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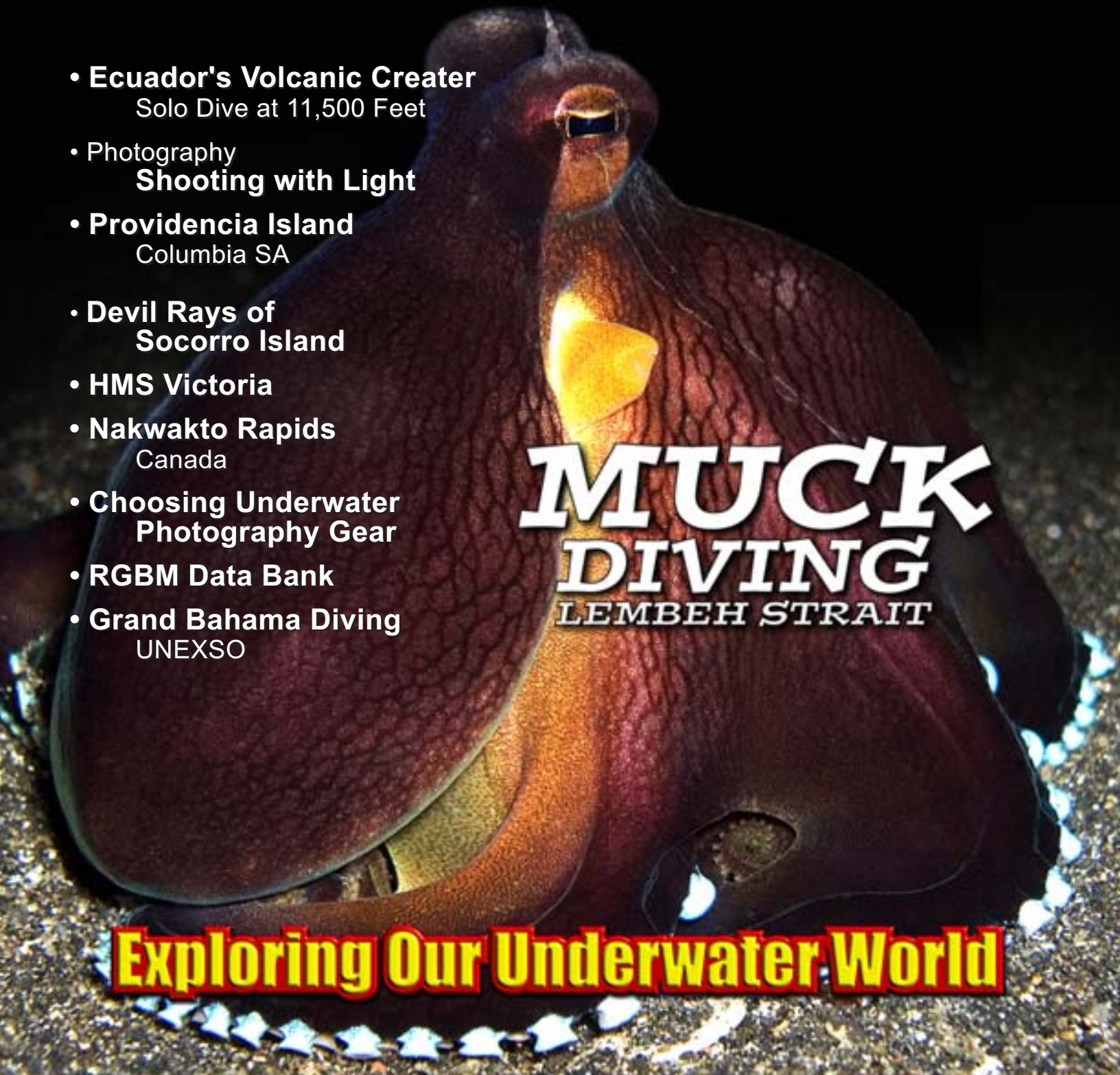

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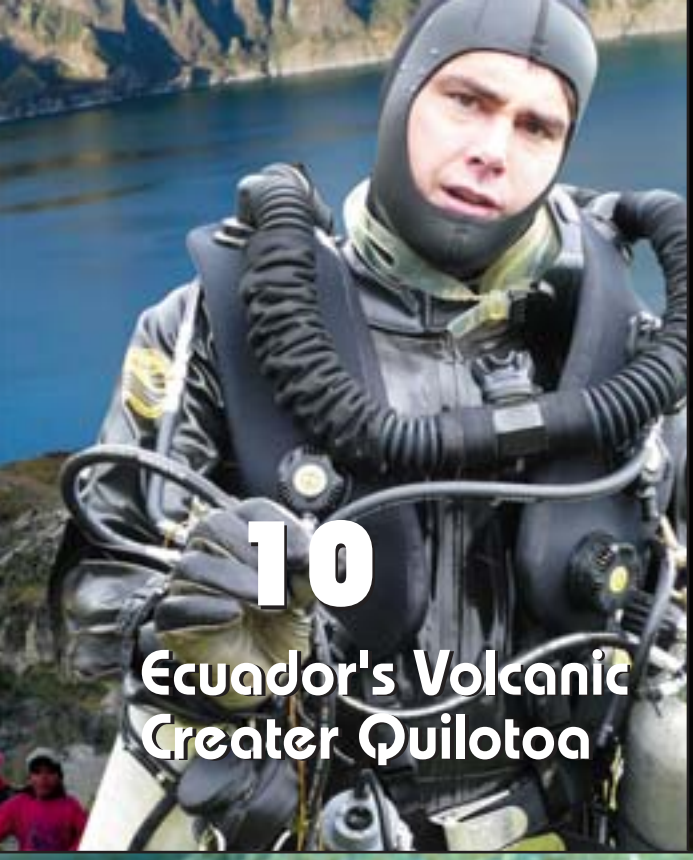

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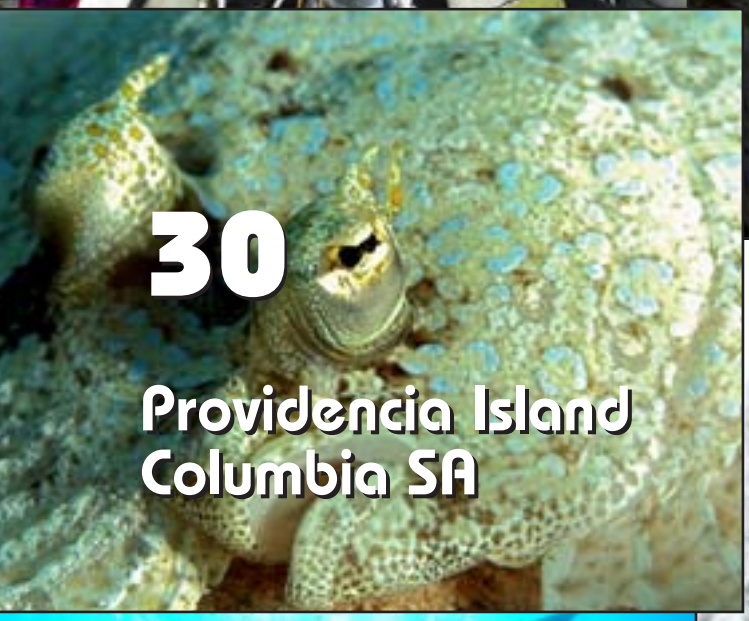

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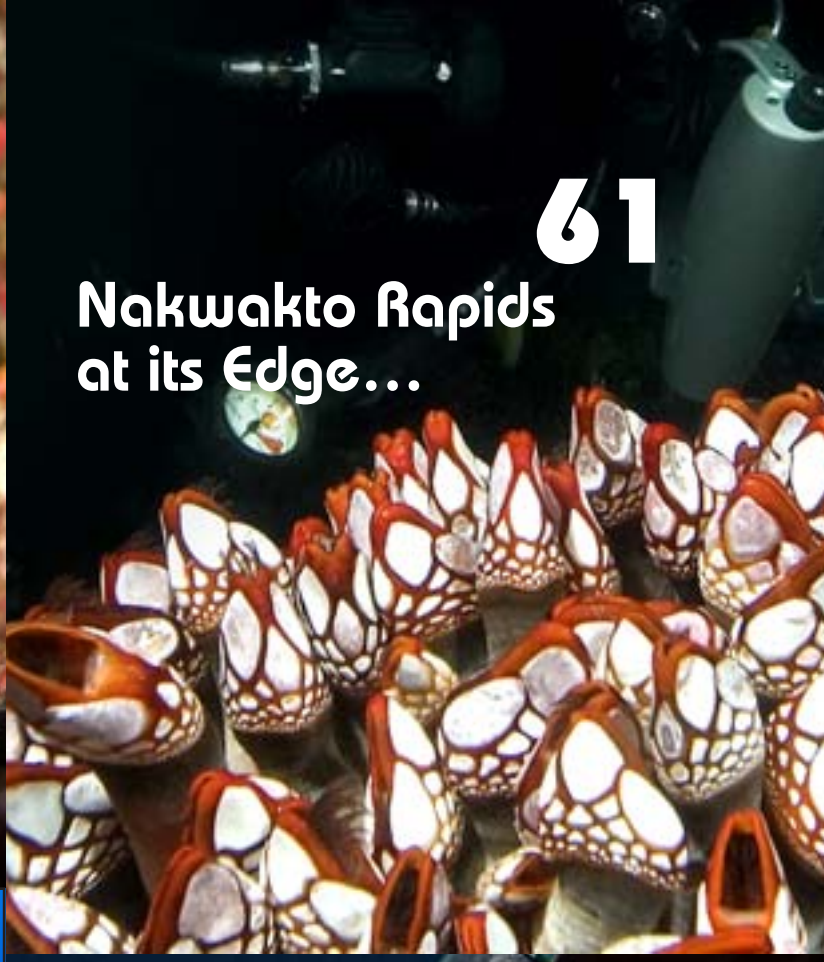

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Ecuador's Volcanic Crater

Quilotoa

Solo Dive at 11,500 feet

Text by ADM Explorer Erik Foreman
Photography by Luis Ya Lamuaya

When it comes to inner-space exploration, being first is king. New records are set every day. Depth, time, distance, and exploration are all reasons to push the envelope and see what's possible.

Ecuador is the part of South America that for most divers means diving Gordon Rocks in the Galapagos or Salinas on the Pacific Coast. I did some research and found that Ecuador is full of volcanoes, and several of them contain deep, unexplored lakes. Based on local legend, logistics, and a gut feeling, I identified one primary and two secondary targets: good chances to dive at altitude, test my Megalodon COPIS, and satisfy the possibility of future exploration. I packed my CCR, sorb, two aluminum 40's, wing, back plate, harness, armadillo-inspired side-mount system, dry suit, and everything else I would need to conquer Ecuador's highest and most fabled lakes.

Extreme solo diving is not for everyone; but for me, this only added to the challenge. How would I know my mix at altitude in the thin air of the Ecuadorian Andes? Mathematics. As a diver ascends from sea level, the percent of various gases that make up the atmosphere remain the same. However, the partial pressures of these gases decrease. How much is a matter of calculation. Not completely trusting my own math skills, I turned to the experts at Innerspace Systems Corporation, where Leon and Jerry immediately set out to answer my question. What is the partial pressure of oxygen in the 11,500-12,500 foot altitude range? Within hours I had my answer: 0.14 in air and 0.67 in pure oxygen. With this crucial information, anything was possible.

The logistics of diving closed-circuit in the middle of Ecuador include finding gas, finding the dive site, and finding help getting to the water. Immediately upon arriving in Quito, Ecuador's capital, I put the valves back on my cylinders and headed out to find some air and oxygen. I looked in the phone book for the address for ADA, a local distributor for Linde Gases. The doorman hailed a taxi, and Luis Ya Lamuaya drove up. Little did I know it at the time, but he would become my driver, navigator, negotiator, shore support, and best friend. He told me he was a former Ecuadorian prize-fighter, and from his stature, I had little doubt. We made it to the plant, only to find out it was too dangerous to fill on that day. We were then told that if we came back the next day it would be all right.

Hopeful, yet disappointed and desperately needing a pick-me-up, I asked Luis if he knew of a place to get tattoos. For weeks, the vision of a beautiful mermaid with my wife's face and the body of a shark had entered my mind during long hours of deco. A sacrifice of flesh somehow seemed appropriate. A mythical denizen of the deep with long flowing hair would, I hoped, serve as a special good-luck charm. Dark, smoky, and crowded, the parlor was just what one might expect to find in the back alleyways of Quito's red light district. After a two hour artist's translation of a fleeting dream to permanent ink on skin, I returned to the hotel to rest, confident I would be back in the water soon.

Above: Explorer Erik Foreman wades out from the sandy shore to become the first rebreather diver to explore in Quilotoa Crater, Ecuador. A small band of locals gather along the volcanic shore, certain that Erik would never again return to the surface of the lake.
Photo by: Luis Ya Lamuaya

After two more days, several different supervisors, one hydro, and much pleading, Senor Juan Cova came to my rescue and supplied me with a cylinder of oxygen. I was told I would have to leave the plant and trans-fill my own cylinder on the street. We left the factory, drove around the corner, and using a state of the art portable blending station that Steve Rokicki of Submerged Resources, Inc., supplied me, we trans-filled, returned the other cylinder, and hit the road.

The highest and most technically challenging objective would be my first choice: the crater at Quilotoa. Approximately 9 miles to the north of Zumbahua lies the village and infamous volcanic crater Quilotoa with a serene mysterious green lake inside.

From the rim of the crater, you descend approximately 1300 feet through a deep cut in the wall before reaching the level of the lake at approximately 11,500 feet. With the lake itself over 950 feet deep, I knew most of it would be out of my reach, but still I dreamed of what the bottom might hold. We arrived to find the small village market deserted of other tourists. Since I was the first diver the locals had ever seen, they were eager to help. We gathered up all my gear and started the climb down from the greater rim.

At first glimpse, the dive site seemed a daunting distance, but after descending the steep trail for about thirty minutes and rounding a small bend, a couple of boats and a colorfully-dressed woman came into view. I reached the small sandy beach and dropped gear. Quickly surveying the dive site, I noticed that other than a thick mat of algae surrounding the water's edge, the entry would be fairly routine. By this time, Luis and the rest of my gear had arrived. It was time to dive, so I donned my dry suit. The local men began to divide up my stuff, certain I was never to return alive. I pulled on my rebreather, and Luis began to stage me up. The women began to pray out loud, asking God to spare my life. I thanked them, needing all the help I could get.

Entering the water, I pushed the long, green, stringy algae aside. The bottom maintained a steep angle all the way to the shore. With compass set, light on, and camera ready, I gave the locals a wave, and slipped beneath the surface. Because of the low pH of the water, I had been told that nothing other than algae lived in this lake. But in any body of water this deep, who knows what might be hiding below? I slowly made my way into the lake, with visibility at 5 to 10 feet, crawling over car-sized boulders. I felt as if I were diving on the moon. At 101 feet, I turned left and began the search for treasure. Grey ash and striated cliffs punctuated by massive single boulders became common-place. At that altitude and depth, time to surface racks up fast. My VR-3 safely guided my way up, as a rush of emotions flooded my mind. With confused thoughts of exploration, conquest, accomplishment, sacrifice, and things still to come, the decompression passed faster than ever. Breaking the surface, my first sight was of a large crowd that had gathered eager for my return.

Immediately, a barrage of questions filled the air. "What does it look like? Are there any fish? Is there anything living down there?"

I had a few questions of my own. "How long before dark? How would I get back to the crater rim?"

I answered their questions and they answered mine. Bartering answer for answer, I yelled out, "It looks like the moon!"

"We have one hour before it gets very cold and very dark," replied a young boy.

"No, I did not see any fish."

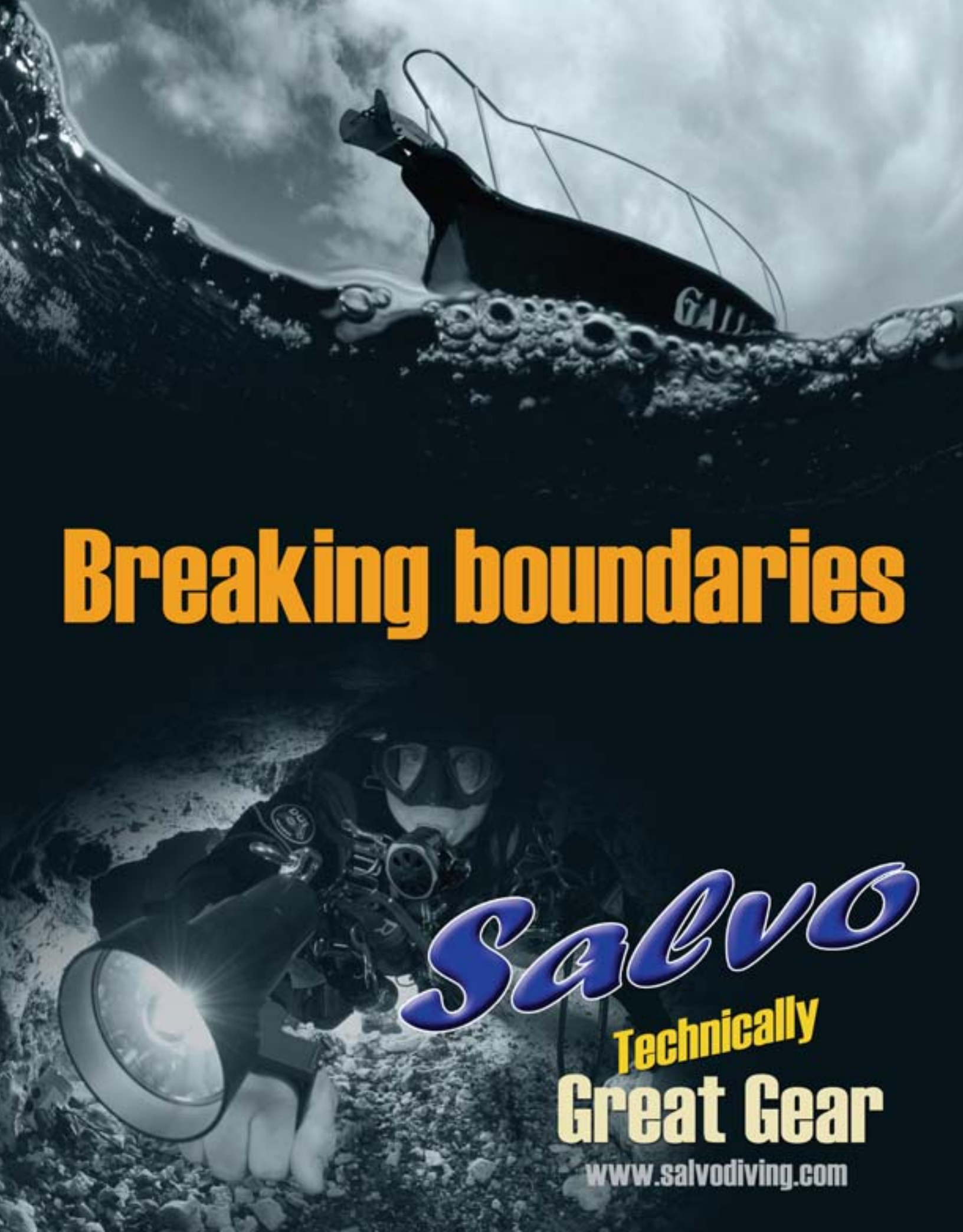
"We brought donkeys for you to ride out of the volcano."

Relieved I would not have to walk, I climbed aboard my trusty steed, Jose. I came to find out that Jose made that trip several times a day and knew the trail very well. Leaning completely forward and holding tightly to a rope, I managed to hang on even in the steepest sections of the trail. Reaching the top, I could see the long shadow of the crater rim stretching across the water to the far wall.

Night was approaching quickly, and a long four-hour drive back to Quito lay ahead. We finally reached the hotel. I said goodnight to Luis and rode the elevator to my floor, tipped the doorman, and, exhausted, I tried to remember every detail of the entire day's experience. But I could only concentrate on getting to bed.

I ended up diving two other calderas, both remarkable in their own right, and, yes, I dove the Galapagos. I saw all the usual species including hammerheads, reef sharks, sea turtles, manta rays, penguins, sea lions, and various reef fishes. South America is fantastic for diving. I know I'll be back soon for more adventure.

I would like to thank the following: Luis Ya Lamuaya - my guide, driver, and new buddy, Senor Juan Cova at ADA - for breathing gases, Mel Clark & Curt McNamee & Silent Scuba - for training, logistics and technical support, Advanced Diver Magazine - for promoting technical underwater exploration, and my Mother - without whose support this trip wouldn't have been possible.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PHOTOGRAPHY
SHOOTING WITH LIGHT

Text by Curt Bowen
Photography by Jeff Toorish and Curt Bowen

As an avid cave / wreck diver and professional underwater wide-angle photographer, I often find myself in dark, silt-covered, inhospitable locations attempting to get that good photo that few others can. In the past, photographers have been required to bring multiple high-powered underwater strobes capable of providing the light required to fill the large dark voids we were attempting to capture. Many times, we did not achieve the desired results due to the power output of the strobes in relation to the subject and the black background.

Above Image:
Location: Fourty Fathom Grotto, Ocala Florida
Subject: Airplane fuselage
Depth: 90 feet
ASA: 1600
Shutter Speed: 50th of a second
F-Stop: 2.8
Lens: 10.5mm

Lighting:
High afternoon sunlight from above
Distant diver: Diverite 35 Watt HID
Close diver: Solus Submersible Products 400 watt SV2 - Single video light
On Camera: Solus Submersible Products 400 watt SV2 - Single video light

Standard underwater photography can be tricky, even in excellent lighting conditions such as found in shallow reefs and clear water where you can see the subject, meter to the natural sunlight, and have ample time to adjust strobes to fill flash the subject. Now complicate this scenario with extreme depths, poor visibility, confined overhead spaces, extra life support equipment such as rebreathers, bailout stages, lights, reels, etc., — not to mention that it's usually almost pitch black — and you have a recipe for disappointment and failure.

I had often dreamed of bringing giant studio-style video lights into the cave or wreck and lighting the desired location with just the right amount of continuous soft lights to obtain the photo I could see in my head, but could not seem to get with strobes. Of course, this would be next to impossible because of the logistics of designing, building, and powering such underwater lights on a budget any less than NASA's.

In the last several years, new HID and now super bright cluster LED light technology is making giant strides toward a portable underwater lighting system that can provide the huge amount of lumens required for still or assisted strobe photography. Plus, the new technology maintains a manageable size for maneuvering in crowded or difficult locations, and a long enough burn time to be effective.

Initially, these light systems were designed for underwater video productions, but I have found that they are now on the edge of providing enough lumens for my Nikon D200 still camera and close wide-angle photography.

These lighting systems are also small enough to have other divers, which I call light assistants, to carry and provide lighting effects from multiple angles away from my camera. Many times I have used these divers to light the subject from above, on a side such as along a giant cave wall, or even

behind the main subject to create the "light blast" which adds a more three-dimensional effect.

With the new digital camera technology, images that were once almost impossible to obtain are now becoming possible. In the old film days, we were limited to the number of exposures on the roll of film, normally 24 to 36 shots. Today, you can buy memory cards for your digital camera that can hold hundreds, if not thousands, of images on a single dive. The speeds of these new digital cameras and memory cards have increased to match or surpass the old film cameras, enabling the digital photographer to produce film bursts of up to 25 images in a couple of seconds. High-end digital cameras can also be set for high ASA film speeds of over 1600, thus enabling them to almost see in the dark.

Of course, the strobe technology cannot keep up with these fast film bursts, but continuous lighting techniques can. I like to call it the "bring the sun with me" technique. This technique is extremely useful for technical diving photography where you are severely limited on the amount of time that you have to capture the photo in a very harsh and demanding environment.

I also employ a technique I call "Machine Gun Fire" shooting. It's more of a haphazard method of adjusting the camera's light meter and shutter speed to the basic lighting provided, either by my lights or limited natural light. Then, during the fast action of the dive, such as being swept down the side of a wreck in high currents, I lie on the trigger and hope that one or two images out of the 150 I just took while being tossed in the current turn out to be something useable. Not really professional, but in extreme conditions, I feel it's better to get something rather than nothing.

Above Image:
Location: Yucatan Cenote, Yucatan Mexico
Subject: Ancient Maya Human Remains
Depth: 12 feet
ASA: 640
Shutter Speed: 180th of a second
F-Stop: 2.8
Lens: 10.5mm

Lighting:
No natural lighting
Close diver: Green Force 250 Watt HID
On Camera: Solus Submersible Products 400 watt SV2 - Single video light

As lighting technology develops, manufacturers will be producing even more powerful, longer burning lighting systems capable of illuminating even larger photo areas.

The best final results still seem to come from being in the right spot at the right time with the right people modeling, and the best person lighting the subjects. It is easy to get discouraged in this type of demanding photography; but when all the pieces come together, and you are able to shoot that one image that no one else has ever seen or been able to capture, it makes all the hard work and tens of thousands of dollars in equipment worth it. And very few divers are fortunate enough to have the chance to visit many of these wrecks and cave sites, so I believe that documentation is very important.

Of course, nothing has replaced a well-trained, sexy underwater model and an eager-to-please lighting assistant. Without them, who would I have to boss around underwater?

Above Image:
Location: Yucatan Cenote, Yucatan Mexico
Subject: Cow Skull
Depth: 145 feet
ASA: 1000
Shutter Speed: 100th of a second
F-Stop: 2.8
Lens: 10.5mm

Lighting:
No natural lighting
Diver: Salvo 35 Watt Video HID
On Camera: Solus Submersible Products 400 watt SV2 - Single video light

Above Image:
Location: Peacock Cave, Florida
Subject: Diver in cave passage
Depth: 75 feet
ASA: 1000
Shutter Speed: 50th of a second
F-Stop: 2.8
Lens: 10.5mm

Lighting:
No natural lighting
Diver: Standard 10watt Green Force HID
On Camera: Twin Solus Submersible Products 400 watt SV2 - Double video light

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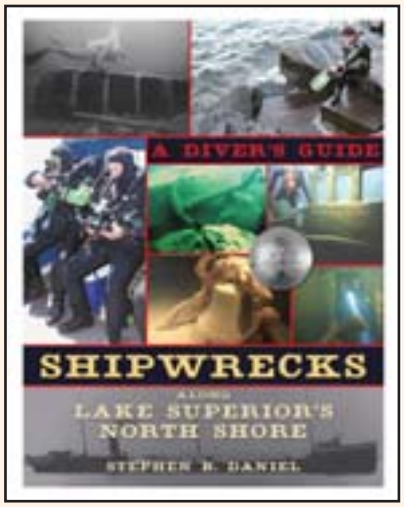

Shipwrecks Along Lake Superior's North Shore

By: Stephen B. Daniel
Format: paper, 208 pages, 8.5 x 11, 300 BW photos, 75 drawings, 40 maps

Beneath the icy waters of Lake Superior lies a vast museum of maritime treasures, relics, and souls that in years past were lost to the crashing waves of this massive body of water. Today, those who remain on the surface can glimpse some of this sunken bounty, but most of it is accessible only to those who slip into scuba gear and brave the darkness of the deep.

In Shipwrecks Along Lake Superior's North Shore, veteran diver Stephen B. Daniel, in collaboration with the Great Lakes Shipwreck Preservation Society, provides in-depth tours of the many sunken ships submerged in the waters of this region of Lake Superior. Readers will not only learn the maritime history and structural details of the original vessels, they'll also find the fascinating stories of the wrecks themselves—how they happened, what actions were taken to save both crew and vessel, and the modern-day efforts to preserve these sites. With detailed descriptions and hundreds of photographs, charts, and diagrams that will impress even the most seasoned diver, this book will also appeal to anyone who has ever wondered what nautical mysteries lie beneath the waves of the greatest of the Great Lakes.

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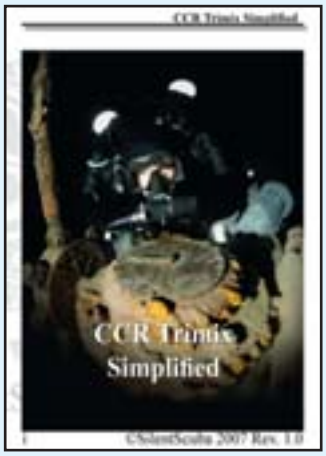

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- EO Connectors with electronic sensor to prevent shorting if unplugged underwater.

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- Machined aluminum canister type battery uses 5 D Cell Alkaline batteries (not included).
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www.niteriderdive.com

Dive Rite's New Line of Dive Pockets

Dive Rite is launching a new line of harness accessory pockets that build upon daisy chain technology from the backpacking industry. Daisy chains are small webbing loops sewn to form a chain and mounted onto backpacks for attaching carabineers and accessories. Dive Rite has taken this concept one step further by developing unique sheaths for Z Knives and Trauma Shears that will clip into daisy chain loops located on the outside of the pockets.

But that's not all. Inside each new pocket is a 36-inch looped lanyard to clip reels, lights, slates and line markers into. No more fumbling for the right tool, simply pull out the lanyard and select the tool needed, then replace the loaded lanyard. Tools remain secure and cannot mistakenly fall out of the pocket.

Coordinating with our daisy chain pockets are new cutting device sheaths for Z Knives, Cold Water Z Knives and Trauma Shears. Using heavy-duty Annex clips, each sheath simply snaps through the daisy chain loops and holds the sheath in place. Sheaths can be worn vertically or horizontally and will also attach to cylinder hose retainers, wrist straps or a chest strap. A quick-release Velcro lanyard attached to the tool and sheath keep tools from slipping.

Dive Rite's new pocket line up includes two vertical, waist-mount Bellows Pockets, one with Velcro closure, the other with a zipper closure; a horizontal Bellows Pocket with two zipper compartments and a redesigned Thigh Pocket with proprietary leg band material that grips the exposure suit and eliminates slippage.

www.diverite.com

Tri-Hunter 6000 Mixing Stick

The Tri-Hunter 6000 is a continuous blending Trimix and Nitrox mixing stick in a league all of its own. It eliminates expensive and inefficient partial pressure gas blending. Due to a proprietary electronics / software package known as the *Accublend*, it is the only mixing stick that does not require you to drain the existing mix from your tanks. Instead you can top off an existing mix and save expensive gas. In addition, this device works with your compressor, making a Haskel unnecessary.

The Tri-Hunter *Accublend* display allows you to monitor your O_2 and He percentages as they are blended with its built-in analyzer. The electronically controlled shut-off solenoids have six(6)built-in safety features that stop the flow of both oxygen and helium if:

- The auto calibration button is pushed while the compressor is running
- There is any loss of power to the *Accublend* electronics box
- The O_2 sensor reaches 39.9%
- The sensor cables are unplugged
- The power switch is turned off
- The compressor stops running

The Tri-Hunter retails for $3,200, which includes the complete package of regulators and electronics

www.AmigosDiveCenter.com

Providencia Island
Colombia SA

Text and photography
by ADM photojournalist Tom Isgar

I generally write about fantastic dive sites which are off the beaten path. Providencia is off *all* the paths, but easy for American divers to get to - fly to Panama City, switch to a flight to San Andres, and catch the commuter to Providencia. You can leave Miami early in the morning, and get in an afternoon dive in Providencia. This is an undiscovered deserted island, with electricity, running water, cold beer, and great diving.

Providencia is one of two small islands in the Caribbean, roughly 160 miles east of Nicaragua and 480 miles north of Colombia. San Andres is the other island and will be covered in the next issue.

The islands and reefs are Colombian, but claimed by Nicaragua, and have in the past been a source of tension between the two countries. Providencia is in a nature reserve (McBean Natural National Park) with keys, oceanic shallows and banks, and is Colombia's most extensive reef area. The barrier reef is 12 miles long and 660 yards wide. The archipelago is considered a biosphere reserve. Providencia's maximum elevation is 360m above sea level. The island has a tropical climate with an average temperature in the low 80's.

History

Like other Caribbean islands, San Andres and Providencia have a history of romantic pirate tales and control by various European countries. The first inhabitants were black slaves from Barbados who arrived around 1630. Later, people came from England, Wales, and Holland. It was the site of an early Puritan colony - a sister colony to the Massachusetts Bay Colony.

Within a few years Providencia became an important center of slave traffic, which led to piracy, and the sale of contraband. The pirates were able to assault passing Spanish ships, leading to an attack by the Spanish and the expulsion of all the English residents.

Locals fish, raise some fruit and vegetables, and harvest coconuts. Oil and gas deposits are believed to exist offshore. Tourism is seen as very important, and the Colombian government is currently attempting to raise awareness of the two islands.

All non-residents are required to purchase a tourist card that you can get from the airline or at the airport in San Andres. Americans are not required to have a visa. Travelers from other countries may need a visa.

Accommodations

There are a few small hotels on the island as well as some rooms in private homes. I was hosted by the Sirius Hotel and Dive Center. (Sirius is the name of the brightest star in the sky after the sun.) The hotel and dive center have been in business for 20 years, and still have the original family involved. The hotel has seven air conditioned rooms and suites which can handle up to 22 guests. It is casual and friendly. If you are lucky, you can sit at the counter of the outdoor kitchen and watch breakfast being prepared. Lunch and dinner are available at local restaurants on the beach. For about $6.00 you can get a complete snapper, recently caught and cooked over wood, and a beer. Since there are so few tourists on the island, Sirius has decided not to serve lunch and dinner so that guests will take business to some of the nearby places.

Although I was there to dive, there are several activities for the deco day –

- Exploring on your own with a rental motor bike or jeep
- Horse back riding
- An island tour with lunch on the beach
- Snorkeling and beach time
- There are also some smaller keys you can visit with a hire boat
- A hike to the top of the highest point on the island

The Diving

The dive center is a PADI center with two dive masters who are certified to offer PADI training through the dive master level. They also have "first responder emergency medical certifications." The nearest chamber is on San Andres – three hours away by boat.

The shop has a full complement of rental gear, but you should not plan to buy dive gear on the island. Their open boats can handle twelve divers, but would be best with six. Unless you take your own dive buddy or a group, you might have a private boat. The busy times coincide with Colombian school holidays.

The diving is the best the Caribbean has to offer. Although underwater it will appear familiar to experienced Caribbean divers, the health of the coral and sponges, the abundance of fish, and the size of some species is fantastic. I swam with and photographed a school of French grunts that seemed endless. Photographing them from the side was like swimming beside a yellow school bus. Most of the sites are a short ride from the dive center, so the boat often returns to the shop after each dive. Some of the wall diving takes a little longer but is worth the trip.

There is truly diving for everyone here. Sunny shallows packed with grunts and snapper swimming around coral heads will remind you of Key Largo, whereas sheer walls beginning at 70 feet and dropping to 200 are similar to Cozumel. If the weather permits, there are a few sites where two currents converge and large schools of jacks and other predators assemble to feed. Diving is divided into four distinct areas. A few of the thirty named sites are described below.

The Northern Reef

The barrier reef runs from about one mile south of the island, along the eastern side of Providencia, to about eleven miles north of the island, ending at a small exposed section of reef that has a navigational lighthouse on it (metal tubular tower with a light on top). It is known locally as El Faro. On one of my dive days, we dove this area. A highlight was having a fish fry by the lighthouse.

Table Rock (25 feet) If Disney were to design a dive site, this is it - a system of large chambers, interconnected with large passages providing a good view to open water. The chambers are teeming with silversides, and the sunlight rays are spectacular.

The Bight (60-150 feet) Start the dive on a sand platform, and drop onto the wall that is covered with beautiful corals and sponges while observing large jacks and rays in the open water.

Wreck of the *Andy* (35 feet) The Andy is a broken wreck on the outside of the reef. It is a good location to see Nassau groupers as well as reef and nurse sharks. There are extensive coral and sand patches in front of the reef.

Outside the Reef

These are the least dived of the island's sites because they are affected by the open ocean. When conditions are right, the diving is very rewarding.

Dos Puntas - Two Points (60-80 feet) This site consists of two underwater ridges on the outside of the reef. The many gorgonian and stony corals are in pristine condition.

El Jardin -The Garden (70 feet) The dive starts on a gentle slope of sand and grass covered with queen conch, and gradually slopes down to colorful corals and sponges, including many large barrel sponges. Some larger coral mounds have pillar corals with schools of fish and moray eels. When the water is clear, this site offers gives a real sense of the vastness of the Caribbean Sea.

Patch Coral

Tete's Place (30-40 feet) This site is in front of the dive shop about 1/2 mile off shore. The main attraction is the variety and number of fish. There are always large schools of goatfish, grunts, schoolmasters, and squirrelfish - truly swimming in an aquarium.

Manta City (45 feet) Sorry, no manta rays. The local term for any ray is manta, and thus the name. I did see large Southern stingrays. The dive starts out over sand with large coral mounds the size of a house. Another treat are the brown garden eels.

Paulino's Place (40 feet) Located near Manta City, this site is also a sand bottom with large patch coral. Southern stingrays, a large jewfish, and hawksbill turtles frequent this site.

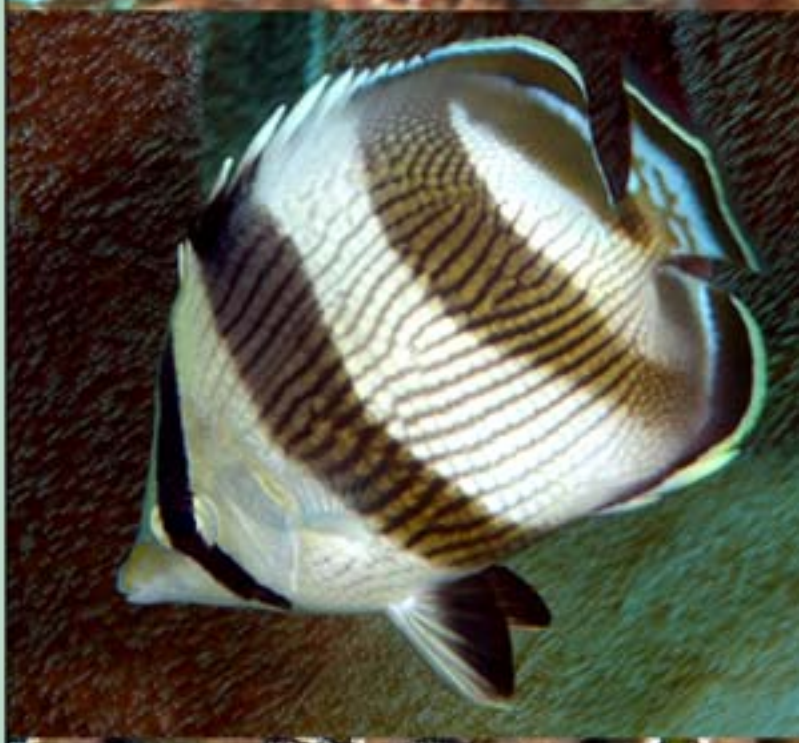
Wall Dives - West of Providencia

There is an extensive wall along the western extent of the reef system. The wall is very steep and provides for great diving. The outer wall sites have large schools of Creole wrasse along the reef edge. Each site has the possibility of encountering turtles, eagle rays and the occasional shark. In some spots, a platform is visible at about 150 to 200 feet, and in other places it is just deep blue. The current is moderate allowing opportunity to examine the wall at your leisure. If there is current, the boat picks up divers when they surface.

Nick's Place (50 feet at top of wall) Reef sharks and turtles often cruise the wall. The dive can be done in either direction depending on the current. I saw jacks and grouper on this dive far larger than any I have seen before.

If you want to kick back on a nearly deserted beach, dive from a private boat, and explore the best diving in the Caribbean, this is the place to go. And, if you would like to get in some shopping and nightlife before heading home, read the San Andres article in the next issue.

www.siriusdivecenter.com



Devil Rays of Socorro Island

Text and Photography by
ADM Staff Photojournalist Jim Rozzi

The Wabash River flows near my childhood home in Indiana. It was not distant. No more than two hundred yards away and thirty feet below our front yard. Sycamore trees, Willows and Oaks grow along the river banks to screen the flowing water from view. With the spring rains, the sounds of the river surging out of its banks would reach my ears. At my front door step, I would stand listening to the powerful sounds made by the rushing water. Sometimes the crash of a tree being carried away by the roiling water could be heard. Other times I would hear nothing more than the screech of a blue heron or hundreds of crickets in concert.

After the rains, the water would recede to remain within the river banks as the muddy river flowed ever on to join with other river waters spilling into the Mississippi and eventually the Gulf of Mexico. With the flood gone it was time to explore. I was fascinated with the river and its mysteries. It surely held great unseen wonders.

As mothers do, my mother warned me about the dangerous waters where many unfortunate children were lost. I learned to swim and began to explore the river. I became the mental owner of about one mile of river banks. I knew where the old dam spillway foundations remained to expose themselves at low water, where the old Interurban railroad bridge pilings crossed the river with echoes of railroad sounds long past, where several small springs with crystal clear water flowed, where to be on the look out for cotton mouths and snapping turtles and where the sunfish and goggle eye holes were.

My mother orphaned at childbirth was raised by her Uncle John. Uncle John lived on a small farm which abutted our property. Always full of strength, excitement, fun and adventure, he was a giant to me. He told me many stories about the "Old Timers." One of my favorites was about Orlie Pew, long deceased, who lost a hand in some misadventure and had a hook fitted to his forearm. He would go into the river searching for huge catfish hiding in the holes along the river banks. He would dive down and jam the arm with a hook into the hole and hope to drag out a huge catfish. Why I was told "some were as big as seventy five pounds…good eating too!" They put up a terrible fight and sometimes he would come out with a snapping turtle. I could not imagine the courage of such a man.

I can imagine that you are wondering how this leads to the Devil Rays of Socorro Island. Well, read on and I will tell you.

Living on the river, exploring the river and hearing stories of the river led me to wonder what it would be like to see beneath the water's surface. What a fascinating thought. I read Jules Verne, Herman Melville and Jack London. I "road the river" with Huck Finn and Tom Sawyer; however, the deep sea creatures were my favorites. Melville could paint such an image of Moby Dick. I still get a chill thinking of this awesome creature rising from the deep to claim Captain Ahab. Somewhere in all of this reading I came across a reference to a Devil Ray. This animal was said to be a sailor's nightmare. It was described as a fearsome creature that had the very horns of the Devil. From that time forward I wanted to see one.

Like most, my youthful wants and dreams were set aside with the requirements of adulthood; but they were never lost. I knew someday I would be able to see firsthand the Devil Rays of my youth. This happened on a dive trip aboard the Solmar V to the Revillagigedo Islands, Mexico. Manta Rays were there on almost every dive and proved to be much different than those portrayed in the stories of my youth and known as Devil Rays. The animals seemed to be very gentle and highly inquisitive.

The Revillagigedo Islands are a group of four island of volcanic origin in the Pacific Ocean about two hundred fifty miles south of Cabo San Lucas, Mexico. The islands are San Benedicto, Socorro, Roca Partida and Clarion. All Islands are under Mexican jurisdiction and are uninhabited with the exception of naval personnel. There is a small naval station located on Socorro where all visitors clear customs and a smaller naval garrison on Clarion Island.

Because of the islands' isolation from the mainland, there are many endemic species. It is considered an endemic bird area and is some times referred to as Little Galapagos. The islands are covered with dry forests and are generally dry with little annual rainfall. San Benedicto was devastated by a volcanic eruption on August 1, 1954.

Underwater the islands are generally surrounded by grey rock, not much coral, and small numbers of reef fish. However the lack of interesting reef fish was made up for by the presence in numbers of larger marine animals. On each dive we were joined by many Manta Rays, Scalloped Hammerheads, or Porpoises.

In 1954, the Mexican Government dedicated the Revillagigedo Islands as a "Biosphere Reserve." No fishing allowed. However, Seawatch reports that sometimes fishing boats sneak into the area and set up many miles of longlines catching hundreds of mantas and sharks for nothing more than their fins. The islands are accessible by boat from either mainland Mexico or Cabo San Lucas. My point of departure was Cabo San Lucas aboard the Solmar V.

My dive buddy, Paul Sweet had agreed to join me on my search for Devil Rays. We took advantage of the opportunity to explore Cabo and discovered that it was a great place for a cold beer, tequila and great fishing. The striped marlin were running in early December so we wandered down charter boat row and booked a two day marlin fishing trip. No disappointment allowed. The first day we caught and released two striped marlins. The second day, as I was confined to my hotel room with Montezumas revenge (must have been the tequila chasers) my traveling companion caught and released five striped Marlins.

The third day we boarded Solmar V for the 20 hour trip to the Islands. The boat, the crew and other guests all proved to be exceptional. My waistline will also attest to the quality and abundance of food aboard Solmar V. We had a smooth passage and eagerly awaited our check out dive as we drew near to San Benedicto. The water was great with a temperature in the mid 70s and with eighty to one hundred feet of visibility.

The check out dives went well and we were off in search of the Mantas. We were not to wait long. Solmar V anchored in 110 feet adjacent to the dive site El Fondeadero at San Benedicto. The island is grey and draped with lava much as it must have flowed to the sea when molten. A nylon line was run from the vessel's stern to one of four small submerged islands near shore. The depth to their tops ranged from 40 to 60 feet. The bottom was sand at 80 feet on the outside of the islands. It did not take long. A manta appeared near the surface and swam gracefully toward our group. We had been told not to chase or act aggressively toward the animal. This proved to be good advice. The manta joined our group making several passes over head. It seemed to enjoy swimming through our exhaust bubbles. It made sweeping turns almost disappearing from view and then would glide toward us for another look. Our pressure gauges told us that we needed to return to Solmar. The manta seemed to wave farewell as we turned to make our ascent.

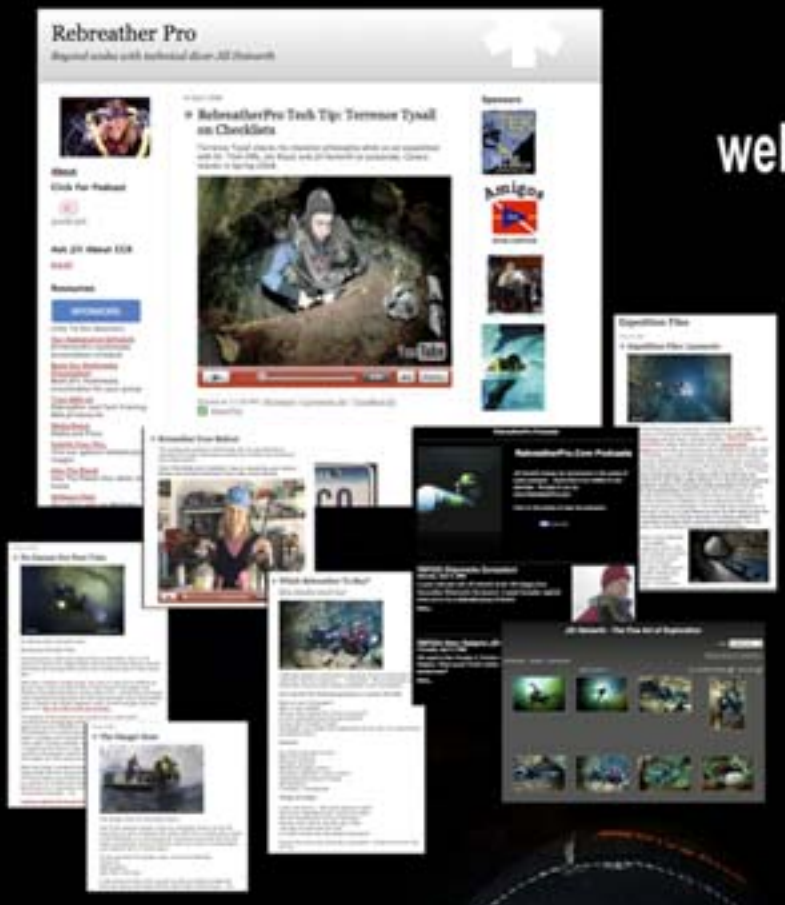
Solmar V raised anchor to motor to the west side of San Benedicto where we dove El Boiler which is a submerged giant mass of rock from a depth of fifteen to one hundred thiry feet. The dive filled with many large animals proved to be equally as interesting as before. The balance of the week aboard Solmar V passed too quickly. We visited several more

island dive sites, Roca Partida then to Isla Socorro at Punta Tosca and Cabo Pearce. No dive was without big animals. Mantas visited us regularly along with scalloped hammerheads and dolphins. At times, we had both or all.

Pacific Manta rays can grow quite large. Some reach wing spans of nearly thirty feet. Average is about twenty two and they may weigh as much three thousand pounds. Mantas are gentle giants with no real means of defense except speed and agility. Unlike other rays, they do not have a stinger in their tail. Mantas seem to visit the Revillagigedo Island to feast in waters enriched with high concentrations of plankton. And, as it turned out, those devil horns that I read about as a child, they unfurl while feeding to direct the tiniest of plankton to the mouth…not spears or Devils horns at all.

RebreatherPro.com

Beyond Scuba with Jill Heinerth



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HMS VICTORIA NO SECRET FOR

By Cedric Verdier • Trimix CCR Instructor Trainer

What could be the common point between a fish exporter from Norway, a Chief Information Officer and diving instructor living in the Netherlands, a renowned lawyer based in Cyprus, a Project Managerworking inSweden, and a Technical Diving Instructor far from France?

Apparently none. Except their love for underwater wrecks and their desire to explore some of the most famous ones all over the world.

A few months ago, Per Bjorn Rakvag, Pim van der Horst, Spyros Spyrou, Henrik Enckell and Cedric Verdier decided to participate in a wreck expedition to Lebanon.

Their goal: exploring the HMS Victoria, a British battleship sunk in 1893 between Beirut and the Syrian border.

Their main tool for this impressive exploration to 140m/460ft is the ISC Megalodon Closed-Circuit Rebreather.

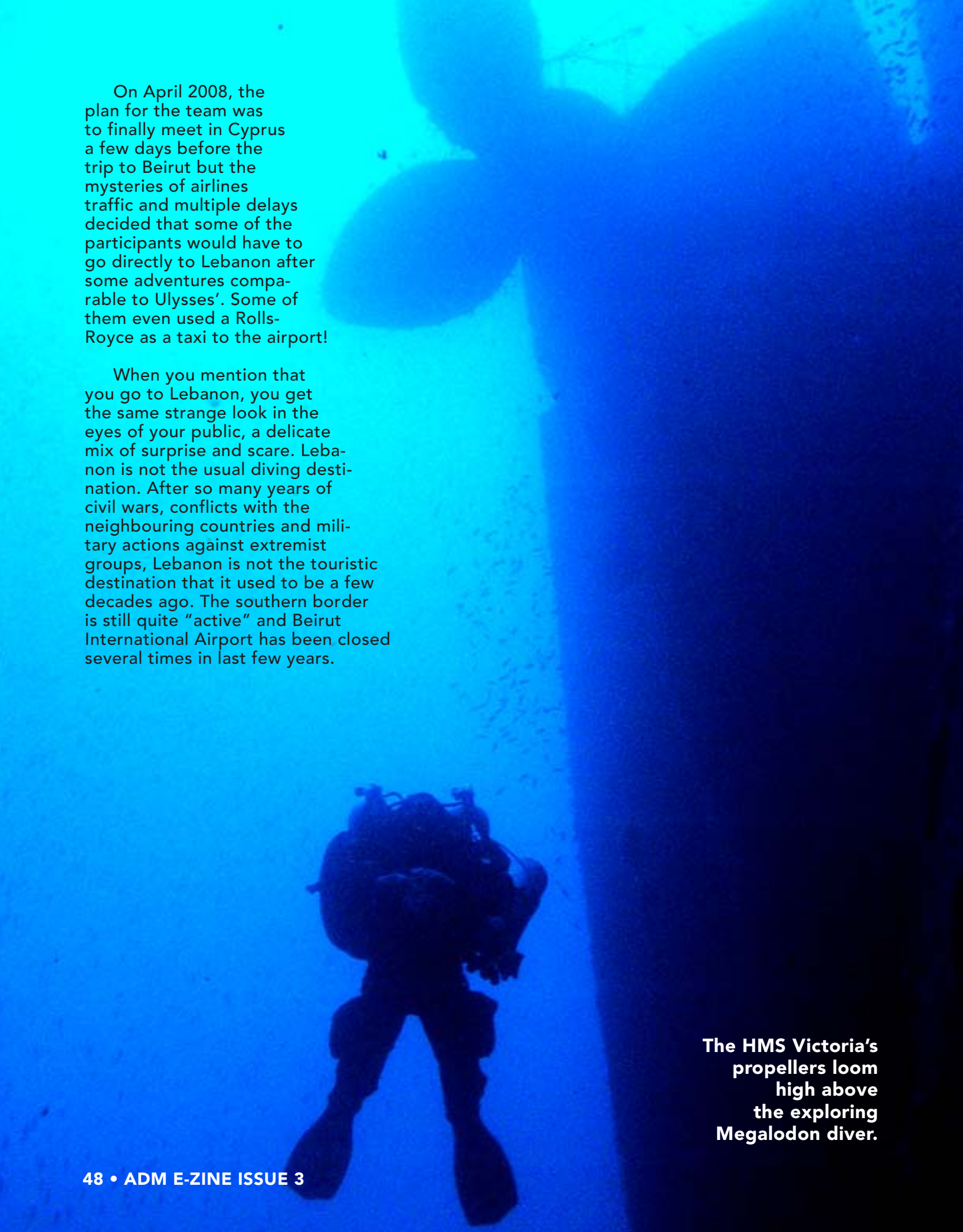
Their life insurance for such a big exploration: the DIRrebreather diving standards.

Since summer 2007, Spyros and Cedric have been discussing about the HMS Victoria, the impressive and quite unusual wreck that lies vertical between 140m/460ft and 77m/250ft, her bow deeply stuck in a thick layer of silt, a few miles off Tripoli, Lebanon. Spyros has contacted ambassadors and officials from Cyprus and Lebanon in order to get the proper authorisations. He soon became in touch with Christian Francis, owner of Lebanon Divers and original discoverer of the wreck.

During that time, thanks to the DIRrebreather forum and its members, Cedric spoke with several experienced rebreather divers who wanted to participate in this interesting project. Soon a team was formed. But this kind of expedition not only asks for a lot of good will and tenacity, but also experience and finances.

On April 2008, the plan for the team was to finally meet in Cyprus a few days before the trip to Beirut but the mysteries of airlines traffic and multiple delays decided that some of the participants would have to go directly to Lebanon after some adventures comparable to Ulysses'. Some of them even used a Rolls-Royce as a taxi to the airport!

When you mention that you go to Lebanon, you get the same strange look in the eyes of your public, a delicate mix of surprise and scare. Lebanon is not the usual diving destination. After so many years of civil wars, conflicts with the neighbouring countries and military actions against extremist groups, Lebanon is not the touristic destination that it used to be a few decades ago. The southern border is still quite "active" and Beirut International Airport has been closed several times in last few years.



The HMS Victoria's propellers loom high above the exploring Megalodon diver.

But one has to admit that Lebanon is a beautiful country, also well known for its surprising nightlife, its extremely rich archaeological heritage and the warm hospitality of its inhabitants. Lebanese people, who are most of the time multi-lingual, have also learnt to live with war and enjoy peaceful moments in their stunning landscapes.
Once very westernized in their tastes, religion and manners, Lebanese people have been very closed to France and the UK.

That is the reason why a fleet from the Royal Navy went to anchor off Tripoli, a couple of hours north of Beirut. According to the Naval Historical Collectors and Research Association (Review Autumn 2007): "*The tragic sinking of the 10 470 ton HMS Victoria remains the Royal Navy's biggest peacetime disaster [...]. On 22 June 1893 twenty-two officers and 334 of her crew were drowned after the HMS Camperdown accidently rammed the Mediterranean flagship in an elaborate and ill-judged fleet manoeuvre ordered by Vice-Admiral Sir George Tryon KCB.*"

Within thirteen minutes, while most of the crew jumped in the water, the proud battleshipwasdragged downward by the 111 tons of her two forward-mounted main guns in their huge turret, the ship still being driven forward by her churning propellers.

After reading a very epic court martial of the main officers involvedat that time, and many attempts to find the wreck, Christian Francis, a local Dive Centre owner, finally found her resting place, where the battleship was last spotted by the nearby Tower of Lions. Why was the wreck so difficult to find? Simply because the HMS Victoria is vertical, her bow deeply buried in a thick layer of mud, making any search with a depth sounder very difficult…

If you ask the five DIRrebreather members who explored this wreck in April, what are the most impressive things, you'll definitely get five different answers. Spyros will tell you that "this wreck is clearly like no other, as it's so weird and disturbing to go down along what you are used to see horizontal". Pim and Per

Archived photo of the HMS Victoria's forward-mounted main guns.

Bjorn will speak about the pictures they took of the two impressive propellers pointing toward the surface. Henrik will maybe mention the artefacts and portholes, the fishing nets and the huge rear gun he looked at for a few minutes. Cedric wouldn't avoid explaining how a wreck of this kind could accommodate any level of Trimix Divers, ranging from the comfortable tour of the stern at 77m/250ft to the extreme exploration of the wreckage at 140m/460ft.

It looks like Victoria got something for everyone!

These five rebreather divers were lucky enough to find the perfect weather conditions to explore the whole wreck. They shot pictures and videos, paying their price at the end of the end with long decompression stops in 18C/64F cold water. Thanks to the robustness of their ISC Megalodon rebreather, they didn't experience any single equipment failure during their expedition in Lebanon. All the dives were done according to strict DIRrebreather team procedures, using standards mixes, setpoints and decompression schedules. None of the participants suffered of any sign of decompression sickness, something quite required by the remoteness of the location and the relative lack of state-of-the-art recompression chamber. Apart from the trouble eating the local corned beef, everyone has participated in a safe and extremely enjoyable deep rebreather diving expedition.

All the team members want to express their acknowledgements to Christian and the staff of Lebanon Divers.

For more information:
Web: **www.DIRrebreather.com**
email: **DIRrebreather@yahoo.com**

Below: Some members of the DIRrebreather team from left to right: Henrik Enckell • Cedric Verdier Christian Francis (Lebanon Divers) Pim van der Horst • Spyros Spyrou and Per Bjorn Rakvag

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Muck Diving in Lembeh Strait

Text and photography by Szilvia Gogh

Muck diving is not a derogatory term describing a type of adventure one would experience in filthy, cold, dark waters, but it is rather an exciting emerging warm water dive trend that many get excited about, especially photographers.

I have been diving for 18 years, logged close to 5000 dives, travelled around the world a few times, but only recently heard about muck diving. It is hard to define what muck diving really is about, but those who tried it, became addicted to the rather unusual type of scuba experience.

After spending a week diving the wealthy and diverse coral reefs of Wakatobi Island early November 2008, I had an opportunity to continue my travels through Asia and visit a friend who runs a dive center on Lembeh Island.

Even though Lembeh Island's location is not far from Wakatobi, we (my husband accompanied me) had to return to Bali first in order to catch a flight through Ujung Pandang to Manado.

Flying with Garuda Indonesia is quite an experience on its own. At the check in desk all travelers can see the warning: "Don't put valuable items into your check-in luggage!" The small transfer airport in Balipapa really gave me a reality check. There were no bars, no food courts, and the smoking room's door was wide open, so the smoking man (woman don't smoke) can get fresh air. To our remedy, we discovered a foot massage place where we could relax and get a half-an-hour massage for five dollars.

Finally, we arrived in Manado, where we were greeted by a guy from the resort. Heading to the Western part of North Sulawesi, we drove trough well kept, blossoming villages. To my surprise, we saw a great number of catholic churches. For some reason, I always pictured Indonesia to be a Muslim country.

After a short boat ride from the mainland, Les Williams, the resort manager, welcomed us. He stood on the last step of the stairs, and appeared from the shadow on that misty night. He personally greets every guest, regardless of what time they arrive. Just like in Fantasy Island.

Lembeh Resort has 14 cottages, all of which were built on cliffs overlooking the pool, the dive center, and the Strait. Viewing the sunrises and sunsets from comfortable armchairs on the spacious verandas never seems to get boring.

At dinner we reunited with my friend, Johan. We worked together many years ago in Thailand as dive instructors. Johan and his girlfriend Kat are the managers of the dive center. While sharing our meal they briefed me about the dives for the next day.

I was super excited to try something new. I looked forward to muck diving like a kid looks forward to opening christmas presents. At last, the sun rose waking us up. I was anxious to board the boat and finally get wet.

After descending into Lembeh Strait, my first impression was, "this is like a garbage dump. What am I going to do here for 60 minutes?" The next thing I knew, the 60 minutes were up. I saw the most bizarre, unusual critters I had ever seen and was dying to get back into the water to find more.

The muck is the perfect habitat for unusual, exotic and juvenile organisms that make their homes in the sediment and trash at the bottom of the ocean. Creatures hiding in the muck are so interesting and different from the usual tropical

marine life. I pictured a nutty professor pouring some potion into the water creating these bizarre looking animals that even the most imaginative fiction writers could not have made up.

Odd and beautiful critters were pointed-out for me by the enthusiastic divemasters. The local dive guides knew where everybody lived underwater and were proud to show me one thing after another.

We encountered seven different types of frog fish. My favorites were the hairy frogfish, and the one that looks like it was the offspring of a frog and a clownfish.

The colors of the nudibranchs we saw are indescribable. It was just too great of a variety to know where to begin. I probably have seen every possible color combination of purple, orange, blue, black, yellow, and pink… There were big ones and small ones, then bigger ones and smaller. There were fast ones and slow ones, brave and shy ones.

I found myself admiring rare species of octopi for long periods of time — the most impressive of our dives. The octopi I came across before were very shy, hiding behind rocks or in holes. Our divemasters, in Lembeh, found and lured-out the mimic octopus, the coconut octopus, and the wanderpus providing countless opportunities to photograph them from up-close.

The calm and shallow waters offered amazing opportunities to take pictures of little creatures like shrimps and the hairy orangutan crab. Muck diving in Lembeh Strait is perhaps the best place on the planet for macro photography.

Peculiar critters included the scary looking devilfish, the magical looking dragon mistress, the fairy tale pegasus seamoth, the bright scorpion leaf fish, the vibrating electric shell, the ornate ghost pipefish, the glorious flamboyant cuttlefish and the frightful wasp fish.

The list of the extraordinary inhabitants that mesmerize divers dive after dive seems endless. Even today, every dive presents an opportunity to discover a species new to science in that part of the world.

The dive crew was extremely proficient at finding critters divers wished to see. I asked them to point out manta shrimps for me as I am enchanted by them. Manta shrimp are able to turn their eyes 360 degrees, look vivid and have a characteristic temper. They are also known to dart out of their hiding and brake aquarium glass or even camera ports when they feel frightened.

Most often however, divers on our vessel requested to see the pygmy seahorse. They are difficult to spot due to their incredibly well camouflaged body. The color of the seahorse matches the pink or purple gorgonian it inhabits, while their body tubercles look very similar to the polyps of the gorgonian. Their quarter inch size doesn't help spottng them either. An unusual aspect of the seahorse is that it's the male who becomes pregnant and carries the eggs in a pouch in his belly, after the eggs have been deposited there by the female.

I found two great tools to ease my task of macro photography. The first being metal pointer which was given to me to dig into the muck in order to stabilize myself with one hand while taking pictures with the other. The 2nd was magnifying glass that I used to help me locate the tiny critters around Lembeh Strait.

Every dive proved to be perfect for divers like me — short attention spans! I could barely finish taking a picture of one unusual critter when my dive guide was directing me to the next one.

The boat crew was one of the most attentive I've come across during my diving career. They were extremely friendly, took care of our camera gear with great caution, and found us all sorts of critters that divers asked to see (my list being particularly long). Every member of the dive team has logged hundreds of dives in the Strait and was extremely knowledgeable about the fish and shrimp that lived in their waters.

After the thrilling dives, we shared stories and well prepared meals in the restaurant with fellow divers. One of things I enjoy about travelling is meeting new people, and divers tend to be a whole different breed. There is nothing normal and ordinary about us. It is intriguing to hear about places I never knew were on the map, taking mental notes about their locations. Word of mouth is the only true way to find out the real story about places you should visit. Take it from me, leave the books on the shelf.

Well-traveled divers, many who have visited numerous famous dive destinations all over the world, agree that there is no place like Lembeh. It is still relatively unknown, therefore peaceful and filled with a great number of breath taking marine wonders. Upon our departure, Les waved us off and wished farewell, again, just like on Fantasy Island.

www.miss-scuba.com

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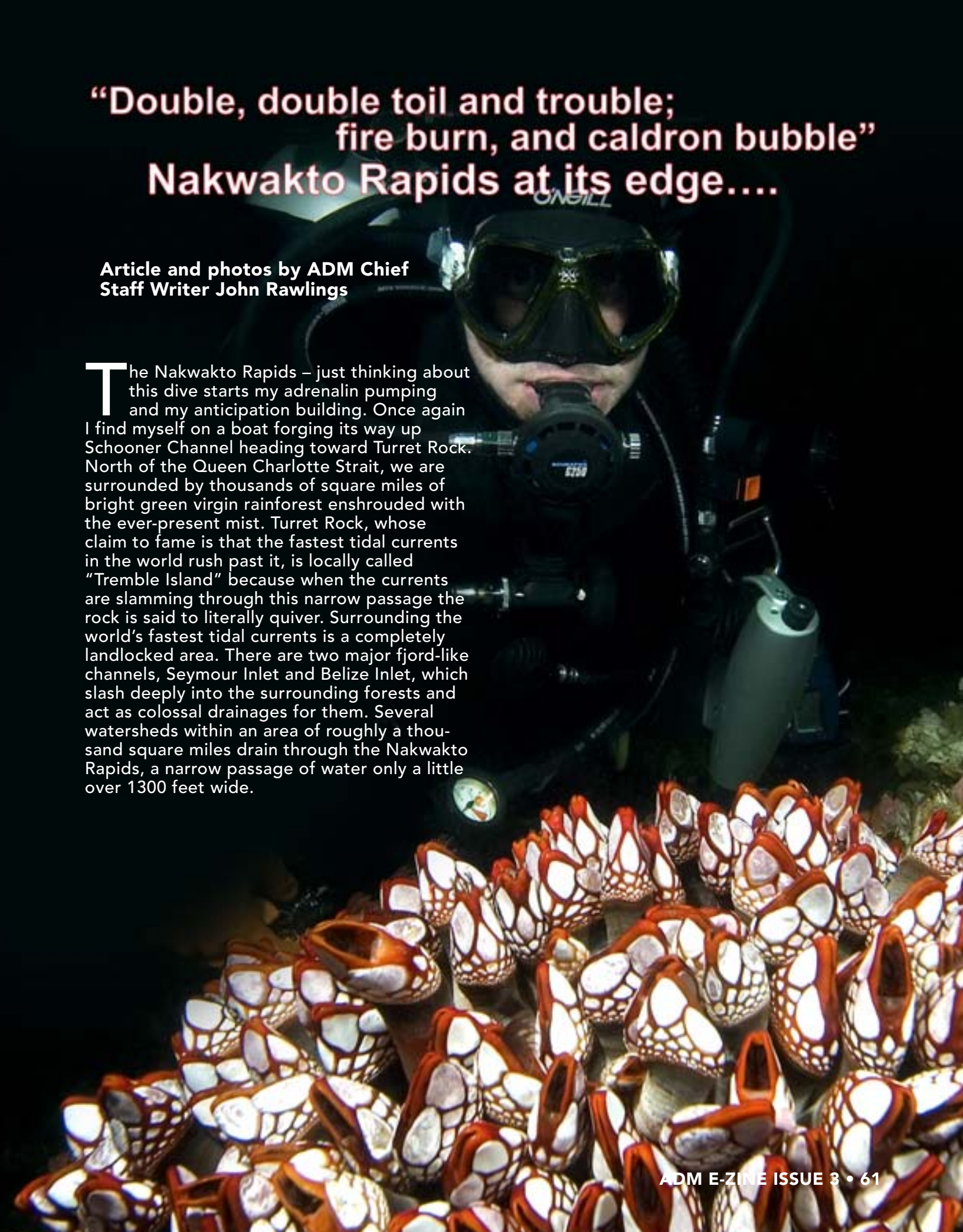
"Double, double toil and trouble; fire burn, and caldron bubble"
Nakwakto Rapids at its edge....



Article and photos by ADM Chief Staff Writer John Rawlings

The Nakwakto Rapids – just thinking about this dive starts my adrenalin pumping and my anticipation building. Once again I find myself on a boat forging its way up Schooner Channel heading toward Turret Rock. North of the Queen Charlotte Strait, we are surrounded by thousands of square miles of bright green virgin rainforest enshrouded with the ever-present mist. Turret Rock, whose claim to fame is that the fastest tidal currents in the world rush past it, is locally called "Tremble Island" because when the currents are slamming through this narrow passage the rock is said to literally quiver. Surrounding the world's fastest tidal currents is a completely landlocked area. There are two major fjord-like channels, Seymour Inlet and Belize Inlet, which slash deeply into the surrounding forests and act as colossal drainages for them. Several watersheds within an area of roughly a thousand square miles drain through the Nakwakto Rapids, a narrow passage of water only a little over 1300 feet wide.

Raindrops fall on my glasses as I assemble my kit and I'm thankful for the thick knitted cap protecting my head from the biting wind. Slack water – or what passes for it here – has not yet arrived, and our skipper, John DeBoeck, watches the water conditions carefully, tight-lipped with concern because he wants to drop us at exactly the right moment. Known for tidal currents that regularly reach 16+ knots, timing is absolutely critical here to avoid being literally seized and swept helplessly down the channel, and because we have arrived slightly early John has the engine running constantly just to stay in place in the lee of Turret Rock. We are about to dive this site at about the largest tidal exchange that he will consider for dropping divers into the water here, and the serious look on his face is clearly evident to each of us. On the trip up the channel John had regaled us with stories of things that he had personally witnessed here - the most impressive of which was while he was watching with a group from a nearby island on a huge non-diveable current a large log was sucked under by the currents, only to eventually surface like a rocket almost 1/3 mile downstream. Stories like that tend to make you sit up and take notice when you are about to leap into that very same stretch of water…..

There are five of us on this trip – Benjamin Nussbaum, Erin Keck and Chris Lopez are all diving open-circuit and form a 3-diver team, while my dive buddy, Josh Smith, and I are diving closed-circuit rebreathers and form a separate 2 diver team. Josh is diving with his COPIS Meg while I'm diving with my Classic KISS. From what we have been able to tell, only a handful of divers have dived Nakwakto using CCRs.

Sliding the boat into position next to Turret Rock, John deBoeck gives us a solid briefing. He is clear and to the point - this dive is all about HIDING from the current and using the rock to block it throughout the dive. We are dropping into the lee of the rock, but should only stay there for a few minutes as we await the onset of slack water. We are then to kick downward along the North side of the rock into the face of the diminishing flood current, where we will find a new lee on that side. He mentions a "sweet spot" that we will find there, but that time there will be strictly limited and we should go no deeper than 60 FSW as beyond that depth we will be out of the shelter of the rock itself. He wants us on the surface at the 30 minute mark, together and tight to the rock in the center of the lee waiting for pick-up – no fooling around. A bit sobered by these instruc-

tions, the open-circuit half of the team checks over their gear and then giant-strides off the side, dropping into the green water below. Josh and I make our final equipment checks as we watch the others sink out of sight beneath the rich emerald surface, their bubbles marking their path. John's predictions of the current's behaviour would prove to be completely accurate, and our group would discover what the repercussions are for deviating even a minute or two from the plan when you are diving at Nakwakto.

Moving to the edge, I glance down to be certain that our team-mates are clear, and after double-checking my PO2 I nod at Josh and stride out over the swirling water, its surface seeming to rush up to meet me and the chill of the cold water almost startling as it collides with my face. Seconds later, Josh joins me in the water and the boat slowly backs away from the rock. Nodding to each other, we each deflate our wings and sink slowly down alongside walls completely enshrouded with invertebrate life. Having been here before, I know what to expect - yet I'm still amazed. This is Josh's first time here, and he will later describe it to me as a "psychedelic version of Alice in Wonderland". For the moment, though, I am thoroughly enjoying his reactions to his first sight of the most current-swept dive site on Earth. Below us I see the other team, clustered around heaps of giant blood-red Goose-neck Barnacles, *Pollicipes polymerus*. These animals were once thought to only exist as tiny, dull grey creatures in the intertidal zone along rocky coastlines with constant surf conditions, the intense currents at Nakwakto have birthed a sub-species that is completely unique. They are absolutely beautiful animals - their "heads" are covered with bluish-silver plates, and they have bright red "lips" outlining the tips. Interspersed with these amazing creatures is an abundance of their cousins, the Giant Acorn Barnacle, *Balanus nubilus*, as well as bright blue-black mussels of absolutely huge proportions, some as large as my feet. Each of these species is a filter-feeder and the current swept environment of the Nakwakto Rapids is perfect for them. The barnacle species here are so incredibly prolific, with generations of animals stacked upon preceding generations, that they appear to have literally re-shaped the contours of the bottom.

From the corner of my eye I notice the other team clustered around a small pinnacle of Goose-neck barnacles and Featherduster tubeworms, *Eudistylia vancouveri*, the flash from Benjamin's

camera rapidly firing. After the dive he will proudly show me some shots that he took of a beautiful bright orange juvenile wolf-eel that he had found hiding and laced amongst the stalks of the tubeworms. Sinking farther down the face of the wall, I am once again stunned at the colossal amount of life here, all animals designed to thrive in an environment constantly fed by massive currents. Solidly attached to the rocky face, to the extent that the rock itself has ceased to be visible, each species feeds on the nutrients and small animals that flow past, the feathery tendrils from the various barnacle species being particularly evident.

It is like diving inside a kaleidoscope.....

Both teams continue to slowly descend, marvelling at the panorama of color. After just 15 minutes of descending through fairly calm water, subtle changes began to take place in the current….the Nakwakto currents are changing exactly as John predicted and because we have spent too much time with our photography we have not yet reached the new lee on the North side of the rock. At approximately 60 FSW, while looking through my camera viewfinder, I suddenly feel a hard blow to my left arm and turn to find Erin shooting past me like a rocket in what appears to be an uncontrolled ascent. I kick hard in an attempt to reach her, and in so doing I cross an invisible line into the same colossal updraft that has her in its grip. Shooting suddenly upward, I grab my O2 add valve and hit the plunger, making certain that my PO2 remains near my set point, and kick to my right to exit the current. Josh had been to my right and was stunned when I suddenly was plucked away from him "like a rag-doll in a hurricane" as he would later describe it. Not quite believing what he was seeing, he moves slightly to the left and is suddenly sucked upward in our wake, his head and feet exchanging positions several times. Like me, he manages to add oxygen to his loop to stave off hypoxia and we find ourselves scrambling behind a large overhanging ledge blocking the force of the current, our eyes big inside our masks.

Realizing that the current has now turned and will only get worse, and that our time-table has been blown, we catch our breath and signal each other to begin the ascent – our dawdling is now going to come with a hefty price! Sliding to the right of the ledge we suddenly find ourselves caught in the grip of an even MORE powerful downward current plunging us down a narrow chute cloven into the rock. Within seconds we find

ourselves at the bottom of the chute around 70 FSW, clinging to giant acorn barnacles in an effort to stabilize ourselves, looking at each other with wide eyes but laughing hysterically like maniacs….I must admit that my laughter was slightly tinged with a bit of fear – the power of the water is incredible. My final photo of the dive is taken here – looking slightly down at Josh as he hangs on with both hands while we again pause to catch our breath. Folding my camera arms up alongside my Aquatica housing, we again begin our ascent, this time behaving much like rock-climbers as we move from ledge to ledge and watch for any tell-tale signs of current-swept areas ahead of us. Following John's instructions to the letter was obviously the thing we should have done, and with each move we make I quite sheepishly regret not having done so….

As we near the surface, we can see the other team above us trying to secure themselves in clefts in the rock as they await pick-up. From 20 FSW I can clearly see a massive flow of water to the left of them, resembling a Class IV rapid from below, and quite obviously steadily increasing in strength. I signal Josh that we need to move more to our right to avoid this, and his quick response tells me that he already sees the danger as well. Slowly making our way upward, we breach the surface immediately next to the other team amidst much hooting and hollering….Erin looks at me with wide eyes and says, "John, I peed my Weezle!", causing a moment of hilarity in the midst of s serious situation. It has been one HELL of a ride…one I would just as soon have not taken!

John deBoeck brings the boat in as close to the rock as he dares, and at his shouted command we all simultaneously push off from the rock and grab the "granny line" strung down the side of the boat. Hanging off the side of the boat, we drift quickly downstream until we reach a back-eddy where it is safe to begin clambering aboard one at a time. Tired from our exertions but still excited by the experience, we marvel at the huge upwellings and whirlpools that are now evident in the water and the river-like appearance of the flow next to Turret Rock….it is difficult to believe that we had been diving there only a short time before. Watching the fierce movements of the water is humbling – we could have easily been caught up in it simply for the sake of a few more minutes and a couple of more photos. I realize that John knows what he's talking about and wasn't kidding one bit when he briefed us on the need for exact timing. Listening to the excited chatter of the team as John steers us southward down the channel toward the Strait – the kind of excited chatter you hear after soldiers have just managed to fight their way clear of an ambush - I know that this will be a dive they will remember for the rest of their lives….as will I.

The Nakwakto Rapids in the wilderness of British Columbia is a dive site whose excitement, colors and sheer abundance of species rivals anything to be found anywhere else in the world. More information on this and other beautiful aspects of dives on Vancouver Island can be found on the following websites:

Browning Pass Hideaway – John DeBoeck
www.vancouverislanddive.com

Tourism Vancouver Island
www.vancouverisland.travel/outdoor/divingsnorkeling

Tourism Port Hardy
www.porthardy.travel

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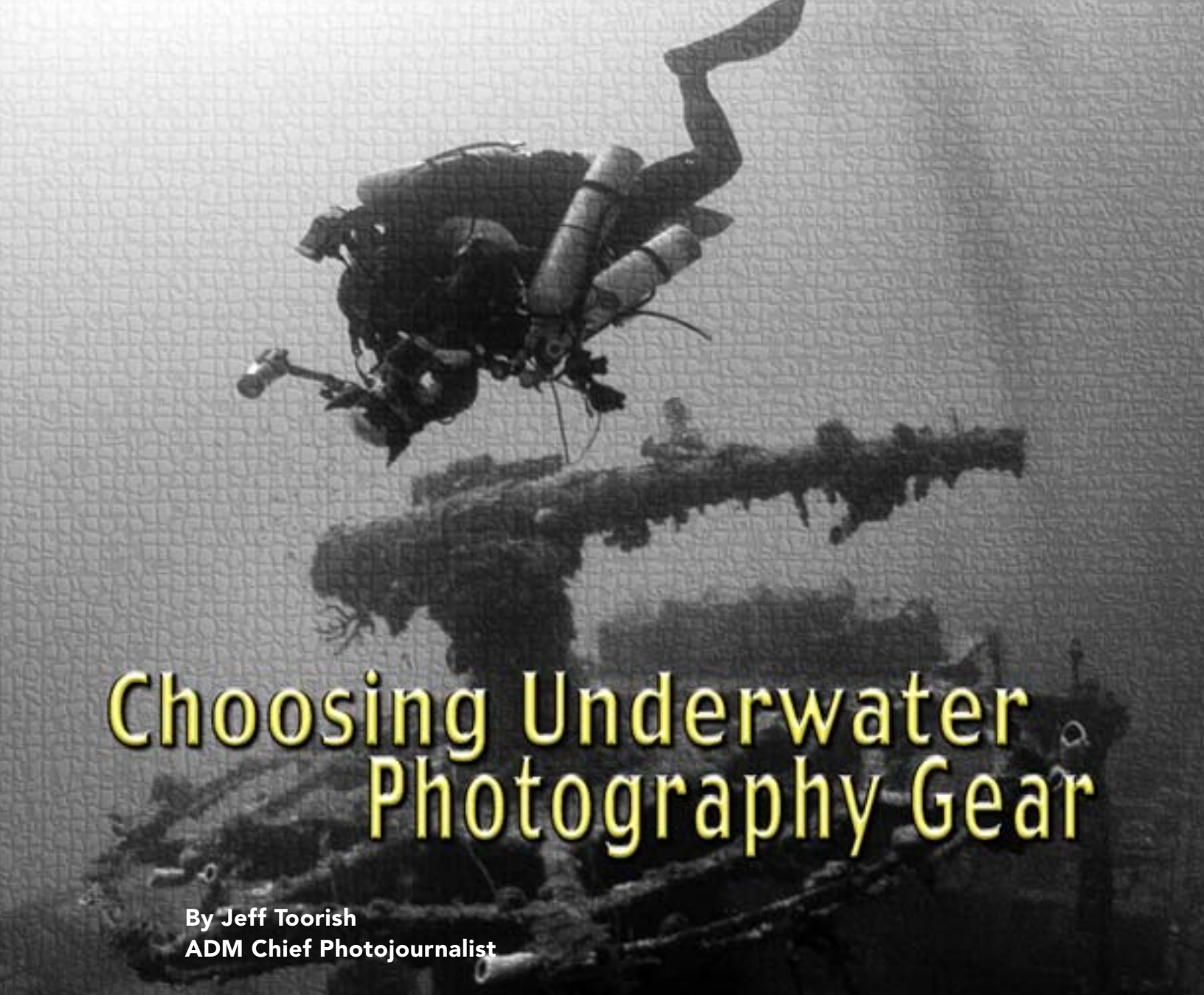


Choosing Underwater Photography Gear

By Jeff Toorish
ADM Chief Photojournalist

Photography equipment is very personal. Just take a look at the constant battle between Canon and Nikon users. At one time Nikon was the undisputed leader in the 35mm professional category. Then Canon came along and boasted improved optics, eventually capturing the professional photojournalist and sports photographer market (just take a look at all those long white lenses along the sideline of any sporting event, Canon all). There are, of course, many fine cameras made by other manufacturers as well.

For underwater photographers at all levels there are the additional questions about housings and lights. There are a variety of both from the modest to high-end professional level gear.

Break It Down *Barney* Style

So let's start out with a simple consideration; all cameras and housings will pretty much do the job. The quality of modern cameras is excellent, so the camera you choose will work as it's supposed to. Housing manufacturers have made great strides in recent years and housings do their jobs as well.

A few years ago I was on assignment at Parris Island covering Marine Corps basic training. I spent a lot of time with some Marines and they had a great expression for getting to the basics, "break it down *Barney* style." (As in Barney the purple dinosaur.) I thought that was a very expressive way to suggest explaining things fundamentally.

Photo by Curt Bowen

Questions to ask yourself *BEFORE* deciding on a camera

Psychologically we make many decisions emotionally and later justify what we decided; parsing the data so it fits what we wanted to do. We often make extremely important decisions, such as what camera to buy, in exactly this way. That can obviously lead to problems, so here are some questions to ask yourself, and honestly answer, before you drop the credit card for new photo gear.

What do you plan to shoot?

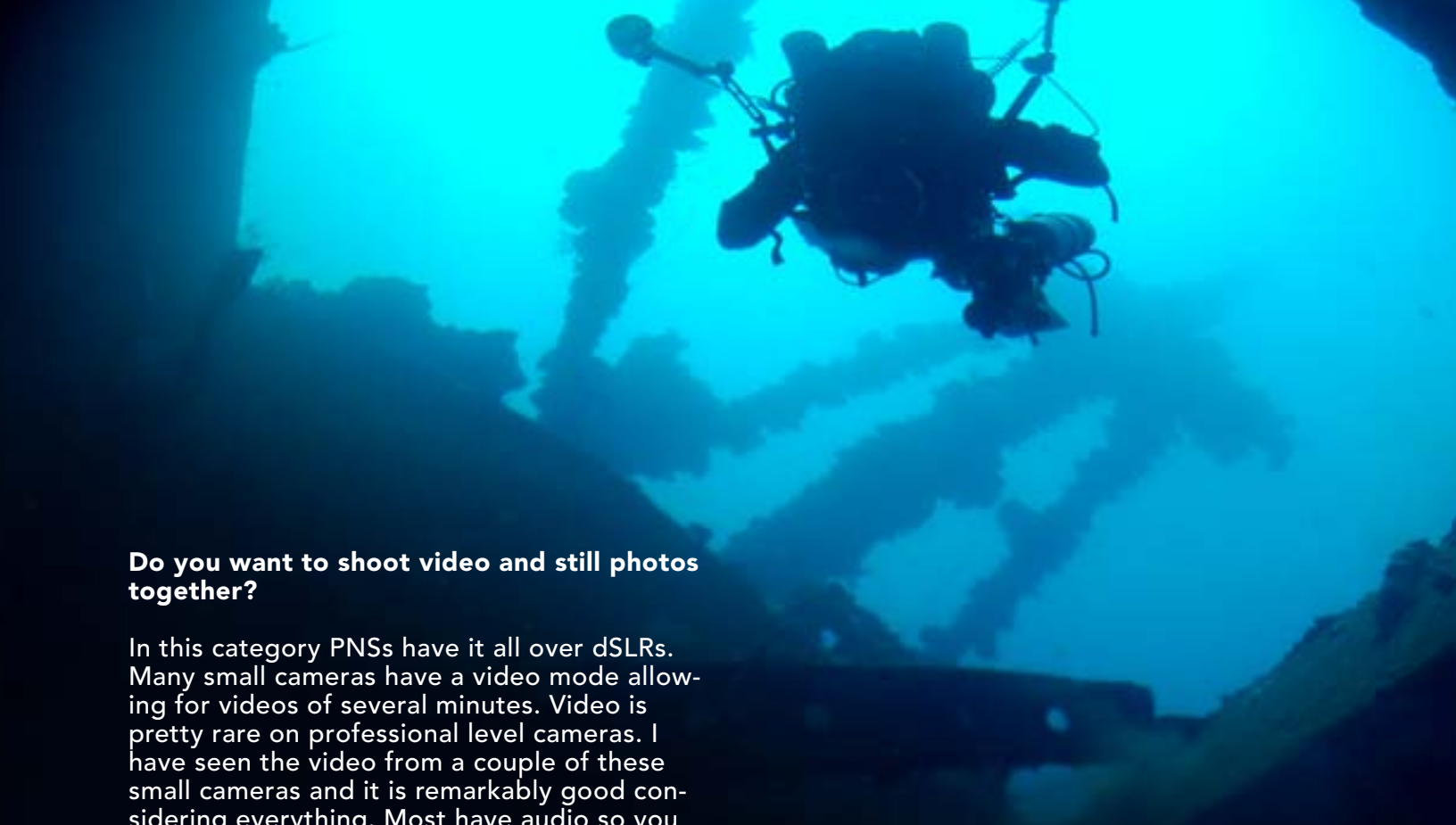
Most underwater photographers are interested in wildlife such as fish or reefs, and that makes a difference. Most point and shoot cameras have some shutter lag so using them to snap a photo of a fast moving fish is pretty tough. Point-and-shoots (PNSs) are very effective for shooting other divers however, provided you have trained them to stay still for a few moments to pose. By the same token, if you are dead set on shooting animals, you can't afford even a slight shutter delay because you will miss the shot. Remember, you rarely get the shot by chasing the animal. You get the shot by waiting for the animal to come to you and then releasing the shutter at exactly the right moment.

So the real question is, what level of photography are you aiming for? Breaking it down to a couple of basics, there is the point-and-shoot variety of photography, the "prosumer" level, and the professional dSLR level of photography. For our purposes we will limit ourselves to digital still photography. The simple fact is, if ever there was a logical place for digital to completely supplant film it is underwater where digital sensors and batteries allow the photographer to take hundreds or even thousands of photos without having to open the camera to change film.

Remarkably, many professional level cameras share identical or similar sensors with their point-and-shoot and prosumer brothers and sisters. There are even point-and-shoot cameras with larger sensors and higher resolution than some professional level dSLRs. The difference is in size, speed, lens selection and features.

Many articles on how to choose an underwater camera kit focus more on the cameras and housings, laying out the various features of different cameras. I believe a much better approach gear selection is to determine your shooting expectations and then fit the camera kit to that.

Photos by Jean Bruneau



Do you want to shoot video and still photos together?

In this category PNSs have it all over dSLRs. Many small cameras have a video mode allowing for videos of several minutes. Video is pretty rare on professional level cameras. I have seen the video from a couple of these small cameras and it is remarkably good considering everything. Most have audio so you get the sound along with the moving pictures. It is impractical to carry a video camera and large still camera underwater (and on land too, for that matter) so a camera that allows you to do both is very convenient. Of course, most digital *video* cameras allow you to shoot still photos, but the quality of the still images is usually not very good. The same is true of post production video frame captures –their quality is too low for mast applications.

Are you comfortable with gear that is technologically advanced?

Most PNSs are easier to use, no question. Although, ironically, they often have more features than their larger counterparts. Even with more features, they are often intuitive to operate and there are fewer decisions you have to make. A point-and-shoot camera is really designed to do just that, point, push the button and a photo is made. You don't have to make complex lens selections as you do with a dSLR. On the other hand, if you prefer to have more control, including the ability to select from a variety of lenses then a prosumer or professional level dSLR will be more to your liking.

Do you mind carrying a lot of gear?

There is no question; with it comes to traveling with camera gear, professional level gear presents difficulties. Remember also, with underwater photography the gear bulk and weight increases exponentially with housings and lights. When traveling by air, for example, most ADM photographers carry-on all their camera gear, including housings. That means everything else must be checked, including most scuba gear. If the notion of not having your regulators in your hand-held bag turns you green, you probably want to stick with a smaller camera set-up.

Photo by Curt Bowen

Photo by Curt Bowen

Recent changes in airline baggage rules have also significantly increased the cost of a second checked bag. In the past, most airlines allowed two standard checked suitcases, but most major airlines are not charging for the second case. There are also ominous noises among some airlines about checking the weight of carry-on luggage.

Remember, we don't take underwater photos in a vacuum. In addition to moving your camera equipment onto and off planes, through customs, into cabs or buses and eventually hotels; you have to get it on and off the boat which is a chore.

Will you be shooting under difficult conditions, such as areas of low visibility or low light?

This may be the real deal breaker for smaller cameras. On dives where the visibility is low due to high levels of particulate matter in the water a small PNS is not likely to cut it. The onboard flash will do nothing but illuminate the muck in the water, creating backscatter. For such dives, external lights are required. Those lights should also be on arms that allow them to be extended so the sides so the particulates don't show up (at least not as much) in the photo. Most PNS cameras just don't have that capability. In low light powerful external strobes or hot lights are needed. Some small cameras can use large lights but it presents a somewhat difficult package to use because the lights can be unwieldy with a smaller housing.

And that brings us to the housings themselves. There is a remarkable selection of housings. Some camera companies offer housings for some of their models, but these are mainly limited to PNS models. I am not aware of any major camera company that also offers housings for professional level cameras. For that you must use third party suppliers. For the most part, housings retain most of the camera functions. But choosing a housing can be a bit confusing. Remarkably, it is not unusual for a housing to cost more than the camera.

How deep to you intend to take the housing?

This may be the most important question. If you plan to stay within the recommended recreational limits, then a Plexiglas or plastic housing will probably do the trick. If you intend to dive deeper than about 200 ft you will need an aluminum housing. These would usually be for dSLRs, for the most part point and shoot cameras are not rated that deep (although there are exceptions). It is also important to note that housing ratings are not just guidelines. While there may be some fudge factor involved and variables such as altitude, temperature, fresh or salt water may play some small part in maintaining housing integrity, if a camera housing is rated at 200fsw, I would not recommend taking it deeper than that.

Final and perhaps most important question

If You Buy it, Will You Use It?

You can purchase the greatest gear in the world, but that photo isn't going to take itself. If you have a terrific set up that you leave at home, or in the hotel room, or on the boat because it's too big, too small or just not what you really want, you bought the wrong gear. It is always a good idea to evaluate yourself and not just what you want to do but what you

realistically *will* do with your gear. At the end of the day, if you just want to have fun dives and you're not going too deep then a PNS that you can slip into a BCD pocket is probably the best idea. If you really want to be the underwater Ansel Adams, they you're going to need some heavy duty gear. But be honest with yourself and choose a kit that will really work for you.

Shedding Some Light on your Photography

Selecting the right lights for your underwater camera outfit can be as complicated as choosing the camera and housing. In fact, for many of us, the lights are more complicated to use than the camera. For point-and-shoot cameras you may decide to go with the onboard flash which, while very limiting, certainly makes things less complicated.

For outboard lights, there are two basic configurations: lights that are rigidly attached to the housing or lights that are on articulated arms and can be positioned in an infinite number of positions.

The rigidly configured lights (or lights with minimal movement capabilities) work best in very clear water. Because the lights are positioned close to the camera, any particulate matter in the water will reflect back on the camera sensor, degrading the photo with backscatter.

Articulated arms are more complicated to dive with and use, but allow the photographer to move the arms to light the subject more from the side and reduce or even eliminate the backscatter. Although some photographers hold their lights, preferring not to mount them at all, this is relatively unusual.

Most rigid lights come as a system that is dedicated to the specific camera/housing. Articulated lights are sold as components. If you are interested in macro photography or wide angle photography you don't have much choice, you will need lights on arms that can be arranged for each individual shot.

And then there are the lights themselves, and your options are huge. In general professional photographers subscribe to the notion that more power is better when it comes to lights. Lights can always be dialed down to reduced power but once you dial up to the max that's it. For the most part this is a good rule of thumb but more powerful lights are bigger, heavier and, of course, more expensive. Large articulated lights are also somewhat unwieldy underwater, throwing off trim and certainly slowing the photographer's swimming

because of increased drag. Expect to use more gas when you are shooting, especially if you are using a large professional camera and housing.

The lights, arms and usually camera housing is negative, but you can't count that weight as part of your weighting system because you may have to set the camera down or hand it off to another diver for a moment, creating an unsafe buoyancy situation.

Unlike studio photography where you want the biggest, baddest light available; underwater I want lights that are within the range of what I will need, but are as compact as possible. Two light manufacturers are Inon (**www.inonamerica.com**) and Ikelite, (**www.ikelite.com**).You can also help your trim and buoyancy by using positively buoyant arms, such as the ones sold by Ultralight Control Systems (**www.ulcs.com**).

Some tips

If you use a large camera, when you get to your destination, buy a plastic tub (I usually get Rubbermaid). They cost less than ten dollars and will make your life a lot easier. Make sure it's large enough for your camera housing with lights attached. Put your gear into it and use that to carry onto and off the boat. You can fill it with fresh water before you leave and rinse your camera when you climb back onboard. When I am diving the same boat for several days, I always offer to leave the tub –boat crews can always find a use for it. If you are diving different boats over the course of the trip, offer it to the last boat.

Never put a housing into a tub with masks or anything else. Many people use mask defog chemicals which do not play nice with the O-rings on the housings. When people use sun screen, it also gets on their masks and that can cause problems as well.

Use a piece of strong bungee cord with spring clips on each end. The bungee I use is about 3 feet long. Make sure one clip is firmly attached to the camera housing and ask the mate or captain to hand you the unattached clip when you are in the water. I always take the captain or mate aside and explain exactly what I need them to do early on and usually confirm it with them shortly before we go into the water. The last thing you want to do is try to explain what you need them to do once you have made that giant stride. When the crewmember hands you the free clip, snap it to a D-ring on your harness or BCD. That way

even if the camera slips while the mate is handing it down, it is still attached to you. Use the reverse process when getting back onto the boat. Never, ever, jump into the water holding your camera. If it is too rough for someone to hand the camera to you, it is not a good day to shoot. Remember, you also have to get that camera and housing back into the boat at the end of the dive.

Sometimes you have no choice but to check some or all of your photo and dive equipment with the airlines. Once your bags disappear on that conveyor belt into the bowels of the airport –there are no guarantees you will see them at your destination. While the number of bags misplaced is increasing, relatively few bags are permanently lost. Of course, that's of little comfort when you are trying to scrounge diving gear at your destination. One thing that can help is Global Bag Tags **(www.globalbagtag.com)** a very clever bag tag that can be traced anywhere around the world.

Oh, and of course, whatever you do, make sure you have fun taking those photos!

Resource links

www.luminous-landscape.com –I believe this is the best general photography review site on the Internet. Before I buy any important piece of equipment I check this site

Scrubber Duration Study

Jetsam Technologies, manufacturer of the Classic KISS and Sport KISS rebreathers is delighted to announce the results of recent scrubber duration testing. The testing reinforces our previous beliefs regarding how long scrubber will remain effective during diving. This is great news for KISS rebreather divers everywhere!

Jetsam Technologies has opted to release all its scrubber duration data, including testing methodology, via paid media. At Jetsam Technologies, we believe it is important for divers to have as much information as possible.

Testing was done at ANSTI Test Systems who are based in the United Kingdom. This independent testing agency, utilizing established, strict scientific standards tested both the Classic KISS and the Sport KISS rebreathers. ***The criterion below utilizes a constant rate of CO2 which is well beyond what any human could produce, for the duration of time listed below.*** These tests were conducted in accordance with the EN14143 European CE Standard and utilized Sofnolime 797 grade.

Data for the Classic KISS

Depth (meters)	**Temperature** (degrees C)	**CO^2 Generation** (litres)	**Breathing Rate** (litres / min)	**Duration** (min) 5 mbar CO^2 Point
40m	4 degrees C	1.6 litres	40 litre/min	157 min - 5 mbar CO^2

Data for the Sport KISS (several sets of data were studied, with positive results)

Depth (meters)	**Temperature** (degrees C)	**CO^2 Generation** (litres)	**Breathing Rate** (litres / min)	**Duration** (min) 5 mbar CO^2 Point
40m	4 degrees C	1.6 litres	40 litre/min	65 min - 5 mbar CO^2
18m	4 degrees C	1.6 litres	40 litre/min	87 min - 5 mbar CO^2
18m	12 degrees C	1.6 litres	40 litre/min	116 min - 5 mbar CO^2

When comparing this data with information provided by other rebreather manufacturers, it is important to ensure you are comparing "apples to apples." It is vital that the durations are based on the same depth, temperature, CO2 generation and breathing rate.

Why is Jetsam doing this? Because we believe all divers should have as much information as possible to ensure their safety. For more detailed information, we invite you to visit www.jetsam.ca.

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Kim Smith, Director
Jetsam Technologies, LTD.

Advanced Diver Magazine

ISSUE 28

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ADM PRODUCT REVIEW

ULTRALIGHT'S NEW BUOYANCY ARMS

By ADM Staff Photojournalist John Rawlings

When you first look at the new larger "Buoyancy Arms" from Ultralight, with their two-inch diameter and rock-solid appearance, it's extremely easy to make the misguided assumption that they are heavy and unwieldy. My first impression was that they were almost club-like and I couldn't imagine switching from the thin and streamlined arms I had used successfully for years. Then I reached out and picked one up….just like that, in an instant, my paradigm shifted. The size and shape of the new Buoyancy arms is deceptive – while they LOOK solid, they are in fact completely hollow and almost shockingly lightweight. Even after months of use, each time I lift one of them I still marvel at how feather-light they truly are compared to their outward physical appearance. What this translates into underwater is a set of arms that gives your entire camera system an incredible amount of lift and buoyancy, increasing your positioning versatility and allowing the photographer to, literally, float your system into position.

Made of lightweight aluminum, the large Buoyancy Arms are available in various sizes, ranging in 2-inch increments from the smallest at 8 inches in length to the largest at 16 inches. Each size has its own level of buoyancy - for example, the 8 inch arms have 4.5 ounces of buoyancy per arm section while the 12 inch arms possess 11 ounces of buoyancy per section, (based on fresh-water testing). This allows a photographer to build an arm system that is best suited for the weight of the camera/housing/strobe combination that will be used.

While on a recent trip in the Queen Charlotte Strait in British Columbia I used a combination of two 12 inch arms and two 8 inch arms along with my heavy Aquatica housing and a pair of Ikelite DS-125 strobes. As always, I was impressed by the ability of

Photo by Ginny Rawlings

these arms in terms of lightening the load of my system underwater, but I decided to see just how buoyant they really were! With my camera clipped off to a D-Ring, I completely released my system and watched to see how quickly it would sink. I was stunned to see that not only did it NOT sink, it simply floated in front of me in the water, allowing me to nudge it in any direction I chose with a fingertip!

Like other Ultralight arm systems, the larger Buoyancy arms have robust O-Rings inserted into the balls. This is an innovation that allows the photographer to adjust the arms underwater in smooth, fluid motions, unlike some other systems that require far more effort and move stiffly. The ease with which subtle, (and not so subtle!), adjustments can be made in arm positioning is a colossal advantage. As a cold-water photographer, another huge advantage for me, and others of my "ilk", is the large diameter of the Buoyancy Arms themselves – it is a far easier matter for a diver wearing thick and clumsy dry gloves to seize and adjust these arms than any other system I have tried.

I am extremely pleased with this latest product in the Ultralight line. These new large Buoyancy Arms have proven to be a real boon to me in my photography, and I highly recommend them, most especially to anyone dealing with heavy digital camera systems.

Ultralight has a large variety of accessories and adapters suitable for every underwater use. For additional information or to design your own arm system, please see their web site at

www.ulcs.com

Photo by Ginny Rawlings

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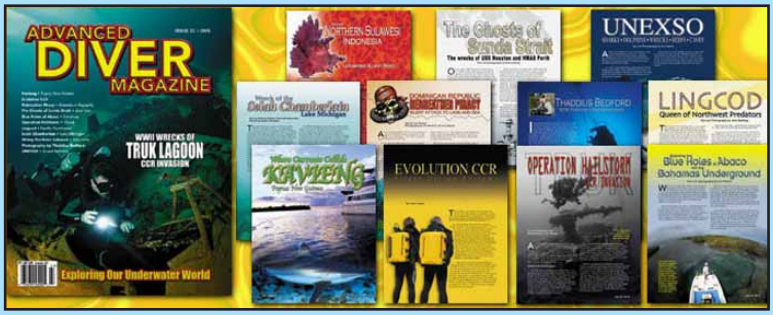

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RGBM DATA BANK AND RISK ANALYSES FOR SELECT DIVE TABLES, METERS, AND PROFILES

By Bruce.R. Wienke
and Tim.R. O'Leary
Photography by Curt Bowen

RISK BASICS

Introduction

Linking model (RGBM) with data (RGBM Data Bank), we have further correlatedmodel parameters with diving profiles. The full analysis will be published in the Annals Of Biomedical Engineering, but we would like to pass back salient aspects, particularly aspects impacting the RGBM Tables, in this special *ADM* article. Much ground is covered, but the most interesting aspects likely reside in various risk estimates deduced for tables, meters, and profiles. The RGBM Data Bank, unlike previous profile compilations, incorporates deep stop data for correlation with a deep stop diving paradigm. This is important, since earlier compilations impose shallow stop staging, a built in bias for any model correlation.

At the outset, we should point out some often misquoted and misunderstood information (even from people who should know better) about DCS risk and underlying DCS incidence in the data structures from which risk is deduced. Risk and incidence are NOT the same thing. Incidence in a data bank is just the number of DCS hits divided by the number of entries. Risk is the statistical estimate of DCS probability for a given dive profile (mix, descent rate, bottom depth and time, decompression stops, mix switches, ascent rate, and altitude). The estimated incidence rate across all recreational diving, for instance, is something like 1/50,000 across all profiles. However, the risk associated with diving air to

popular NDLs is near 1.2%, considerably higher than the incidence rate. This is seen later. The incidence rate across technical diving is estimated to be 10 times greater, yet the risk associated with diving to helitrox NDLs is in the 1.6% range. With that in mind, let's first take a look at the RGBM Data Bank, a data bank providing profile information useful for statistical analysis and related risk estimates, and a data structure with an incidence rate below 1%.

RGBM Profile Data Bank

Divers using bubble models are reporting their profiles to a Data Bank, located at LANL (also NAUI Technical Diving Operations). The profile information requested is simple, but very important. It is the only technical diving data bank presently existing.

Dive Data Structure

Information is both invited and tendered, but always filtered for reliability. Input information is the usual dive profile:

1. bottom mix/*ppO*2 , depth, and time (square wave equivalent);
2. ascent and descent rates;
3. stage and decompression mix/*ppO*2 , depths, and times;
4. surface intervals;
5. time to fly;
6. diver age, weight, and sex;
7. outcome (health problems), rated 1 - 5 in order of poor to well.

This information aids validation and extension of model application space. Some 2,823 profiles now reside in the RGBM Data Bank. There are 19 cases of DCS in the data file. The underlying DCS incidence rate is, $p = 19/2823 = 0.0067$, below 1%. Stored profiles range from 150 *fsw* down to 840 *fsw*, with the majority above 350 *fsw*. All data enters through the authors (BRW and TRO), that is, divers, profiles, and outcomes are filtered. A summary breakdown of DCS hit data consists of the following:

1. OC deep nitrox reverse profiles – 5 hits
2. OC deep nitrox – 3 hits
3. OC deep trimix reverse profiles – 2 hits
4. OC deep trimix – 2 hits
5. OC deep heliox – 2 hits
6. RB deep nitrox – 2 hits
7. RB deep trimix – 1 hit
8. RB deep heliox – 2 hits

Deep nitrox means a range beyond 150 *fsw*, deep trimix means a range beyond 200 *fsw*, and deep heliox means a range beyond 250 *fsw* as a rough categorization. The abbreviation OC denotes open circuit, while RB denotes rebreather. Reverse profiles are any sequence of dives in which the present dive is deeper than the previous dive. Nitrox means an oxygen enriched nitrogen mixture (including air), trimix denotes a breathing mixture of nitrogen, helium, oxygen, and heliox is a breathing mixture of helium and oxygen. None of the trimix nor heliox cases involved oxygen enriched mixtures on OC, and RB hits did not involve elevated oxygen partial pressures above 1.4 *atm*. Heavy-

to-light gas switches occured in 2 cases, violating contemporary ICD (isobaric counterdiffusion) protocols . None of the set exhibited full body nor CNS (central nervous system) oxygen toxicity. The 19 cases come *after the fact*, that is diver distress, most with, but some without, chamber treatment following distress. The next section describes many of the profiles in the RGBM Data Bank, as well as broader field testing reported to us. Profiles come from seasoned divers using wrist slate decompression tables with computer backups. Some profiles come to us directly as computer downlaods, which we transcribe to the requisite format.

Profiles come from the technical diving community at large, essentially mixed gas, extended range, decompression, and extreme diving. Profiles from the recreational community are not included, unless they are involve extreme exposures on air or nitrox (many repetitve dives, deeper than 150 *fsw*, altitude exposures, etc). This low rate makes statistical analysis difficult, and we use a global approach to defining risk after we fit the model to the data using maximum likelihood. The maximum likelihood fit links directly to the binomial probability structure of DCS incidence in divers and aviators. It is a powerful, and time tested statistical technique.

Field Testing And Profile Data Entries

Models need validation and field testing. Often, strict chamber tests are not possible, economically nor otherwise, and models employ a number of benchmarks and regimens to underscore viability. The following are some supporting the RGBM phase model and (released) nitrox, heliox, and trimix diving tables and meters. Profiles are recorded in the RGBM Data Bank, and are representative of entries in terms of dive counts and technical diving applications.

1. Counterterror and Countermeasures Team (C & C) RB and OC exercises have used the RGBM (iterative deep stop version) for a number of years, logging some 2245 dives on mixed gases (trimix, heliox, nitrox) with 0.4% incidence of DCS – 85% were deco dives, and 55% were repets with at least 2 hr SIs, with most in the forward direction (deepest dives first). Some 9 cases of DCS were logged by the Team, mainly in the deep reverse profile category on nitrox and trimix, plus RB hits on heliox;

2. NAUI Technical Diving has been diving the deep stop version for the past 9 yrs, some estimated 22,000 dives, on mixed gases down to 300 *fsw*, with 2 reported cases of DCS, both on trimix. Some 15 divers, late 1999, in France used the RGBM to make 2 mixed gas dives a day, without mishap, in cold water and rough seas. Same thing in the warm waters of Roatan in 2000 and 2001;

3. NAUI Worldwide released a set of no-group, no-calc, no-fuss RGBM Tables for air, EAN32, and EAN36 recreatational diving, from sea level to 10,000 ft, a few years ago. Minimum SIs of 1 hour are supported for repetitive diving in all Tables, and

safety stops for 2 *min* in the 15 *fsw* zone, plus 1 min deep stops at half bottom depth, are required always. Tables were tested by NAUI Insructor Trainers, Instructors, and Divemasters over a 2 year period without mishap, and continue so today as the the mainstay teaching Tables in NAUI basic air and nitrox courses;

4. Modified RGBM recreational algorithms (Haldane imbedded with bubble reduction factors limiting reverse profile, repetitive, and multiday diving), as coded in Suunto, Mares, Dacor, UTC, Zeagle, Steam Machines, GAP, ABYSS, HydroSpace, Plexus decometers, maintain an already low DCS incidence rate of approximately 1/50,000 or less. More RGBM decompression meters, including mixed gases, are in the works;

5. A cadre of divers and instructors in mountainous New Mexico, Utah, and Colorado have been diving the modified RGBM at altitude, an estimated 1,200 dives, without peril. Again, not surprising since the altitude RGBM is slightly more conservative than the usual Cross correction used routinely up to about 8,000 ft elevation, and with estimated DCS incidence less than 1/10,000;

6. Within decometer implementations of the RGBM, only a few scattered DCS hits have been reported in nonstop and multidiving categories, beyond 1,300,000 dives or more, up to now, according to statistics furnished the author (BRW) by meter vendors;

7. Extreme chamber tests for mixed gas RGBM protocols are in the works, and less stressful exposures will be addressed shortly – extreme here means 300 *fsw* and beyond;

8. As seen, probabilistic decompression analysis of selected RGBM profiles, calibrated against similar calculations of the same profiles by Duke, help validate the RGBM on computational bases, suggesting the RGBM has no more theoretical risk than other bubble or dissolved gas models (Weathersby, Vann, Gerth methodology at USN and Duke);

9. All divers and Instructors using RGBM decometers, tables, or Internet software have been advised to report individual profiles to DAN Project Dive Exploration (Vann, Gerth, Denoble and others at Duke), plus to the RGBM Data Bank (Wienke, O'Leary at LANL and NAUI);

10. GAP, HydroSpace RGBM Simulator, and ABYSS are NET software packages that offer the modified RGBM (folded Buhlmann ZHL) and, especially, the full up, deep stop version for any gas mixture, have a fairly large contingent of tech divers already using the RGBM and have not received any reports of DCS to date. The EXPLORER RGBM Simulator is furnished to meter owners of the HydroSpace EXPLORER;

11. Outside of proprietary (commercial) and RGBM Tables, mixed gas tables are a smorgasboard of no longer applicable

Haldane dynamics and discretionary stop insertions, as witnessed by the collective comments of a very vocal and extremely competent, experienced technical diving community;

12. Extreme WKPP profiles in the 300 *fsw* range on trimix were used to calibrate the RGBM. WKPP profiles are the most impressive application of RGBM staging, with as much as 12 hours less decompression time for WKPP helium based diving on RGBM schedules versus Haldane schedules, with estimated 200 dives;

13. Ellyat, a TDI Instructor, dived the Baden in the North Sea to 540 *fsw* on RGBM Tables on two different occasions, and 3 hours were shaved off conventional hang time by RGBM application. Unfortunately, with diver error and mismatched gas switching strategies from helium to nitrogen, dives to 840 *fsw* resulted in vestibular DCS;
14. NAUI Worldwide released sets of deep stop RGBM nitrox, heliox, and trimix technical and recreational Tables that have been tested by NAUI Technical Diving Operations over the past 9 years, with success and no reported cases of DCS, for open circuit regulators and rebreathers,

15. Doppler and imaging tests in the laboratory, and analyses by Bennett, Marroni, Brubakk and Wienke, and Neuman all suggest reduction in free phase counts with deep stop staging;

16. deep air RGBM Tables with surface oxygen decompression are employed by American oil patch diving companies;

17. Scorese, a NAUI instructor, and his students made a total of 234 dives on the Andrea Doria using rebreathers and RGBM (constant *ppO*2) RB Tables, and various nitrogen and trimix diluents. Dive abortions off rebreathers employed ranged RGBM (open circuit) Tables as bailouts, and witnessed no mishaps;

18. Freauf, a Navy SEAL in Hawaii, logged 20 trimix decompression dives beyond 250 *fsw* on consecutive days using RGBM Tables (pure oxygen switch at 20 *fsw*);

19. Gerth, a US Navy researcher at NEDU, suggested that deep stops are necessary and cost effective for air and nitrox Navy divers, that is, risk versus decompression time;

20. Melton, owner of HydroSpace Engineering and developer of the RGBM EXPLORER (OC plus RB) dive computer reports 100s of dives in the 400 *fsw* range on the RGBM EXPLORER;

21. GAP, Gas Absorption Program, an RGBM software product out of the Netherlands, supports brisk and sustained use of the RGBM within the tec and rec diving community;

22. NEDU in Panama City is performimg deep stop man trials in open water using a US Navy bubble model;

Table 1. Probabilities Of Decompression Sickness For Underlying Incidences.

N (dives)	*n* (hits)	*P*(*n*) *p* = 0.01 *q* = 0.99	*P*(*n*) *p* = 0.10 *q* = 0.90
5	0	0.95	0.59
	1	0.04	0.33
	2 or more	0.01	0.08
10	0	0.90	0.35
	1	0.09	0.39
	2 or more	0.01	0.26
20	0	0.82	0.12
	1	0.16	0.27
	2 or more	0.02	0.61
50	0	0.61	0.01
	1	0.31	0.03
	2 or more	0.08	0.96

23. heliox RGBM Tables are being used by a commercial diving operation in Argentina;

24. Raine, a wreck diver in California, reports 100s of RGBM dives in the 250 *fsw* range with low Doppler counts;

25. The RGBM site, *RGBMdiving.com*, receives 100s of hits weekly, and provides custom RGBM Tables;

26. ANDI, a training agency, has adopted a custom version of GAP for diver training on mixed gases, OC and RBs;

27. NAUI similarly employs a custom version of GAP for dive planning, with nominal GAP parameter settings recovering released and published NAUI RGBM Tables;

28. O'Leary, Director NAUI Technical Operations, has made over 70 dives on OC and RB systems using RGBM Table and the Hydrospace EXPLORER to depths beyond 250 *fsw*, with anywhere from 6 - 9 other divers during NAUI Technical Instructor Training Courses;

29. O'Leary, Sharp, Scorese, Bell, Hunley, and 6 other NAUI Instructors used RGBM OC and RB Tables to dive the USS Perry in Anguar in very strong currents, down to 260 *fsw*, logging 2 repetitive deco dives a day for a week or so.

With DCS binomially distributed in incidence probability, many trials are needed (or other close profiles) to fully validate any model at the 1% level. Additionally, full validation requires DCS incidences, the higher the number, the better, contrary to desired dive outcomes. While the foregoing list of field tests and profiles are not controlled scientific experiments with attendant data collection, the shear number of diving events and diversity of exposure spectrum might not be discounted nor treated lightly. The collective information has been dubbed the *living laboratory* by segments of the technical, scientific, and operational diving community.

Probabilistics

Decompression sickness is a hit, or no hit, situation. Statistics are binary, as in coin tossing. Probabilities of occurrence are determined from the binomial distribution, which measures the numbers of possibilities of occurrence and non-occurrence in any number of events, given the incidence rate. **Table 1** lists corresponding binomial decompression probabilities, *P*(*n*), for 1% and 10% underlying incidence (99% and 90% nonincidence), yielding 0, 1, and 2 or more cases of decompression sickness. The underlying incidence, *p*, is the (fractional) hit rate. The non-incidence, *q*, is just 1Å*p*, or the (fractional) non-hit rate.

As the number of trials increases, the probability of 0 or 1 occurrences drops, while the probability of 2 or more occurrences increases. In the case of 5 dives, the probability might be as low as 5%, while in the case of 50 dives, the probability could be 39%, both for $p = 0.01$. Clearly, odds even percentages would require testing beyond 50 cases for an underlying incidence near 1%. Only by increasing the number of trials for fixed incidences can the probabilities be increased. Turning that around, a rejection procedure for 1 or more cases of decompression sickness at the 10% probability level requires many more than 50 dives. If we are willing to lower the confidence of the acceptance, or rejection, procedure, of course, the number of requisite trials drops. **Table 1** also shows that the test practice of accepting an exposure schedule following 10 trials without incidence of decompression sickness is suspect, merely because the relative probability of nonincidence is high, near 35%.

Table 2. Nonstop Time Limits For 1% and 5% DCS Probability.

depth *d* (*fsw*)	nonstop limit *tn* (*min*) $p = .05$	nonstop limit *tn* (*min*) $p = .01$	nonstop limit *tn* (*min*) US Navy
30	240	170	
40	170	100	200
50	120	70	100
60	80	40	60
70	80	25	50
80	60	15	40
90	50	10	30
100	50	8	25
110	40	5	20
120	40	5	15
130	30	5	10

RGBM Data Correlations And Risk Estimates

For the past 10-15 years, a probabilistic approach to assessing risk in diving has been in vogue. Sometimes this can be confusing, or misleading, since definitions or terms, as presented, are often mixed. Also confusing are risk estimates varying by factors of 10 to 1,000, and distributions serving as basis for analysis, also varying in size by the same factors. In a word, the probabilistic approach amounts to defining a risk function for diving, and then fitting the risk function to the data using a statistical method called maximum likelihood. Risk functions might be supersaturations, Doppler bubble counts, bubble formation and growth rates, separated bubble volumes, and combinations thereof. For our RGBM analysis, the risk function is bubble growth rate over number of bubbles initially excited into growth under compression-decompression.

Years ago, hundreds of air dives were analyzed using this procedure, yielding decompression schedules with 95% and 99% non-incidence (5% and 1% incidence). Tables were published by US Navy investigators, and **Table 2** tabulates the corresponding nonstop time limits ($p = 0.05, 0.01$), including standard US Navy (Workman) limits for comparison. Later re-evaluations of the standard set of nonstop time limits estimate a probability rate of 1.25% for the limits. In practice, incidence rates are below 0.001%, and most divers do not dive to the limits. The risk function used in **Table 2** is the dissolved gas oversaturation, that is, the difference between tissue tension and ambient pressure.

SIMPLE DIVING RISKS

RGBM Single And Repetitive Air Dive Risks

To perform risk analysis with the RGBM Data Bank, a risk estimator need be selected. For diving, dissolved gas and bubble estimators are useful. For recreational diving, all estimators are

roughly equivalent, because little dissolved gas has likely separated into free phases (bubbles). Analysis shows this true for all cases examined. The only case where dissolved gas and phase estimators differ (slightly here) is within repetitive diving profiles. The dissolved gas estimator cues on gas buildup in the slow tissue compartments (staircasing for repets within an hour or two), while the phase estimator cues on bubble gas diffusion in the fast compartments (dropping rapidly over hour time spans). This holding true within all recreational diving distributions, we proceed to the risk analysis.

Nonstop limits (NDLs), denoted *tn*, from the US Navy, PADI, NAUI, and ZHL (Buhlmann) Tables provide a set for comparison of relative DCS risk. Listed in Table 3 are the NDLs and corresponding risks for the profile, assuming ascent and descent rates of 60 *fsw/min* (no safety stops). Dissolved gas, *s*, and phase, *r*, estimates vary little for cases, and only the phase estimates are included.

Table 3. Risk Estimates For Standard Air NDLs.

	USN NDL	risk	PADI NDL	risk	NAUI NDL	risk	ZHL NDL	risk
d (*fsw*)	t_n (*min*)	r	t_n (*min*)	r	t_n (*min*)	r	t_n (*min*)	r
35	310	4.3%	205	2.0%			181	1.3%
40	200	3.1%	140	1.5%	130	1.4%	137	1.5%
50	100	2.1%	80	1.1%	80	1.1%	80	1.1%
60	60	1.7%	55	1.4%	55	1.4%	57	1.5%
70	50	2.0%	40	1.2%	45	1.3%	40	1.2%
80	40	2.1%	30	1.3%	35	1.5%	30	1.3%
90	30	2.1%	25	1.5%	25	1.5%	24	1.4%
100	25	2.1%	20	1.3%	22	1.4%	19	1.2%
110	20	2.2%	13	1.1%	15	1.2%	16	1.3%
120	15	2.0%	13	1.3%	12	1.2%	13	1.3%
130	10	1.7%	10	1.7%	8	1.3%	10	1.7%

Risks are internally consistent across NDLs at each depth, and agree with the US Navy assessments in Table 2. Greatest underlying risks occur in the USN shallow exposures. The PADI, NAUI, and ZHL risks are all less than 2% for this set, and risks for single DCS incidence are less than 0.02. PADI and NAUI have reported that incidence rates (*p*) across all exposures are less than 0.001%, so considering their enviable track record of diving safety, our estimates are liberal. ZHL risk estimates track as the PADI and NAUI risks, again, very safely. Estimates were also independently corroborated *[Gerth,priv comm, 2001]* within USN and DAN data sets at Duke, both in Table 3 and Table 4.

Next, the analysis is extended to profiles with varying ascent and descent rates, safety stops, and repetitive sequence. Table 4 lists nominal profiles (recreational) for various depths, exposure and travel times, and safety stops at 5 *msw*. Mean DCS estimates are tabulated for both dissolved gas supersaturation ratio (ZHL), *s*, and excited bubble volume (RGBM), *r*, risk functions, with nominal variance, $r\pm = r \pm 0,004$, across all profiles.

Table 4. Dissolved And Separated Phase Risk Estimates For Nominal Profiles.

profile (*depth/time*)	descent rate (*msw/min*)	ascent rate (*msw/min*)	safety stop (*depth/time*)	risk *r*	risk *s*
14 *msw*/38 *min*	18	9	5 *msw*/3 *min*	0.0034	0.0062
19 *msw*/38 *min*	18	9	5 *msw*/3 *min*	0.0095	0.0110
28 *msw*/32 *min*	18	9		0.0200	0.0213
37 *msw*/17 *min*	18	9	5 *msw*/3 *min*	0.0165	0.0151
18 *msw*/31 *min*	18	9	5 *msw*/3 *min*	0.0063	0.0072
	18	9		0.0088	0.0084
	18	18		0.0101	0.0135
	18	18	5 *msw*/3 *min*	0.0069	0.0084
17 *msw*/32 *min* SI 176 *min*	18	9	5 *msw*/3 *min*		
13 *msw*/37 *min* SI 174 *min*	18	9	5 *msw*/3 *min*		
23 *msw*/17 *min*	18	18	5 *msw*/3 *min*	0.0127	0.0232

The ZHL (Buhlmann) NDLs and staging regimens are widespread across decompression meters presently, and are good representations for dissolved gas risk analysis. The RGBM is newer, more modern, and is coming online in decometers and associated software. For recreational exposures, the RGBM collapses to a dissolved gas algorithm. This is reflected in the risk estimates above, where estimates for both models differ little .

Simple comments hold for the analyzed profile risks. The maximum relative risk is 0.0232 for the 3 dive repetitive sequence according to the dissolved risk estimator. This translates to 2% profile risk, which is comparable to the maximum NDL risk for the PADI, NAUI, and ZHL NDLs. This type of dive profile is common, practiced daily on liveaboards, and benign. According to Gilliam, the absolute incidence rate for this type of diving is less than 0.02%. Again, our analyses overestimate risk. Effects of slower ascent rates and safety stops are seen only at the 0.25% to 0.5% level in relative surfacing risk. Safety stops at 5 *msw* for 3 *min* lower relative risk an average of 0.3%, while reducing the ascent rate from 18 *msw/min* to 9 *msw/min* reduces relative risk an average of 0.35%. Staging, NDLs, and contraints imposed by decometer algorithms are consistent with acceptable and safe recreational diving protocols. Estimated absolute risk associated across all ZHL NDLs and staging regimens analyzed herein is less than 2.32%, probably much less in actual practice. That is, we use $p = 0.0067$, and much evidence suggests incidence $p < 0.0001$, some ten times safer.

Implicit in such formulations of risk tables are assumptions that given decompression stress is more likely to produce symptoms if it is sustained in time, and that large numbers of separate events may culminate in the same probability after time integration. Though individual schedule segments may not be replicated enough to offer total statistical validation, categories of predicted safety might be grouped within subsets of corroborating data. For instance, risks on air dives might be estimated from just nitrox data, risks on trimix from just trimix data, risks on heliox just from heliox data, etc. Since the

method is general, any model parameter or meaningful index, properly defined, can be applied to decompression data, and the full power of statistical methods employed to quantify overall risk. While powerful, such statistical methods are neither deterministic nor mechanistic, and cannot predict on first principles. But as a means to table fabrication with quoted risk, such approaches offer attractive pathways for analysis.

Questions of what risk is acceptable to the diver vary. Sport and research divers would probably opt for small risk (1% or less), while military and commercial divers might live with higher risk (5%), considering the nearness of medical attention in general. Many factors influence these two populations, but fitness and acclimatization would probably play strategically.

UW Seafood Diver Air Tables

As another application of the RGBM Data Bank to table construction and analysis, we detail a set of tables of interest to the University of Wisconsin (UW), along with estimated risk for various nonstop limits gleaned from the data. These Tables have no groups, and simple rules. Released mixed gas RGBM Tables resulted from similar analyses across both the technical and recreational segments. Such Tables are certainly useful for a broad spectrum of diving, and are easy to use. **Table 5** lists the maximum NDLs for any series of dives (up to 3) with 60 *min* SIs between dives. Divers need make a deep stop at 1/2 the maximum bottom pressure for 1 *min*, plus a shallow safety stop in the 15 *fsw* zone for 2 *min*. Descent rate is 60 *fsw/min*, and ascent rate is 30 *fsw/min*. The NDLs are listed for maximum risk after 3 repetitive dives to the (same) depth indicated, or to a lesser depth.

Table 5. RGBM Repetitive Risks For Air Dives

depth (*fsw*)	r 5.14% maximum time (*min*)	r 3.29% maximum time (*min*)	r 1.37% maximum time (*min*)
100	24	20	14 deep stop 60/1 shallow stop 15/2
80	38	32	24 deep stop 50/1 shallow stop 15/2
60	50	42	32 deep stop 40/1 shallow stop 15/2
40	130	120	100 deep stop 30/1 shallow stop 15/2

Tables like these are of interest to Puerto Rican diving fishermen, and fishing sport divers. NAUI uses a variant, detailed next, for training. Technical Training Agencies also employ mixed gas tables for decompression diving, as well as dive planning software, all based on the RGBM algorithm. Some risk estimates of profiles in these RGBM Technical Tables also follow.

RGBM Air And Nitrox Recreational Tables (sea level - 10,000 *ft*)

For comparison, consider similar RGBM Tables employed by NAUI for air and nitrox diver training, sea level up to 10,000 *ft*. They are basically the same as the Puerto Rican seafood diver tables above,

except that successive dives must always be shallower than the previous. Descent and ascent rates are 75 *fsw/min* and 30 *fsw/min*, and SIs are 60 *min*. At sea level to 2,000 *ft* elevation, three dives may be made in a day on air or nitrox. At elevations above 2,000 *ft*, only two dives are sanctioned. There are 9 RGBM Tables in all, 3 for air, 3 for EAN32, and 3 for EAN36, ranging in altitude, 0 - 2,000 *ft*, 2,000 - 6,000 *ft*, and 9,000 - 10,000 *ft*. In Tables 9a through 9i, risks are tabulated at the end of the 3 or 2 dive sequence. Moving from left to right (first dive through last permitted dive) successive decrements in permissible depths are seen. Safety stops at half the bottom depth are required for 1 *min*, and an additional safety stop in the 15 *fsw* zone for 2 *min* is part of the protocol. Maximum risk is seen in the air tables at 10,000 *ft* elevation, and minimum risk in the EAN36 tables at sea level.

Table 6a. RGBM Air Tables (0 - 2,000 *ft*)
Maximum Risk After Dive 3, *r* = 1.69%

Dive 1		Dive 2		Dive 3	
depth (*fsw*)	time (*min*)	depth (*fsw*)	time (*min*)	depth (*fsw*)	time (*min*)
130	10	80	30	30	150
120	13	75	30	30	150
110	16	70	40	30	150
100	20	65	40	30	150
90	25	60	55	30	150
80	30	55	55	30	150
70	40	50	80	30	100
60	55	45	80	30	150
50	80	40	110	30	150
40	110	35	110	30	150
30	150	30	150	30	150

Table 6b. RGBM Air Tables (2,000 - 6,000 *ft*)
Maximum Risk After Dive 2, *r* = 1.92%

Dive 1		Dive 2	
depth (*fsw*)	time (*min*)	depth (*fsw*)	time (*min*)
110	9	70	28
100	13	65	28
90	17	60	38
80	22	55	38
70	28	50	54
60	38	45	54
50	54	40	85
40	85	35	85
30	125	30	125

Table 6c. RGBM Air Tables (6,000 - 10,000 *ft*)
Maximum Risk After Dive 2, *r* = 2.36%

Dive 1		Dive 2	
depth (*fsw*)	time (*min*)	depth (*fsw*)	time (*min*)
90	11	60	28
80	15	55	28
70	21	50	40
60	28	45	40
50	40	40	64
40	64	35	64
30	103	30	103

Table 6d. RGBM EAN32 Tables (0 - 2,000 *ft*) Maximum Risk After Dive 3, *r* = 1.44%					
Dive 1		Dive 2		Dive 3	
depth (*fsw*)	time (*min*)	depth (*fsw*)	time (*min*)	depth (*fsw*)	time (*min*)
120	20	80	47	40	150
110	25	75	47	40	150
100	30	70	60	40	150
90	38	65	60	40	150
80	47	60	85	40	150
70	60	55	85	40	150
60	85	50	115	40	150
50	115	45	115	40	150
40	150	40	150	40	150

Table 6e. RGBM EAN32 Tables (2,000 - 6,000 *ft*) Maximum Risk After Dive 2, *r* = 1.65%			
Dive 1		Dive 2	
depth (*fsw*)	time (*min*)	depth (*fsw*)	time (*min*)
100	20	65	43
90	26	60	57
80	33	55	57
70	43	50	84
60	57	45	84
50	84	40	120
40	120	35	120
30	150	30	150

Table 6f. RGBM EAN32 Tables (6,000 - 10,000 *ft*) Maximum Risk After Dive 2, *r* = 1.84%			
Dive 1		Dive 2	
depth (*fsw*)	time (*min*)	depth (*fsw*)	time (*min*)
90	17	60	43
80	24	55	43
70	32	50	60
60	43	45	60
50	60	40	96
40	96	35	96
30	140	30	140

Table 6g. RGBM EAN36 Tables (0 - 2,000 *ft*) Maximum Risk After Dive 3, *r* = 1.12%					
Dive 1		Dive 2		Dive 3	
depth (*fsw*)	time (*min*)	depth (*fsw*)	time (*min*)	depth (*fsw*)	time (*min*)
110	31	80	60	50	150
100	35	75	60	50	150
90	46	70	85	50	150
80	60	65	85	50	150
70	85	60	115	50	150
60	115	55	115	50	150
50	150	50	150	50	150

Table 6h. RGBM EAN36 Tables (2,000 - 6,000 *ft*) Maximum Risk After Dive 2, *r* = 1.24%			
Dive 1		Dive 2	
depth (*fsw*)	time (*min*)	depth (*fsw*)	time (*min*)
90	21	60	79
80	39	55	79
70	54	50	114
60	79	45	114
50	114	40	150
40	150	35	150
30	150	30	150

Table 6i. RGBM EAN36 Tables (6,000 - 10,000 *ft*) Maximum Risk After Dive 2, *r* = 1.66%			
Dive 1		Dive 2	
depth (*fsw*)	time (*min*)	depth (*fsw*)	time (*min*)
80	29	55	54
70	37	50	84
60	54	45	84
50	84	40	128
40	128	35	128
30	150	30	150

COMPLEX DIVING RISKS
Helitrox Nonstop Limits (NDLs)

Helitrox is enriched trimix, that is, the oxygen fraction is above 21 % in the breathing mixture. Helitrox is gaining in popularity over nitrox when helium is available for gas mixing. Diving agencies often use helitrox in the beginning sequence of technical diver training. Listed below in **Table 7** are nonstop time limits and corresponding risks, *r*, for exposures at that depth-time. The mixture is helitrox (enriched 26/17 trimix), sometimes called triox.

Table 7. Helitrox NDLs And Risk

depth *d* (*fsw*)	time *tn* (*min*)	risk *r*
70	35	1.4%
80	25	1.4%
90	20	1.4%
100	15	1.4%
110	10	1.5%
120	8	1.5%
130	6	1.4%
140	5	1.5%
150	4	1.6%

These NDL triox risks track closely with NDL risks for air and nitrox.

Comparative Helium And Nitrogen Staging And Risk

Consider a deep trimix dive with multiple switches on the way up. This is a risky technical dive, performed only by seasoned professionals. **Table 8** contrasts stop times for two gas choices at the 100 *fsw* switch. The dive is a short 10 *min* at 400 *fsw* on 10/65/25 trimix, with switches at 235 *fsw*, 100 *fsw*, and 30 *fsw*. Descent and ascent rates are 75 *fsw/min* and 25 *fsw/min*. Obviously, there are many other choices for switch depths, mixtures, and strategies. In this comparison, the oxygen fractions were the same in all mixes, at all switches. Differences between a nitrogen or a helium based decompression strategy, even for this short exposure, are nominal. Such usually is the case when oxygen fraction is held constant in helium or nitrogen mixes at the switch.

Table 8. Comparative Helium and Nitrogen Gas Switches

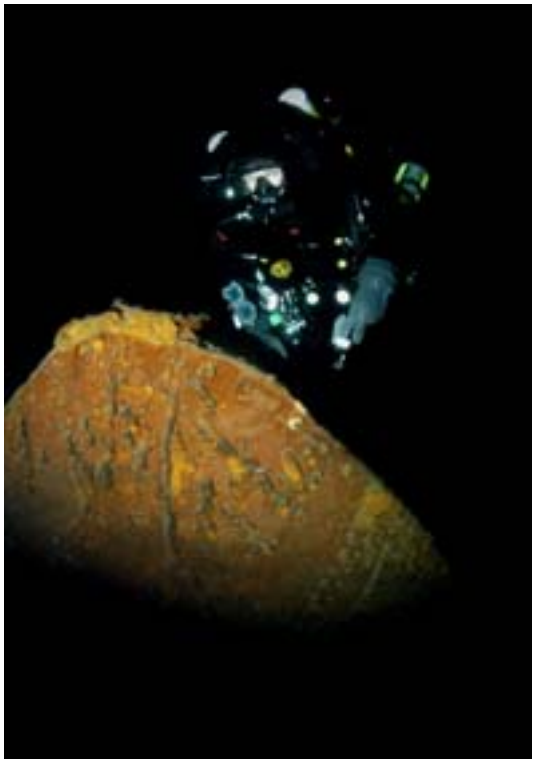
depth (*fsw*)	r 6.42% stoptime (*min*) Tx10/65/25	r 6.97% stoptime (*min*) Tx10/65/25
400	10.0	10.0
260	1.5	1.5
250	1.0	1.0
240	1.0 Tx18/50/32	1.0 Tx18/50/32
230	0.5	0.5
220	0.5	0.5
210	0.5	0.5
200	0.5	0.5
190	1.0	1.0
180	1.5	1.5
170	1.5	1.0
160	1.5	1.5
150	1.5	2.0
140	2.0	1.5
130	2.0	2.5
120	4.0	4.0
110	4.5 Tx40/20/40	4.0 EAN40
100	2.5	2.0
90	2.5	2.0
80	2.5	2.0
70	5.0	4.0
60	6.5	5.5
50	8.0	6.5
40	9.5 EAN80	7.5 EAN80
30	10.5	10.5
20	14.0	14.0
10	21.0	20.5
	TDT(min) 123.0	TDT(min) 116.0

Comparative profile reports suggest that riding helium to the 70 *fsw* level with a switch to EAN50 is good strategy, one that couples the benefits of well being on helium with minimal decompression time and stress following isobaric switch to nitrogen. Shallower switches to enriched air also work, with only a nominal increase in overall decompression time, but with deeper switches off helium to nitrox a source of isobaric counterdiffusion (ICD) issues that might best be avoided. Note the risk, *r*, for the helium strategy, 40/20/40 trimix at 100 *fsw*, is slightly safer than the nitrogen strategy, EAN40 at 100 *fsw*, but in either case, the risk is high.

WKPP Extreme Exploration Dives

The Woodville Karst Plain Project (WKPP) has reported a number of 300 *fsw* dives with OC and RB systems on trimix for many hours bottom time, and some 8 *hrs* of deompression. Pure oxygen is employed in the 30 *fsw* zone with the help of an underwater habitat. Successful regimens systematically roll back the helium fraction and increase the oxygen fraction in roughly the same proportions, thus maintaing nitrogen fractions low and fairly constant. Diving starts in the cave systems of Wakulla Springs

Table 9. WKPP Extreme Trimix Dives Surfacing Risk, *r* = 16.67%		
depth (*fsw*)	stop time (*min*)	mixture
270	360	10.5/50 trimix
260	1	
250	1	
240	1	18/40 trimix
230	2	
220	2	
210	2	
200	3	
190	3	
180	3	21/35 trimix
170	4	
160	4	
150	5	
140	5	
130	6	
120	7	35/25 trimix
110	8	
100	9	
90	10	
80	12	
70	16	50/16 trimix
60	21	
50	27	
60	34	
50	41	
40	49	
30	150	100% *O2*



in Florida. **Table 9** summarizes the ascent and decompression profile. The risk is, of course, high, but WKPP professionals continue to attempt and complete such extreme exposures, pushing the exploration envelope. These dives served as calibration points for the RGBM algorithm on whole.

World Record OC Trimix Dive

Consider risk after an OC dive to 1040 *fsw* on trimix, with matched ICD switches maintaining the relative fraction of nitrogen constant as helium is reduced in the same measure as oxygen is increased. Dives without this rather well known strategy ended in some serious chamber time for treatment of vestibular DCS. Reports hint this dive was attempted, maybe accomplished, but contradictions abound. We merely treat it as academic exercise for risk prediction.

Table 10 roughly summarizes the RGBM profile and ascent protocol. Stops range from 740 *fsw* to 10 *fsw* for times ranging 0.5 *min* to 31.0 *min*. Descent rate is assumed to be 60 *fsw/min*, and ascent rate between stages is assumed to be 30 *fsw/min*. Mixes and switch depths are indicated, as in **Table 9.**

Table 10. Trimix Dive To 1040 *fsw* And Risk Surfacing Risk, *r* = 29.24%		
depth range (*fsw*)	stop range (*min*)	mixture
1040	1	5/67 trimix
740 - 530	0.5 - 1.5	
520 - 300	2.0 - 3.5	
290 - 180	4.0 - 6.5	14/56 trimix
170 - 140	7.0 - 9.5	
130 - 70	10.0 - 15.0	27/56 trimix
60 - 40	16.0 - 20.50	
30 - 20	24.5	80/20 nitrox
10	31.0	100% *O2*

The computed risk for this dive is very high, near 30%. Total decompression time is near 415 *min*. Logistics for stage cylinders are beyond formidable, and the risk for deep support divers is also high.

Extreme RB Profile

The following, **Table 11**, is a deep RB dive downloaded off the HydroSpace EXPLORER computer. From a number of corners, reports of 400 *fsw* dives on rebreather systems are becoming commonplace. Consider this one to 444 *fsw* for 15 *min*. Diluent is 10/85 trimix, and *ppO2* setpoint is 1.1 *atm*. From a decompression standpoint, rebreather systems are the quickest and most efficient systems for underwater activities. The higher the *ppO2* , the shorter the overall decompression

time. That advantage, however, needs to be played off against increasing risks of oxygen toxicity as oxygen partial pressures increase, especially above 1.4 *atm*. The higher percentage of oxygen and lower percentage of inert gases in higher *ppO2* setpoints of CCRs results in reduced risks, simply because gas loadings and bubble couplings are less in magnitude and importance. This shows up in any set of comparative *ppO2* RB calculations, as well as in OC versus RB risk estimates.

The risk associated with this 400 *fsw* is less than a similar dive on trimix to roughly the same depth for a shorter period of time, that is, Table 8.

Table 11. Extreme RB Dive and Risk
Surfacing Risk r = 5.79%

depth (*fsw*)	time (*min*)
444	15.0
290	0.5
280	0.5
270	0.5
260	0.5
250	0.5
240	0.5
230	1.0
220	1.0
210	1.0
200	1.0
190	1.5
180	1.5
170	1.5
160	1.5
150	2.0
140	2.0
130	2.0
120	2.5
110	3.0
100	3.5
90	4.0
80	4.5
70	5.0
60	7.0
50	7.5
40	8.0
30	12.5
20	14.0
10	18.5

Table 12. USS Perry RB Repetitive Decompression Dives And Risk
Surfacing Risk After Dive 1, r = 7.48%
Surfacing Risk After Dive 2, r = 7.79%

depth (*fsw*)	time (*min*)
260	40
170	1
160	1
150	1
140	1
130	1
120	1
100	2
90	2
80	2
70	3
60	3
50	4
40	5
30	6
20	9
10	12
0	270
210	20
90	1
80	1
70	1
60	1
50	2
40	2
20	4
10	5

USS Perry Deep RB Wreck Dives

A team of divers uncovered the wreck of the USS Perry in approximately 250 *fsw* off Anguar, and explored it for a week on RBs. Diving in extremely hazardous and changing currents, their repetitive decompression profile appears in **Table 12**. Profiles and risk for the two dives, separated by 4 *hrs* SI, are nominal, with no accounting of exertion effort in current implied. Diluent is 10/50 trimix, with a *ppO2* setpoint of 1.3 *atm*.

Summary

The reduced gradient bubble model (RGBM) has been correlated with profiles housed in the RGBM Data Bank. The Bank stores technical, mixed gas diving profiles with outcome. Some 2800+ deep stop profiles reside in the Bank, with 19 cases of DCS. Parameters in the RGBM are calibrated against data using maximum likelihood. Risk estimates for select NDLs, tables, meter algorithms, and diver profiles in the RGBM Data Bank were tabulated, using a bubble phase volume estimator integrated over the whole profile.

A few points important points need be reiterated here:

1. Deep stop date is intrinsically different from date collected in the past for diving validation, in that previous data is based on shallow stop diver staging, a bias in dissolved gas model correlations;
2. Deep stop data and shallow stop data yield the same risk estimates for nominal, shallow, and nonstop diving because bubble models and dissolved gas models converge in the limit of very small phase separation;
3. If shallow stop data is employed in all the cases detailed, dissolved gas (only) risk estimates will be categorically higher than those computed herein;
4. Data entry in the RGBM Data Bank is a ongoing process of profile addition, extended exposuredepth range, and mixed gas diving application.

Grand Bahama Diving and the Fabled UNEXSO

Text by Jeff Toorish
Photography by Curt Bowen and Jeff Toorish

"Not just a commitment to diving, but to divers."

It was the largest drug bust in the history of Grand Bahama. Police arrested the owner of a freighter called the *Sea Star,* and confiscated the ship, along with a quantity of drugs. He was eventually killed in a gangland style execution while the *Sea Star* was left to rot in a side canal in the Port Lucaya area of Freeport.

Eventually, the *Sea Star* became a hazard to Navigation. "Everyone wanted to get rid of this ship," recalls Christina Zenato, a well knows scuba instructor on the island.

In early 2001, Cathy O'Brien, an instructor at the Underwater Explorers Society had an idea; the *Sea Star* could be put back into practical use as an artificial reef. O'brien worked to secure the necessary permission, raise the ship, clean it and prepare it for scuttling. She worked with Gary Simmons from the salvage company Sea Tow. O'Brien and Simmons worked throughout the spring and summer of 2001 preparing *Sea Star*. The work was difficult but O'Brien was passionate about the project.

But Cathy O'Brien would never see the *Sea Star* in its final resting place.

On a November night in 2001 tragedy struck. O'Brien was driving her brand new Grand Cherokee home after working on the wreck. She called the truck "Tweety Bird" because it was bright yellow.

She never saw the truck coming, but it broadsided her with the full impact on the driver's side door. When news of the accident spread, her many friends and coworkers on the island were devastated. O'Brien was known for her passion and positive attitude. At that moment, others vowed to finish the *Sea Star* reef project as a tribute to Cathy O'Brien.

The Underwater Explorers Society, normally referred to as UNEXSO, understood O'Brien's passion for the *Sea Star* reef. Managers at UNEXSO quickly moved to continue the project and 2002, the *Sea Star* was scuttled. Today is one of the most dived locations in the Bahamas.

The wreck displays a plaque with Cathy O'Brien's photo and a brief explanation of her work on the project, which is also home to a diverse undersea population, including schools of silver sides, tiny fish that can normally be found on the fantail of the wreck.

The story of the *Sea Star* and Cathy O'Brien illustrates UNEXSO's commitment to not only diving, but to *divers*.

Shaken but not Stirred, Bahamas Diving is Back!

- Have some of my conch chowder.
- You read the wrong books, Mr. Bond.
- About conch chowder? Being an aphrodisiac. It just so happens that I like conch chowder.
- Oh...!

James Bond
Thunderball (1965)
Location, The Bahamas

There was a time when the Bahamas was *the* scuba diving destination in the world. Many of today's innovations in scuba, such as hyperbaric medicine, were developed and tested at UNEXSO at Port Lucaya, Freeport, Grand Bahamas. Some of the critical diving equipment we all use today, such as the safe second stage regulator, was perfected there.

As recreational diving became more common, popular underwater TV shows and movies were filmed off the coast of the Bahamas, featuring lush reefs and an abundance of marine wildlife as a natural backdrop. For those old enough to remember; *Sea Hunt*, the grand daddy of scuba entertainment, was filmed at dive sites near Port Lucaya, which is a section of Freeport. One of the old *Sea Hunt* sets is still at the bottom of the ocean there; the remains of a single engine airplane used in the program (although today it looks more like a go cart, as the locals delight in pointing out).

The 1965 espionage thriller, *Thunderball* found British super secret agent James Bond sharing a bowl of conch chowder on a Bahamian beach with Dominique 'Domino' Derval. More recently, *Pirates of the Caribbean* II and III were filmed on the islands, and if you are lucky you might even see Capt. Jack Sparrow's stunt double cutting a swath in Port Lucaya.

A Very Rough Year

Back to back hurricanes in 2004, a particularly difficult hurricane season, left the diving industry in the Bahamas in shambles. The one-two punch started in late August with Hurricane Frances, a category 4 storm. Shortly after Francis battered the islands Hurricane Jeanne settled over the Bahamas for days.

The storm damage was so extensive, several hotels closed and longtime residents say diving fell off for many years. But much like James Bond's ability to escape the clutches of Spectre's Emilio Largo, Grand Bahama was shaken but not stirred. Now diving in the Bahamas is making a dramatic comeback and it looks to be better than ever with the venerable UNEXSO leading the way.

EASY TO GET THERE, HARD TO LEAVE

The Bahamas is a short flight from the US East coast, hardly enough time to order up a medium-dry vodka martini. English is the language and Bahamian and American Dollars are interchangeable. UNEXSO is located in the Pelican Bay Resort, and is a very short walk along the piers to the restaurant district of Port Lucaya.

A favorite dive spot of both locals and tourists is Theo's Wreck, located about a mile and a half west of Silver Point. Theo Galanopoulos, the architect of the wreck, sank the 228 foot cement hauler in 1982 as a present to the Bahamas. It is the first artificial wreck in the islands and remains such a popular destination it appears on many maps of the area.

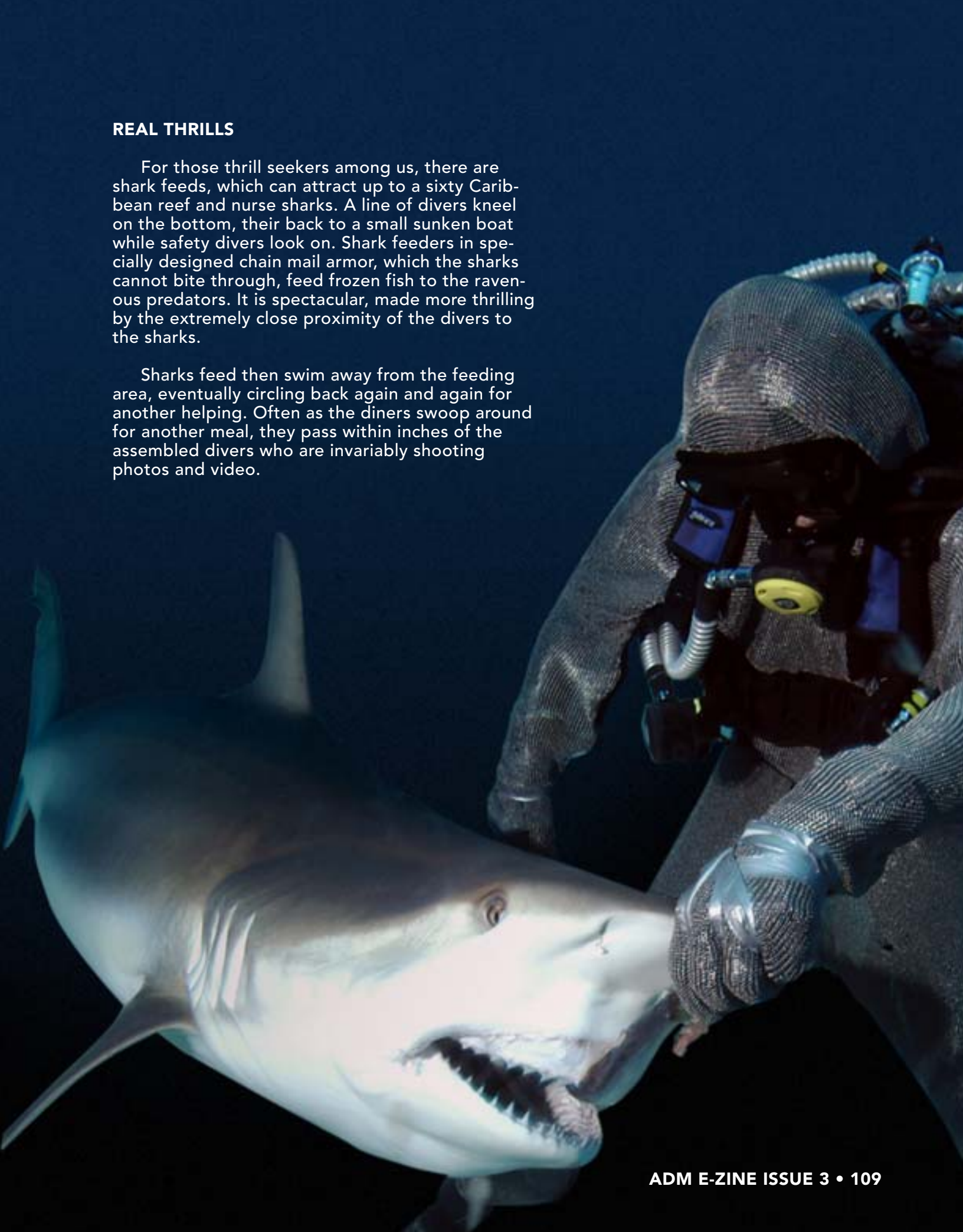
Theo's Wreck lies on its port side in 100 feet of water and offers simple penetration, provided divers are with a dive master or local guide. Wildlife on the wreck includes anemones, colorful sponges, Caribbean reef fish and moray eels. The favorite penetration port is the large cargo hold amidships.

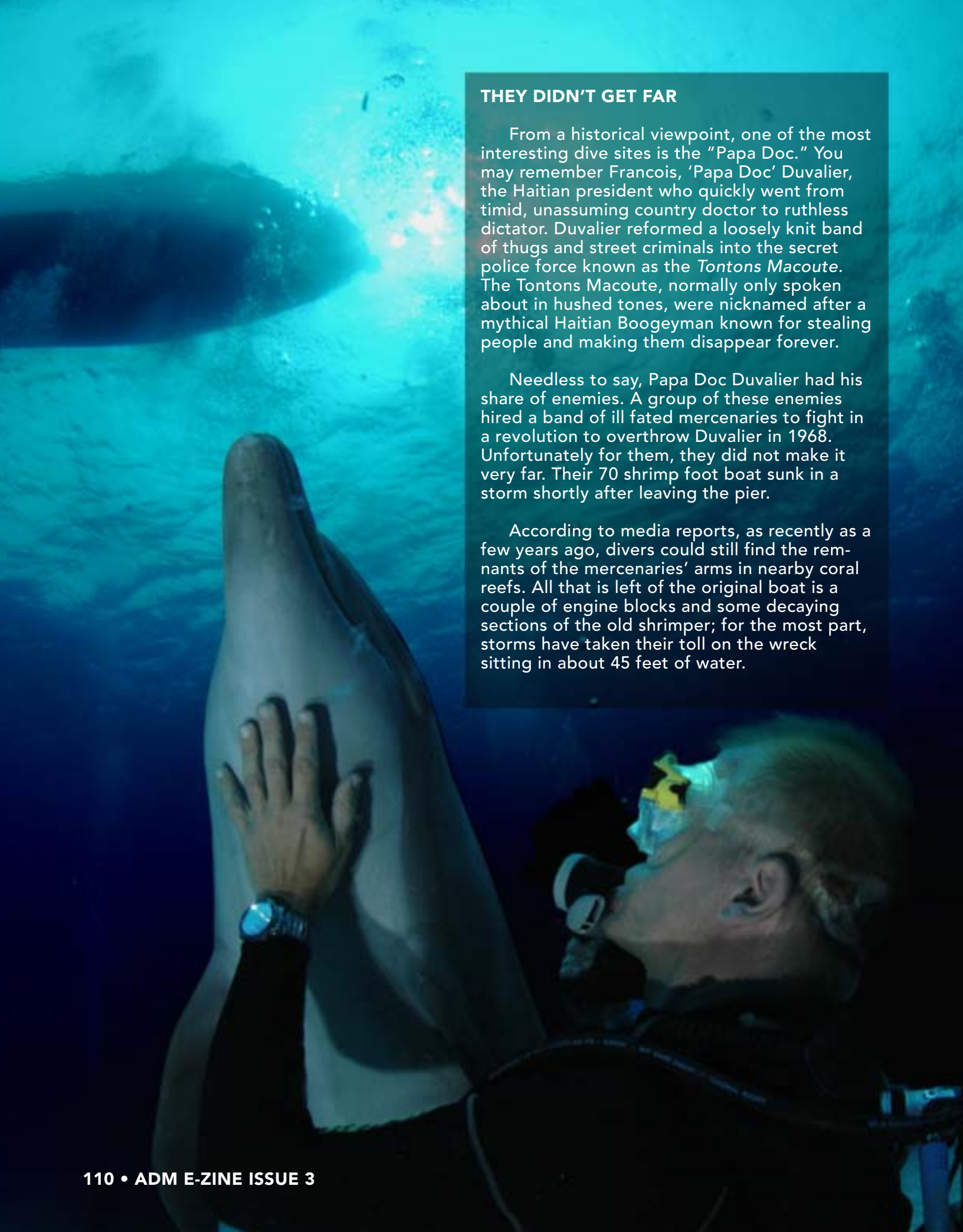
While technical diving is limited on the islands, certified cave divers can explore Ben's Cave located in the Lucayan National Park. The cave was named for Ben Rose, one of the original staff members at UNEXSO. But a word of caution, before planning to dive Ben's Cave, check with UNEXSO about availability.

REAL THRILLS

For those thrill seekers among us, there are shark feeds, which can attract up to a sixty Caribbean reef and nurse sharks. A line of divers kneel on the bottom, their back to a small sunken boat while safety divers look on. Shark feeders in specially designed chain mail armor, which the sharks cannot bite through, feed frozen fish to the ravenous predators. It is spectacular, made more thrilling by the extremely close proximity of the divers to the sharks.

Sharks feed then swim away from the feeding area, eventually circling back again and again for another helping. Often as the diners swoop around for another meal, they pass within inches of the assembled divers who are invariably shooting photos and video.





THEY DIDN'T GET FAR

From a historical viewpoint, one of the most interesting dive sites is the "Papa Doc." You may remember Francois, 'Papa Doc' Duvalier, the Haitian president who quickly went from timid, unassuming country doctor to ruthless dictator. Duvalier reformed a loosely knit band of thugs and street criminals into the secret police force known as the *Tontons Macoute.* The Tontons Macoute, normally only spoken about in hushed tones, were nicknamed after a mythical Haitian Boogeyman known for stealing people and making them disappear forever.

Needless to say, Papa Doc Duvalier had his share of enemies. A group of these enemies hired a band of ill fated mercenaries to fight in a revolution to overthrow Duvalier in 1968. Unfortunately for them, they did not make it very far. Their 70 shrimp foot boat sunk in a storm shortly after leaving the pier.

According to media reports, as recently as a few years ago, divers could still find the remnants of the mercenaries' arms in nearby coral reefs. All that is left of the original boat is a couple of engine blocks and some decaying sections of the old shrimper; for the most part, storms have taken their toll on the wreck sitting in about 45 feet of water.

Because of the site's historical significance, In 1996 UNEXSO sank a second boat at the site. The tugboat, *Badger* now sits where the mercenaries who had hoped to overthrow one of the 20th century's most notorious dictators lost their original ship. Two wrecks for the price of one.

AFTER THE DIVE

Once the dive gear is cleaned and stowed, Freeport offers an abundance of nightlife. There are all inclusive resorts on the island, but unlike many resort areas, there is plenty to do in the town square, which features live music several nights a week.

For travelers who prefer more immersion in local culture, Port Lucaya is the perfect destination, with everything from downtown bazaars to upscale restaurants (be sure to try the conch chowder). There is a local casino for those who prefer to take their chances with other kinds of sharks. Beach bars with names like Bikini Bottom and Toads on the Bay are a short cab ride away.

If you are looking for a getaway for some casual snorkeling or scuba diving, or a more advanced wreck or shark dive with plenty to do after you're back on land, Freeport, Grand Bahamas is the place to be.

Just remember to dive by the *Sea Star* and say thanks to Cathy O'Brien.

Jeff Toorish is the Chief Photojournalist for Advanced Diver Magazine and ADM E-Zine.

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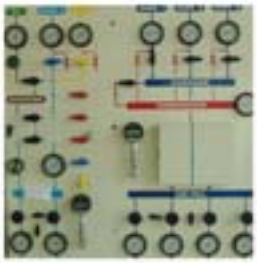

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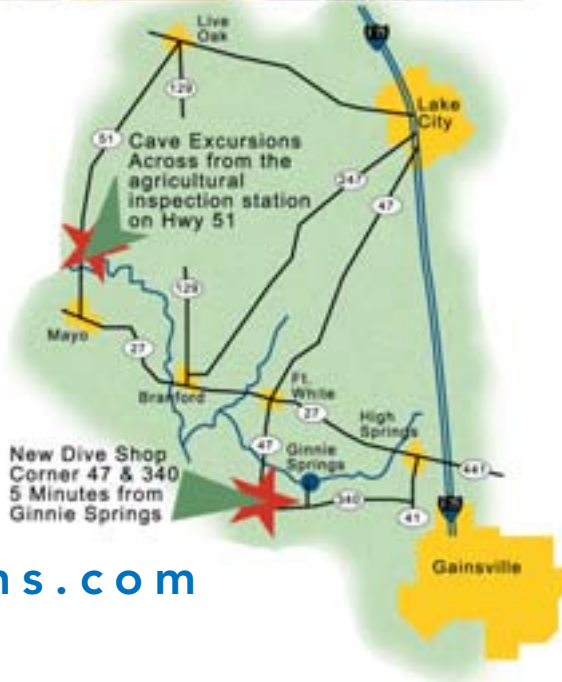

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