 146 m/480 ft and a gross register tonnage of almost 7,500 tons. In late August 1939, *Seattle* was on her way back toward Hamburg, when soon after passing Panama, she received a radio signal ordering her toward home waters, or, if that was not feasible, to enter a neutral harbor. Hence, she entered the port of Curaçao. After the outbreak of the war and the German invasion of the Netherlands, Curaçao was no longer a neutral harbor, and *Seattle* was interned. In the spring of 1940, an opportunity to flee presented itself, and the motorship managed to sail from Caribbean waters to Norway without any navigational aids.

TEXT & PHOTOS **DERK REMMERS**

SØRLANDET WRECKS

HISTORIC WRECK INVENTORY

The dive center that supports the project is placed in a beautiful location in southern Norway.



The fuselage of the Do-24 water plane.

Project work on the Do-24 wreck.

As luck would have it, however, at the exact time she arrived in Kristiansand Harbor, Germany began its invasion. Both German and Norwegian forces fired at the *Seattle*, as both sides mistakenly considered it an enemy vessel. The *Seattle* sank and was not found until 1988. Since then, she has become a well-known dive site with a starting depth of 25 m/82 ft at the stern and going down to 71 m/232 ft. In the 20 years of diving the wreck, she has collapsed considerably.

MOSEL

The former fishing trawler *V1605* ex-*Mosel* was seized by the Kriegsmarine and used as a Vorpostenboot (VP-Boat). As such, she escorted the tanker *Inger Johanne* along the coastline of southern Norway in 1944. When she was spotted by Canadian and British fighter planes, she was attacked and, along with the tanker, stood no chance against the 21 Beaufighters and 17 Mosquito aircraft. She sank with all souls aboard but one and rests at a depth of between 35-52 m/115-170 ft. Although first discovered in 2001, she has collapsed since that time, particularly the superstructure and the flak platforms.

WATER PLANE

The third documented wreck is *Do-24*, a water plane that belonged to a German Luftwaffe Seenotstaffel, a sea rescue squadron. *Do-24* was bombed and sunk close to its mooring in front of Kjevik Airport by a Canadian Mosquito fighter plane in April 1945.

The remains of this wreck are remarkably intact, but its condition is declining due to the lightweight aluminum construction but also because this airplane wreck is a well-known and relatively shallow dive site at a depth of 25-35 m/82-115 ft.

ICONIC FEATURES

The goal of the 2019 project was to document the current state of these wrecks with photo and video, to establish a baseline, and then to compare it to older pictures and films, so the deterioration over time can be documented. Moreover, some iconic features and details of the wrecks were captured on video and still photos to have a proof of their position relative to the wreck. So in case of looting, authorities can compare these documents to prove the origin of parts.

A week of diving was combined with the joy of the great southern Norwegian landscape.

TEAM *Natalie Gielen, Rene Gielen, Christoph Pickmann, Anja Koonen, Derk Remmers, Sabine Maigatter, Andreas Müller & Henning Franke*

Adykk's impressive RIB is perfect for the often rough conditions in Norway.

Divers examining the aft flak gun of V1605 Mosel.

TEAM DIVING

TEXT MARK MESSERSMITH & TODD LEONARD
PHOTOS JOAKIM HJELM & JP BRESSER

METHODS & MOTIVATIONS

From buddy pairs to research and exploration projects, divers worldwide are employing team concepts to improve the efficiency, safety, and enjoyment of their underwater experience.

Like other team sports, team diving provides a source for camaraderie and rich friendship.

PHOTO JOAKIM HJELM

Teams are a natural consequence of people recognizing they enjoy each other's company and share common goals and interests. While teams vary greatly in purpose, size, longevity, and degree of formality, team concepts and constructs prove to be useful in many areas of life. Our intent is to provide a brief outline of team diving with the goal of presenting a few concepts you may find useful integrating into your current dive activities.

ROLES AND RESPONSIBILITIES

One basic facet of planning a dive or series of dives is to identify the tasks that may or will need to occur, and to ensure that someone is prepared and planning to fulfill each of those tasks. Creating a variety of roles, and deciding in advance on the aggregate of tasks each role will bear, simplifies this division of responsibility in a couple of respects: First, it frees the planner from having to enumerate each little detail of what may be a fairly complex project by delegating responsibility. Second, it frees individual divers from needing to know exactly what they'll be doing on the day of the dive—they simply prepare for all the tasks their role may be called upon to do, and in so doing reduce the need for last-minute scrambling when plans inevitably change. Third, a team creates a synergism where each member's strengths are incorporated into a program leading to the achievement of goals not easily accomplished or possible by individuals working solo.

Individuals will often take on more than one role concurrently, or trade off roles over the course of the day or from one outing to the next. This aids in minimizing fatigue and helps to keep things interesting for everyone.

While by no means complete, below are a number of roles that can be combined as necessary to meet the needs of a diving project.

A buddy is the most fundamental of all diving team roles, bringing redundancy and direct assistance for all in-water tasks. Buddy diving provides each diver another set of resources, both equipment and intellectual, to assist in an emergency or just to keep things fun and running smoothly.

Lead divers (a.k.a. exploration divers, push divers, etc.) comprise the team fulfilling the primary task for a given series of dives, often with the assistance of other dive teams as described below. The push team often goes deeper, travels farther, and stays longer than any of the other teams. In so doing, they will generally incur greater decompression obligations, use more gear, and require greater assistance.

Setup and cleanup divers move gas and gear from one place to another. The complexity of this can vary tremendously, depending on depths, distances, and the amount and type of equipment to be moved. Some projects may call for subdividing this role by depth and/or distance.

Support divers often focus more on people than gear. They are tasked with monitoring decompressing divers, providing assistance as they switch between dive and deco harnesses or get in and out of habitats, and are prepared to respond to any emergency that may arise. Support divers relay messages to and from the surface, bring down extra gas, and provide other resources as needs evolve. The need for dedicated support divers increases with decompression obligations.

A surface manager is responsible for coordinating roles, for keeping track of how and when all the teams need to interact, and for ensuring people are in the right place at the right time. The surface manager needs to see the big picture and must form plans in coordination with the lead divers. One of the major challenges for the surface manager is in receiving up-to-date information from the support teams.

Another challenge is that the surface manager needs to be very clear with support divers, ensuring that they make the most of their down time—long dive days require rest, rehydration, and nourishment.

Medical professionals shouldn't be needed as a matter of routine, but coordinating their potential involvement does need to be a part of all dive planning. The team needs to know what phone numbers to call in what situations, how to provide or arrange for transportation to a medical center, and needs to ensure up front that any emergency response will be fast and effective. Remote sites present increased challenges in this realm.

The boat captain in ocean diving is another team member who is often overlooked, sometimes considered little more than a hired taxi driver. You might assume they have some sort of first aid training and maybe emergency oxygen, but a wise organizer will confirm that before the dive. The captain's responses to various signals and events should be made clear. For example, some boat captains have never seen a surface marker buoy deployed in a nonemergency situation. Will they keep the boat in place until all divers are on the surface or bring the distressed diver onboard and head for shore leaving decompressing divers still in the water?

Media officers coordinate and assign photo and-video documentary missions and objectives to the dive teams and collect and secure all digital media after the dives.

STANDARDIZATION

Standardization facilitates smooth communication, avoids frustrating delays, increases efficiency, and speeds up critical response time in the event of an emergency. With standardization, we avoid the confusion that inevitably happens when divers employ different equipment or dissimilar procedures.

EQUIPMENT

Gear standardization carries with it a number of benefits that make sense in team diving: First, and by far the most often utilized, are the several levels of redundancy provided by standardized equipment. Virtually all divers have arrived at a dive site to discover someone, a fellow diver or a student, has forgotten some critical piece of gear. Even if they have all their gear, maybe today is the day that not one but two items fail during the pre-dive equipment check sequence. There is rarely a greater sigh of relief when a fellow team member is able to pull a functionally identical replacement piece of gear from a bag to save the dive for the buddy and the team. From wings to lights, from hardware to lost gas, all deficiencies can easily be overcome if everyone has the same type of equipment.

> **“THOROUGH DIVE PLANNING IS IMPORTANT. AT LEAST, A GOOD PLAN MAY SAVE A DIVE; AT BEST IT MAY SAVE YOUR LIFE.**

A second advantage of standardized equipment is in response to scenarios requiring a specific response in adverse conditions. If for some reason an additional light, or worse, a functioning regulator is needed immediately, knowing your buddy has the same type of gear as you do and where that gear is on their body adds a priceless level of redundancy and safety. In the event your fellow team member is the one with the emergency, being intimately familiar with every piece of gear, point of attachment, buoyancy control, etc. makes the emergency response dramatically more efficient.

A third advantage to standard gear is that it ensures consistency in configuration from dive to dive. When divers are constantly reacting and adapting to changes in configuration, it is all too easy to overlook or explain away subtle indications of gear failure or any other aberration, potentially allowing minor issues to cascade into serious problems. Consistency allows divers to rapidly identify anything or anyone behaving differently from the norm and react to it immediately and predictably.

GAS MIXTURES

In lieu of having each diver concoct their own “best mix,” a great advantage is enjoyed when everyone has the same gases. As stated before, if one diver forgets a bottle or has a failure, it is very helpful if the buddies have the same gas to share. This enables the dive to continue as planned and avoids dissimilar decompression schedules that end up like solo diving. Matched gases truly provide a great degree of safety and convenience. Furthermore, use of standard bottom mixes that are suitable for a broad range of depths allows a couple of efficiencies unavailable to “best mix” divers. The team can begin the process of mixing before dive plans are final, avoiding last-minute rush jobs at the fill station. The team can also respond to changing conditions and switch dive sites, retaining a much broader set of options than merely sites at the same depth as originally planned.

Finally, standardized deco gases allow the setup and cleanup divers to maximize their efficiency by moving gear to and from gear depots established at depths that will be required by all team members.

DIVE PLANNING

An honest review of almost any diver accident analysis compilation will reveal a common theme, a lack of proper dive planning. Almost without fail, the majority of dive accidents could have been prevented if all members of the dive team properly discussed and prepared for the upcoming dive. When assumptions are made and shortcuts taken, the door is left open for Murphy’s Law. Conversely, thoughtful communication between divers, support personnel, the surface manager (or boat captain), and the local medical resources greatly reduces the surprise factor and dramatically increases the likelihood of a successful problem resolution in the event something unexpected does occur.

Each member of the team has a role. It is useful to designate one diver as the team leader to facilitate communication and decision making. The various tasks to be accomplished from gear preparation, detailed run time management, decompression

profiles, photo/video, and other critical tasks can be executed by different team members, but it is useful to have each diver aware of the other team members' responsibilities and, if possible, to be able to change roles if required or desired.

It is important to review the dive plan with the boat captain, support personnel, and even the local medical professionals. If an emergency does occur, knowing what to expect becomes critical. Time lost trying to find an important phone number when a diver is in trouble is inexcusable. We often overlook these theoretical contingencies and simply hope that everyone will do the right thing, but when a crisis occurs, what happens next can be a life-or-death situation.

Thorough dive planning is important. At least, a good plan may save a dive; at best it may save your life.

RESULTS

Team diving creates synergism. Much like a football team, it is impossible for one player to simultaneously perform all the tasks necessary to get the ball into the end zone. True success is only possible when all members of the team work efficently and smoothly together, each executing their unique responsibilities correctly at the appropriate time. Historically, diving has been considered an individual sport except in the realm of commercial diving and the military.

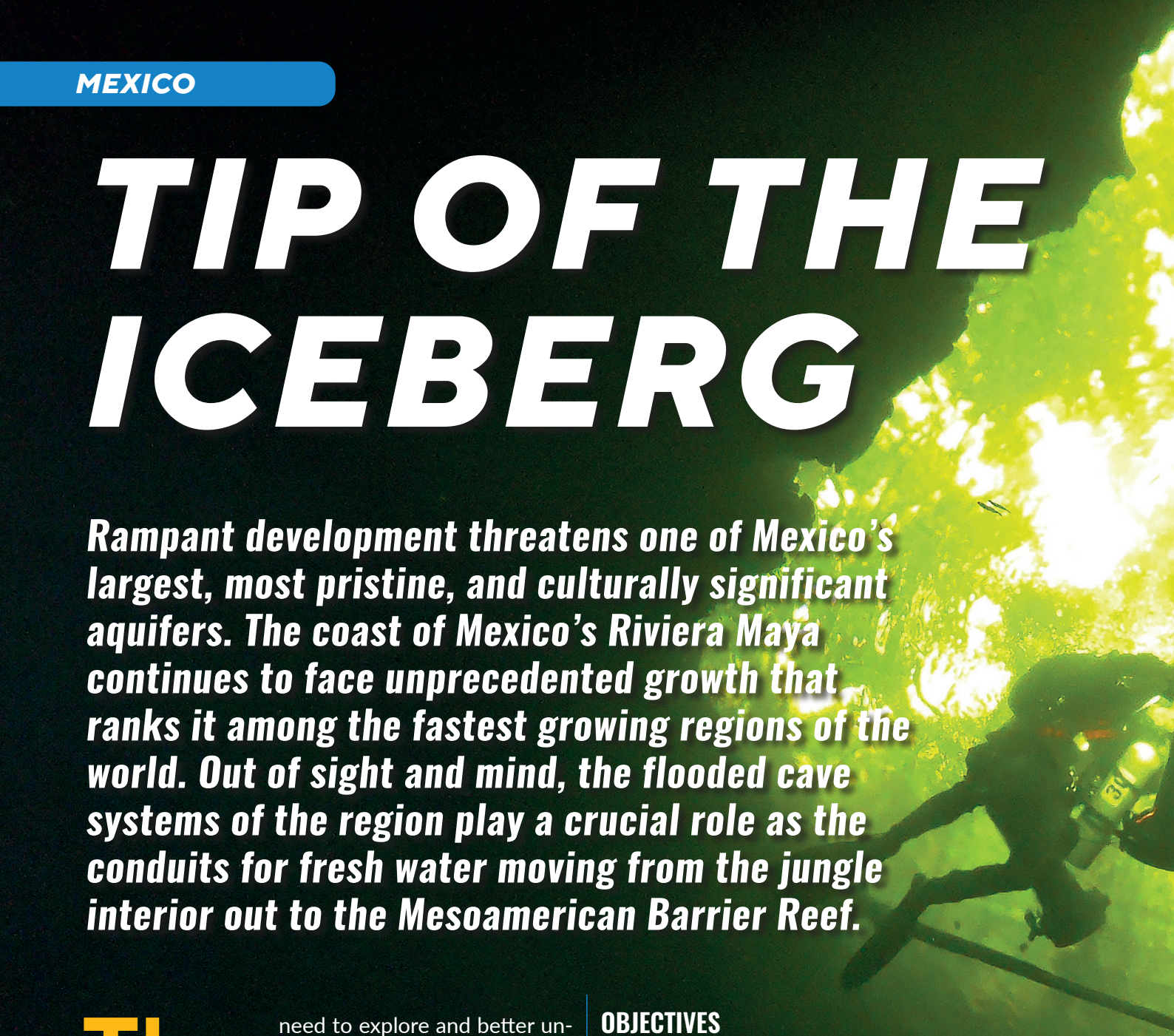
Recently, informed divers have started to incorporate the principles of "team" commonplace with other sports and the workplace. Now, through a collaborative effort, dive efficiency and safety have increased, thereby providing a platform to accomplish greater underwater objectives. World record caliber dives are being accomplished as a consequence of talented, dedicated divers working cohesively as a group in the pursuit of a greater goal.

And finally, there is one other very important aspect of team diving that should not be overlooked. Team diving is fun! Much like other team sports, team diving provides a source for camaraderie and rich friendship that, together with a little nourishment, can provide an unlimited source for countless cherished memories shared.

PHOTO JP BRESSER

Team diving opens opportunities for exciting adventures and challenging dives.

TIP OF THE ICEBERG



Rampant development threatens one of Mexico's largest, most pristine, and culturally significant aquifers. The coast of Mexico's Riviera Maya continues to face unprecedented growth that ranks it among the fastest growing regions of the world. Out of sight and mind, the flooded cave systems of the region play a crucial role as the conduits for fresh water moving from the jungle interior out to the Mesoamerican Barrier Reef.

The need to explore and better understand the aquifer of Northern Quintana Roo is important, as it directly influences the health and economic well-being of the human population above it and the many ecosystems it nourishes from below. Due to the aquifer's extreme fragility and vulnerability to contamination, the development at the surface poses a significant threat to the economic and social welfare of the region. Since this region contributes approximately 10% of Mexico's GNP, the impact of a contaminated aquifer and associated ecosystems would have far-reaching and potentially disastrous results, not only for the region's tourist-based economy but for Mexico as a whole. Cave diving explorers provide a critical knowledge base by mapping the subterranean waterways, providing a foundation for scientific work that ultimately can help us understand and protect the aquifer and the many ecosystems that it supports.

OBJECTIVES

Central to the objectives of CINDAQ (El Centro Investigador del Sistema Acuífero de Quintana Roo A.C.) is to continue exploration of the region's aquifer, to support scientific research, and to raise awareness about the aquifer. We are still convinced that our actions can bring about the necessary change and awareness to help protect the aquifer of the Yucatan Peninsula. In 2019, we have seen our position in the area elevated as a trusted source of information and expertise.

OBJECTIVES FOR 2019

- Continued exploration of the Ox Bel Ha cave system
- Continued support to the Hoyo Negro Project with logistical and diver support
- Refine our use of underwater photogrammetry and apply to new areas.
- Refine how we use Ariane software and the Mnemo cave survey tool

TEXT & PHOTOS **SAM MEACHAM, FRED DEVOS, CHRISTOPHE LE MAILLOT, DANIEL PONCE TAYLOR & SU EUN KIM.**

CINDAQ/ MCEP 2019 ACTIVITY REPORT

PHOTO **SAM MEACHAM**

Divers in Cenote Push in the Ox Bel Ha Cave System.

- Build capacity within our own team and develop the next generation of cave explorers
- Test emerging technologies and develop equipment to expand our capabilities
- Support scientific studies of the aquifer

With these objectives in mind, and the support received from Dr. Robert Lourie, Rami Shakarchi, Rick Guerin, The Mayakoba Classic, INAH-SAS, The Strauss Family Foundation, DroneDeploy, Halcyon Manufacturing, Zero Gravity Dive Center, and Suex, the following actions were realized.

SISTEMA OX BEL HA

The year 2019 was a remarkable year for us, and we were able to build on our efforts from 2018. In the Ox Bel Ha cave system, we have far surpassed our expectations for resurvey and new exploration. Since January 2019 and as of December 2019, more than 55,000 m/181,000 ft of cave passageway was resurveyed, and more than 27,000 m/91,000 ft of new cave passageway was explored. Resurvey and exploration were conducted from 11 distinct entrances within the system and with the assistance of over 20 divers using the Mnemo cave survey tool. CINDAQ has purchased four Mnemos for these purposes, and volunteer divers have contributed the use of their own units. Resurvey enables us to update our data, add more precise observations in our survey notes, and mark leads for further exploration. We have been able to correct survey errors from our previous hand survey and to add lines that we did not have in our original database. The ratio of resurveyed line to new exploration is 2:1. Given this ratio, it is not unrealistic to think that Ox Bel Ha will grow considerably as a result of our future efforts. What would have been an absurd proposition—the resurvey of the approximately 300,000 m/990,000 ft of

cave associated with Ox Bel Ha—now seems very reasonable. The process of resurvey allows us to explore by making more intelligent decisions based on the most precise and updated data for the cave. The results speak for themselves.

REAL-TIME SNAPSHOT

In addition to the resurvey effort, three projects were conducted from Cenote Ya'ax Kai in order to begin a detailed map of the historic section of Ox Bel Ha, where we began to explore in the late 1990s. Working from Ya'ax Kai, divers resurveyed the stretch of line to Cenote Esmeralda. When completed, the map will highlight over 1,000 m/3,300 ft of cave passageway in detail. All participants have been trained in the Global Underwater Explorers (GUE) Cave Survey class, providing us with a capable and motivated workforce.

Our exploration and survey teams are actively diving the adjacent cave systems to Ox Bel Ha. This is important for obtaining a broader idea of the layout, as well as seeking potential future connections to Ox Bel Ha.

We continue to benefit from the seamless integration of the Mnemo and the Ariane cave mapping software. Ariane has allowed us to consolidate all our data and visualize it in one place. We now have cloud storage backup of our data using GitHub and Sourcetree. We have continued to incorporate the data collected by our fleet of drones into Ariane in order to provide a real-time snapshot of what is happening on the surface and how it relates to what we see underwater. We now have coverage of over 2,000 hectares of surface terrain above Ox Bel Ha at a resolution of 10 cm/4 in., and plan to collect more.

HOYO NEGRO

In 2019, CINDAQ continued to support the documentation of the Hoyo Negro site with over four weeks of diver support and logistics. The Hoyo Negro site is considered one of the most significant paleontological sites to be discovered in the Western Hemisphere. Hoyo Negro and the area surrounding it contain one of the oldest sets of human remains found in the Americas, as well as the remains of 42 individual animals representing 14 species, seven of which are extinct. As in past years, CINDAQ aided in sampling, collection, photogrammetry, as well as video and photographic documentation of the site. For the November 2019 field season, CINDAQ sponsored the participation of cave diving pioneer and filmmaker Mike Madden to film the field season. The CINDAQ field truck was also made available to the Hoyo Negro science/dive team for the duration of all fieldwork.

GUE SURVEY DIVER

In conjunction with the Mexico Cave Exploration Project (MCEP), CINDAQ organized and executed three survey projects in May, September, and December in the Ox Bel Ha system. All divers were trained in the use of the Mnemo cave survey tool. Any divers that had taken the Global Underwater Explorers (GUE) Cave Survey course were put to work making a detailed map between Cenotes Ya'ax Kai and Cenote Esmerelda.

MAY PROJECT

Four divers from three countries joined us for our initial efforts to create a detailed map from Cenote Ya'ax Kai to Cenote Esmeralda. During the five-day project, 15 dives were conducted, resulting in approximately 45 hours of cumulative bottom time. Over 1,000 m/3,300 ft of cave passageway was resurveyed between the two cenotes, and sidewall and floor-to-ceiling measurements were taken along the entire passageway. An initial sketching of the first section of the cave was then made.

SEPTEMBER PROJECT

Nine divers from seven countries joined for this project in the Ox Bel Ha cave system. For five days, 26 dives were conducted, resulting in 65 hours underwater. Two dive teams diving from Cenote Gemini focused on a resurvey of existing lines in order to align and update 20 years of previous cave data, as well as setting up for more detailed mapping in the future. In four days, more than 5,500 m/18,150 ft of cave line was surveyed using the Mnemo cave survey tool. Lines that were not previously part of our database were included, and significant errors in our survey database were identified and corrected. Using DroneDeploy software, a total of 1,600 hectares was overflown by our drones producing a surface map of the area at 9 cm/3 in. resolution. The team from Ya'ax Kai cenote began a detailed map of the two main passages headed toward Cenote Esmeralda. After measuring sidewall and floor-to-ceiling distances, details were sketched in. This marks the culmination of GUE Cave Survey trained divers coming together to tackle the complex task of creating a detailed map of the historic section of Ox Bel Ha.

DECEMBER PROJECT

5,500 m/18,150 ft of the Ox Bel Ha cave system was resurveyed, and the detailed mapping efforts from Cenote Ya'ax Kai to Cenote Esmeralda in Sistema Ox Bel Ha continued. Resurvey of the upstream part of Ya'ax Kai has started, too. This is a complex part of the cave with large and extensive

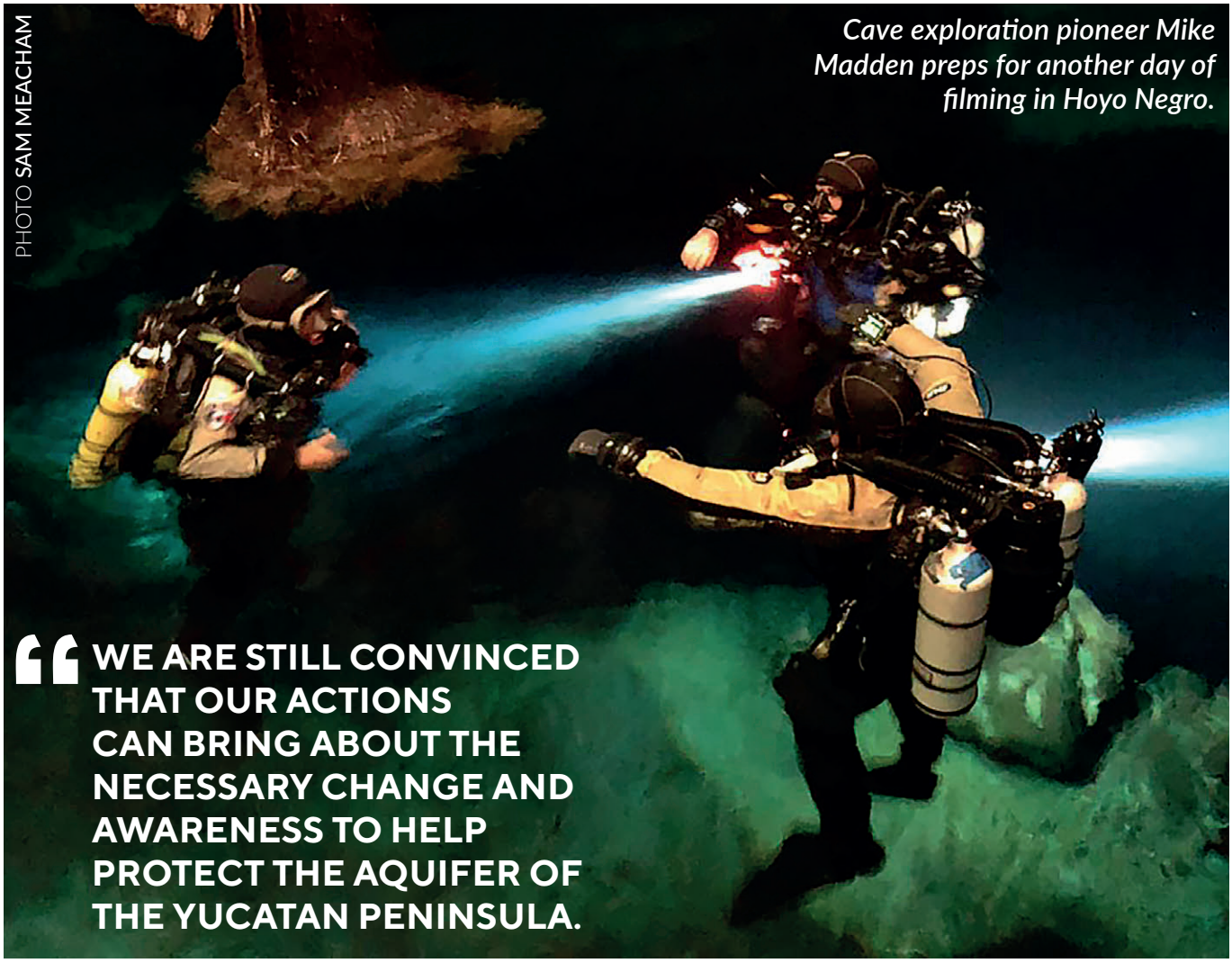


PHOTO SAM MEACHAM

Cave exploration pioneer Mike Madden preps for another day of filming in Hoyo Negro.

"WE ARE STILL CONVINCED THAT OUR ACTIONS CAN BRING ABOUT THE NECESSARY CHANGE AND AWARENESS TO HELP PROTECT THE AQUIFER OF THE YUCATAN PENINSULA.

passageways that lead to iconic cenotes like Coka Ha, Sac U, and Sac Ek.

CITIZEN SCIENCE

For the tenth year in a row, CINDAQ and MCEP (Mexico Cave Exploration Project) aided in a citizen science project under the direction of Dr. Eduard Reinhardt of McMaster University. The value of this collaborative work is illustrated with the recent publication of two peer-reviewed journal papers and an additional one in review from Dr. Reinhardt's students. This brings us to a total of 14 scientific publications since this collaboration began, with several more to come in the new year. These efforts have also made contributions to other initiatives studying Caribbean aquifers in Cuba and the Bahamas (Dr. Mathew Peros at Bishop's University in Canada, and Dr. Peter van Hengstum at Texas A&M Galveston in the United States).

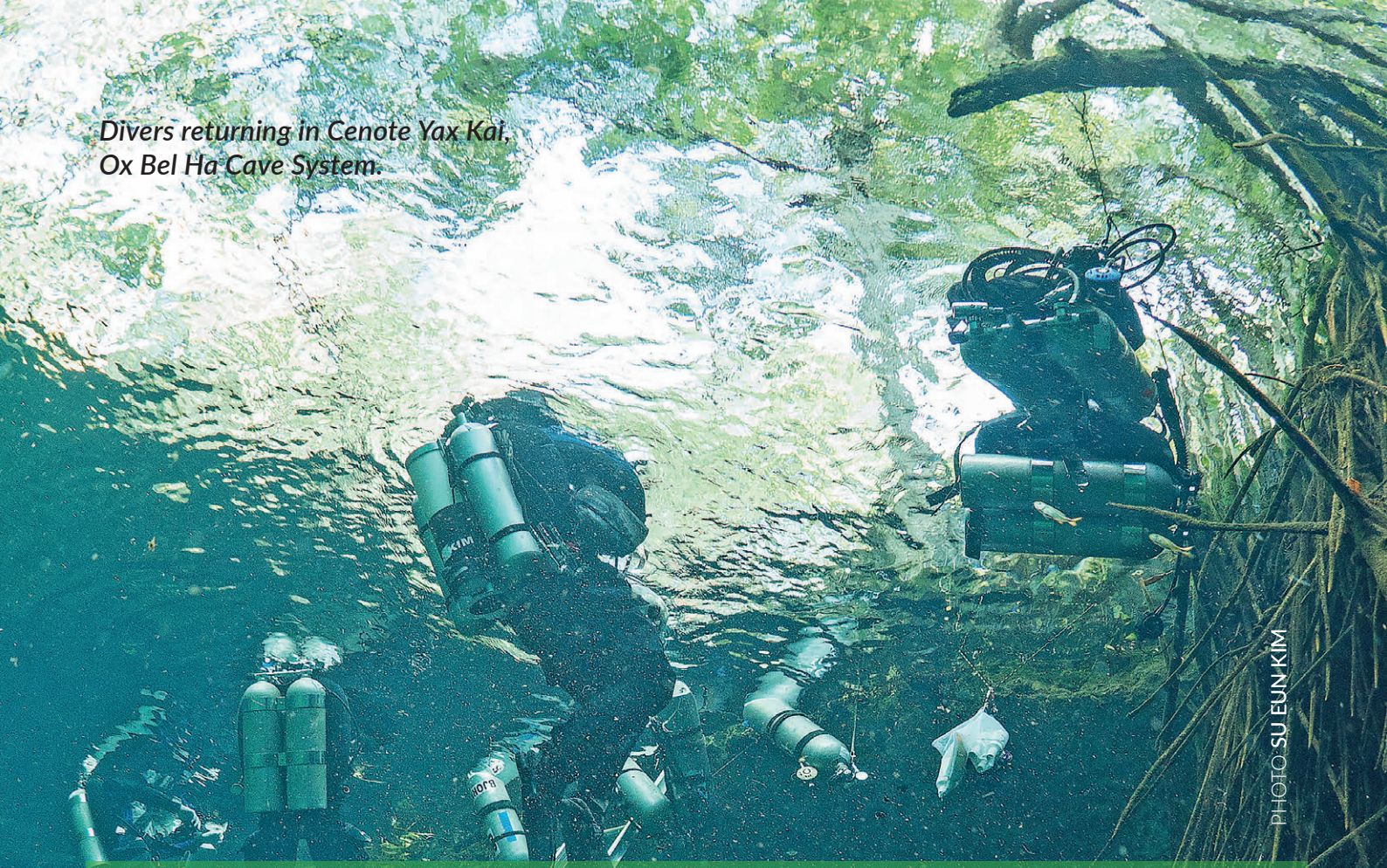
Twenty-six volunteer cave divers representing ten countries joined MCEP and CINDAQ during the science project. During this project, we combined both mapping and scientific objectives. Twelve different sites were accessed to sample water and algae, to replace and install sediment traps, and to conduct plankton tows. In addition, two remote camera traps were downloaded and reassembled, and tests were conducted of an experimental imaging system for 3D modeling of flooded cave passages.

SOUTH CAROLINA UNI CAVE MAPPING PROJECT

In December, as part of our science project and under the direction of Dr. Ioannis Rekleitis of the University of South Carolina, a cave mapping instrument was tested in the caves of this area. The sensor suite constructed at the University of South Carolina collects acoustic (sonar), visual, inertial, and depth information. The collected information can be combined to extract the trajectory of the sensor in space and to create sparse reconstructions of the environment. We look forward to seeing the results of the tests.

DRONE DEPLOY

We are pleased to have been chosen by DroneDeploy (DD) as one of their official NGO partners. CINDAQ now has a complete Enterprise license and access to the full range of capabilities that DD offers.



Divers returning in Cenote Yax Kai, Ox Bel Ha Cave System.

PHOTO SU EUN KIM

In addition to allowing us to map surface features and show elevation and plant health, we can also create 3D models of surface terrain and generate 360-degree panoramic still images that can be loaded into VR/AR goggles.

VIZCORE

Our relationship with University of California San Diego's Cultural Heritage Engineering Initiative continued to grow this year. CINDAQ is now in possession of VizCore, the proprietary visualization software for 3D models that CHEI engineer Vid Petrovic has created. VizCore allows us a great range of freedom to visualize, merge, and interpret the photogrammetric models that we create.

BOXFISH 360-DEGREE AR CAMERA

In the month of May, we were given the opportunity to test a Boxfish Research 360-degree camera in the caves. We filmed in a variety of settings and immediately realized the immense value of this technology. Finally, with 360-degree photographs and videos we have a means to break down the barriers and take people to a place they would never have imagined they would go. Furthermore, with the important paleontological and archaeological sites we discover, the scientists we work with can observe and interpret the sites in much greater detail.

SIDEMOUNT RB80

The back-mounted Halcyon RB80 semi-closed circuit rebreather has been a mainstay of our exploration efforts since the mid-2000s. Chris Le Maillot has now conducted over 15 dives using a sidemount RB80 and spent 60 hours in the water adjusting it to our needs. We now feel confident that, starting next year, we will be able to incorporate the side-mounted RB80 into our tool kit, allowing us to further expand into new areas for science and exploration.

TOP OF THEIR GAME

As we write our report this year, it has come to our attention that the threats to the aquifer continue to mount. It is our genuine hope that our efforts will help encourage further exploration and scientific study of this area, so rich in both natural and cultural treasures. Now more than ever, it is urgent to increase the level of awareness and protect our aquifer. As explorers of the last spaces that humans can physically explore, we still feel we are only seeing the tip of an iceberg. Our team is at the top of their game. Fred Devos, Chris Le Maillot, and Sam Meacham have over 70 years of combined experience and close to 15,000 dives in this environment. This translates into tens of thousands of hours of valuable experience and lessons learned both above and below the water. Our goal is to continue to build and use our expertise to further the knowledge of the

PHOTO SAM MEACHAM

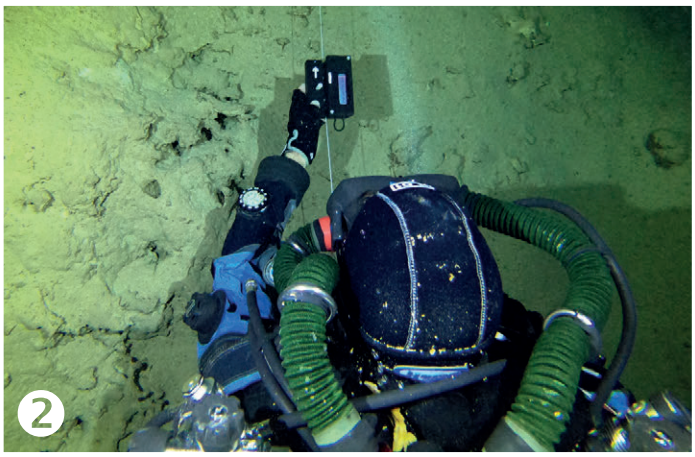


PHOTO CHRIS LE MAILLOT

PHOTO SAM MEACHAM

PHOTO SAM MEACHAM

❶ Mapping team for the May project in Cenote Ya'ax Kai. ❷The Mnemo device in use during cave survey. ❸ Emöke Wagner and László Cseh prepare to dive. ❹Fred Devos with his "disco ball" lighting setup for filming with the Boxfish 360.

extent of these caves. We have limitless opportunities to explore, and a network of dedicated, well-trained volunteer divers to help us. This is what gets us up and out of bed every morning. ❹

We are grateful to all our patrons, volunteers, and supporters.

CINDAQ/MCEP 2019 SCIENCE AND MAPPING PROJECT PARTICIPANTS

Steve Blanchard, Chantelle Blanchard, Sigurd Bowitz, Angie Brown, Paul Brown, Ivo Chiarino, Ken Cochrane, Aaron Coutino, László Cseh, Fred Devos, Alessandro Fenu, Chris Finney, Mathias Frey, Fred Devos, Peter Gärtner, Richard I. Guerin, Dominic Hafner, Paul Hotko, Pirkko Kekalainen, Kyungsoo Kim, Su Eun Kim, Josh Maxwell, Anya Krywy-Janzen, Chris Le Maillot, Oren Levstein, Casey McKinlay, Chelsi McNeill-Jewer, Sam Meacham, Emir Memic, Jong Moon Lee, Gustavo Padilla, Laura Johana Pohanen, Levi Page, Alison Perkins, Mike Pinault, Eduard Reinhardt, Ioannis Rekleitis, Cameron Russo, Zsolt Szilagyi, Manuela Schoch, Michael Spahn, François Tremblay, Mario Valotta, Hens van Oeveren, Flip Vernooij, Alessandro Vezzani, Emöke Wagner, Hildegard Wiggenhorn, Patrick Winkler & Michael Westreicher

2019 EXPLORATION TEAM

Alejandro Alvarez, Sigurd Bowitz, Ivo Chiarino, Steve Cox, László Cseh, Fred Devos, David Dusek, Alessandro Fenu, Mark Garland, Osama Gobara, Bjarne Knudsen, Chris Le Maillot, Gideon Liew, Sam Meacham, Casey McKinlay, Alberto Nava, Ali Perkins, Cameron Russo, David Watson & Emöke Wagner.

MCEP/CINDAQ Valued Contributors

Mario Arena, Franco Attolini, Susan Bird, Roberto Chavez Arce, Alessandro Fenu, Jarrod Jablonski, Dr. Todd Kincaid, Richard Lundgren, Mark Messersmith, Gina Castillo, Dominique Rissolo, Per Thomsen, Mario Valotta & Dr. Chris Werner.

More at *www.cindaq.org*

OLIERO

– CAVE SURVEY

Oliero is a massive and beautiful cave system. It has been well known since the 18th century and has been explored several times in the last 30 years. Unfortunately, no accurate map had been made–until now.

The adventure began in 1988, when Luigi Casati and Jean Jacques Bolanz first explored the system. From 1988 to 2004, Casati put forth great effort toward exploring the entire underwater system and succeeded in exploring almost all of syphon 1. He also explored both the Covol dei Siori and the Covol dei Veci branches, where he discovered and visited the active tunnel.

In 1994, Olivier Isler dived the deeper part and explored within two kilometers from the entrances. In 2004, Rick Stanton and John Volanthen went beyond syphon 1 when they dived all of syphon 2, adding another 1,000 m/328 ft to the exploration. In 2012, another team consisting of Alberto Cavedon, Günter Faul, Pedro Balordi, and others went again to syphon 2 and further explored the dry part.

FORGOTTEN TUNNEL

Four years ago, Alessandro Fenu and Antonio Tedesco decided to search for the forgotten active tunnel. Alessandro spoke with Casati and read his old texts, wherein he mentioned finding a big tunnel with lots of water flow. After several dives they found it again. Then, two years ago Fenu, Tedesco, and Casey McKinlay dived the entire active tunnel and succeeded in reaching the end of it. Unfortunately, it seems that there is no prosecution.

So far, the main European explorers had dived Oliero, and their focus had been on extending the penetration and the knowledge of it. The entire system had never been surveyed, and therefore no accurate map had been made.

SURVEY EFFORTS

Last year we decided to survey the cave at least until the first bypass that connects Siori and Veci. We did it using the Mnemo tool, an amazing instrument that increases survey quality and precision. With Mnemo, we moved quickly and efficiently while we surveyed. That made it possible for us to reach our goal—to remain within three hours of deco for every dive.

This year a new challenge inspired us. We wanted to map the whole Oliero System once and for all through the end of sump 1 and into all known underwater branches. Exploiting the data from last year, and thanks to the Suex and Blueprint Subsea technologies, we took a big step forward. We had

TEXT **STEFANO GUALTIERI**
PHOTO **STELLA DEL CURTO**

> **“THE POSSIBILITY OF MAPPING ON THE FLY GAVE US THE CHANCE TO SURVEY THE ENTIRE SYSTEM, ENSURING DATA, QUALITY, AND PRECISION AT THE SAME TIME.**

an opportunity to use a revolutionary inertial navigation system, complete with sidescan sonar and front- looking sonar carried on board of a Suex dual-DPV system. The possibility of mapping on the fly gave us the chance to survey the entire system, ensuring data, quality, and precision at the same time.

Alessandro Fenu, Antonio Tedesco, Diego Aldegani, and Stefano Gualtieri, with the support of Marco Costantini as surface manager, were able to reach the goal. The first windows of good weather were at the end of December 2019 and in January 2020. In eight dives, we did the job. We dived a total of 35 km/21 miles underwater, spending more than 15 hours scootering, making 25 hours of deco in water that was 8 °C/46 °F.

UNBELIEVABLE TECHNOLOGY

The Suex and Blueprint technologies onboard the unit worked flawlessly, and after some post-production work, we now have a 3D interactive model. It was the first time that these technologies were used to survey a cave. In order to be sure that the collected data was precise, we overlaid last year's work with the new one. We can say that the data is consistent. So important a cave, with that massive water flow, placed under a big plateau, deserves to be completely understood and displayed. We also hope that our work will be used by scientists to help take better care of our territory and improve its conservation.

We have already produced a dynamic KLM map version, and we are now working on a 2D cartography map. All our work will be released as open source in the future, and of course, we are continuing on with our exploration.

TEAM *Alessandro Fenu, Antonio Tedesco, Diego Aldegani, Marco Costantini & Stefano Gualtieri*

VIDEO *www.facebook.com/alessandro.fenu.589/videos/10222675756548318*

RHIB FEST

GUE Seattle, GUE BC, and Eight Diving combine forces to introduce new GUE divers to diving from rigid hull inflatable boats (RHIBs) and to some of the historic wrecks in Lake Washington.

TEXT **GUY SHOCKEY** PHOTOS **ANDREA PETERSEN, DANIEL GELDOF & KEES BEEMSTER LEVERENZ**

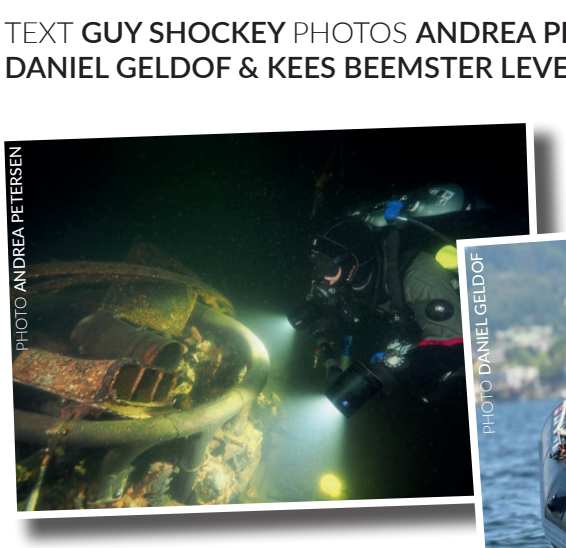


PHOTO ANDREA PETERSEN


PHOTO DANIEL GELDOF


PHOTO DANIEL GELDOF

Lake Washington was home to three days of RHIB diving for members of GUE BC, GUE Seattle, and Eight Diving during the first week of August 2019. The dive charters were organized so some of the newer GUE recreational and technical divers and students from Eight Diving would get a chance to dive from RHIBs and experience some of the excellent wreck diving in the lake. Many of the best dives in this 60 m/200 ft lake require boat access and top cover because of all the boat traffic. Jay Olsen was the admiral of the flotilla with his tricked-out RHIB. Coll Jaxen, Andrea Petersen, and I provided squadron support with our own RHIBs. We managed three days of diving with three dives a day in some beautiful, sunny weather. The lake is very warm at the top 6 m/20 ft in the summer, and this combined with the warm August topside weather made for some beautiful days. We had local attendance as well as divers who traveled from Vancouver, Vancouver Island, and even both Alaska and Florida. In a show of solidarity, a group of like-minded divers came together to share the underwater world in a perfect example of community building. Priority was given to new divers, many of whom were experiencing wreck diving for the first time. Some of the more experienced group members provided surface support and even helped carry gear.

RECREATIONAL DEPTH PHOTOGRAMMETRY

While part of our goal was to provide an opportunity for new GUE members to dive some unique sites, we also wanted to introduce them to photogrammetry project diving. Kees Beemster Leverenz led a group of recreational divers on several dives on the Wolf Bay wreck a small, relatively intact boat in about 15 m/50 ft of water.

The project demonstrated that photogrammetry is a terrific team-building opportunity at the recreational range, where GUE divers could use their solid fundamental skills to maintain position and manage lighting for the photographers. Kees put the gathered data together and produced the model attached. Personally, I have always looked at diving as an enjoyable means to an end, and this project demonstrated how much fun project diving can be.

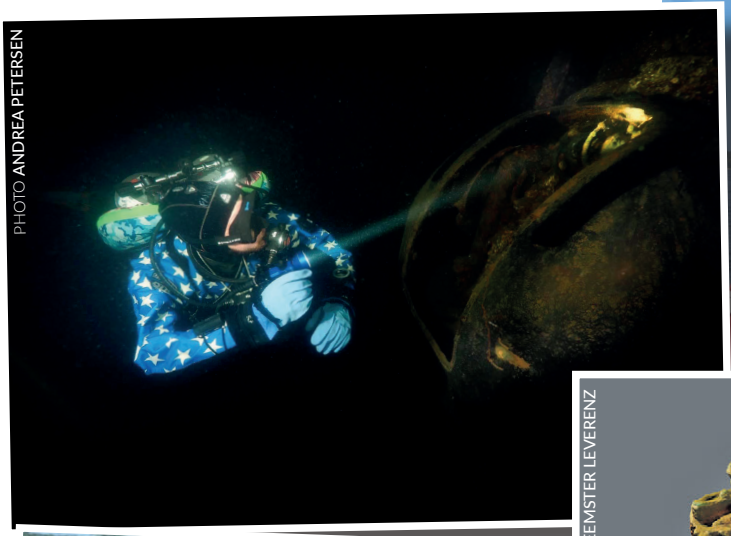


PHOTO ANDREA PETERSEN


PHOTO ANDREA PETERSEN


PHOTOGRAMMETRY KEES BEEMSTER LEVERENZ


PHOTO DANIEL GELDOF

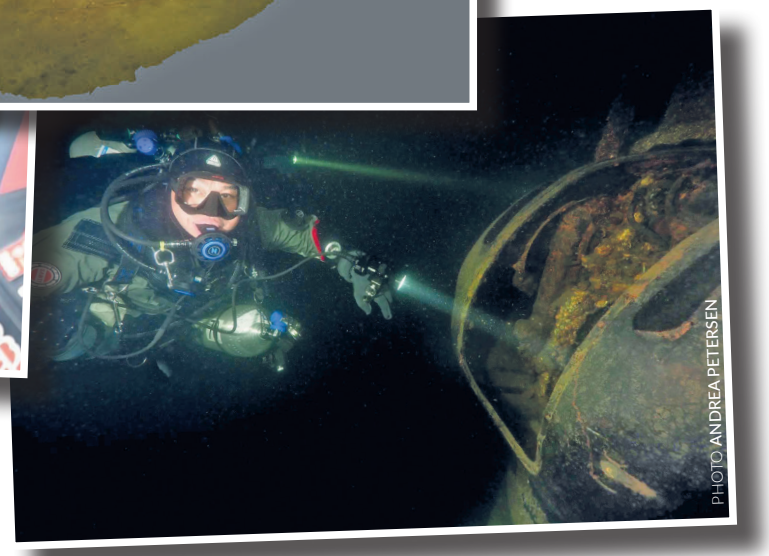


PHOTO ANDREA PETERSEN

ALASKA INVASION

Ron and Alex Fancher from Dive Alaska were in the neighborhood for some DPV training, so they also had the opportunity to experience Puget Sound hospitality. We teamed them up with some of our newer technical divers and dropped them on the *PB4Y* bomber in the lake. Andrea and Kees were the technical group's dive guides as well as paparazzi, both above and below the water. The Alaska mafia brought their own special style to our three days of fun and helped make everything more memorable for all.

PROOF OF CONCEPT

One of the additional goals of our event was to demonstrate that not all projects need to be pinnacle events that need months of planning and heavy logistical support. Groups of like-minded divers around the world can create and run their own local projects and provide valuable experience at the "minor league" level that is necessary before stepping up to the "major leagues." I am frequently asked, "How do you get the experience needed to participate in some of the really amazing world-class GUE projects?" The short answer is of course, "gain experience," but just how do new divers do this? I believe we can introduce our new divers to local projects like we did above, and they can gain experience while under the mentorship of more experienced project divers. Our three days of diving proved this works, and our results speak for themselves. Stay tuned for RHIB Fest 2.0!

TEAM *Jay Olsen, Coll Jaxen, Heidi Kirk, George Ringer, Devon Ringer, Young Kuah, Myra Wisotzky, Alex Fancher, Ron Fancher, Orie Braun, Colin Miller, Michael Wong, Chor Li, Daniel Geldof, Daniel McMath, Yui T, Kees Beemster Leverenz, Andrea Petersen & Guy Shockey*

COLLABORATIONS

TEXT MARCUS ROSE
PHOTOS SHINGO ISHIDA & LIVING SEAS

GUE's pursuit of excellence across its three pillars—education, conservation, and exploration—has led to numerous collaborations since the organization's conception in the late 1990s. Close links with decompression research scientists, conservation bodies, and leading manufacturers have facilitated success throughout GUE's diverse pursuits. These collaborations give divers a genuine sense of purpose in their diving and add credibility to projects.

This article will identify some of the benefits and challenges of collaborations, highlight the fact that their advantages are worth the time and effort invested in developing them, and demonstrate that the combination of highly capable divers as well as scientific expertise can produce outstanding results. To demonstrate the strength of collaborations, this article will conclude by showcasing a number of recent community-level GUE and Project Baseline collaboration efforts.

WHY COLLABORATE?

Collaborations are often the key to generating meaningful goals for project divers. While exploring a new dive site is a perfectly valid reason for diving, project diving by its very definition suggests more ambitious goals. If the aims of a project are to simply document a site, this can be performed to a high standard by divers independently. However, having an output for a project adds interest and provides additional motivation for divers. This motivation is key to generating and maintaining teams of divers effective in quality data collection, an essential skill for productive collaboration.

Collaborations are also a great way to raise awareness of the growing challenges affecting the underwater world. Divers passionate about the environment they dive in routinely discuss their dives with those close to them, but in order to protect these environments, the general population and governing bodies need to be aware of what lies beneath the surface. A wonderful benefit of joining forces is that data collected reaches a broader audience. This benefits education and also demonstrates to commercial and political entities that change is needed to protect these essential environments.

Collaborations with citizen scientists can be challenging for scientific and conservation organizations. Collecting data underwater requires that divers not only be competent, but also that they possess the tools and the skill sets that enable them to collect quality scientific data. The fact that many divers outside the commercial diving world do not possess these skills often discourages potential partners from engaging with the recreational diving community. While the lack of sufficient skills is often not the case within GUE's communities, demonstrating this to external agencies can be challenging.

Despite the various challenges, forming mutually beneficial partnerships is ultimately advantageous. Not only are there previously mentioned advantages for the divers, but the potentially larger volume of data collected for analysis as a result of the collaboration efforts also benefits the science community. Citizen scientists can be a less expensive and more readily available source of data than commercial divers. But for scientists to expand their use of the recreational diving community, it is important that those participating make the effort to develop applicable skills and produce the best quality data possible.

Removing lost fishing gear is a rewarding activitity, but it requires capable divers with solid skills.

EXAMPLES

The challenges associated with project diving should not discourage less-experienced divers from getting involved. The majority of projects have spaces for and welcome those new to project diving. Only by taking the plunge and getting involved can divers build their skills and progress onto more demanding projects. Another way to get started with project diving is to consider the many available courses that develop appropriate skills. These include Documentation Diver, Scientific Diver, and Photogrammetry. Finally, Project Baseline is a fantastic way to get started. The range of data collection can be scaled to meet the diver's ability, and the Baseline team provides excellent support for those that are new but enthusiastic.

The following projects, which demonstrate the value of collaborations, are just a snapshot of the fantastic partnerships being explored around the world.

GHOST NETS

Divers all over the world are getting involved in the removal of lost and abandoned fishing gear; this is a fantastic example of the benefit of collaborations. Organizations such Ghost Fishing UK and Ghost Divers offer divers a challenging and rewarding goal for their efforts. The piles of nets and pots on the jetty at the end of a dive is perhaps the most obvious and immediate reward for being involved with projects like these.

Although this is not exclusive to GUE divers, the fishing gear removal effort benefits from their solid skill sets; GUE divers' capacity and comfort in the water allows net removal to take less effort and therefore be more efficient.

DEEP SPONGE EXPLORATION BC

Over the past year, GUE divers in British Columbia have had a unique opportunity to join the Deep


PHOTO LIVING SEAS

The reef restoration projects in Bali are a result of collaborations on many levels.

Sponge Exploration Team in the waters of Howe Sound, Canada. The goal of the project is to ground truth and document the enormous and prehistoric glass sponge reefs and bioherms that are located outside recreational diving limits.

The team has been collaborating with the Marine Life Sanctuaries Society of British Columbia (MLSSBC) and the Underwater Council of British Columbia (UCBC). The information gathered is used to assist in formulating an ongoing management plan to protect the sponges. The previous work done by MLSSBC and UCBC aided in the creation of several Marine Protected Areas in the Strait of Georgia and Howe Sound, which was only made possible by the dive team's delivery of sound data.

Nick Bowman, who supports the collaboration, explains the benefits of working with these bodies. "It has been a very exciting and rewarding project thus far. The principal team creator is very happy with the skill set we've brought to table."

CORAL CONSERVATION PROJECT

A group of GUE divers has been leading a coral planting conservation project in Bali and Jakarta. By attaching coral to modular frames on the reef, the divers are able to regenerate coral populations. This conservation effort is being conducted in collaboration with the Coral Triangle Centre and Kopernik.

The dive team has learned a great deal from collaborating with these respected and knowledgeable marine conservation organizations—both of which helped to legitimize the project. The partnership has also introduced the team to others involved in the conservation scene in Indonesia and Bali, and information sharing and networking have been hugely beneficial.

In the case of Kopernik, the team embarked on two separate projects, one to assess bioplastics degradation in the marine environment, and another to scientifically assess the efficacy of different reef restoration methods and substrates. In both cases, the group in Bali has also benefited from strong social media and awareness campaigns, bringing reef conservation issues to the general public's attention. Team members also benefit from the interaction between scientific entities—learning a great deal from the more established organizations about the conservation processes and public awareness of local issues.

REWARDS

A diver's engagement in project work is usually motivated, at least partially, by the sense of achievement that comes with utilizing their hobby for a greater cause. The examples within this article support that and clearly demonstrate how rewarding this work can be. What's less obvious is the benefit to the non-diving collaborator. To be effective, collaborations require divers to be attentive to the needs of the non-diving entity. Forming strong, mutually beneficial collaborations can be time consuming and require hard work, but the reward for doing so is well worth it.

REEF REHAB

TEXT **LEON BOEY** PHOTO **ALBERT LINCOLN**

For the past two years, GUE divers have been contributing to an ongoing coral planting project that aims to rehabilitate a damaged reef. Operating out of Padang Bai in Bali, Indonesia, the divers have been using a reef rehabilitation methodology consisting of coated metal structures called Reef Stars to rebuild the damaged reef.

The coated metal structures were developed with funding from Mars Incorporated. The six-legged structures measure 80 cm/2.6 ft across and 30 cm/1 ft high, resembling a spider or a star. These structures are coated with an anti-rust agent, then coated with sand to produce a substrate that corals attach themselves to.

By attaching coral fragments to these structures, they are elevated above the sand, allowing the corals to get nutrients from the current and reducing death from sand particles damaging the exposed flesh of the coral.

Corals are attached securely to the metal frames using cable ties, which stabilize the coral and allow them to grow and attach permanently to the frames. The small size of the structures allows for easy deployment by divers; the modular nature of the structures also allows for flexibility in the construction of the reef, going over or around existing obstructions such as rocks and other corals.

THE SITE

Mimpang was chosen as the first site for this project. This site consists of three large rocks that are located in the main current flow with very deep water on one side and a shallow ridge on the other. The shallow ridge is almost fully overgrown with branching *Acropora* colonies; however, there is evidence of fish bombing activities in the past, resulting in large dead areas over the entire ridge.

After over a decade of diving at this site, there has been no evidence of natural rehabilitation, due to the strong current and sandy bottom, making it difficult for larval coral to naturally recruit and grow. In fact, the dead areas are expanding, encroaching on the living coral colonies due to debris moving around in the dead areas and damaging the bases of the live coral colonies.

THE PROCESS

In June 2018, we decided to rehabilitate this reef and began the process of procuring the Reef Stars and planning the project. The process begins with sinking the Reef Stars and arranging them into a mesh that is anchored together and to the seabed using long metal stakes.

The size and modular nature of the structures allows a single diver to carry and combine it with the existing mesh structure, allowing the entire site to continue growing as we add more pieces.

Broken coral fragments are then rescued from the surrounding area, cleaned up, and attached to the metal structure using two cable ties each.

Having learned excellent dive skills from GUE, we were able to perform these activities without any impact to the existing reef or substrate.

The use of doubles and stages also assisted in allowing us to stay down longer and increased productivity and efficiency.

THE RESULTS

Within two months of attaching the corals, there was visible growth in the size of the coral. By the third month, permanent attachment was visible as the coral started to grow over the cable ties and onto the metal frames. Fish life moved immediately into the area above the structures, resulting in a vibrant reef where there was once only sand and rubble. After a year of maintenance and monitoring of

> HAVING LEARNED EXCELLENT DIVE SKILLS FROM GUE, WE WERE ABLE TO PERFORM THESE ACTIVITIES WITHOUT ANY IMPACT TO THE EXISTING REEF OR SUBSTRATE.

Marcellyna Citra carries a Reef Star to its final home on the seabed at Mimpang.

the site, the corals have grown so thick and large that, in some areas, you cannot see the structures underneath the corals.

ONGOING EFFORTS

Due to the early success of the project, we have plans to continue this indefinitely, eventually covering up the 50x100 m/160x300 ft dead area in the coral fields. Since 2019, we have also started up another site at Baung Penyu off Padang Bai, as well as in Seribu off Jakarta, in the hopes of increasing the diversity of the reefs.

Currently, we have almost 300 Reef Stars in the water over three different sites, covering about 200 m^2/2,150 ft^2 of the seabed. The beauty of the methodology we have chosen is that it is relatively easy to continue adding to the reef we have built piece by piece.

We are also introducing this activity to other divers on our regular day trips by inviting them to participate and plant their own reef. In the process, we are exposing them to the importance of having good dive skills in order to participate in projects like this, as well as gaining an appreciation of how corals are vital to the continued health of the reef.

TEAM *Leon Boey, Agus Triawan, Aryo Damar, Fikri Hudah Falah, Kevin Esteves, Ryan Koesuma, Marcellyna Citra, Arthur Lee, Albert Lincoln, Pamela Wikarta, Brett Sutton, Ho Peck Kheng, Sam Boh & Bel Goh*

ALEXANDRIA BAY DIVE PARK

Over the past several years, members of Northeast Underwater Explorers have worked together to construct an underwater dive park in the St. Lawrence River in upstate New York.

TEXT & PHOTOS **BOB SHERWOOD**

The Thousand Islands region is a freshwater paradise for divers. It spans approximately 80 km/50 miles along the St. Lawrence Seaway, between New York and Ontario, with shorelines in both the United States and Canada. Running through one of the largest water shipping routes in North America, the area is home to hundreds of wrecks, breathtaking underwater structures, and an abundance of unique North American wildlife. There are numerous dive spots that are suitable for divers of all skill levels, from introduction dives all the way through the advanced technical decompression dives, as well as multiple dive sites for easily accessible shore and boat entries.

ONGOING EXPLORATION

It comes as no surprise, then, that an active dive community has grown strong in the region. The Northeast Underwater Explorers (NEUE) have served as the cornerstone of GUE activity in the area. With the cooperation of the Bonnie Castle Resort and Marina in Alexandria Bay, NEUE has developed a large shore-accessible dive park.

Thanks to year-round ongoing exploration and maintenance, the park is constantly evolving and growing, while new underwater highlights are discovered, marked, and mapped.

BONNIE CASTLE UW PARK

Access to the underwater park is located in the marina at Bonnie Castle Resort in Alexandria Bay. This area is suitable for divers of all skill levels, and it includes features such as:

- Custom-made dive benches large enough to hold gear for a dozen recreational divers at a time and a large lawn for staging gear.
- Easy underwater access to two 3x5 m/12x16 ft wooden training platforms. These are a 15 m/50 ft shallow swim from the shore, and are situated at a depth of 10 m/30 ft in a low current area. They serve as an ideal training location for classes of all levels.
- A large underwater mirror which serves as an invaluable training aid.
- A well-marked recreational area, which starts directly below the training platforms at a depth of 20 m/66 ft, and is clearly marked with cave line and custom printed markers. Highlights include an abandoned car, a shipwreck, and other various underwater structures.

ADVANCED EXPLORATION

Beyond the recreational area lies 4.8 km/3 miles of cave line leading to other underwater highlights. Due to the strong currents, long distances, and ev-

PHOTO BOB SHERWOOD

For technical dives, the gear is easily staged within arms reach of the water.

PHOTO BOB SHERWOOD

PHOTO BOB SHERWOOD

A NEUE diver drives a stake into the bed of the river.

er-changing lines, the use of DPVs is highly recommended here.

Upstream from the recreational area about 60-90 m/200-300 ft, cave line leads directly to the remains of the *Islander*, a 19th century steamboat and one of the most popular shore dives in the area. Downstream from the *Islander* lies the most actively explored area, which has yielded the discovery of new wrecks (on average one a year for the past few years), as well as other artifacts, such as wagon wheels, discarded anchors, and countless antique bottles.

Occasionally, the line branches directly away from shore and into the river into deeper terrain. For example, a line traversing 120 m/400 ft directly across the river's current connects the recreational area to the base of Sunken Rock Island, whose breathtaking underwater cliffs exceed 60 m/200 ft in depth. A line runs around the island and also connects a few hundred feet away to a late 19th century steam-powered yacht known as the *Catherine*.

FUTURE PLANS

Exploration of the new area and maintenance of the mapped area is a year-round endeavor. During the summer, Northeast Underwater Explorers hosts workshops at the dive park. Topics include scuba fundamentals and DPV skills, as well as underwater surveying, laying line, staking, and map and compass skills. These workshops have attracted divers from across the country, growing and strengthening the network of like-minded divers while augmenting the ability of the community to maintain and grow the dive park.

TEAM *Bob Sherwood, JonPaul Vanier, Josh Brewer, Heison Chak, Warren Lo, Lisa Goodlin, Christian Lundkvist & Stephanie Yang*

FIREWORKS ANEMONES

Scottish sea lochs are special places that mimic the dark, still conditions normally found in much deeper waters. They offer a unique opportunity for recreational divers to monitor species that would normally be out of reach.

TEXT & PHOTOS **VANESSA CHARLES & MARTIN HYND**

In the 1980s, the pioneering UK diver and author Gordon Ridley observed that a new sea anemone had been found in Loch Duich. One of many fjordic lochs on the west coast of Scotland, they have long been popular with recreational divers who value the year-round sheltered conditions they provide. The large areas of deep mud they contain may not immediately seem exciting, but the anemone that Ridley mentioned, *Pachycerianthus multiplicatus*, is one of several impressive species that thrive in this habitat. Commonly known as the fireworks anemone, its long, elegant tentacles can spread to well over 30 cm/1 ft across.

In recent times there has been growing concern over the vulnerability of benthic species in Scottish waters. Seabeds are regularly dredged for scallops (*Pecten maximus*) or trawled for langoustines (*Nephrops norvegicus*), causing catastrophic damage to a range of marine habitats. Communities of burrowing megafauna such as fireworks anemones and tall sea pens are particularly susceptible to damage due to their slow growth. Fortunately, a number of marine protected areas (MPAs) have been designated under national legislation, including Loch Duich and its neighbors, Loch Alsh and Loch Long. One feature of these lochs is their extensive burrowed mud habitats.

SEASEARCH

It is not coincidental that the 1980s were a time when new species were recorded in Scottish sea lochs. There was a great deal of enthusiasm and knowledge among a growing number of non-professional divers, which was harnessed when the UK-based Marine Conservation Society devised a citizen-science recording scheme called Seasearch. Several decades of data have now been collected, with the aim of mapping out the various types of sea beds found in the near-shore zone around the whole of Britain and Ireland. In addition, individual species and their abundance are logged, the richest sites for marine life are identified, and the sites where there are problems are noted. Participating divers are trained in recording skills, and the quality assured data goes toward national decision making.

Much work has been done by Seasearch divers over the past 14 years in assessing the distribution and abundance of fireworks anemones in Scottish sea lochs. The findings of a number of anemone-specific surveys were compiled in a 2013 report, authored by Owen Paisley, Seasearch coordinator for the west of Scotland. It was a substantial achievement, and further surveys are anticipated.

LOCH ALSH

One of several locations noted for further study in the Seasearch report was a small, semi-enclosed basin in Loch Alsh, close to the famous Scottish landmark Eilean Donan Castle. When it was suggested that a Project Baseline initiative be set up in the area, this site was investigated, along with a number of other shore-accessible options. Having discovered a substantial colony of fireworks anemones in the basin, the chance to combine an ongoing Project Baseline study with further Seasearch surveys was presented.

The Fireworks Anemone Monitoring Project in Loch Alsh was set up in 2019. The main aim is to monitor individual anemones within the population on a long-term basis, with a view to recording size, appearance, closely associated species such as *Myxicola infundibulum* and, ultimately, growth, reproduction, and longevity. In addition, there are regular temperature and visibility checks. The team currently managing the project lives in close proximity to the site, and the loch's sheltered conditions enable them to dive there in all seasons and weather conditions. High levels of rainfall on the west coast of Scotland result in periodic spates of fresh water runoff, and the anemones appear to benefit from the associated organic material that eventually settles on the bed of the loch.

The anemones selected for study are at a depth of 15-16 m/49-52 ft. There is a small wreck on the seabed close to the upper depth limit of the anemone colony, which quickly became a useful reference point from which individual anemones could be located. A permanent guideline was installed next to the wreck running parallel to the shore, and pieces of plastic piping have been pushed into the soft seabed next to specific anemones to create several study stations.

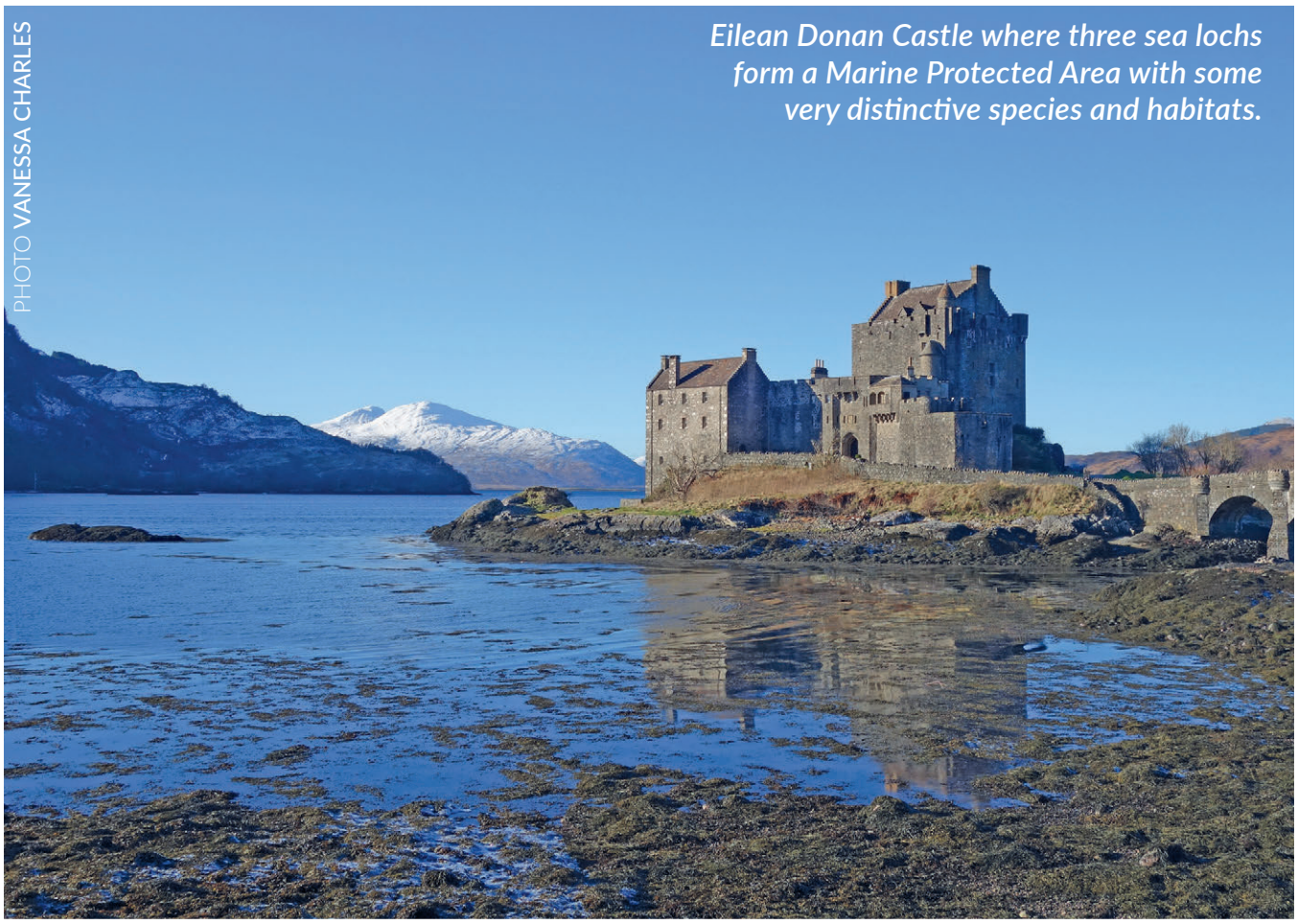


PHOTO VANESSA CHARLES

Eilean Donan Castle where three sea lochs form a Marine Protected Area with some very distinctive species and habitats.

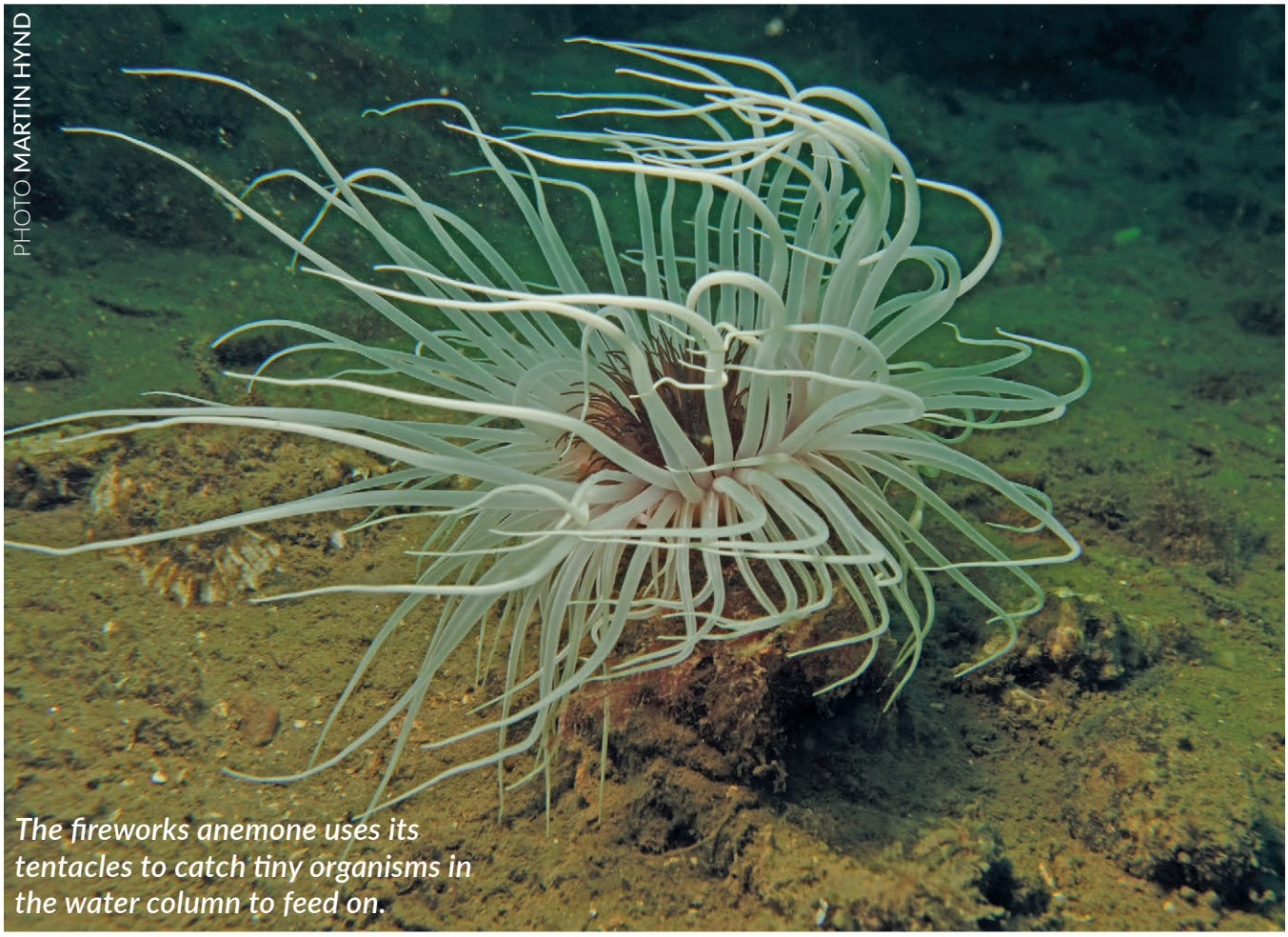


PHOTO MARTIN HYND

The fireworks anemone uses its tentacles to catch tiny organisms in the water column to feed on.

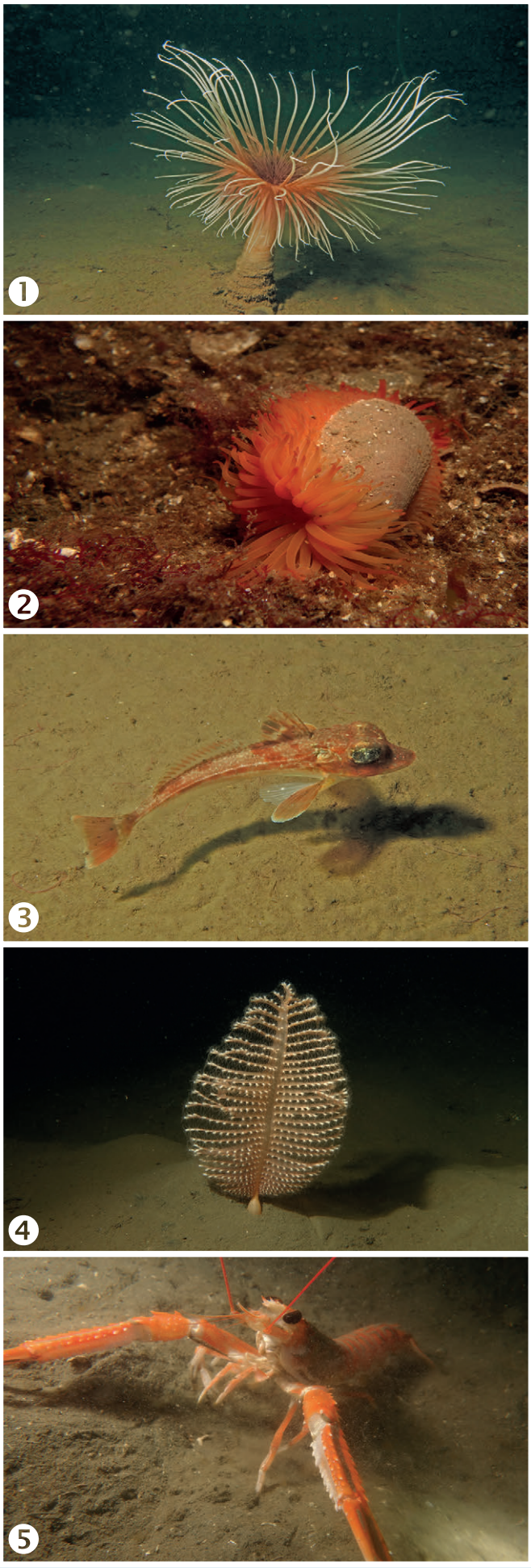
The GUE divers managing the project also carry out Seasearch surveys at the site. These record detailed information about the anemone population as whole, along with associated species and physical features of their habitat. The combination of these surveys with a regular monitoring program should enable a greater overall understanding of the entire environment.

FUTURE PLANS

There is currently a very small team of local divers engaged in this project, but Loch Alsh, and its neighbour Loch Duich, have a massive potential for further research. Not only do they hold extensive burrowed mud habitats, they also contain an estimated 100 million flame shells, the largest known bed of this animal anywhere in the world. It is an irony that that MPA also contains a salmon farm, consisting of twelve net cages. However, the company that owns them are looking to close the farm within the next couple of years. This may present the rare opportunity to examine the recovery of a site that has been impacted by aquaculture.

There is a strong network of active conservation divers in Scotland, many of whom regularly contribute to surveys and training courses. The development of the Loch Alsh monitoring project has been greatly assisted by the skills and knowledge of Seasearch divers, and this spirit of collaboration will continue. It is anticipated that the fairly narrow focus of the current GUE project will be augmented by further Seasearch surveys, including those that revisit other anemone sites for comparison. A GUE-focused project weekend could include the investigation of some of the deeper, boat-accessed sites that hold the potential for further anemone colonies.

The fireworks anemone is one of many exceptional and vulnerable species that live on the west coast of Scotland. If populations are not monitored closely, there can be no sense of how well they are doing and, as a result, we may lose them forever.



❶ The fireworks anemone tube can extend over one meter into the mud. ❷ Flame shells (Limaria hians) live hidden on the seabed in nests built from shells, stones and other materials. ❸ A young gurnard searches for food in the shallows. ❹ The megafauna of Scottish lochs includes the phosphorescent sea pen. ❺ Langoustines are a key commercial species on the west of Scotland.

LAKE ROTOTOA MUSSEL SURVEYS

A team of New Zealand GUE divers is working with regional authorities to survey a unique population of endangered freshwater mussels and save them from extinction.

TEXT EBRAHIM (EBI) HUSSAIN **PHOTOS** OLLIE HORSCHIG & EBRAHIM (EBI) HUSSAIN

Lake Rototoa is a monomictic dune lake northwest of Auckland, New Zealand, located in a rural area on the west coast. With a surface area of 1.39 km²/0.54 mi² and a maximum depth of 26 m/85 ft, it is the largest and deepest of a series of sand dune lakes found along the country's western coastline.

Lake Rototoa is of great cultural value to the indigenous people of the area; the name Rototoa translates to "Lake of the Warrior" and is part of a line of lakes known as "the Footsteps of Kawharu," who was a famous Māori warrior. This lake is also esteemed for its natural beauty, and it is often referred to as the jewel in the Auckland crown. The pristine nature of this lake can be largely attributed to its 4.08 km²/1.58 mi² catchment of low-intensity land use composed of native bush, pine forestry, and deer farming.

Lake Rototoa is also known for having a diverse population of native submerged macrophytes and large freshwater mussel beds, both of which are increasingly rare in New Zealand. This lake is one of the last strongholds of endangered freshwater mussels (*Echyridella menziesii*) in the region; however, this mussel population is on the brink of extinction.

FRESHWATER MUSSELS

Freshwater mussels are one of the most imperilled organisms on Earth, and populations are declining globally with 70 percent of species considered at risk or threatened, including three species endemic to New Zealand.

The global decline of these keystone species is largely attributed to the loss of habitat, eutrophication, sedimentation, pollution, and invasive species incursion. Unlike their marine counterparts, freshwater mussels cannot anchor themselves to a substrate. Instead, they bury themselves into the sediment, which makes them vulnerable to any alterations in the lakebed and water quality. Fine silt and suspended particulate matter clog up their gills and suffocate them, leading to the death of many individual mussels.

Mussels are an important part of a lake ecosystem; as biofilters and bioturbators they filter out nutrients, algae, bacteria, and fine organic material, which helps purify the water. They have the capacity to filter up to one 1 liter/0.25 gallon per hour, and if present in large enough numbers, they can filter the entire volume of a small lake within days. They also oxygenate the sediment by moving it around, which decreases anoxia and stems sediment nutrient remobilization.

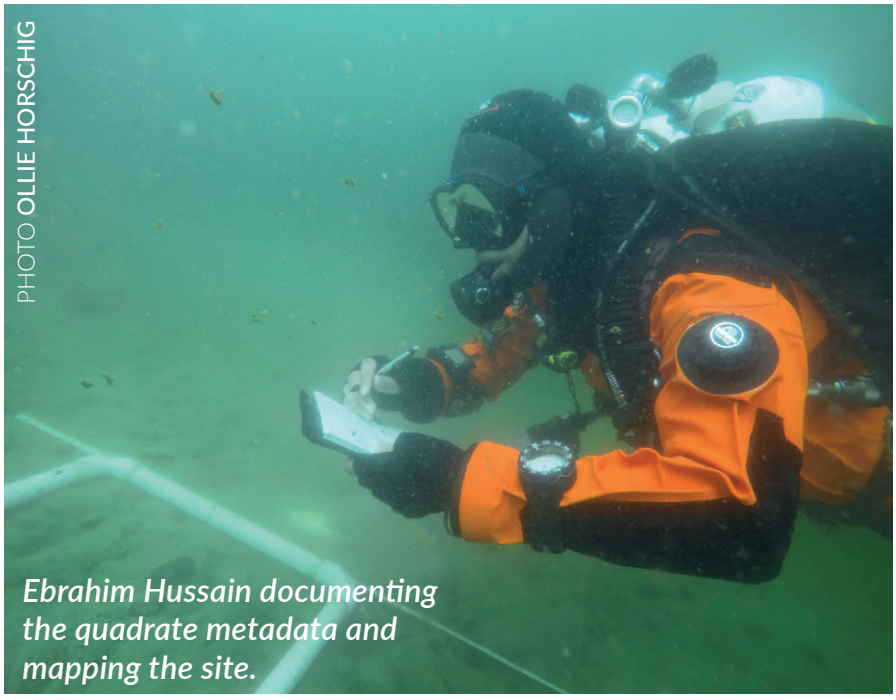


PHOTO OLLIE HORSCHIG

Ebrahim Hussain documenting the quadrate metadata and mapping the site.

HOW IT BEGAN

Lake Rototoa once had extensive beds of freshwater mussels and was considered one of the healthiest lakes in Auckland. These mussels are keystone species and are directly linked to several ecosystem functions. The water quality of the lake has been steadily declining over the past two decades, and the exact causes are not well understood. Mussel surveys have never been done in Lake Rototoa before, and there is no information regarding the population and the health of these species.

The dive team set out to explore the lake and document any obvious signs of environmental

PHOTO OLLIE HORSCHIG

Counting and size classing individual mussels in a 0.25 m²/2.5 ft² area.

impacts, and during the first dive it became glaringly obvious that there has been a recent mass extinction of freshwater mussels. We mapped over 800 m/2,625 ft of dead mussel beds on the first dive alone; we found no juveniles and all the individuals were estimated to be more than 10 years old, which means there had been no viable recruitment for almost a decade. Shockingly, this also meant that a mass extinction event had occurred within that time and had gone undetected by the long-term lake monitoring programs that are operated by the regional authorities.

It is likely that the collapse in mussel populations is in part responsible for the deteriorating water quality in the lake, but the extent of this extinction event and the impact it has had was not documented or understood. The dive team partnered with the Auckland Council Biodiversity and Environmental Monitoring teams with the aim of answering a series of key questions that would allow the regional authorities to develop restoration and management strategies to save this population of endangered mussels from complete extinction.

SURVEY METHODS

We knew that the mussel population had been severely impacted, but we were not sure why. The first step to understanding the full scope of the issues was to draft a series of key questions and knowledge gaps. We wanted to map the location and extent of mussel beds; quantify the density, distribution, and abundance of mussels; determine general size classing and age distribution; assess recruitment regimens and; lastly, identify the primary impacts and factors that are limiting the mussel population. We also wanted to integrate additional environmental and habitat information, such as macrophyte extent, sediment condition, invasive species incursion, and basic water quality information.

There were no existing survey techniques or methodologies that could easily capture all the parameters we wanted to document in a standardized way. As a result, we began developing a survey method in collaboration with the country's leading freshwater mussel research scientists.

We developed a stratified survey approach that would allow for consistent and comparable population statistic estimates (density, distribution, abundance, size classing, recruitment, condition, and age), habitat information and mapping, as well as basic environmental observations. This survey method can be carried out by a small team of trained divers (two or three divers) in a relatively short time. The information gathered through these surveys will also be used to develop a predictive tool whereby we can accurately delineate likely mussel beds using basic bathymetry and environmental information.

As a result, this method is now being used nationally by various research organizations and is considered the national best practice method for assessing freshwater mussel population health. We are extremely proud to have contributed such a meaningful tool to New Zealand's biodiversity management.

RESULTS

We have successfully completed four full survey events and have mapped over 1 km/0.4 mi of habitat, encompassing four mussel beds, ranging from 1.5-2 km²/0.58-0.77 mi². The habitat mapping data we collected has al-

PHOTO EBRAHIM HUSSAIN

Echyridella menziesii *bed with a mixture of live and dead adult sized mussels.*

lowed us to develop a predictive assessment methodology that uses basic bathymetric maps, aerial imagery, and geospatially displayed environmental information to predict the likely locations of mussel beds.

The surveys thus far indicate that there has been no recruitment for approximately a decade, and there have been no signs of juveniles to date. All the individuals are within the same adult size classes and are likely to be 20 to 30 years old. The most shocking statistic is that 70 percent of the mussels we surveyed were dead. These results clearly show that a recent mass extinction event has occurred, and that if nothing is done to stop this decline, these threatened species will die off completely over the next 20 years or less. The scary reality is that this has happened at a lake that has been routinely monitored for water quality since the 1980s, and no one has noticed it. This shows the importance of subsurface observations and diver-based surveys.

We have some preliminary data indicating that the reason for this population collapse is closely related to pest fish incursions, sedimentation, and organic silting. These mussels rely on dwarf inanga (*Galaxias gracilis*), a small native fish, as an intermediate host, and the introduction of invasive perch has caused the extinction of dwarf inanga through over-predation. No dwarf inanga have been sighted during any of the dives and recent fish surveys. Without these intermediate hosts, the mussels cannot complete their life cycle and no viable recruitment can occur. Some of the shallower mussel beds were buried by a thick layer of fine sediment and organic matter. The sediment likely stems from land-based activities and increased erosion. The organic material is a consequence of elevated nutrient loads, which cause algal blooms that eventually die and settle on the lakebed.

IMPACT

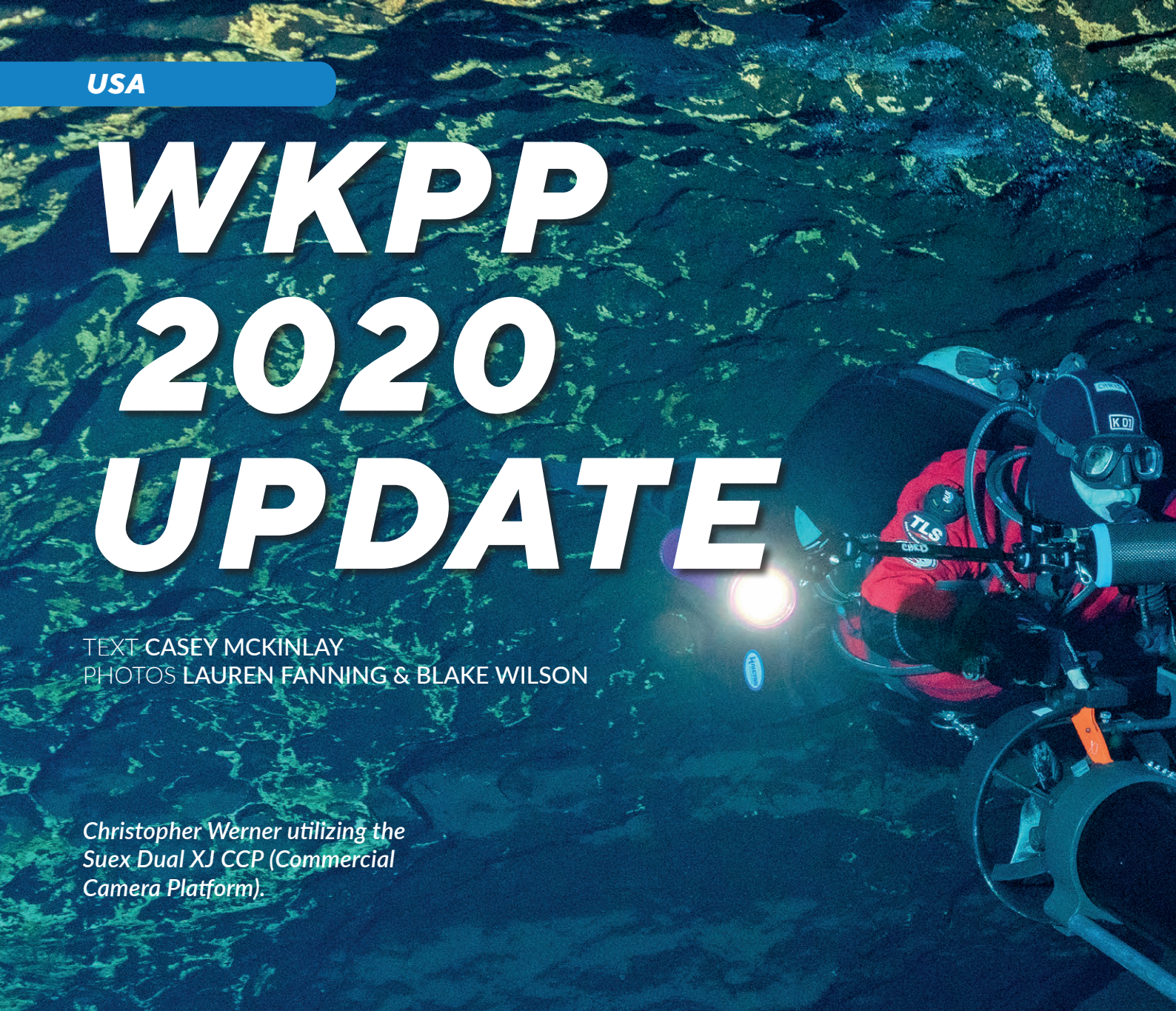
Even though this project is less than a year old, it has been one of the most impactful initiatives I have been a part of. We were the first people to identify and document a recent mass extinction event in this lake and, as far as we know, there has not been a similar event documented in New Zealand.

The survey and habitat mapping methods we developed are now considered as the gold standard and will be used for mussel surveys across the country. This is a huge achievement for us and means that all data collected in this way will be directly comparable, which will allow for a national assessment of these threatened species.

By highlighting the plight of these species, we have managed to include their management and restoration as a regional biodiversity objective set by the Auckland Council. This project is the first of its kind in New Zealand, and we intend to expand into other parts of the country. Our ongoing efforts to save these threatened species from extinction will hopefully serve as an example of how citizen science can drive change and create a healthier environment for all of us.

WKPP 2020 UPDATE

TEXT CASEY MCKINLAY
PHOTOS LAUREN FANNING & BLAKE WILSON

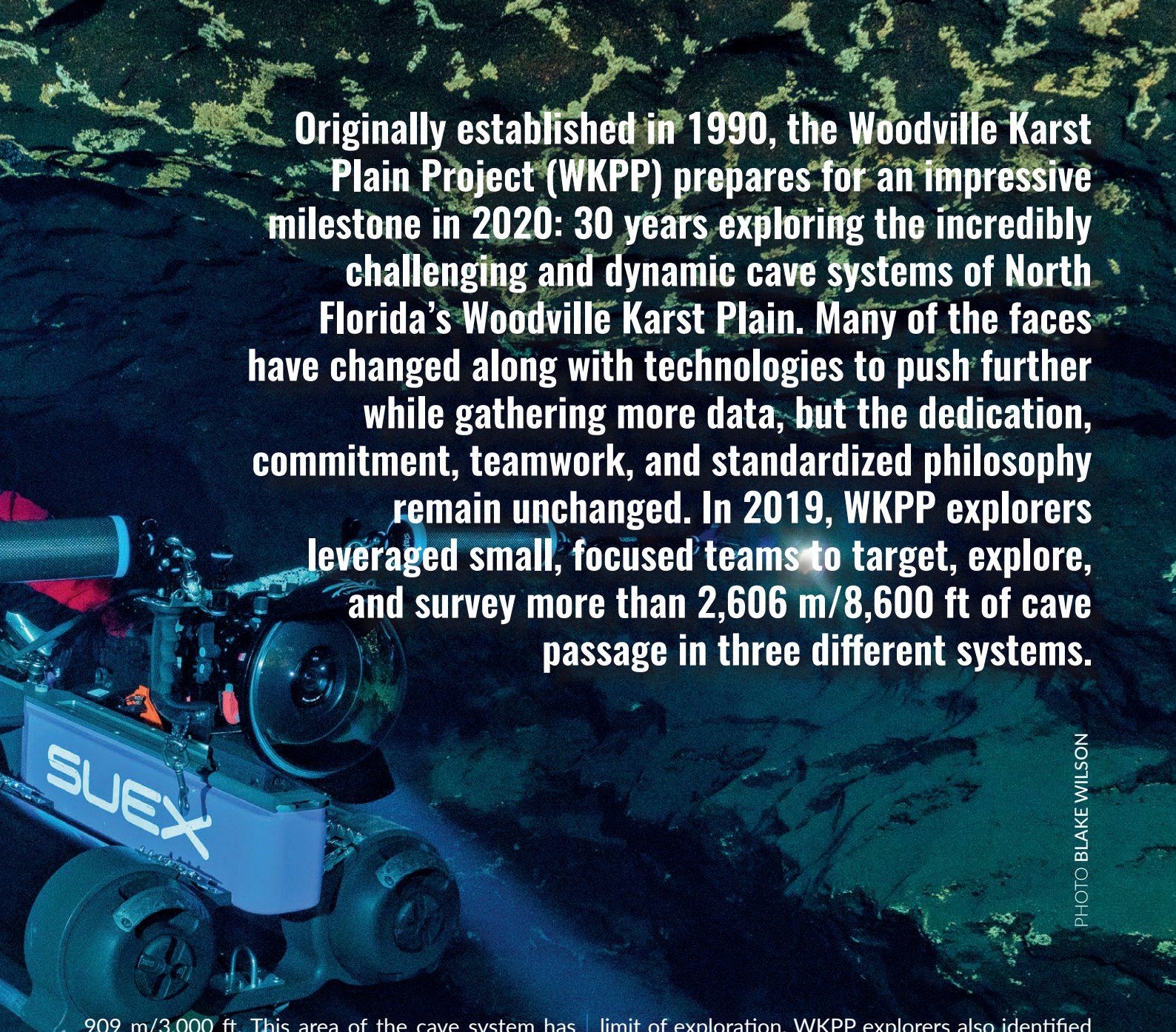


Christopher Werner utilizing the Suex Dual XJ CCP (Commercial Camera Platform).

The Wakulla-Leon Sinks Cave System (WLSCS), including Wakulla Springs, remains the primary focus of the WKPP. The southern part of the system heading south toward the Gulf of Mexico has seen limited activity in recent years due to various water dynamics, increased rainfall, and reduced visibility. The large, deep passages in this section of the WLSCS require a minimum of 10 m/33 ft visibility in order to explore safely and productively. Due to poor visibility, the WKPP has focused its efforts on the clear groundwater tunnels near the spring entrance to refine video, photo, lighting, and sonar/INS mapping capabilities, including support of researchers conducting photogrammetry documentation of the various bone fields near the cave entrance. Additional efforts have focused on habitat replacements, line replacement, and site maintenance, so that once water clarity improves, the team is ready to "go long" once again.

The northern part of the WLSCS system, including Emerald Sink and the cave system entrances found within the Apalachicola National Forest, has numerous exploration opportunities. WKPP divers have been exploring downstream from Emerald Sink, including the western Fish Hole and Darkwater passages. In 2019, WKPP divers re-surveyed more than 1,212 m/4,000 ft of the Fish Hole passage and surveyed 577 m/1,904 ft into the darkwater passage for a total passage length of 1,203 m/3,971 ft. The WKPP is currently awaiting permit renewal for the national forest entrances, which should be confirmed this year.

The middle part of the WLSCS, including Turner Sink, has seen extraordinary discoveries in the past five years, including additional passages to the north, west, east, and south. Turner CMDR (downstream) with 1,950 m/6,435 ft explored, Pippen (upstream) with 1,843 m/6,082 ft explored, and 2020 to-date exploration upstream has exceeded



Originally established in 1990, the Woodville Karst Plain Project (WKPP) prepares for an impressive milestone in 2020: 30 years exploring the incredibly challenging and dynamic cave systems of North Florida's Woodville Karst Plain. Many of the faces have changed along with technologies to push further while gathering more data, but the dedication, commitment, teamwork, and standardized philosophy remain unchanged. In 2019, WKPP explorers leveraged small, focused teams to target, explore, and survey more than 2,606 m/8,600 ft of cave passage in three different systems.

PHOTO BLAKE WILSON

909 m/3,000 ft. This area of the cave system has surprised us the most and continues to reveal more and more each year. Recent property acquisitions by the State of Florida to the east (Ferrell Tract) should enhance WKPP efforts to push into this area and reveal significant information about the water flow into the WLSCS.

SHEPHERD SPRINGS

To the south of WLSCS, and bordering the Gulf of Mexico, is the St. Marks National Wildlife Refuge. Operating under special use permit, WKPP explorers have been active in the Shepherd Springs Cave System for more than 25 years. Originally explored by the late Sheck Exley to 969 m/3,200 ft, the WKPP has extended the cave system to 2,867 m/9,461 ft of surveyed passage including 1,060 m/3,498 ft in 2019. For many years, this seemingly isolated system was thought to have shut down, but in 2019 the way on was confirmed through a low section at the limit of exploration. WKPP explorers also identified the source of the water flowing into the system with a large borehole tunnel heading north. This system remains a high exploration priority and a fascinating example of the impact that salt water intrusion and rising sea levels are having on coastal spring cave systems. The WKPP is capturing UHD-4K video and images on every dive and working with researchers to capture water quality data.

CHIPS HOLE CAVE SYSTEM

To the west and southwest of the WLSCS is the Chips Hole Cave System. Current explored and surveyed passage totals 10,202 m/33,668 ft including 3,357 m/11,079 ft in recent years. The primary goal is to push for a connection between the Chips System and the WLSCS. Recent efforts have identified several potential areas for connection, but the goal is proving elusive. Near term plans include targeted dye tracing efforts to narrow down the connection.

PHOTO LAUREN FANNING

> **WHEN THE CONNECTION IS COMPLETED, THE WLSCS WILL ABSORB THE CHIPS SYSTEM AND PUSH THE TOTAL SYSTEM LENGTH BEYOND 67 KM/220,000 FT MAKING WLSCS ONE OF THE LARGEST FLOODED CAVE SYSTEMS OUTSIDE MEXICO.**

Steve Cox utilizing the Suex dual unit DPV system that can provide a WKPP diver with more than 9 km/30,000 ft of range.

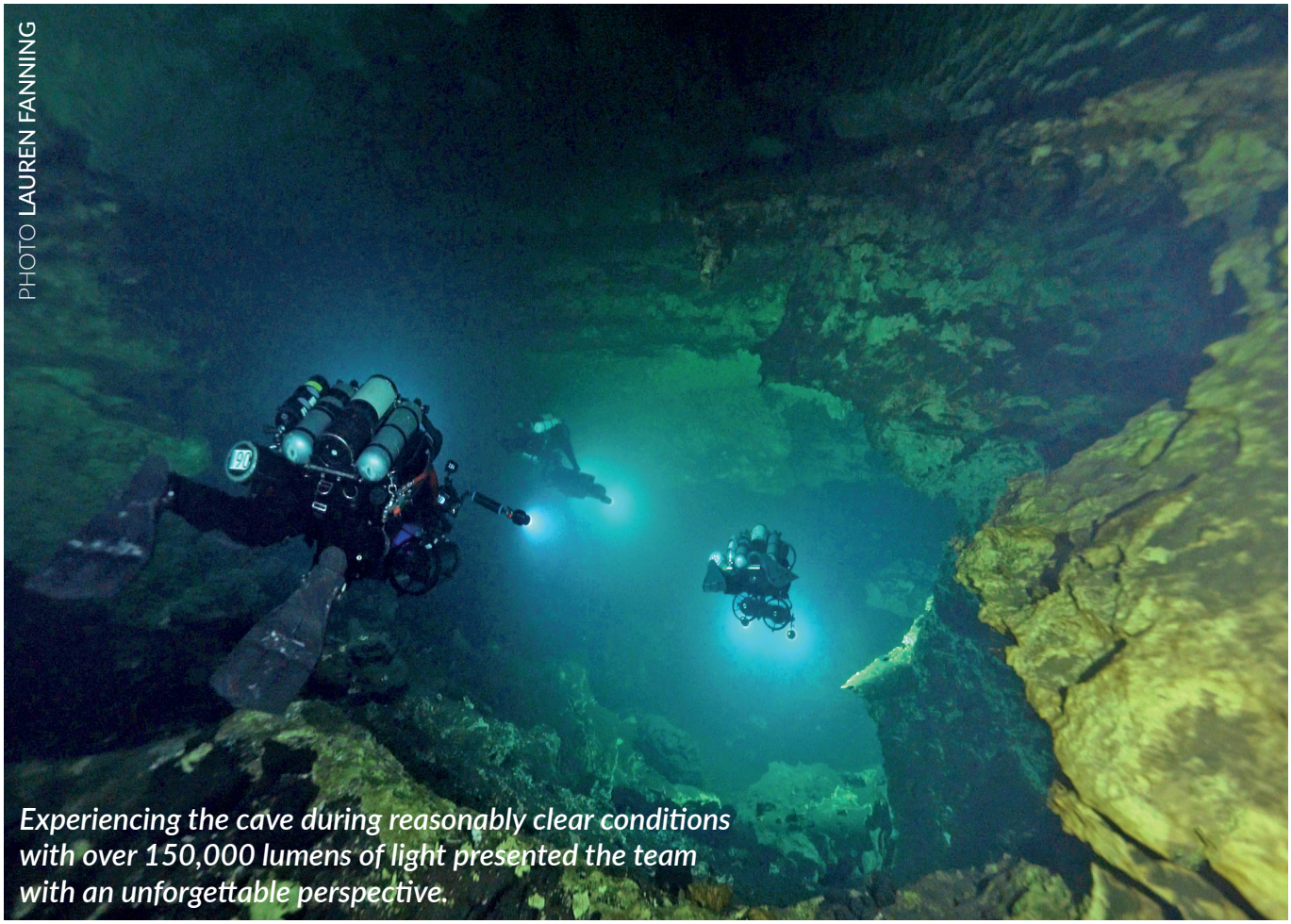


PHOTO LAUREN FANNING

Experiencing the cave during reasonably clear conditions with over 150,000 lumens of light presented the team with an unforgettable perspective.

When the connection is completed, the WLSCS will absorb the Chips System and push the total system length beyond 67 km/220,000 ft making WLSCS one of the largest flooded cave systems outside Mexico.

FALMOUTH SYSTEM

To the east of the Woodville Karst Plain is the historical Falmouth Cave System including Cathedral Canyon, made famous by the renowned explorer Sheck Exley. The upstream section from Cathedral has seen significant exploration over the years and remains active in large part to the efforts of owners Jon and Kristi Bernot. Downstream from Cathedral are more than a dozen separate entrances with access controlled by various landowners. The Falmouth System has many site-logistics challenges, including reduced visibility even in the best of conditions. In 2015, the WKPP established relationships with two landowners for access into the system from Mount Sink and Jade Hole Sink. To date, WKPP explorers have re-lined and re-surveyed more than 5,395 m/17,804 ft of historical passage and explored and surveyed more than 4,478 m/14,779 ft of new passage. WKPP explorers have also confirmed the water flowpath downstream which does not generally travel through the known section of passage ending in Suwannee River State Park. The true path of the water is proving to be a formidable challenge to explore but remains wide open at the end in a howling siphon at 51 m/170 ft depth.

EQUIPMENT DEVELOPMENT

Starting in 2018, the WKPP began working with Suex, SRL to develop a redundant, long-range and stable DPV platform to further exploration, gather data, and serve as a video capture system for long-range, cave diving missions at depth. The result of that collaboration has produced the Suex Dual XJ CCP (Commercial Camera Platform). The stability gained from the system's width, mounting rails, and counter-rotating propellers is generating some exceptional footage in the most challenging of environments. This effort remains a work in progress along with testing various lighting systems, but the overall result todate will allow the WKPP to capture exceptional footage from remote sections of the cave system that historically were out-of-reach with legacy equipment.

In addition to the CCP, the requirement to develop a reliable, redundant, enhanced range, comfortable, and fast dual unit system for extending exploration in the large, deep passages beyond 4,545 m/15,000 ft remains a high priority. When the water visibility im-

> EARLY WKPP EXPLORERS QUICKLY REALIZED THE KEY TO SUCCESS WAS STANDARDIZATION—TRAINING, EQUIPMENT CONFIGURATION, AND EQUIPMENT.

proves, it has been decided the WKPP must be ready to go and to resume exploration. Using similar tools from the 2000s was not going to get it done. Even a marginal increase of 9 m/30 ft per-minute over the course of a 15 km/50,000 ft dive would deliver significant benefits—reducing bottom time by almost two hours as well as fatigue and risk. Not to mention the power to put the hammer down on the exit. The current dual unit systems developed for this task can provide a WKPP exploration diver with more than 9 km/30,000 ft of range per system with numerous options to tow single units for exploration of specific tasks.

SONAR MAPPING

An additional goal in developing the dual unit systems was to enhance the data collection capabilities along the way. To that end, WKPP explorers worked with Suex SRL and their partners to refine a system for cave system data collection. This effort included forward and sidescan sonar capture (for passage dimensions) and inertial navigation (INS) data to refine position relative to surface features and enhance the accuracy of the survey and map data. So far, the WKPP has used this data-gathering platform to capture in excess of 9 km/30,000 ft of cave passage data in the WLSCS. The results to date are impressive, and the protocols to refine this process are being developed. There are some limitations due to the size of the hardware in smaller passages and details to be worked out for initializing the system, but overall the concept is working and will eventually become a standard element of WKPP exploration capabilities.

UHD-4K VIDEO LIGHTING

From the early days of the WKPP, developing the capabilities to transport, light, capture, and share video and photo data from the far reaches of the cave system has proven incredibly challenging. Recent developments with UHD-4K cameras, depth-rated housings, lithium battery technology, software, and LED bulbs have made the challenge of taking this hardware into deep cave systems easier to manage. Coupled with a dual Suex video platform, the smaller form factor, longer burning lights, and technology built into the cameras for auto focus, exposure, and drive storage have provided significantly better footage without added task loading. The introduction years ago of the GoPro camera systems and deep housing has also allowed for multiple points of view and footage redundancy. This aspect of the exploration will remain a work in progress.

FUTURE PLANS

Early WKPP explorers quickly realized the key to success was standardization: training, equipment configuration, and equipment. Familiarity with diving protocol allowed different team members to dive together both comfortably and effectively. Common equipment configuration allowed for quick and efficient responses to equipment problems or failures. Standardized equipment allowed for interchangeability of equipment between team members both pre-dive and during a dive, thus increasing the chance for success and increasing productivity. Formalizing and refining these fundamentals into an organized, progressive training curriculum was lacking in the early years until GUE took on the challenge in the late 1990s. Over the past 20 years, the WKPP has benefitted from having among its membership many of the top GUE cave instructors as well as a global network of trained, capable GUE cave divers looking to contribute. The WKPP-GUE partnership remains strong, as does the commitment to constantly improving safety, efficiency, and capabilities as new challenges arise.

While the goal of exploring and mapping as much of the Woodville Karst Plain as possible remains, the reality is that now more than ever, the project is "on the clock." Land management decisions, permit applications, rainfall, sea level rise, saltwater intrusion, and time have to be considered. On the other hand, commitment, experience, teamwork, partnerships, and resolve remain stronger than ever within the WKPP to push one more station and get it done. Special thanks to those team members this past year that have gone above and beyond in their commitment to the WKPP: Steve Cox (Project Coordinator), Lauren Fanning (Media Coordinator), John Adair (Legal Advisor) & Dr. John Rose (Project Cartographer).

DIVE IN THE FAST LANE

SUEX

www.suex.it

OJAMO

TEXT **MAURO SACCHI**
PHOTOS **ANDREI VOINIGESCU**

Project Baseline at Ojamo, a world-class mine diving destination, explores the biological impact of ongoing human and industrial activities at the quarry.

PHOTO ANDREI VOINIGESCU

Ojamo is world-class dive site for both open water training and mine diving.

PHOTO ANDREI VOINIGESCU

A sincere thanks to the local diving community represented by the Ojamon Tekniikkasukeltajat association for their support.

The Ojamo quarry in the city of Lohja is a former Finnish calcite mine, closed in 1965. The site has an open water area and several layers of underwater tunnels, starting from 28 m/92 ft of depth to a maximum of about 250 m/820 ft. Beyond being a world-class dive site for the technical diving community, today the quarry is used for sea rescue training by Meriturva, a public company, as well as for commercial diving and underwater construction training by Luksia, a municipal school. The quarry is located only a few hundred meters from the city's groundwater collection site.

A TRULY MULTI-PURPOSE SITE

The Wärtsilä Project Baseline team found in Ojamo a perfect site for starting its journey into sustainability projects, possible only through diving activities. In fact, Ojamo is just 45 minutes from Helsinki by car and offers multiple levels of diving, as well as a unique combination of biological and industrial activities.

Our team selected Ojamo as the starting site before engaging in more demanding projects in the Baltic Sea, where conditions can be rougher and more difficult. Ojamo is not only a perfect test lab to practice the installation of Project Baseline stations and the usage of sensors, but the site is also a perfect training ground to develop safe and sound diving skills needed in the Baltic Sea. Finally, Ojamo is also a world-class technical diving site for the local community, which actively helped to set up the station and performed the regularly needed maintenance.

HYPOTHESIS UNDER STUDY

A station equipped with sensors was installed in December 2019 near the dive schools area. Sensors log temperature, pH, dissolved oxygen, and luminosity at regular intervals. Temperature and luminosity are also logged at the surface, and additional data is retrieved from the Finnish Meteorological Institute to correlate water characteristics to atmospheric events.

The specific-use cases the team is working on are to monitor and understand the fluctuation of biological activities in the quarry compared to those of natural lakes. The main stakeholder is the Finnish Ministry of Environment, who offered us guidance to design the station and support to interpret the results.

The first of three specific-use cases the team is working on is to monitor and understand the fluctuation of biological activities in the quarry compared to those of natural lakes. The main stakeholder is the Finnish Ministry of Environment, who offered guidance to design the station and to interpret the results.

The second is survey the impact of human activities underwater, such as construction work or welding. The main stakeholders are the commercial diving school Luksia and Wärtsilä.

The final case is to compare water characteristics and biological activities of the open water area affected by rain water and other meteorological events in deeper tunnels, which are only affected by groundwater influx. The main stakeholder is the City of Lohja water supply department.

The initial findings from the data collected from December 2019 to April 2020 clearly show a correlation between the underwater activities and water characteristics. Dissolved oxygen and pH especially respond to human driven events, though these insights are not yet conclusive. A minimum of one year of data needs to be collected to understand the seasonal fluctuations.

One of the immediate results this project already produced is the engagement of the network of stakeholders involved. Representatives of the diving community, local and national authorities, and companies are brought together by a common topic. Awareness has risen and cooperation to conduct this study is established.

SNEAK PEEK NEXT STEP

The findings at Ojamo will be used in the Baltic Sea. In 2020, our team will begin cooperation with a group of non-profit organizations, government offices, and corporations. The primary objective will be to assess the risk of possible oil leakage from selected sunken vessels, mostly dating to WWI and WWII, and develop a simple scalable method to enable citizen science in supporting the authorities with this challenge. A study has already been conducted by the North European countries' officials, which identified hundreds of shipwrecks potentially at risk. The Baltic Sea is already suffering from eutrophication due to the rare circulation of water happening and the fact that it acts as a basin for the fresh waters of the surrounding countries. An additional environmental threat like oil leakage could pose an amplified effect to the already stressed underwater ecosystem.

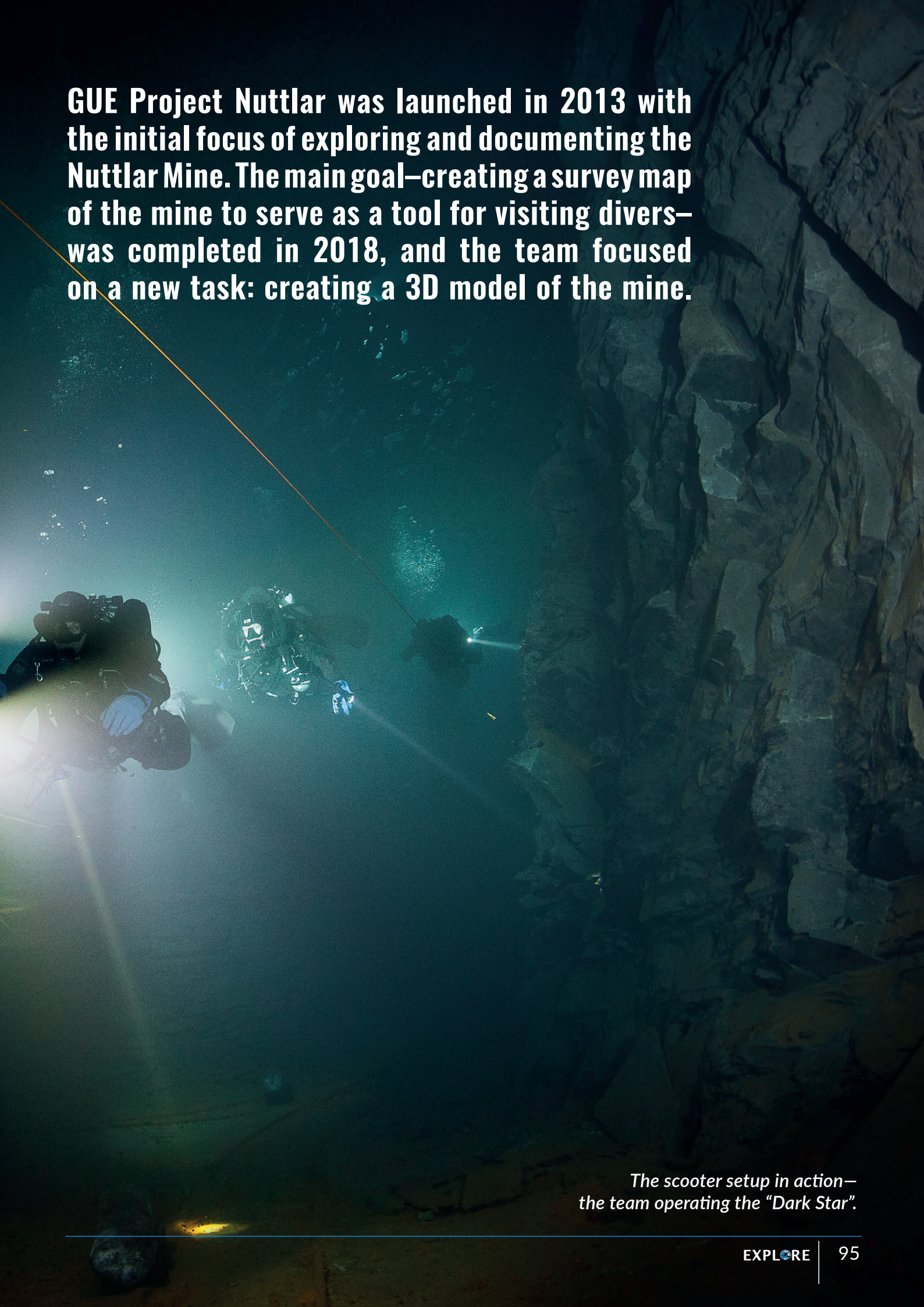
TEAM *Juha Flinkman (Finnish Environment Institute & co-founder of Badewanne), Jouni Leinikki (Finnish Scientific Diving Association & MD of Valtamer Oy), Jarno Seppänen (Luksia Education and Training), Jarkko Helin (GUE Instructor), Esa Tuominen, Andrei Voinigescu (Wärtsilä), Mikko Gustafsson (Wärtsilä), Jussi Heikkola (Wärtsilä), & Mauro Sacchi (Wärtsilä)*

GERMANY

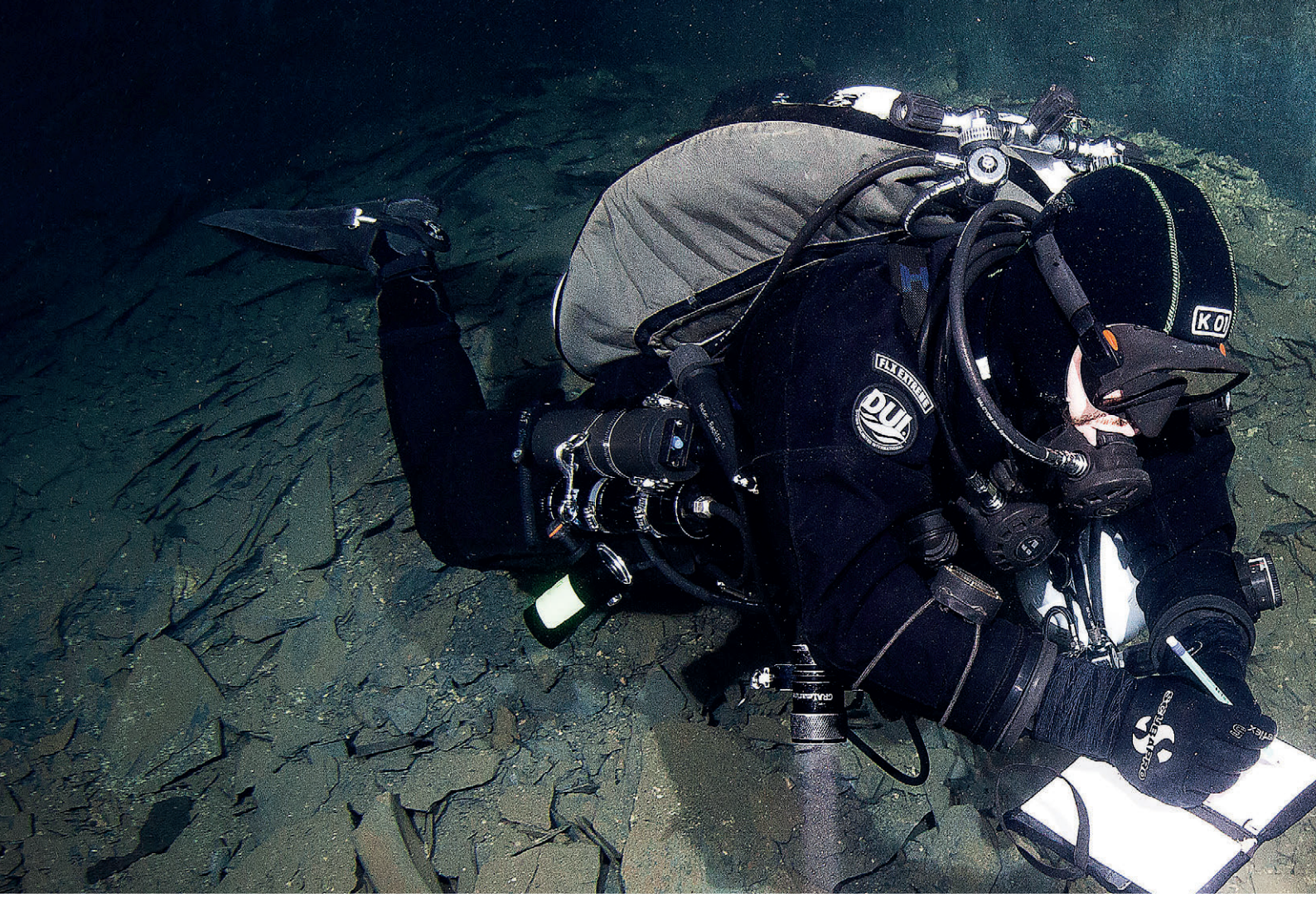
PROJECT NUTTLAR

TEXT MAREN ISIGKEIT
PHOTOS JULIAN MÜHLENHAUS

GUE Project Nuttlar was launched in 2013 with the initial focus of exploring and documenting the Nuttlar Mine. The main goal–creating a survey map of the mine to serve as a tool for visiting divers–was completed in 2018, and the team focused on a new task: creating a 3D model of the mine.



The scooter setup in action—the team operating the "Dark Star".



The team has been working hard for five years to create a survey map to help visiting divers find their way and explore new areas of the mine. During the 2018 project issue, the last data for the map was collected, and it was later added to the map by our survey manager, Torsten Schnitter. The official handover of the map to Matthias Richter, operating the diving at the Schieferbergwerk Nuttlar, took place at the annual trade show "boot" in Duesseldorf, Germany, in 2019.

TASKS IN 2019

From that point on, the project team completely focused on their new task—to create a 3D model of the mine. With the preliminary work of the previous project issues in 2018, where the team, among other things, compared the use of high-end cameras and low-end cameras for data collecting, the data collection process got more streamlined and straight forward. The special scooter setup that 3D model experts Johan Wouters and Peter Brandt puzzled out (implementing nine action cameras and six lights with around 9,000 lumen each) was used to gain the data for the overall model. In order to capture some of the remains of the miners and mining in more detail, single high-resolution cameras came into play, with the results to be integrated into the model later on. So, in 2019, most of the buddy teams were busy collecting pictures and video. Every dive team consisted of one diver operating the camera while a second diver accepted the task of the light diver, responsible for lighting the area that needed to be captured. In a dark slate mine, lighting needs a lot of attention in order to avoid creating too much shadow while preventing the camera from catching the light directly.

Besides these main tasks, the project also took footage of the work to be able to explain the process of photogrammetry in more detail with a documentation video later on. There was also one dive team assigned to reorganize and fix the line at the deep level of the mine.

PROCESSING THE RESULTS

Diving is fun! But the real work for projects often starts after all the dive gear is dry and stored, and the results are ready to be processed. Creating the survey map alone took a lot of time and enthusiasm, but with a 3D model the workload is immense. Processing the images is a very repetitive activity involving many trial and error cycles. To ease this, extensive effort was spent trying to find a way to automate this process in a way that leaves the judge-

ment of the quality of the model to the computer. Some experiments are being run with automation/quality control in Python since Agisoft has an extensive API for this, giving almost full control over all parameters from the Python script.

STATISTICS

After two years of collecting data for the 3D model, all passages and chambers, including the cavern zone of the so-called "yellow system" of the mine, have been captured. The full Nuttlar project now consumes around 12 TB of disk space. Extracting images from the 4K video of the scooter setup utilizes all usable hard disk capacities and takes enormous amounts of time. In 2019, the project focused on imagining the so-called "container room," which is one of the halls where the slate was mounted. For the general model alone, 30 minutes of recording time was needed with the scooter setup, resulting in 16,000 images for the model and a sparse cloud of 6.5 million points and a dense cloud of 950 million points. Disk space stays a critical factor when processing these types of projects.

WHAT IS IT FOR?

3D models have a lot of value to offer. Aside from freezing the status of the object being modeled, the resulting images can be used to share the object with those who would otherwise be unable to explore it themselves. Our photogrammetry specialists found out how to transfer even the Agisoft data to Unity, which is a gaming engine, and succeeded in making VR work. So, in 2019, the team got a demo of the first result, which was also presented to the mine owners, who were very excited to go on a virtual dive to parts of their mine that they had not seen since the mine was flooded in 1985.

See the release on our photogrammetry efforts at GUE.tv. Search for "Nuttlar".

For more information, videos, and pictures, please visit ***www.facebook.com/GUEProjectNuttlar.***

The survey maps can be downloaded here: ***www.bergwerktauchen.de/karten***

TEAM *Holger Amecke, Niels Bossow, Peter Brandt, Damaris Brunke, Manuel Eickhoff, Niko Gerdau, Jan-Hinrich Hoffmann, Maren Isigkeit, Thilo Krepkowski, Susanna Labisch, Jan Medenwaldt, Marc-Christopher Menzel, Julian Mühlenhaus, Stefan Schandelle, Mike Schernbeck & Johan Wouters*

TAMATEA BLUE PROJECT

TEXT ROB WILSON
PHOTOS ROB WILSON & KINA SCOLLAY

A lot of garbage and debris from visiting vessels needs to be cleaned up.

GUE Ghost Divers join the dive charter Pure Salt to descend into historical Fiordland to remove over 2,000 kg/4,400 lb of bottles and trash from the seemingly pristine water of this exclusive location. An anchor and a plundered sink from a nearby wreck of some historic significance was removed from one of the sites during this project.

PHOTO KINA SCOLLAY

The helicopter insertion through some of the most incredible mountains felt very much like we were special forces, and especially so as an ex-New Zealand Navy vessel, the MV *Flightless*, was waiting for us at our landing zone. It is now owned by local business Pure Salt (see www.puresalt.co.nz). However, with such a unique insertion, carry-on equipment was restricted, so we were traveling light and diving shallow.

The flight through the snow-capped peaks was one of the most incredible experiences of my life, and I was virtually speechless at its sheer rugged beauty. The helicopter touched down, and we piled out to get on a small boat heading toward the majestic 27 m/88 ft *Flightless*.

We met Maria and Sean, our hosts, who had invited the team to start this incredible project. They were the most amazing people—with passion, energy, sheer love, and total respect for this land we all call our home, Aotearoa, New Zealand.

HISTORIC SIGNIFICANCE

The Tamatea Blue Project actually has a double meaning. One meaning is that Dusky Sound, the area where we were heading, is called Tamatea in the Māori language. The other meaning is that the area pays homage to one of New Zealand's greatest explorers, Tamatea, who has been described as the Māori Marco Polo. He circumnavigated the North and South islands and also explored inland. He was sometimes called Tamatea-pōkaiwhenua (land explorer) or Tamatea-pōkai-moana (sea explorer). To say that this area is of historical significance is by far the biggest understatement of 2020.

This area marks the first meaningful interaction between Europeans sand the local Iwi tribes; in 1773, on his second voyage, Captain Cook interacted directly with the Iwi. Additionally, Luncheon Cove, the beautiful project operation site, was the site of the first European settlement in New Zealand in 1792.

ISOLATED LOCATION

Fast forward to 2019, and my dive team is suiting up in their drysuits and Halcyon kit, ready to dive in this incredibly exclusive and isolated location. In all honesty, I was not expecting what we usually encounter with our typical Ghost Dives or Project Baseline Clyde Quay dives. Surprisingly though, the sight I saw was not so dissimilar!

Bubbles roared from the exhaust tee of my Halo as I descended through the tannin-rich water. Scanning left and right, I saw numerous bottles and the first of 27 gumboots we recovered.

DIVERS WORKING IN HARMONY

Since the launch of Ghost Diving here in NZ, I have seen the value of working with highly skilled freedivers a number of times, and this project again proved their invaluable support.

Throughout this project, we were working side by side as they swooped past our dive team operating just above the sea bed. Both teams hauled beer bottle after beer bottle, filling giant canvas bags to be removed in one hit. We even found an anchor that had snared everything from fishing lines to ropes of various sizes and types.

The final item had yet to be discovered. As I surged home to the vessel on my DPV, I noticed an odd circular shape on the seabed. The circle was no more than an inch across, but after years of doing this I have an uncanny eye for the uncanny. Descending back to the sea floor, I began clawing at the edges of this bizarre looking object. To my surprise, it was a sink!

We had found everything, including the kitchen sink! As soon as I saw the Union Steamship logo, I knew it was something interesting. In fact, this sink had a surprising significance. This particular sink had been plundered and then dumped from a nearby wreck of a vessel called the *Waikare*, a steamship that had struck an uncharted rock between Indian Island and Passage Inlet in 1910 before beaching on Stop Island for the passengers to safely disembark.

> **“ WE WILL ENDEAVOR TO RETURN THIS MAGICAL PLACE TO ITS TRUE MAJESTY.**

The skippers, Sean and Maria, recognized the sink and its significance straight away—again showing their intimate knowledge of this area. Maria and Sean, without hesitation, got this historic sink off to a local maritime museum where it is now proudly on display.

The teams worked in amazing cohesion for the time we had in the darkened water.

A grand total of over 2,000 kg/4,400 lb of trash and debris was removed from this amazing and beautiful area, most of which had been thrown from visiting vessels.

MAGICAL PLACE

Tamatea/Dusky Sound is world famous for its black coral, some of which we found in 11 m/36 ft of water. Any diver will tell you that this is incredible, since black coral is a deep water species. At the end of the project, the Pure Salt team spoiled us with a dive to see this majestic black coral in 25-29 m/82-95 ft of water.

Black coral is rare and fascinating, and it grows in the depths of Milford Sound.

Known as *Antipathes fiordensis*, this black coral is native to the Fiordland area. Black coral usually lives in deep oceans, but thanks to the geology of Milford Sound, you can see black coral at depths as shallow as 10 m/30 ft below the surface.

As heavy rainfall drains through the lush forests, the rainwater is stained with tannins until it is the color of strong tea. Because fresh water is less dense than salt water, the rainwater forms a protective top layer over the salt water from the incoming Tasman Sea. The darkened fresh water blocks sunlight, with light levels at 10 m/30 ft deep in Milford Sound being equivalent to those at about 70 m/230 ft in the open sea. Due to this unique environment, the fjord supports the world's largest population of black coral trees.

There are 60 varieties of black coral in Milford Sound, and it is also home to rare red corals and the enormous bubblegum coral, which can grow up to 7 m/23 ft high and live for centuries. There are about seven million colonies of coral in Milford Sound.

This successful first step in the Tamatea Blue Project with the crew of Pure Salt featured a truly magnificent location and was an incredibly valuable project. Some of my team members are joining me again, along with some gutsy volunteers and battle-tested freedivers, at the next annual event, hopefully to make a positive difference in this once-pristine environment. We will endeavor to return this magical place to its true majesty.

PHOTO ROB WILSON

To be airlifted in a chopper to the dive site felt like being special forces.

The kitchen sink with the Union Steamship logo is now on display at a local maritime museum.

PHOTO ROB WILSON

BATTLE OF THE EGADI ISLANDS

TEXT **MARIO ARENA** PHOTOS **CLAUDIO PROVENZANI**

The GUE team ArcheoX operated on the archaeological site of the Battle of the Egadi Islands during the summer of 2019 in collaboration with RPM Nautical Foundation and under the direction of the archaeologists of the Soprintendenza del Mare of Regione Sicilia.

The Battle of the Egadi was fought on March 10, 241 B.C., between Roman and Carthaginian war fleets, sinking dozens of ships and killing 10,000 warriors.

The battle site was discovered in 2010 by Soprintendenza del Mare and RPM Nautical Foundation. It is a vast area measuring more than 10 km²/3.8 mi², located seven nautical miles off the Favignana island shore, at a depth of 80 m/262 ft under the sea surface. GUE joined the research project in 2017, and since then has conducted four field campaigns.

The sea floor of the area is a substantially flat, sandy desert scattered with rocky outcrops and formations. Artifacts related to the battle are found scattered, often isolated, without any clear path. Up to now, the joint effort between RPM Nautical Foundation and GUE has led to the discovery of more than 1,000 amphorae, 23 warships' bronze rams, 40 bronze helmets, and a number of other items ranging from personal and tableware to weapons and coins.

SUCCESSFUL OPERATION

The 2019 campaign was another successful operation that led to several new, important findings and exciting discoveries. AUV and ROV surveys run by RPM with its research vessel RM *Hercules* led to the discovery of four other warship rams and two ancient anchors. The anchors, of a rare type, are the first found on the battle site. ROV inspections also led to the discovery of three bronze helmets, one of which features a finely carved griffin, a mythological animal with the head of an eagle and the body of a lion.

GUE divers performed extensive and intensive surveys on several areas of the battle site. Extensive surveys, run by formations of divers with Suex DPVs visually inspecting the bottom, led to the discovery of several potteries and two bronze helmets, one of which was decorated with an amphisbaena, a mythological double-headed snake. Intensive surveys were carried out by divers using metal detectors, which led to the discovery of a concentration of artifacts in proximity of the warship's rams #15 and #16. Artifacts include seven cheek guards, three helmets, a sword, two bronze Carthaginian coins, several bronze nails, and other items. This area will need to be further investigated, as it could be the place where a ship was resting.

During the operations, divers were also tasked with performing photogrammetry surveys of several artifacts, including rams and helmets buried in the sediment, in order to prepare them to be lifted to the surface. For the excavations, divers used the revolutionary ROSA/Suex self-contained underwater vacuum system designed by GUE team member Cristiano Rosa and specifically developed by Suex. The hoover allowed for a much faster and more effective excavation of the artifacts, and allowed divers to dig test trenches in proximity of the warship rams to verify the presence of parts of the ships' hulls.

The ArcheoX-GUE 2019 campaign—based in the Museum of the Stabilimento Florio of Favignana island—lasted 36 days and included a seven-day mission to Lipari island (on the Aeolian archipelago). During this mission, GUE divers operated together with a submarine on the deep portion of the archaeological area of Capistello bay and on the ancient Greek wreck site Panarea III, discovering new artifacts and conducting survey operations.

The activities carried out by the team on the Battle of the Egadi battlefield included 17 days of diving operations for 32 team dives, 79 man dives, for a total of 52.5 hours of bottom time. Typically, dives ranged between 40 and 60 minutes of bottom time, followed by three and a half to five hours of decompression.

TEAM *The ArcheoX-GUE Team, led by Mario Arena and Francesco Spaggiari, was composed of scientific divers Claudio Provenzani, Cristiano Rosa, David Lee, Fabio Portella, Federico De Gado, Gideon Liew, Jan Medenwaldt, Lingyu He, Mario Arena, Piero Labò, Ryan Booker, and Stefano Gualtieri*

Francesco Spaggiari, Giovanni Polizzi, and Nadja Kupfer headed logistics, safety, and boats

Representatives from the Soprintendenza del Mare included Adriana Fresina, Francesca Olivieri, Valeria Livigni, Roberto La Rocca & Salvo Emma

Artifacts related to the battle are often found scattered and isolated.

PHOTO CLAUDIO PROVENZANI

PHOTO CLAUDIO PROVENZANI

Surveys by formations of divers with DPVs led to the discovery of potteries and bronze helmets.

Professor Sebastiano Tusa

IN MEMORIAM

RPM, SopMare, and ArcheoX-GUE teams were dismayed by the tragic loss of Professor Sebastiano Tusa (66).

Professor Tusa was among the victims of the Ethiopian Airlines plane crash on March 10, 2019, when he was traveling to Malindi, Kenya, to make a presentation at the UNESCO Conference for the Protection of Underwater Cultural Heritage and Sustainable Tourism Development in Eastern Africa. Professor Tusa was a prominent marine archaeologist, founder and Director of the Soprintendenza del Mare, and Regional Counselor for Cultural Heritage of Sicily. The Battle of the Egadi site was found thanks to his studies and intuitions, and the investigations on the site were carried out under his masterly and wise direction and coordination from the beginning. All the operations, present and future, on this site will strive to follow his example, and are dedicated to his memory.

TEXT ANDY PILLEY PHOTO OWEN FLOWERS

LOCH LONG

After the success of the 2018 Project Weekend, the members of Project Baseline Loch Long have been building their team capability and expanding their goals across the west coast of Scotland.

Project Baseline Loch Long is collaborating with Emily Addington, a PhD researcher at the University of Strathclyde, to collect marine-based sediment samples in an effort to uncover new marine-based species of *Actinobacteria*. Actinobacteria are a key source of antibiotic compounds, and new medicines are needed in order to fight the growth of antibiotic-resistant bacteria. As part of the collaboration, a sediment sampling competition was set up in order to generate samples from a broad range of locations across the U.K. The diver whose sample revealed the most interesting bacterial strains would win a Halcyon Infinity single cylinder wing system.

As a result of the DFA project competition and collaborations with Project Baseline Loch Long, the team received an influx of sediment samples from which an enormous number of Actinobacteria were isolated. Samples came from across the U.K., with many from Scotland, England, and Ireland. All isolates were added to a strain bank for long-term storage, allowing for continued testing and identification in the future. Isolates were screened against clinically relevant pathogens, including methicillin-resistant *Staphylococcus aureus* (MRSA) and *Pseudomonas aeruginosa*, both major causes of infection in hospitals that are showing increasing resistance to antibiotics. Excitingly, five isolates showed bioactivity against MRSA, with one of these also demonstrating activity against *Pseudomonas*, which is particularly hard to kill. These bioactive strains were sequenced, with results indicating that the isolates were composed of four species of *Streptomyces* and one *Micromonospora*, two genera of Actinobacteria known to be prolific producers of antibiotic compounds. The winner of the DFA competition was collected in Brixham, England, and is likely *Streptomyces niveus*, a species previously isolated in the United States, which is a producer of the antibiotic Novobiocin. Future work will involve identifying the antimicrobial compounds produced by these bioactive strains, which requires a combination of biochemical and bioinformatic approaches. The DFA project aims to continue working with divers to sample the U.K. marine environment for novel Actinobacteria and uncharacterized antimicrobial compounds.

OBAN WRECKS (GFUK)

As part of the 2019 Project Weekend, we were fortunate to be able to dive on the wreck of the *Madame Alice*, an armed cargo ship that lies in the Firth of Lorn, approximately two miles northwest of Oban on the west coast of Scotland. She sank on March 16, 1918, after a collision with HMS *Iolaire* and lies at a general depth of 43 m/140 ft. A number of the wrecks in the area are not frequented by divers due to the poor visibility and strong tidal flow that the area can experience.

The wreck itself is largely intact, lying on a 45-degree list to port with two cargo holds amidships that have silted up over the past 100 years. A team of eight divers descended to the wreck with a view to exploring the site for potential future visits and documenting its condition. Due to the wreck's location, it has been listed as a hazard to fishing activities, and there are large nets draped over the bow and stern, as well as clusters of creel pots on the port side of the wreck.

As part of the dive debrief, a report was submitted to document the size and location of the nets on the wreck. After that, plans were made in collaboration with Ghost Fishing U.K. to revisit the wreck and remove nets. Over the course of two weekends, dives were made to survey the nets and recover them to the surface. These efforts were complicated by the position of the wreck and the poor visibility that is often found in the area; however, both project weekends were highly successful, and a large portion of the net was recovered and sent for cleaning and recycling.

There are plans to visit a number of other sites in the surrounding area over the course of 2020-2021 in order to document these wrecks and discover more of the rich maritime history of this part of the country. These trips are tied in to the larger GUE U.K. Exploration Project that is being coordinated by Neil Powell and Marcus Rose.

CAVES

The main Project Baseline Loch Long site contains a visibility monitoring station at The A-Frames, which is the site of a former refueling jetty that was demolished in the 1960s. There are a number of large pier

sections that are located on the seabed that can be explored by divers. The site is a popular training location, and the visibility station allows divers from all agencies to engage with the project and provide data from the dives.

Loch Long has a number of popular dive sites along the east side, and as part of the project, we have been hoping to identify sites that we can bring into the project. One of the new sites is known as The Caves, a site consisting of a large boulder slope with a number of overhangs which give the impression of an overhead environment. It is home to a wide array of fish, crabs, lobsters, and other marine life; consequently, it is a very popular fishing location. After carrying out a number of dives at this site, it was noted that there was a large concentration of abandoned monofilament line that was continuing to trap and kill marine life.

We decided to do regular clean-up dives to remove this line and free any trapped marine life that we found as part of this work. Over the course of 2019, we removed a large volume of line, along with several kilos of lures, hooks, and weights. As part of this work, we have managed to free at least 20 crabs and lobsters that would have otherwise died. This will remain as an ongoing element of the project, as the site will remain popular with fisherman, particularly over the summer months.

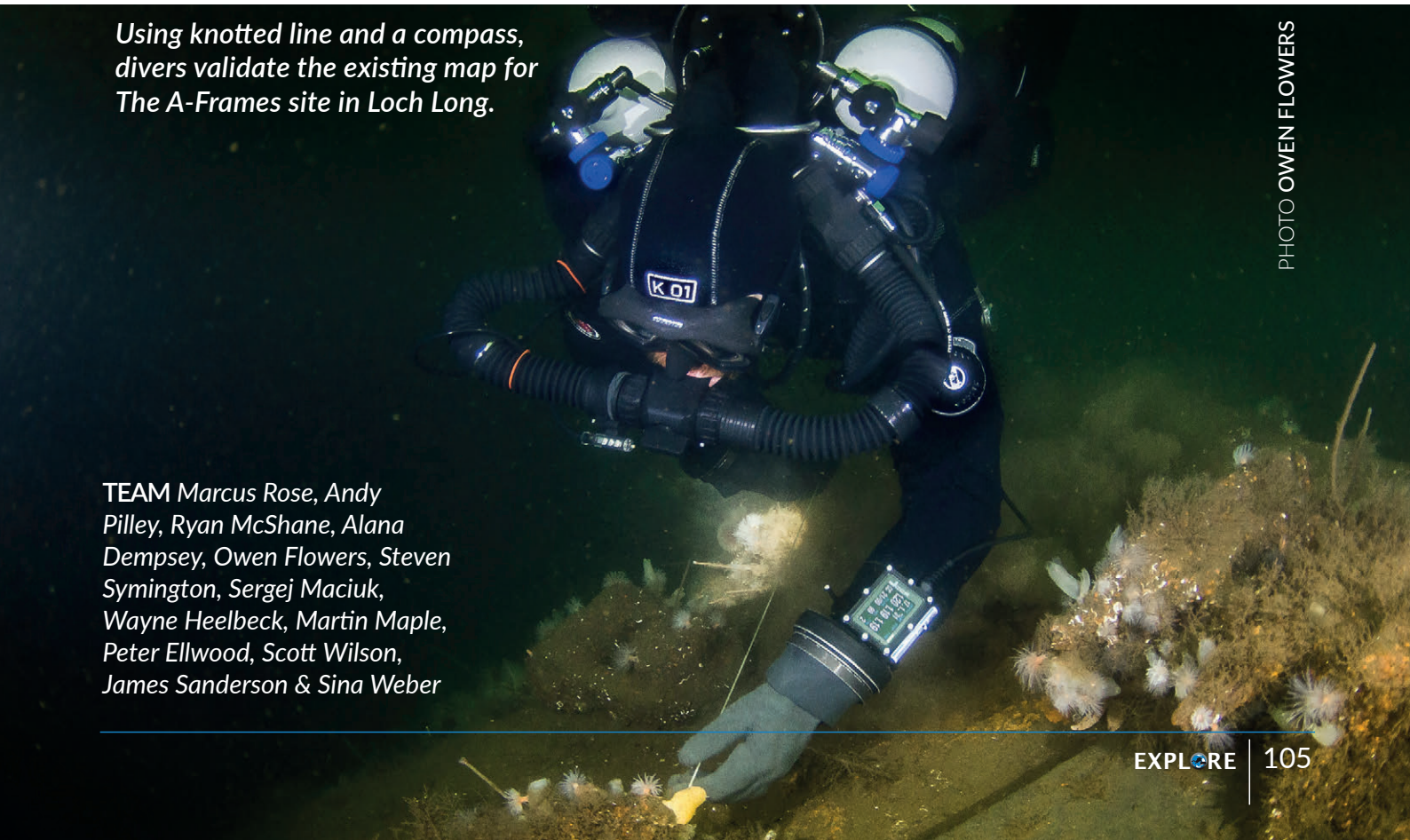
SEASEARCH

Over the past year, we have been working in collaboration with Seasearch, a volunteer-led project with the aim of mapping the various types of seabed found in the near-shore zone around the whole of the U.K. and Ireland. The survey data collected is used to record what lives in each area and to establish a baseline for the richest sites of marine life, the sites where there are problems, and the sites that need protection.

A number of divers have completed surveyor training and are sending back updates to the project administrators from local sites ands less frequently visited locations. This data is then used to assist government policies, such as the establishment of Marine Conservation Zones (MCZs). Data has been submitted to DEFRA (Department for Environment, Food & Rural Affairs) as part of their consultation process, and assisted in the creation of a number of MCZs across the south of England and Scotland.

As part of the ongoing surveys, a number of sites have been identified with a high concentration of Horse mussels (*Modiolus modiolus*). These beds are a priority marine feature and are protected in 12 locations around Scotland. Surveys have been carried out that will confirm numbers, as well as concentrations, and feed this information back to Seasearch. The aim is to survey additional sites across Loch Long, to establish what the concentration levels are, and to determine the particular depths where these beds are most common.

This work will continue through 2020 and beyond as the dataset becomes more mature.



Using knotted line and a compass, divers validate the existing map for The A-Frames site in Loch Long.

PHOTO **OWEN FLOWERS**

TEAM *Marcus Rose, Andy Pilley, Ryan McShane, Alana Dempsey, Owen Flowers, Steven Symington, Sergej Maciuk, Wayne Heelbeck, Martin Maple, Peter Ellwood, Scott Wilson, James Sanderson & Sina Weber*

TEXT MARIO ARENA PHOTO CLAUDIO PROVENZANI

BATTLE OF THE CONVOYS

In 2019, the ArcheoX–GUE teams conducted a series of high-sea excursions in the central Mediterranean in order to carry out preliminary documentation and exploration of several shipwrecks that were sunk during the WWII battles of convoys. These battles were fought from June 1940 to September 1943 as the Italian and the British Navies fought for control of the traffic routes across the Mediterranean Sea and resulted in more than 300 sunken ships.

A GUE project aimed at locating and documenting the wrecks in this area has been active since 2006 and has discovered 38 previously non-dived shipwrecks so far. One of the goals of the project—which is held in collaboration with the Soprintendenza del Mare of Sicily—is to collect materials for a multimedia exhibition dedicated to the battles and shipwrecks.

The project was based on the island of Lampedusa, from which the divers took two- to three-day excursions onboard a 11 m/35 ft fishing vessel. During 21 days of expedition, four of these missions were carried out, for a total of ten days on the high seas of the central Mediterranean.

WRECKS DIVED DURING THE 2019 CAMPAIGN

A total of 11 diving operations were performed, consisting of 28 team dives and 56 man dives, visiting and documenting ten different shipwrecks, two of which had never been dived before.

The German freighter MS *Reichenfels*, which weighed 7,740 tons, was sunk by torpedo bombers in July 1942 while in a convoy from Napoli to Tripoli. The wreck lies on her port side, full of military supplies, at 34 m/110 ft, 60 nautical miles from Lampedusa.

The Italian oil tanker SS *Brarena*, 6,996 tons, was sunk by torpedo bombers in July 1941. The wreck is on its keel at 55 m/180 ft, 36 nautical miles off Lampedusa.

The German freighter SS *Ingo*, which was 3,994 tons, was sunk by torpedo bombers in January 1941 while in convoy to Tripoli, full of military supplies. The wreck is broken in two parts, at 56 m/184 ft, 85 nautical miles offshore. Keith Kreitner identified the ship based upon careful comparison of the hull contour and details, as well as on some specific anti-aircraft weapons carried as part of the cargo on board.

The Free France submarine *Le Narval*, a war grave of the Free French Navy, lies at 39 m/128 ft, 40 nautical miles offshore.

The Italian freighter SS *Caffaro*, which was 6,440 tons, was sunk by torpedo bombers in September 1941, while in convoy to Libya. The wreck lies on her keel at 65 m/212 ft, 90 nautical miles offshore, still full of military supplies.

The American freighter SS *Almeria Lykes*, at 7,770 tons, was sunk by torpedo boats during Operation Pedestal in August 1942 while in convoy to Malta. She was full of military supplies and lies at 125 m/410 ft, 90 nautical miles offshore.

A never-before-dived and still unidentified massive freighter sits upright with its cargo holds full of phosphates or similar materials at 93 m/305 ft, 100 nautical miles from port.

The Italian freighter MS *Marin Sanudo*, 5,890 tons, was torpedoed and sunk by a submarine in March 1942 while in convoy to Libya carrying military supplies and troops. The wreck lays on its side at 75 m/246 ft, 21 nautical miles off Lampedusa.

The Italian postal ferry SS *Egadi*, 861 tons, was sunk by torpedo bombers in August 1941. This spectacular wreck sits on its keel at 75 m/246 ft, 22 nautical miles off Lampedusa.

The Italian small auxiliary cruiser MS *Lago Tana*, 783 tons, was bombed and torpedoed by aircraft in November 1942 while carrying troops. The wreck is on her keel at 125 m/410 ft, 38 nautical miles from Lampedusa.

The teams collected several hours of footage and a number of pictures, as well as an inventory of the most relevant items contained on the wrecks. Besides the fascinating details of their cargo and machineries, all these wrecks feature an astonishing amount of marine life, making the dives even more enchanting and unique.

The next campaign of activities in the area of the battles of convoys is planned for the summer of 2020.

TEAM *The ArcheoX-GUE Team, coordinated by Mario Arena and Francesco Spaggiari, was composed of GUE instructors Peter Brandt, Jin Hui, Caterina De Seta, Keith Kreitner, and Claudio Provenzani, along with GUE Tech divers Davide Dal Molin, Brian Schreuders, Josef Chroust, Nelson Marciano, Marcello Iacca, Simone Castellini, Federico De Gado & Piero Labò.*
WE WISH TO THANK *Mario and Antonio Brischetto of the* Gioel *fishing vessel, and Pelagos Diving Center Lampedusa for helping with fills and storage*

PHOTO **CLAUDIO PROVENZANI**

The funnel of the American freighter *SS Almeria Lykes*, sunk in August 1942 during Operation Pedestal.

IN COLLABORATION WITH *Soprintendenza del Mare and Department of Sicilian Cultural Heritage of Agrigento*

PROJECT PARTNERS *Suex, DAN Europe, HALCYON & EASY DIVE underwater housings*

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