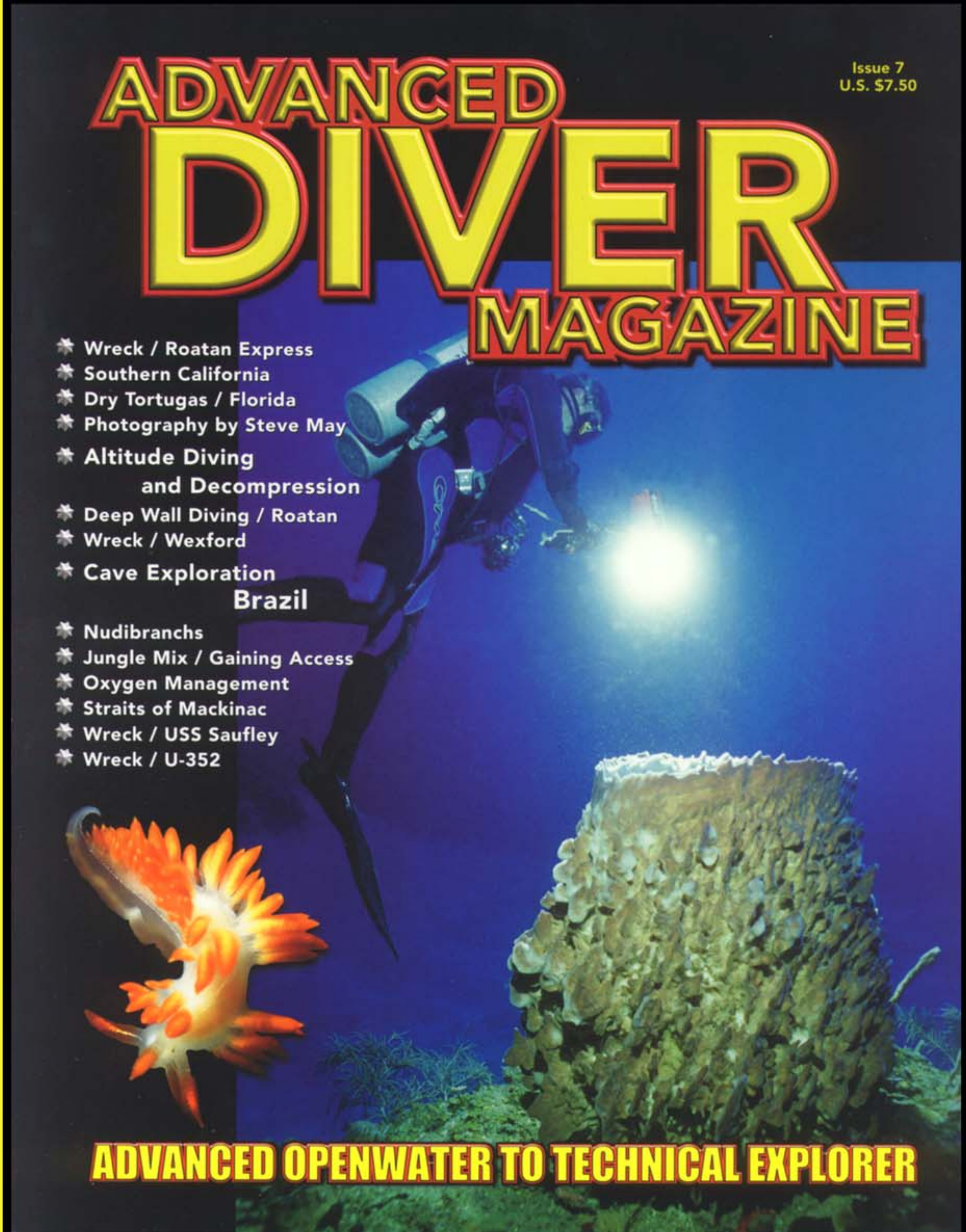
ADVANCED DIVER MAGAZINE

Issue 7
U.S. $7.50



- Wreck / Roatan Express
- Southern California
- Dry Tortugas / Florida
- Photography by Steve May
- Altitude Diving and Decompression
- Deep Wall Diving / Roatan
- Wreck / Wexford
- Cave Exploration Brazil
- Nudibranchs
- Jungle Mix / Gaining Access
- Oxygen Management
- Straits of Mackinac
- Wreck / USS Saufley
- Wreck / U-352

ADVANCED OPENWATER TO TECHNICAL EXPLORER


Air-Z
S600
PureTEK Wing
Digital Depth Gauge
G250 HP
Twin Jet Fin
Jet Fin
R380
Frameless Mask
S-Tek Steamer
& Hooded Vest
Balanced Inflator
Tanks
SCUBAPRO®
UWATEC
SCUBAPRO offers a complete line of technical equipment meeting the needs of demanding divers since 1963
ScubaPro USA
1166-A Fesler Street
El Cajon, CA 92020
(619) 402-1023
Canadian Dist. c/o Nadel Enterprises
565 Fenmar Drive
Weston, ON M9L 2R6
(416) 745-2622
www.scubapro.com

Publishers Notes

April 6th, 1994, I had just returned to the fire house from an EMS call, my fulltime job other than publishing ADM, when the phone rang.
It was a dive buddy of mine with bad news.
My mixed gas instructor and dive buddy, Sheck Exley had died attempting to reach the bottom of Zacaton cave system (1000 feet) in Mexico.

In 1997, Robert Palmer disappeared while deep air wall diving in the Red Sea during a TDI technical dive conference.
In 1998, Richard Roost became lost in the Andrea Doria while searching for china and ran out of gas.
In 2000, Tony Maffatone surfaced unconscious without his equipment and drowned.

During the years I have received many more calls and e-mails with news about divers who, for a multitude of reasons, were seriously injured or died while diving. Many times the contributing factors were a lack of training or deep air diving. Other incidents included switching to the wrong gas at depth, inadequate equipment, exceeding experience levels, failure to follow simple caving / wreck diving rules, poor physical fitness, etc...

In the 80's, only the NACD and NSSCDS offered technical training, followed in the early 90's by IANTD and TDI. NAUI joined the band wagon in 1997 and now PADI announces a technical program to be premiered at DEMA 2001. Even specialized groups such as GUE have joined the training parade with their own training regulations.

Those agencies who fail to regulate and maintain top-notch instructors will be pinpointed by their accident trail. Look closely at the track record of a few already established.

Sheck wrote a small book back in the 80's called "The Blue Print for Survival." It looks closely at accidents and why they occurred. Advanced Diver Magazine plans to continue this survey so that we can learn from the mistakes of others, in the hopes of not repeating them.

Curt Bowen
Publisher ADM

ADVANCED DIVER MAGAZINE

Editor & Publisher Curt Bowen
General Manager Linda Bowen
Text Editor Michele Bluestone
Staff Writer Jim Rozzi
Deco-Modeling Dr. Bruce Wienke

Editorial Support
Jim Bowden•Joe Rojas

Staff, Photography, & Video Imaging
Thaddius Bedford•Jeffrey Bozanic
Larry Curtis•Rusty Farst
Steve Gerrard•Bret Hemphill
Leroy McNeal•William Mercadante

Contributors (alphabetical listing)
Tom Anderson•Jeff Barris
Jack & Karen Bowen•Steve Cantu
John Chluski•Larry Cohen
Rich & Doris Chupak•Ed Dilger
Joao Paulo Franco•Gabriel Ganme
Michael and Sherry Garman•Marcus Gary
Luis Henrikue•Paul & Jill Heinerth
Vangie Jones•Michael Kane•Brian Kakuk
Ken Kurtis•Steve Lewis•Andreas Matthes
Sean Murdock•Harold Rudinger
Carl Saieva•Gustavo Elias Sallum
Eric Santos•Lonnie Sharp•Charlie Tulip
David Walker•Scarlett Watts•Jim Weber
Bert Wilcher•Mike Zee

Advisory Board (alphabetical listing)
Dr. R.W. Hamilton•Lamar Hires•Dr. Tom Iliffe
J.P. Imbert•Dr. A. Kristovich
Tim O'leary•David Rhea•Wes Skiles
Terrence Tysall•Hal Watts

Advanced Diver Magazine is published quarterly in Bradenton, Florida.
Subscription rates are $25.00 for one year (4 issues), $45.00 for 2 years (8 issues).
Canada and Mexico add $20/yr, other foreign add $25.00/yr S&H.
Visa, Mastercard, American Express, Discover, purchase orders, and checks accepted.

Article Submission contact Curt Bowen

Contact Information:

Write P.O. Box 21222
Bradenton, FL 34204 -1222
Phone 941-751-2360 / 877•808•DIVE
Fax 941-753-6419
E-Mail Office: AdvDvrMag@aol.com
C. Bowen: EANx@aol.com
FED EX/UPS Advanced Diver Magazine
3115 48th Ave Dr. East
Bradenton, FL 34203
WEB www.AdvancedDiverMagazine.com

WARNING

Diving is a potentially dangerous activity. Neither Advanced Diver Magazine, its contributors nor its staff accept liability for diving related injuries by our readers, All materials within Advanced Diver Magazine are for informational purposes only and not a substitute for dive training.

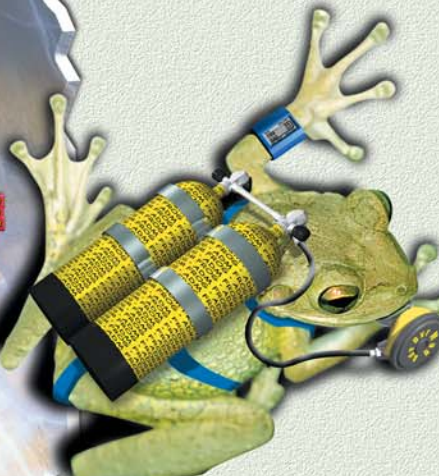


Table of Contents

DEMA 2001 Booth # 3606

Cover: Tim O'leary, NAUI Tec Ops training director examines a giant sponge located on a Roatan/Honduras wall at 210 feet.
Photo: Curt Bowen

The 'BADDEST' Frog in the Swamp!!!

ROATAN EXPRESS

NAPLES / FT. MYERS FLORIDA

By: Rusty Farst

Heading towards Tampa Bay from Honduras, the 180-foot freighter, Roatan Express, ran into rough seas during a severe, no-name storm, just off the Southwest tip of Florida. Carrying a cargo of 23 large container boxes of frozen foods, cars, and several flat bed trucks, the Roatan pushed slowly to the east and safety of the coast of Florida.

At 4:30 am the Captain radioed a distress call that the ship was taking on water. In a last attempt, the captain began pumping out his engine fuel to lighten the load, hoping to last until daybreak. With no success, the captain ordered everyone to abandon ship at around 5:00 am.

Photos and Illustration: C. Bowen

According to accounts by survivors, several members of the crew were attempting to lower the lifeboats when the waves capsized the ship, throwing all ten of the crew and three passengers into the water. The captain and a female passenger were reported still to be on ship.

A coast guard helicopter was dispatched at 4:45 am and was headed towards the last known coordinates given by the captain, some 75 miles to the west-south west. Once arriving, the coast guard searched for several hours, finding nothing until just after sunrise. Following an oil slick from the ship, the rescue helicopter located 13 survivors clinging to some floating wreckage.

Due to weight restrictions in the helicopter, a critical decision had to be made to dump fuel, leaving only just enough to safely return to shore with the additional passenger weight. Lifting twelve of the crew and passengers aboard, severely over weighting the helicopter, the pilot had no choice but to leave one of the Roatan's crew in the water.

Returning to shore the helicopter had to make an emergency landing on Sanibel Beach due to low fuel. Another helicopter was dispatched to the wreck site to rescue the remaining crewmember still floating on the wreckage and to continue looking for the passenger and the captain. At the end of a several day search, nothing of the Roatan was discovered, with the exception of hundreds of plastic coat hangers, bags of Doritos, and a pair of sandals.

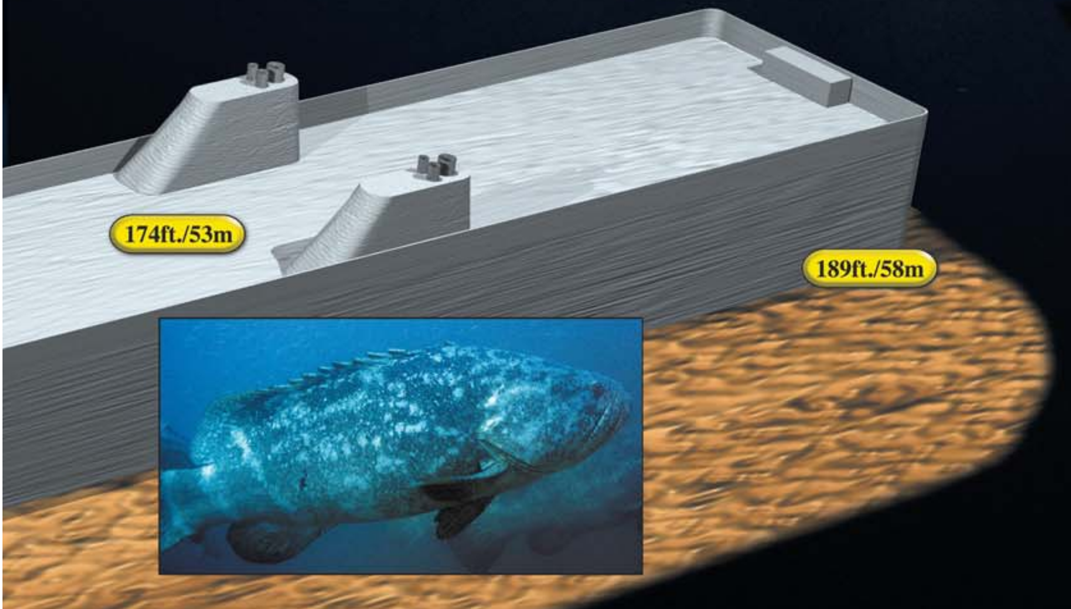
Today the Roatan Express sets in 190-feet of water, 73 miles west of Ft. Myers. She sits intact, upright on the bottom, in surprisingly good condition. One of her lifeboats lays on her starboard side and three flatbed trucks, and two cars are still cabled to her stern deck. None of the container boxes have been found within sight of the wreckage.

Entering the lower deck through the main doorway, a hallway leads to the galley and crew's quarters on the left, and the captain's quarters and bathroom on the right. The second floor contains a dinning room and several equipment storage areas. The pilothouse, still in good shape, is now filled with several large Jew Fish.

The wreck now supports an amazing amount of fish. Hundreds of jacks, snapper, and grouper make the Roatan their home. Spiny sea urchins abound in the thousands, and they have eaten most of the paint from the wreckage.

Visibility normally runs from 50 to over a hundred-feet, with little to no current, making the Roatan an easy wreck to explore. However, due to the long distance from shore, not many divers have ventured to see her.

A video of the Roatan Express is available by Jaws Productions at www.jawsproductions.com.



Left Page Back Drop: Photo taken of the crows nest from the lower deck behind the pilothouse.
(Nikon N90, Provia 100F, 100 ASA)

Far Left: ADM staff diver Jim Weber decompressing after a 30-minute bottom time on the Roatan Express.

Illustration: Artist rendering of the Roatan Express and how it lies on the sandy Gulf of Mexico floor. Missing on the illustration is 3 flatbed trucks and 2 cars, chained to the deck on the Roatan's stern.

Right Lower: Large Jew Fish 100-700 lbs make the pilot house their home.

Right Page BackDrop: ADM staff, Jim Rozzi silhouetted against the midday sun.

Southern California

By: Michael Kane
(Photo by Ken Kurtis)

While Southern California diving is admittedly lacking signature attractions such as the Andrea Doria, USS Monitor, or USS Wilkes Barre, it is not lacking alluring exploration opportunities. Breathtaking deep offshore reefs not only present diving challenges, but also please technical enthusiasts.

Virginal, kelp-blanketed walls, like Cortes and Tanner's Bank, shadow the Mexican border and invite exploration. Sea lions, harbor seals, garibaldi, and moray eels are some of the underwater life that can be regularly seen in Southern California diving. A popular site is Begg Rock, a volcanic protrusion near San Nicholas Island, which entices deep-sea explorers from around the globe.

Razorback Ridge, which is a pure, pronounced drop, leading explorers directly into it’s abyss, shelters grand expanses of sea anemones, giant rock scallops, behemoth lobsters, and marine life that have thus far avoided the carnage of hunting. This trilogy of pinnacles connected by smaller and shallower ridges, allows divers to traverse the totality of the reef. While this is a perfect opportunity for scooter exploration, surge and currents dictate that divers be prepared to descend quickly upon exiting the boat. The remoteness of this site has provided a natural habitat for protection and thus, the local marine life enjoys an enhanced life span. It is considered an anomaly to find a scallop smaller than the size of a normal dinner plate. Each of the Channel Islands has a unique and compelling reason to attract divers.

Old offshore drilling rigs have become increasing interesting in this year's political contests. For a change, oil companies are working hand and hand with enviromentalist. These artificial reefs have become the home to schools of fish and the structures are a refuge for barnacles, metridiums, anemones, sponges, and of course, scallops. A hunter's paradise, since the challenge is not reaching your daily limit of 10, but selecting the best of the bunch. With literally thousands to choose from, how do you decide which will be the most rewarding 10? These man-made structures, that range in depths from 330' to over 1000', are scheduled for dismantling in the near future. Raging controversy from the oil companies and environmental groups has made for surprising bedfellows. To be decided shortly is the fate of these encrusted pillars that rise like out of place skyscrapers in the middle of the ocean. Lost in the political tug of war is the fate, and home, to an immense underwater community.

However, in this author's view, the crown jewel of Southern California's deep reef system is Farnsworth Bank. Sitting a mere two miles off the backside of Catalina Island, this water-covered mountain protrudes from the seemingly bottomless abyss and resembles an Everest-like summit that has fallen 66' short of attaining sea level. Stifled in it’s growth, these impressive offshore pinnacle harbors gorgonians, rare white Abalones, pelagics, crustaceans, nudibranchs, sea fans, and a plethora of marine life. Though, the star attraction of this scenic pinnacle is the rare Allopora California, or simple parlance, Purple Hydrocoral. Juxtaposed against a backdrop of yellow anemones, divers enjoy a purple hue. State law protects rare, cold water, hard coral, which abundantly illuminates this pinnacle. While shark, giant black sea bass, and torpedo ray sightings are commonplace here, it is the illustrious coral that attracts droves of divers. Technical divers enjoy the advantage of routinely exploring depths of 300' and beyond. Since few divers are able to reach these depths, the reef has

from the bottom up

escaped the typical dive stampede and resulting massacre by unqualified divers who mistakenly utilize a reef as a buoyancy control device. As a result of strict enforcement, the environmental protections allow this sanctuary to endure.

Earlier this year, the allure of Farnsworth Bank charmed a few members of the WKPP team to journey to the left coast and explore, first hand, the underwater beauty. While this dive provided a stark contrast to the relatively warm waters of Florida, the WKPP team unpacked their drysuits, donned their C4 undergarments, loaded up the argon, and went exploring.

Prior to this exploration, George Irvine, Jarrod Jablonski, Dan Volker, and Ted Cole gave a DIR demonstration. Many within the local technical diving community had attended. Coming off the heals of this educational event, up to 35 local divers explored Farnsworth Bank using a mix of Hyperoxic Trimix. The vast majority of the explorers settled on a mix of 22/30 and limited depths of 180.' (There were a few teams, however, that could not resist temptation and planned for 300'). This allowed for acceptable PO2's and provided substantially reduced END's. Water temperatures hovered in the mid 50's, while visibility cooperated and allowed for at least 100'. This East meets West encounter was widely regarded as a successful event and bridged the non-personal element that has been missing in the educational process brought to us by the information superhighway.

The unprotected location of this dive often results in significant currents. Coupled with the unpredictable visibility mandates that appropriate rescue procedures are in place to counterbalance these potential environmental changes.

The Great Escape, a longtime friend of the technical diving community, provides the backdrop for our efforts. Based in San Pedro, California, this 85' vessel has ample room for the voluminous requirements surrounding a technical dive. With surface supplied O2 available, a carefully designed free floating decompression system in place, and an experienced captain and crew, the Great Escape remains prepared to meet the demands of the ever-growing technical dive community in Southern California.

A cordial invitation is extended to anyone wishing to explore the left coast. An experience not to be forgotten is awaiting all.

Michael Kane is a longtime deep explorer who enjoys the pleasures of Southern California on a regular basis.

Ken Kurtis is a NAUI Instructor and co-owner of Reef Seekers Dive Co. in Beverly Hills, California. His photos have appeared in many national scuba publications.

DRY TORTUGAS
aboard the Ultimate Getaway

Text by: Linda Bowen
Photography: Steve May

The Dry Tortugas, named by Ponce de Leon after he discovered them in 1513, are as remote a group of islands as can be found in the South and yet, still be considered to be located in United State's waters. They were of little interest to de Leon at the time. The Dry Tortugas were thought of as just another shipping hazard to be avoided, and were marked well on early navigational maps.

Located 70 miles west of Key West, the Dry Tortugas group is comprised of seven islands, of which three are significant. Garden Key is just south of the Park's center and is the site of Fort Jefferson. To the east of Garden Key is Bush Key, noted most for its large sea bird nesting site, designated as a sanctuary and prohibited to visit. Off to the west of Garden Key is Loggerhead Key, a coast guard lighthouse station.

Since there was no fresh water available anywhere on the islands, de Leon designated the islands as "dry." Additionally, large numbers of turtles were taken from the waters by his crew, hence the name, Dry Tortugas. De Leon and his crew spent only one day in the Dry Tortugas before setting sail toward the West Coast of Florida. Early navigators had no idea what encounters they might chance upon. On this particular trip, the discovery of the Straits of Florida and the Gulf Stream would prove to be the most important finds of their journey. Slow moving Spanish galleons were now able to carry discovered treasures from the New to the Old World.

Rick Pitts, owner and captain of the 110 foot Ultimate Getaway, is based out of Ft. Myers Beach and specializes in Dry Tortugas trips and an occasional technical wreck exploration. The Ultimate Getaway vessel is a fully equipped live aboard with all the bells and whistles included. A large spacious study room provides ample space for dinning and video/photography work. Large deck spaces provide more then enough room for preparing dive equipment.

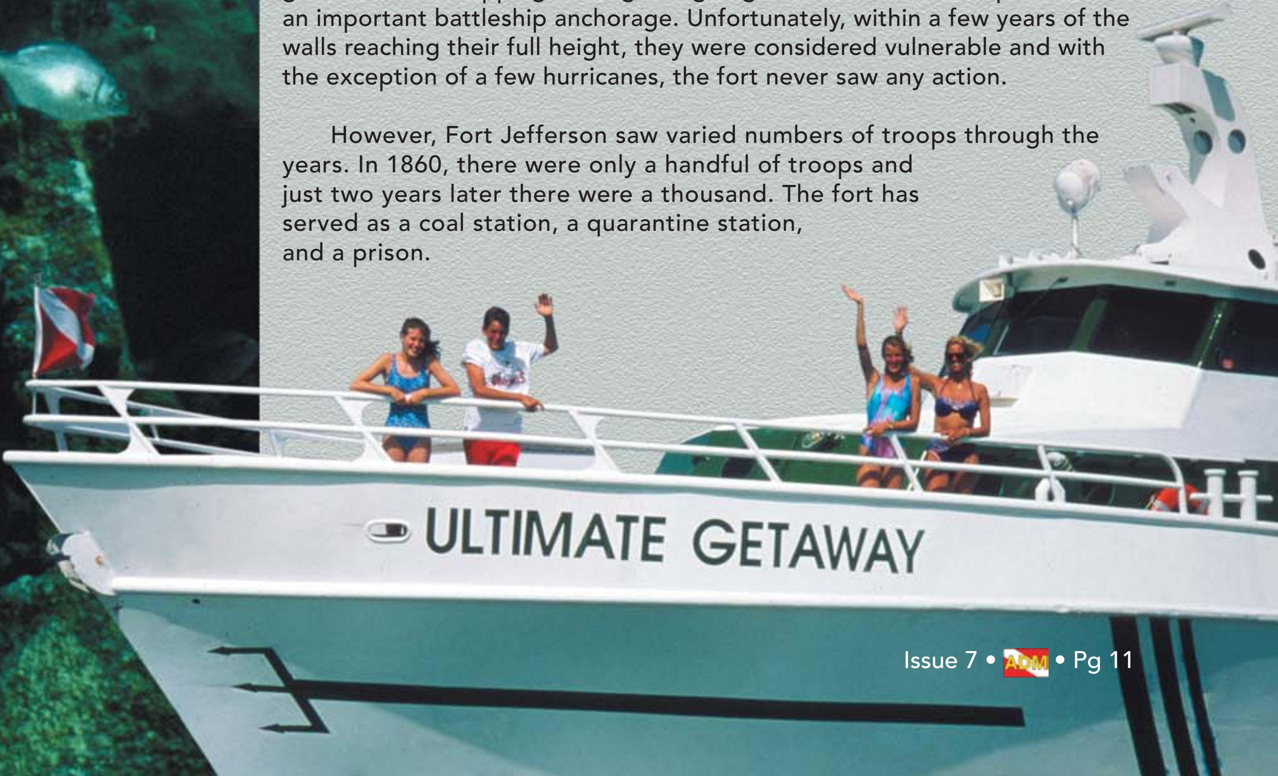
Leaving late in the evening allows us to travel overnight to the Dry Tortugas National Park. As the sun rises we anchor near the light tower that marks Polatski Shoal, located on the eastern edge of the Park. As the divers prepare for their first dive of the morning, they are briefed about its local resident Jewish fish that commonly inhabits the tower's legs. Weighing in at around five hundred pounds and over six feet in length makes this dive a must see for any newcomer to the Gulf of Mexico. Polatski's reef has an abundance of corals, purple seafans, and thousands of tropical fish inhabiting the reef. Hundreds of spiny lobsters live here as if they knew they were protected within the boundaries of the park.

The plan is five to six air dives a day, more if the diver is nitrox certified. Plans are always flexible and left up to the discretion of the divers as to which dives he or she wishes to join.

Our next stop is north of Garden Key, Playmate Rock. In slightly less than 50 ft. of water, Playmate Rock rises nearly straight up for thirty feet to an almost flat top with crisscrossed fissures. The walls are decorated with colorful sponges, purple tipped anemones, and seafans. We see small coral caves, large predator fish, and several more large Jewfish. As the day progresses we move around from dive location to location. By the day's end I have completed eight dives at varied depths, from 90 to 40 feet and over five hours of bottom time.

The next morning we sail toward Garden Key. The site of Fort Jefferson, Garden Key is south of the center of the Dry Tortugas. As we arrive, the pre-Civil War fort nearly covers the ten acre island. Armed with 45-foot high and eight-foot thick walls, the massive fort seems out of place in the tropical setting. In 1846 began the 20 years of labor, placing sixteen million bricks on the small palm-lined island. Despite these efforts, it was never completely finished. Its builders saw this hexagonal structure as a guardian of all shipping coming and going from the Gulf Coast ports and as an important battleship anchorage. Unfortunately, within a few years of the walls reaching their full height, they were considered vulnerable and with the exception of a few hurricanes, the fort never saw any action.

However, Fort Jefferson saw varied numbers of troops through the years. In 1860, there were only a handful of troops and just two years later there were a thousand. The fort has served as a coal station, a quarantine station, and a prison.



The most famous prisoner at the fort was Dr. Samuel Mudd, the man found guilty of setting the broken leg of John Wilkes Booth after he had fatally shot Abraham Lincoln. Mudd was, however, pardoned in 1869 due to his work in the Yellow Fever epidemic of 1867 at the fort.

Two hundred and sixty known ships have been claimed or stranded by the reefs of the Tortugas. One of the most famous is the Avanti, also known as the Wind-jammer Wreck or French Wreck, which lies just southwest of Loggerhead Key. The steel-hulled 260 foot cargo vessel sits in 20 feet of water, sank in 1907. She harbors 134 different species of fish, and is encrusted with Brain Corals. The Avantiis an excellent site for macro photography because of the ample light and encrusted colorful corals.

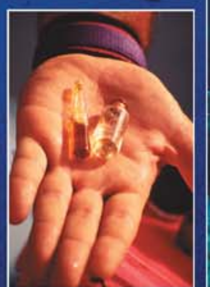
Again, we are able to get in a multitude of dives before the sun set. The Captain chooses an excellent shallow reef to anchor the boat. Dinner is served, then the pool is open for night dives, a no miss photography opportunity.

The third day follows the same routine as the first two, with six to eight more dives, great food, good photography, and lots of laughs.

During the night we travel halfway back towards Ft. Myers. As the sun rises we are parked over the wreck of the Bahia California, a 230-foot freighter which was sunk by a German submarine during WWII. It lies in 115 feet of water. Broken in several pieces, it still contains several artifacts like bottles and dishes, which can be found by the adventurous searcher. Large Jew fish, barracuda, amber jacks and loggerhead turtles are commonly seen on the wreck.

The rest of the afternoon is spent traveling back to port, giving plenty of time to pack our equipment, have a nice lunch, and share underwater videos in the lounge.

Ultimate Getaway
Ft. Myers Florida
Ph: 941•466•3600
www.UltimateGetaway.net



Back Drop: Diver approaches with caution toward this 500 pound Jewfish. Common in the Dry Tortugas and the Gulf of Mexico.

Right: Diver holding some artifacts and the stern section of the Bahia California wreck.

SOLUTIONS FOR TECHNICAL DIVING

OCEAN MANAGEMENT SYSTEMS

IQ PACK
A Soft / Hard
Harness System

45# + 100# Lift
Back Mounted BC's
With or Without Retractable Bands

Stainless or
Aluminum
Backplates

Truly Dry Bag

Emergency
Cutting Tools

Phantom
Light

The Brightest
Compact Light
in its Class

The Most Accurate Oxygen Dive
Analyzer in the World

Programmable
Trimix Computer

Depth Dive Timer

Equipment for Underwater Exploration

PO Box 146 Mongomery, NY 12549 Tel: 914-457-1617 Fax: 457-9497


See Sartek Industries at DEMA 2001
Booth#
3604
Have You Seen
"THE LIGHT"?
Shown:
HID18RW
With Goodman
Handle
The most
Technically Advanced
Lighting System
since the invention
of the bulb!
HID
HIGH INTENSITY DISCHARGE
LIGHTING SYSTEM
• 4x-6x the light output of a Halogen
• 3+ Hours burn time on a single 12V-7AH battery
• No filament to break
• 5,000°K color temperature
• Retrofits to any battery system 9-15VDC
• Perfect for video and photography
• Can be used out of the water
HID VIDEO LIGHTS
BATTERY PACKS
SDC
"DROP" CAMERAS
WITNESS 1
DIVER MOUNTED RECORDING SYSTEM
RSV 1
REDUNDANT SUPPLY VALVE
SARTEK INDUSTRIES INC.
3661-M Horseblock Rd. Medford, NY 11763
Ph: 631•924•0441 Fax: 631•924•2959
www.sarind.com email sarind@idt.net

Featured Photographer

STEVE MAY

I started diving over 30 years ago on the northern coast of California while in the military. After my time with Uncle Sam, I moved back to my native Florida and continued my love for the sport. Through the years I gained experience and additional advanced training including extended range, nitrox, cave and trimix

Twenty years ago, I started underwater photography with a used Kodak Instamatic camera in a homemade plexiglass housing. The camera cost only about a buck and the housing not much more to build. The flash cube insured that the first four shots would be lighted with the remaining shots by natural light only. Obviously this system left a little to be desired as an optimal underwater photo system.

Background Photo:
Wreck of the Fantastico
Ft. Myers, FL
Nikonos V, 15 mm lens,
SB103 strobe, Agfa 100 slide film

Right:
Yellowhead Jawfish
Tortugas Bank, Dry Tortugas
Nikon 8008, Aquatica housing,
105mm macro lens, SB103 strobe,
Fuji Velvia slide film

Background Photo:
Polatski Light Reef
Eastern edge of the Dry Tortugas Park
Nikonos V, 15mm lens,
SB105 strobe, Agfa 100 slide film

Upper Right:
Forty Fathom Grotto
Ocala, FL
Scarlett Watts and Capt. Rick Pitts
Nikon F-3, Aquatica housing, 20mm lens,
SB103 strobe, Agfa 100 slide film

Lower Left:
Painted Tunicates
South of Orange Cay, Bahamas
Nikon 8008, Aquatica housing, 60mm macro lens,
SB103 strobe, Fuji Velvia slide film

Since that time I have upgraded my system several times. Today I use a Nikonos V, Nikonos II, and a Nikon 8008, Nikon F4 in an Aquatica housing. I gain the desired results from using a variety of lenses from 15mm to 105mm macro and light the subjects with Nikon SB 105 strobes. I utilize the superior depth rating of the Aquatica housing for deep wreck and cave shots and for the advantage of superior macro lenses used by land Nikon cameras. I choose Agfa CTX 100 and Fugi Velvia 50 slide films for their superior color saturation and clarity.

Without a doubt, my favorite photo subjects are deep wrecks. The history, mystique, and sea life surrounding wrecks makes each a unique underwater photo studio.

I am a member of the Florida Outdoor Writers Association (FOWA) and have been featured in multiple publications including, Southern Diver, Sport Diver, Dive Journal, DeepTech and now Advanced Diver Magazine.

Each year I organize several photo tours to the Dry Tortugas and the wrecks of south west Florida aboard the 110' Ultimat Getaway liveaboard. Join the crew of the Ultimate Getaway, other professional photographers, and myself for an underwater learning experience guaranteed to satisfy.

Dates: 2001

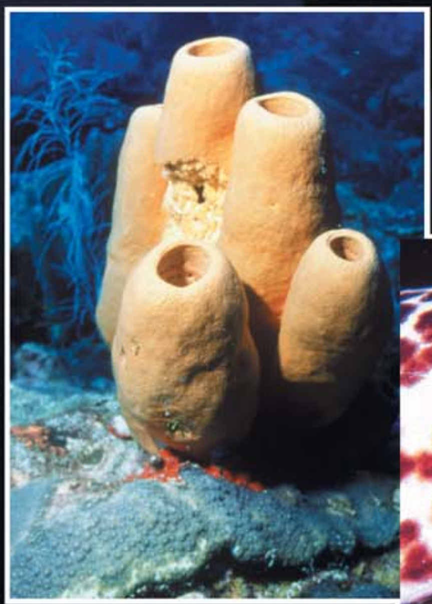
June	14th-17th	Tortugas
Aug	2nd - 5th	Wrecks

for more detailes contact Steve May at 941-728-3536 photodive@myexcel.com

Upper Left:
Horse-eye Jacks
Lighthouse Reef, Belize
Nikonos V, 15mm lens,
SB103 strobe, Fuji 100 slide film

Lower Right:
Spotted Moray, Grand Cayman Is.
Nikonos V, close-up kit,
SB103 strobe, Kodak
Ektachrome 100 slide film

Lower Left:
Yellow Tube Sponges
Alice in Wonderland, Dry Tortugas
Nikonos V, 15mm lens,
SB105 strobe, Agfa 100 slide film



ALTITUDE DIVING

UP THEN DOWN

By Bruce Wienke

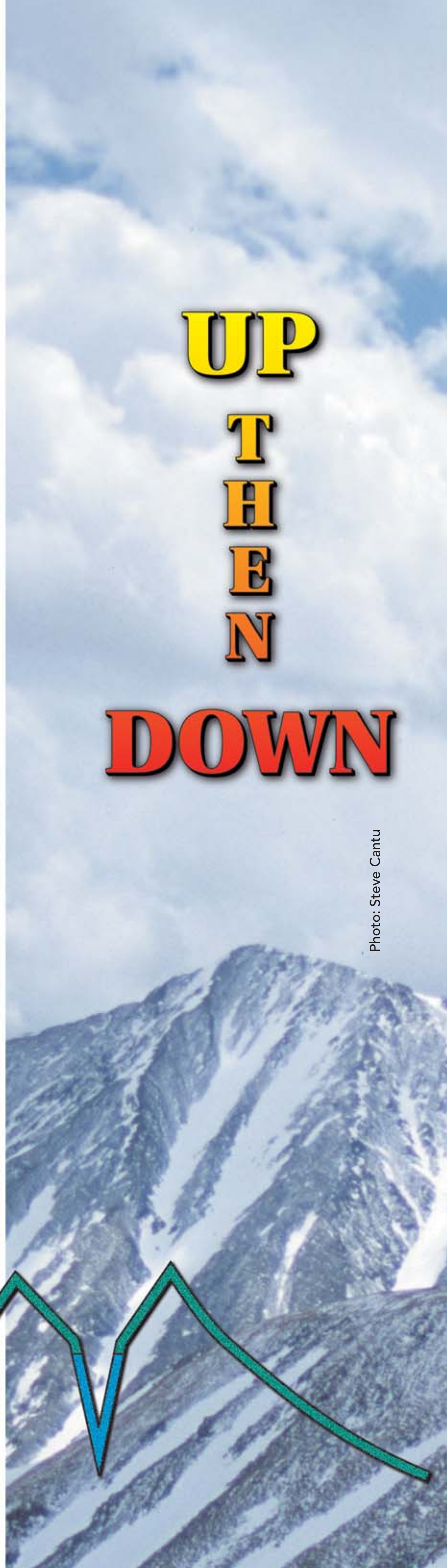


Photo: Steve Cantu

Introduction:

Diving at altitude is diving under reduced atmospheric pressure. Sea level pressure is always greater than ambient pressure at altitude, and that simple fact has some interesting implications for diving activities. Altitude diving is not widely understood because it is rarely taught. Any diver planning to dive above 1,000 ft. should be knowledgeable about altitude conversion procedures, both in theory and practice.

For many divers, a short course in altitude diving can be beneficial; for a few individuals, well-chosen words and the proper advice will suffice. Altitude diving and training might start in the classroom and culminate in the water. Divers can first be apprised of the pressure reduction and effects at altitude, and then be asked to put their newly-acquired knowledge into practice, where it counts, in the water. Novices and veterans alike, build on prior knowledge. Pressure reduction induces buoyancy changes, table modifications, gauge corrections, and physiological constraints, which can be covered in a few hours in a formal lecture. High altitude diving, and calculations can be easily performed with NAUI's new Altitude Conversion Calculator, available from NAUI HQ.

The Short Course:

Topics, which can be woven into any course or presented in totality as a specialty, include: simple decompression theory (Haldane multi-tissue model, applications), tables and meters (altitude modifications, flying, limitations), buoyancy (wetsuit, salt versus fresh), gauges (capillary, non-capillary), physiology (altitude sickness, edema), and air consumption. To maximize impact, operational topics such as table modification, buoyancy, gauges, physiology, and air consumption might be put into practice in the field.

1. Decompression:

Noting that goats saturated at depth did develop decompression sickness if subsequent decompression was limited to half the ambient pressure, Haldane constructed schedules that limited the critical saturation ratio to 1.58 in each of five hypothetical tissue compartments. Compartments were characterized by their half-life (t), the time required for the compartment to half, or double, existent nitrogen. Many compartments are employed in constructing diving tables, with each tissue compartment having its own critical pressure (M-value). The model addresses only rudimentary aspects of gas exchange, neither bubble production mechanisms or the interplay of free and dissolved gas phases.

Slower compartments were added to fit data. Present tables and meters employ the algorithm, or a close variant, directly. Newer models, considering free gas phases within bubble-nucleation models, are developing, hastened by recent statistics linking higher bends frequency to multi-day, repetitive, and multilevel exposures (multi-diving) within Haldane models.

Permissible dissolved gas buildup is limited by these trigger points, having a typical range, 190</=M,</=12 fsw, in absolute pressure units. Sets of t and M used today evolved from self-consistent application of tissue functions to sets of sea level exposure data, that is, trial and error bootstrapping of model equations to observed exposure time limits. Critical tensions, extrapolated to reduced pressure, form the basis of altitude table and meter algorithms. Tables and meters designed for sea level need to be conservatively modified for altitude if possible, otherwise, not employed. Meter and table use are best left to manufacturer and designer discretion, but in any case, modification of M-values is central to any Haldane altitude algotiyhm. We describe a conservative technique, called similarity, appropriate to modification of the USN tables (and NAUI version) for altitude.

2. Depths, Ascent Rates, and Stops:

Actual depths at altitude are multiplied by factors (a), called altitude correction factors, which are just the ratios of sea level pressure to altitude ambient pressure. Wrist altimeters can be used to compute these ratios, which are always greater than one. Table 1 (below) lists pressures and correction factors in multiples of 1,000 ft., with higher altitudes implying deeper relative exposure in terms of sea-level-equivalent depth. The rule (similarity) for altitude table modification and applying correction factors to calculations is straightforward. Convert depths at altitude-level-equivalent depths through multiplication by (a). Convert all table sea level stops and ascent rates back to actual altitude through division by d. Since sport diving is no-decompression diving, stop conversions should be academic, except for

Altitude Change	Ambient Pressure P (fsw)	Correction Factor a	Penalty Group on Arrival at Altitude	Permissible Group for Ascension to to Altitude
0	33.00	1.000	-	-
1,000	31.86	1.036	A	L
2,000	30.77	1.072	B	K
3,000	29.67	1.112	B	J
4,000	28.55	1.156	C	I
5,000	27.50	1.200	D	H
6,000	26.53	1.244	E	G
7,000	25.45	1.292	E	F
8,000	24.55	1.344	F	E
9,000	23.63	1.396	G	D
10,000	22.72	1.452	H	C

Table I. Altitude pressures, correction factors, penalty and ascension groups

safety stops. The ACC provides those depths (Bourdon) in the 10 and 20-ft. columns. Ascent rates, however, are not academic, and are always slower than the standard 60ft. /min., about 3% slower for each 1,ooo ft. increment of altitude. Capillary gauge performs these corrections automatically, giving altitude compensated readout for table entry.

3. Travel To and From Altitude:

Diving at altitude and flying after diving are similar activities. Consider the former first, since flying after diving is really a subcase, namely that flying after diving represents an excursion to 9ooo ft. Maximum, in a pressurized cabin, of course.

If a diver has equilibrated with ambient pressure at any elevation, then any reduction in ambient pressure will throw that diver into a repetitive group, merely because tissue tensions now exceed ambient pressures. Similar comments apply to pressure reductions following any diving activity, with, obviously, sea level diving our usual bill of fare. Typical group specifications are listed in the column 4 of Table 1 and represent penalty time for the excursion to altitude. Entries are appropriate for any excursion (^z) between differing elevations.

In similar fashion, excursions to higher altitude following diving are limited by tissue gas buildup, and minimal repetitive group designators can be attached to any planned excursion ^z. Limits to tissue tensions, converted to standard USN groups, are tabulated in column 5 of Table 1. Entries represent maximum permissible groups for immediate altitude excursions ^z and do not account for any travel time. Thus a diver would have to wait some length of time after a dive, until he dropped into the permissible group category, before ascending. This includes the diver who makes a sea level dive and then ascends to 1,000 ft. The wait-until-D-group rule for flying after diving is a special case in Table 3, namely an excursion to 9,000 ft.

4. Flying:

Wait 12 hours before flying after nominal diving, 24 hours after taxing, near-decompression, or prolonged (repetitive) exposures. (NAUI recommends 24 hours after any diving.) The D-group rule is not as conservative. These recommendations are consistent with recent practices adopted by the Undersea and Hyperbaric Medical Society (UHMS). A diver must also be concerned about loss of pressurization in the cabin.

Caveats:

Limitations of the Haldane model suggest a number of conservative practices in addition to the above. At altitude, they are underscored:

(1) Safety stops for 3-5 min, in the 10-20 ft. zone are highly recommended procedures, especially deep and repetitive exposures (NAUI recommends 3 min. at 15 ft).

NAUI AIR
RGBM Altitude No-Decompression Table
Sea Level to 5000 ft./1524m

Depth (ft./m)	No Deco Times (min)
40 ft./12m	90 min
50 ft./15m	65 min
60 ft./18m	45 min
70 ft./21m	30 min
80 ft./24m	25 min
90 ft./27m	20 min
100 ft./30m	15 min
110 ft./33m	10 min
120 ft./37m	10 min

NAUI AIR
RGBM Altitude No-Decompression Table
5001 ft. / 1524m to 10,000 ft. / 3048m

Depth (ft./m)	No Deco Times (min)
40 ft./12m	75 min
50 ft./15m	50 min
60 ft./18m	35 min
70 ft./21m	25 min
80 ft./24m	20 min
90 ft./27m	15 min
100 ft./30m	10 min
110 ft./33m	10 min
120 ft./37m	10 min

Minimum Surface Interval Time Between Dives is 2 Hours for up to 2 Dives Per Day

WARNING

Use these tables under your own risk! Do Not Use these tables unless you have proper training. No dive table can guarantee that serious injury or death may not occur even if followed within the recommended times.
Neither Advanced Diver Magazine or NAUI accepts responsibility for any use of these tables.

Depth Gauges and Dive Computers must be Calibrated for Altitude!

New NAUI Altitude Tables shown here, can be used directly without depth or altitude adjustment in the two elevation ranges shown 0 to 5,000 ft., and 5,001 to 10,000 ft. elevation. Minimum surface intervals between dives is two hours, and 2 dives per day are permitted. Successive dives must be shallower and shorter than the previous dive. Descent rate is 60 fsw/min and ascent rate is 30 fsw/min. These new NAUI Altitude Tables are Groupless -- making them simple to use.

RGBM (Reduced Gradient Bubble Model) is a modern two phase (dissolved gas and bubbles) decompression model that has been tested over the past 6 years, with more recent analysis and testing over the past 2 years by NAUI Technical Diving Operations.

(2) Limit repetitive dives to a maximum of three per day, none exceeding the 100-ft. level.

(3) Avoid multi-day, repetitive dives to increasing depths.

(4) Wait 12 hours before flying after nominal diving, 24 hrs. after heavy or near-decompression diving (NAUI recommends 24 hours for all.

(5) Avoid multiple surface ascents and short repetitive dives within surface intervals of one hour, particularly to successively greater depths.

(6) Surface intervals of more than an hour is recommended.

(7) Do not dive above 10,000 ft.

AIR
NAUI / RGBM Altitude Decompression Table
Sea Level to 5000ft./1524m

Decompression Stops (minutes) at Depth (ft./m) — Bottom Time (min)

40ft./12m		100	110	120	130
	10'/3m	2	7	10	13
50ft./15m		70	80	90	100
	10'/3m	1	7	13	17
60ft./18m		50	60	70	80
	10'/3m	4	7	14	18
	20'/6m	0	0	1	4
70ft./21m		40	50	60	70
	10'/3m	6	10	13	18
	20'/6m	0	1	1	9
	30'/9m	0	0	0	1
80ft./24m		30	40	45	50
	10'/3m	3	9	10	11
	20'/6m	0	3	5	7
	30'/9m	0	0	1	1
90ft./27m		25	35	40	45
	10'/3m	3	9	10	11
	20'/6m	0	4	6	7
	30'/9m	0	1	2	3
100ft./30m		20	25	30	35
	10'/3m	3	5	8	10
	20'/6m	1	3	4	5
	30'/9m	0	1	2	3
	40'/12m	0	0	1	1
110ft./33m		15	20	25	30
	10'/3m	1	3	6	9
	20'/6m	0	2	4	4
	30'/9m	0	1	2	4
	40'/12m	0	0	1	1
	50'/15m	0	0	0	1
120ft./37m		15	20	25	30
	10'/3m	3	4	8	9
	20'/6m	1	3	4	6
	30'/9m	1	1	3	4
	40'/12m	0	1	2	3
	50'/15m	0	0	1	1
	60'/18m	0	0	0	1
130ft./40m		15	20	25	30
	10'/3m	3	5	9	9
	20'/6m	1	3	4	7
	30'/9m	1	1	4	3
	40'/12m	1	1	2	4
	50'/15m	0	1	1	2
	60'/18m	0	0	0	1

Only one decompression dive allowed per 24 hours.

WARNING

Use these tables under your own risk! Do Not Use these tables unless you have proper training. No dive table can guarantee that serious injury or death may not occur even if followed within the recommended times. Neither Advanced Diver Magazine or NAUI accepts responsibility for any use of these tables.

AIR
NAUI / RGBM Altitude Decompression Table
5001ft./1524 to 10,000ft./3048m

Decompression Stops (minutes) at Depth (ft./m) — Bottom Time (min)

40ft./12m		80	90	100	110
	10'/3m	5	13	18	22
50ft./15m		55	65	75	80
	10'/3m	2	8	17	20
60ft./18m		40	50	60	70
	10'/3m	4	10	16	22
	20'/6m	0	0	4	8
70ft./21m		30	40	50	60
	10'/3m	2	10	14	21
	20'/6m	0	2	7	10
	30'/9m	0	0	0	2
80ft./24m		25	35	40	45
	10'/3m	2	10	11	14
	20'/6m	0	4	6	8
	30'/9m	0	1	2	3
90ft./27m		20	25	30	35
	10'/3m	2	6	10	11
	20'/6m	0	3	4	6
	30'/9m	0	1	2	5
100ft./30m		15	20	25	30
	10'/3m	1	5	8	11
	20'/6m	0	2	4	5
	30'/9m	0	1	2	4
	40'/12m	0	0	1	1
110ft./33m		15	20	25	30
	10'/3m	4	6	10	11
	20'/6m	1	3	4	7
	30'/9m	0	2	3	4
	40'/12m	0	1	2	3
	50'/15m	0	0	1	1
120ft./37m		15	20	25	30
	10'/3m	4	7	10	11
	20'/6m	2	4	5	9
	30'/9m	1	2	4	4
	40'/12m	0	2	3	4
	50'/15m	0	1	1	2
	60'/18m	0	0	1	1
130ft./40m		10	15	20	25
	10'/3m	1	4	9	10
	20'/6m	1	3	4	7
	30'/9m	0	1	4	4
	40'/12m	1	1	2	3
	50'/15m	0	1	1	2
	60'/18m	0	0	1	1

Only one decompression dive allowed per 24 hours.

WARNING

Use these tables under your own risk! Do Not Use these tables unless you have proper training. No dive table can guarantee that serious injury or death may not occur even if followed within the recommended times. Neither Advanced Diver Magazine or NAUI accepts responsibility for any use of these tables.

Charts: Bruce Wienke / C. Bowen

NAUI

EAN 32%

RGBM Altitude No-Decompression Table

Sea Level to 5000 ft./1524m

EAN 32% O_2 / 68% N_2

Depth (ft./m)	No Deco Times (min)
40 ft./12m	140 min
50 ft./15m	110 min
60 ft./18m	80 min
70 ft./21m	50 min
80 ft./24m	35 min
90 ft./27m	30 min
100 ft./30m	25 min
110 ft./33m	20 min
120 ft./37m	15 min

NAUI

EAN 32%

RGBM Altitude No-Decompression Table

5001 ft. / 1524m to 10,000 ft. / 3048m

EAN 32% O_2 / 68% N_2

Depth (ft./m)	No Deco Times (min)
40 ft./12m	130 min
50 ft./15m	105 min
60 ft./18m	65 min
70 ft./21m	45 min
80 ft./24m	35 min
90 ft./27m	25 min
100 ft./30m	20 min
110 ft./33m	15 min
120 ft./37m	15 min

Minimum Surface Interval Time Between Dives is 2 Hours for up to 2 Dives Per Day

WARNING

Use these tables under your own risk! Do Not Use these tables unless you have proper training. No dive table can guarantee that serious injury or death may not occur even if followed within the recommended times. Neither Advanced Diver Magazine or NAUI accepts responsibility for any use of these tables.

Depth Gauges and Dive Computers must be Calibrated for Altitude!

NAUI

EAN 36%

RGBM Altitude No-Decompression Table

Sea Level to 5000 ft./1524m

EAN 36% O_2 / 64% N_2

Depth (ft./m)	No Deco Times (min)
40 ft./12m	160 min
50 ft./15m	120 min
60 ft./18m	90 min
70 ft./21m	70 min
80 ft./24m	45 min
90 ft./27m	35 min
100 ft./30m	30 min

NAUI

EAN 36%

RGBM Altitude No-Decompression Table

5001 ft. / 1524m to 10,000 ft. / 3048m

EAN 36% O_2 / 64% N_2

Depth (ft./m)	No Deco Times (min)
40 ft./12m	150 min
50 ft./15m	125 min
60 ft./18m	85 min
70 ft./21m	55 min
80 ft./24m	40 min
90 ft./27m	30 min
100 ft./30m	25 min

Minimum Surface Interval Time Between Dives is 2 Hours for up to 2 Dives Per Day

WARNING

Use these tables under your own risk! Do Not Use these tables unless you have proper training. No dive table can guarantee that serious injury or death may not occur even if followed within the recommended times. Neither Advanced Diver Magazine or NAUI accepts responsibility for any use of these tables.

Depth Gauges and Dive Computers must be Calibrated for Altitude!

6. Decompression Meters:

Most dive computers on the market today will not function at altitude, though a few are designed to compute correctly when they are turned on to sense ambient pressure, sea level or otherwise. The owners' manual or manufacturer can provide necessary information on the altitude operation of a meter. Unless the meter has an automatic turn on feature (interval probe), it has no way of knowing time at altitude. In that case, the diver must wait until a non-designated letter group status has been attained before using the meter to dive at altitude. Newer meters with interval probes are under development. Today, about 1/2 of the meters work at altitude.

7. Buoyancy:

Buoyancy changes occur when divers move between fresh and saltwater, and/or different elevations. Since fresh water is less dense than salt water, buoyancy is lost in fresh water relative to salt water. Similarly, since ambient pressure at altitude is less than at sea level, wetsuits expand at elevation, increasing buoyancy. Effects, however, tend to offset each other. The increased wetsuit buoyancy amounts to roughly.2% of body weight for each multiple of 1,000 ft. of altitude. The fresh water decrease in buoyancy, relative to salt water, is approximately 2.5% of total diver weight.

8. Gauges:

Capillary, diaphram, and Bourdon depth gauges are usually calibrated at sea level in salt water. Diaphragm and oil-filled gauges indicate depths that are too shallow, while capillary gauges indicate depths are too deep. The capillary gauge is unique in that it automatically registers sea-level-equivalent depths for table calculations at altitude. Today, some Bourdon gauges are available with adjustable scales for re-zeroing at altitude, circumventing most of the problem, excepting the 3% salt-to-fresh water density correction which must still be applied to the reading for actual depth.
To obtain actual depth from a capillary gauge, subtract 3.5% of the reading for each 1,000-ft. increment of elevation. For all other gauges, add one foot for each 1,000-ft. increment, and then add 3% of the reading. For table entry, actual depth is first converted to sea-level-equivalent depth, using Table 1 for instance. Use of a capillary gauge directly or the ACC for Bourdon gauges, simplifies the whole procedure of computing sea-level-equivalent depth from actual depth.

9. Physiology:

Above 10,000 ft., possible physiological complications, in addition to the procedural constraints mentioned, contraindicate repetitive, deeper-than-previous, and multi-day diving. Care must be exercised when diving near and above the 10,000-ft. level. The crux of the problem is reduced pressure. Mountain sickness (low arterial oxygen) and pulmonary edema (lung fluid buildup) can affect individuals, especially those overweight and/or out of shape.

10. Air Consumption:

Consumption rates at altitude are less than sea level rates due to effective reduction in ambient pressure. The same comments apply to compressor pumping rates, output, and horsepower levels. The surface rate at altitude decreases inversely with the correction factor, a. Reductions in surface rate at altitude amount to roughly 3.5% of the sea level rates for each 1,000-ft. step in elevation.

New Tools:

NAUI's technical monograph High Altitude Diving and Altitude Conversion Calculator are designed to work together. High altitude diving, in theory and practice, is covered in the text. The calculator works in the optimal mode of tagging Bourdon gauge readings for fixed sea-level-equivalent depth, in increments of 10 ft., thus facilitating direct table entry. But don't throw away your copy of Altitude Procedures for the Ocean Diver, (C.L. Smith, 1976 NAUI) the tabular information is handy and valuable for reference.

Summary:

Most coastal and inland divers train and dive at or very near sea level, pursuing activities in direct fashion. Tables and gauges are calibrated at sea level. Compressor outputs, air consumption rates, and buoyancy characteristics of materials are quoted at sea level. Density differences between salt and fresh water force slight weighting adjustments in the environments, but affect little else and diving is operationally simple, at least a textbook exercise in theory.

But, for those who train and dive in mountainous and high plateau regions, the situation is more complicated. Dive tables must be converted at altitude because of reduction in ambient pressure. Decompression meters, if not altitude compensated, may be inappropriate at best. Capillary, diaphragm and oil-filled gauges give different readings, none the actual depth. Additional weight needed to counter wetsuit expansion must be balanced against buoyancy loss due to lesser fresh water density, usually the more important effect under 10,000 ft. Excursions to and from sites at different elevations are restricted, controlled in much the same manner as flying after diving. Surface exertion rates may be limited by lower oxygen partial pressures at altitude (hypoxia), while altitude sickness and pulmonary edema can afflict unaclimatized, particularly above 7,000 ft. Air consumption rates are less than at sea level, but table restrictions do not always allow the diver full freedom to exploit the advantage. Yet all this can add another dimension to activities, enhancing understanding, knowledge, and enjoyment of safe diving right from the start.

Into the ABYSS

Story by Jeffrey Bozanic

I hang, suspended and weightless. Moving my feet slowly, gliding through crystalline waters, going deeper, ever deeper ... I sink, slowly. Floating towards the floor, I finally stop. Hovering motionless, I examine the flakes of rusty red rock that are strewn across the bottom of the floor like a dump truck's load of petrified corn flakes emptied many millennia ago. Examining the rocky floor, I ponder both the realistic and surrealistic nature of conducting research underwater in oceanic caves.

Finding not much of anything to hold my interest, I slowly coast into the cave, whose passage beckons me onward. Kicking a little harder, I move slowly into the gaping opening of another tunnel, for me, a gateway to another world. Somehow I feel as though I am moving through the mouth of some giant beast, then down into its throat. While stalactites reach for me from above, stalagmites stretch from below, striving to grasp my body. How short this life would be for me if this were the craw of some primitive dinosaur. Holding that primitive thought, I continue to move slowly past the jaws, leaving the crystalline teeth behind me.

As I swim, I think about the rock icicles hanging above me. I wonder just how many times this passage has been drowned, only to once again have the oceans recede, allowing it to once again breathe the warm air of life. The cave lives only when it is dry. The fantastic features hanging all about me in such amazing profusion were born and grew only when the sea level was lower than it is today. Now, however, they are being slowly etched away. Molecule by molecule, they disappear as the corrosive waters sluggishly dissolve them.

Everything appears to be devoured by time, yet these pillars, these crystalline waterfalls live longer than most. My life is but a brief instant of time next to them. I come and go. My passing is unnoticed. I may return next week, next year, or even next decade, but the changes in these beautiful formations cannot be detected. In a thousand or may be ten thousand years some natural evolution will take place. Nevertheless, who among us has this time to spend to watch the slow wheels of this evolution? I think and wonder some more. What thoughts occupy these crystals? What do they see in their lifetime? If they could speak to us, what experiences would they share?

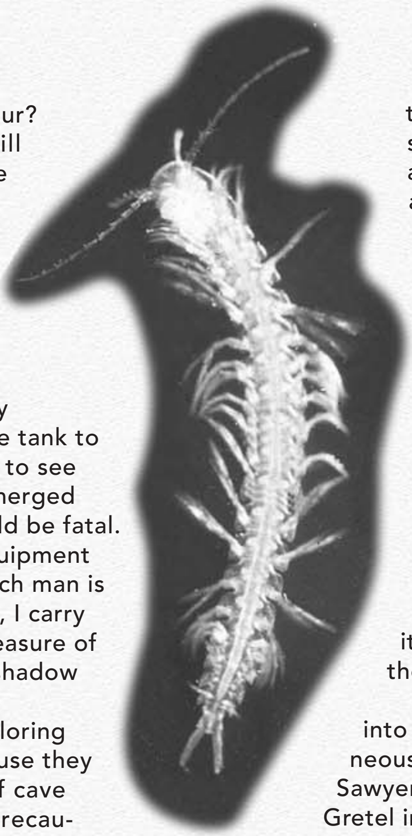
I pass this area, leaving the diamond-like sparkles of my light reflecting from the rocks fading behind me, and it is not all that different from the way those brief flashes of thoughts continue to alight my mind.

I notice that the character of the cave changes. Off to both my left and right, I see more passages. This main passage splits and then splits once again. Like the roots of a tree, these passages wander to the depths of the Earth, traveling to where no person has ever ventured. All of this causes me to once again stop. I feel a bit confused by the choices, wondering which way to swim. I select a passageway, and continue this journey.

Descending slightly deeper into the crack, my light reaches pushing out the darkness. Down here, the black encountered is the darkness of interstellar space, unbroken by any stars or galaxies. Light is ephemeral, but mostly non-existent in this realm. My light beam probes ahead, but beyond that is nothing but pure blackness. The fear of the dark continually nibbles at the edges of my psyche. I continue to sense my fear of the dark and the fear of falling as I hang weightless in the water. I listen to the silent hissing of unseen snakes, an audible phenomenon created by air moving through my regulator as I breathe. I understand, yet everything seems to sound tiny alarms in the back of my mind.

I think about air. I think about how little there is, only what I carry in tanks on my back. How long will this

Photo: Thaddius Bedford



air last me? ... a few minutes? ...an hour? ...maybe two hours? Hopefully, it will last until I reach the entrance, where air is free. Rarely do I think about this as I walk upon the surface above the ocean.

My reliance upon my equipment is absolute. Again, I wonder about.... a breach of integrity in one of my diving cylinders, with the concomitant loss of my air supply; malfunction of my regulator which carries that air from the tank to me; failure of my lights which allow me to see and thread my way through these submerged tunnels. Any of those occurrences could be fatal. Like the astronauts, my life support equipment allows me to explore this realm for which man is otherwise not suited. As life insurance, I carry redundant systems, providing some measure of safety should the finger of fate cast a shadow in my direction.

Hundreds of people have died exploring these dominions. Many drowned because they were unaware of the special hazards of cave diving. Others failed to take proper precautions against potential complications. A few trained and prepared individuals have perished as a result of their overconfidence. Again I wonder.... What were their last thoughts, as they gasped the last wisp of air from their cylinders and strangled in the cold darkness? Chilling.

A bleak environment, ever dark, still, submerged, barren...what animals could possibly live here? We are taught that life is adaptive and manages to retain beachheads of existence in nearly every corner of the globe. It is no different here.

My light beam illuminates motes of dust drifting in the water. These shimmering, moving flecks dance in the water column. Their bright whiteness contrasts with the inky blackness behind them. These tiny specks of light comprise most of the animal life found in these voids in the earth. Smaller than ants, the size of small gnats, these Lilliputian crustaceans are amphipods, isopods, and copepods, all close relatives of shrimps and lobsters.

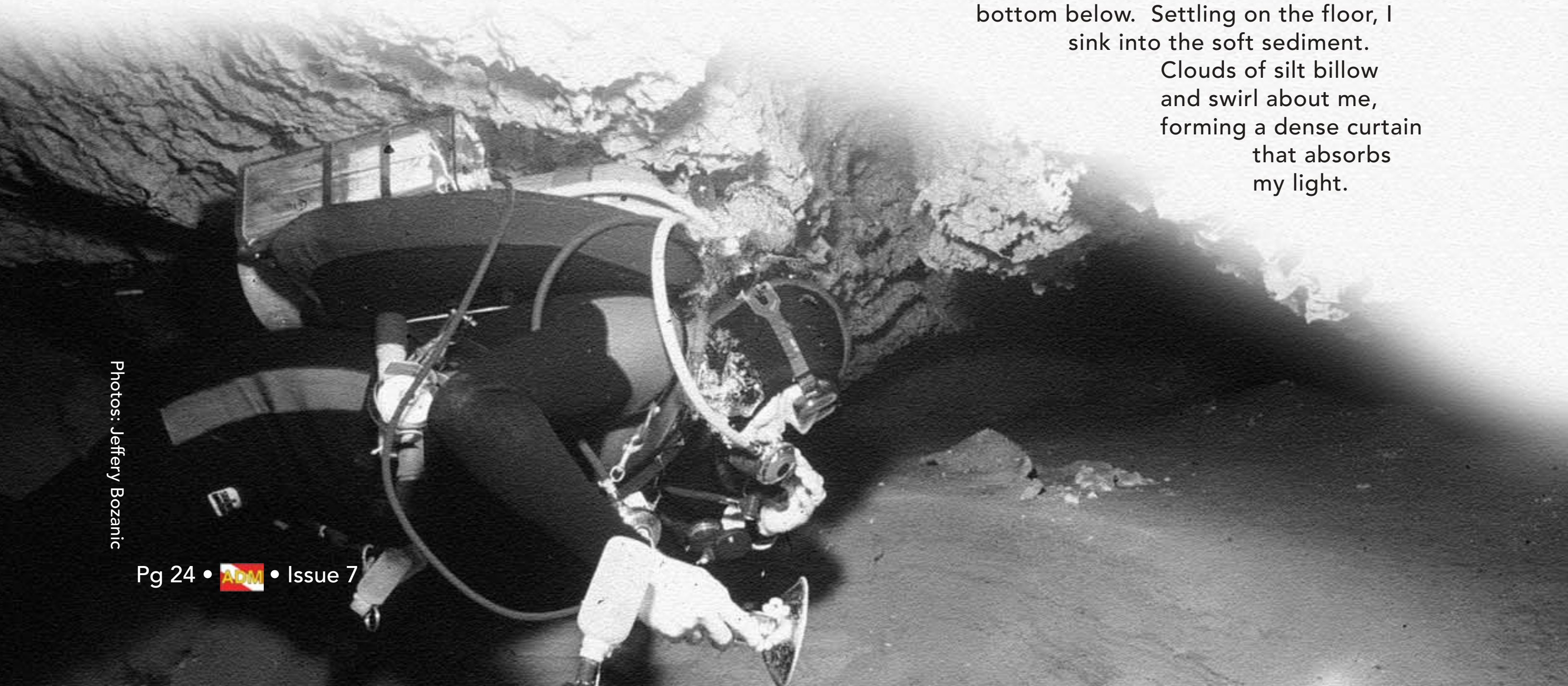
A diminutive fish, only four inches long, swims slowly into my vision. The fish, too, is completely colorless. After all, what need of color do these animal have who live in perpetual darkness? I see them, yet they do not see me. Eyes are another useless extravagance here in the stygian depths. Undulating languidly amidst the stalactites, the fish senses an amphipod nearby. Its blindness does not hamper it. Alas, the minuscule arthropod is swallowed by the fish in the endless struggle for survival. When the fish dies, it will in turn feed the bacteria upon which the amphipod once fed.

I swim beyond the fish, probing further into the unknown corridors beyond. Simultaneously, I pay out a thin string. Like Tom Sawyer in Indian Joe's cave, or Hansel and Gretel in the Black Forest, I leave my trail of breadcrumbs behind to help me find my way out.

I turn a corner, and emerge into a large room. I gaze down onto a serene lake, a lake within the water in which I travel. What is this sharp surface? My journey creates ripples and waves along the interface, dividing these two dissimilar waters. Fresh water above, salt water below, the two do not mix but forever maintain their isolation from each other. Were this refusal to mingle less complete, many tropical islanders would have no water, for this is the root of their drinking supply.

What is the cause of this sharp partition? What influence does it have upon the biology and ecology of the caverns? Why are the rocks below so pitted and corroded, while those above the interface are sharp, clean, and effervescent? How is it maintained? These are questions to which many scientists seek answers.

I fall through the lake's surface, and drop to the bottom below. Settling on the floor, I sink into the soft sediment. Clouds of silt billow and swirl about me, forming a dense curtain that absorbs my light.



Photos: Jeffery Bozanic

The beam is conquered trying to escape. I can see nothing. Like the fish that live here, I also am now blind.

I retreat, groping along the line that is now my only link to the surface. Like a sightless man in an unfamiliar room, I stumble through the darkness. Finally the fog thins, and clear water once again envelops me.

My tenuous bridge to the surface leads me back the way I came. As I swim, I survey the line. A compass divulges the twists and turns I have made. I count knots every ten feet in the line to measure distances. A depth gauge reveals how far below the surface I am. This information is written on my slate underwater. When I surface, I will be able to draft an accurate map of the miles of hallways I have traversed.

How little we know of where these passageways lead. These miles I have mapped are but a small fraction of the cavern system that exists. Huge rivers move below ground, listlessly winding their way into the concealed depths. What other secrets are hidden there?

As I swim towards the exit, I ponder the insights I have gained, the new knowledge gleaned from my brief sojourn. I consider the new creatures others and I have found in this cave and similar ones. Hundreds of new species, new genera, new families, even a new classes of animals have all been captured, studied, and classified.

I have collected clues that will shed some light upon the enigmas of the cave's formation. The geology is complex, yet the thread of chaos is slowly being woven into a tapestry that tells a story of the Earth's past.

The waters have told their own story. While clear, they too hide information from curious eyes, only reluctantly divulging their secrets.

An animal, a crustacean, living in these hidden crevices for millions of years, did not stop the hands of time. Unchanging, they have survived here 250 million years, hiding while the great reptiles rose, dominated the Earth, and long since fell into oblivion. The oxygen deficient waters protect them, asphyxiating any creatures that might feed upon them.

At last, I reach the end of my line. Sunlight bathes me underwater, twinkling upon the ripples created by my bubbles striking the surface. As I leave the darkness behind me, the last of my fears fade away. I am safe.

My head breaks the surface. I breathe sweet, pure air. Again, I am reborn. Passing from the womb of rock, I have reached the sunlight, the air, and the freedom of the earth upon which we live.

About the author:
Jeff graduated from Humboldt State University, CA with a BS in Geology (1979) and a MA in Environmental Education (1980); and from the UCLA with a MBA in International Marketing (1982). He currently serves as Executive Director of Island Caves Research Center, a non-profit institute that conducts research in submerged caves. Jeff has traveled worldwide in pursuit of his biological and geological studies to such locations as Antarctica, the Bahamas, Palau, the Canary Islands, and others. He is the past Chairman of the National Speleological Society Cave Diving Section, and served on the Board of Directors of the National Association of Underwater Instructors (NAUI).
Jeffrey Bozanic: jbozanic@hqonline.com

Where to Find Advanced Diver Magazine

Free Web Site Link! ADM wants to trade links to all our retailer web sites.

Become an Advanced Diver Magazine Retailer and place your dive facility name on this list and in ADM Online for free.

NorthEast

Aqua Shack
449 Boston Post Rd East
Marlboro, MA 01752
Ph: 508•229•7707

Blue Water Divers
806 Rt 17 North
Ramsey, NJ 07446
www.BlueWaterDivers.com

Diving Bell Scuba Shop
681 North Broad Street
Philadelphia, PA 19123-2418
215•763•6868 www.divingbell.com

Elite Divers Inc.
Rt 46 & E. Main St.
Rockaway, NJ 07866

Kings County Divers
2417 Ave U kcdiversny@aol.com
Brooklyn, NY 11229
718•648•4232 Fx 718•934•4154

Ocean Odyssey Dive Center Inc.
20445 Route 19
Cranberry Township, PA 16066
724•779•6800 www.OODinc.com

Sea Dwellers of New Jersey
132A Broadway Hillsdale, NJ 07642
www.seadwellersnj.com
Ph: 201•358•0009 Fx: 358•1519

Splash Dive Center, Inc
3260 Duke St. Alexander, VA 22314
Splashdive@aol.com
Ph: 703•823•7680 Fx: 823•4812

www.StingrayDivers.com
NYC's 1st Tech/Mixed Gas Facility
Huge inventory of wreck/cave gear
DIR friendly! Ph: 718•384•1280

Swim King Dive Shop, Inc.
572 RTE.25A
Rocky Point, NY 11778
Ph: 631•744•7707

T.L. Valas Diving and Supply
1201 Vally View Ave
Wheeling, WV 26003
Ph: 304•242•3676

SouthEast

American Dive Center
900 E Atlantic Blvd #5
Pompano Beach, FL 33060
www.PompanoScuba.com

Amphibious Expeditions
940 I Dougherty
Aiken, SC 29803
Ph: 803•507•5450 rkeller@exr.com

Birds Underwater Ph:800•771•2763
320 NW Hwy 19
Crystal River, FL 34428
www.xtalwind.net/~bird/

Coral Scuba Ph: 941•574•5100
2104 Del Prado Blvd #3
Cape Coral, FL 33990
www.CoralScuba.com

C&D Diving, Inc.
5339 Main St. Ph: 931•486•3710
Spring Hill, TN 37174
www.CD-Diving.com

Depth Perception Dive Center
10075 E. Adamo Dr. Tampa, FL 33619
www.home1.gte.net/divedpdc
Ph: 813•689•DIVE Fx: 661•5621

Dive Outpost Ph: 904•776•1449
Cave Diving At It's Best!
info@DiveOutpost.com
www.DiveOutpost.com

Divers City, USA Inc.
104001 Overseas Hwy
Key Largo, FL 33037
Ph: 305•451•4554

Dixie Divers
1645 SE 3rd Ct.
Deerfield Beach, FL 33441
954•420•0009 www.dixiediver.com

Down Under Dive
11053 Tilburg Steet
Spring Hill, FL 34608
Ph: 352•686•2015

Fantasea Scuba
3781-A Tamiami Trail
Port Charlotte, FL 33952
www.fantaseascuba.com

Ginnie Springs
7300 NE Ginnie Springs Rd.
High Springs, FL 32643
Ph: 904•454•2202 800•874•8571

Kevin Sweeney's SCUBAdventures
971 Creech Rd. Naples, FL 34103
www.SCUBAdventures.com
Ph: 941•434•7477

NADCO, Inc.
4719-B High Point Rd.
Greensboro, NC. 27407
509•452•4006 www.nadcoscuba.com

Rhea's Diving Services, Inc.
313 Whitecrest Dr.
Maryville, TN 37801
Ph: 615•977•0360

Scuba Quest
14 Florida Locations
941-366-1530 941-951-1557
www.scubaquestusa.com/

Smoky Mountain Divers
114 East A.J. Hwy
Jefferson City, TN 37760
865•475•4334 bburton@usit.net

South Beach Divers
850 Washington Ave
Miami Beach, FL 33139
www.SouthBeachDivers.com

Steamboat Diver, Inc
P.O. Box 1000
Branford, FL 32008
Ph: 904•935•3483

Vortex Spring Inc. Ph: 850•836•4979
1517 Vortex Spring Ln.
Ponce de Leon, FL 32455
www.VortexSpring.com

Wateree Dive Center, Inc.
1767 Burning Tree Rd.
Columbia, SC 29210
803•731•9344 wateree@msn.com

Great Lakes

Black Magic Dive Shop
253 Peterson Rd.
Libertyville, IL 60048
847•362•3483 DiveBMDS@aol.com

Captain Dale's Dive Center
71 S. Milwaukee Ave.
Wheeling, IL 60090
847•520•4689 Captaindales.com

Deep Divers International Inc.
DBA Scuba "U" 7113 West 79th Street
Burbank, IL 60459 Ph: 708•599•2630
Scubau@netscape.net

Dive Inn WaterSports
3858 24th Ave. Ph: 810•987•6263
Port Huron, MI 48059
www.DiveInnWaterSports.com

Forest City Scuba
1894 Daimler Rd.
Rockford, IL 61112
Ph: 815•398•7119

Great Lakes Scuba
302 N U.S. 31 S.
Traverse City, MI 49684
Ph: 231•943•3483

Monroe Dive Center, LLC.
1245 South Monroe Street
Monroe, MI 48161-3933
Ph 734•457•3483 Fx 734•457•3484

Minnesota Dive Center Inc.
36 17th Ave NW
Rochester, MN 55901
Ph 507•288•8802 M20320@hotmail.com

Scuba Emporium
16336 S. 104th Ave
Orland Park, IL 60462
Ph: 708•226•1614

Scuba Systems
3919 Oakton
Skokie, IL 60076
www.ScubaSystems.com

Sea Jewels Inc. Ill Institute Diving
436 Roosevelt Rd.
Glen Ellyn, IL 60137
Ph: 630•469•3483 Fx: 469•3491

Sport & Tech Scuba Center, Inc
G-4278 S. Saginaw St.
Burton, MI 48529
Ph: 810•744•1801 Fx:810•744•1803

Sub-Aquatic Sports + Services
347 N. Helmer Rd
Battle Creek, MI 49017
616-968-8551 www.sassdive.com

West Michigan Dive Center LLC
2516 Glade Street 231•733•4200
Muskegon, MI 49444
www.WestMichiganDiveCenter.com

West Shore Aquasports inc.
1201 Sheridan Rd.
Winthrop Harbor, IL 60096
www.WestShoreAquaSports.com

Mid West / Central U.S.

American Diving
1807 Padre Blvd.
South Padre Island, Tx 78597
Ph: 956•761•2030

Aquasports Scuba
2604 North Moore Ave
Moore, OK 73160
Ph: 405•790•0880 Fx 790•0865

Duggan Diving Enterprises
928 Corondo Blvd.
Universal City, TX 78148
210•658•7495 DugganDive@aol.com

Flatirons Scuba and Travel
5127 W 120th Ave
Broomfield, CO 80020
Ph: 303•469•4477

Oklahoma Scuba Inc.
1234 N Interstate Dr
Norman, OK 73072
Ph: 405•366•8111

The Great American Diving Co.
401 N Main Street 314-949-0880
St. Charles, MO 63301
Steve Olfe www.TGADC.com

Underwater Services LLC
3221 SW 94th St. 405•232•DIVE
Oklahoma City, OK 73159
www.UWServicesLLC.com

West Coast

Central Washington Scuba
1715 So. 3rd Ave. #4
Yakima, WA 98903
Ph: 509•452•4006

Dive Commercial International
P.O. Box 70361
Seattle, WA 98107

Nautilus Aquatics
3264 Buskirk Ave
Pleasant Hill, CA 94523
Ph: 925•923•3483

Nautilus Aquatics
3140 Crow Canyon
San Ramon, CA 94583
Ph: 925•275•9005

Omni Divers Underwater Services
5579 Turret Way
Boise, ID 83703-3230
208•345•1990 www.omnidivers.com

Scuba Schools of America
4420 Holt Blvd
Montclair, CA 91763 USA
info@ScubaSchoolsOfAmerica.com

Scuba Schools of America
8099 Indiana Ave
Riverside, CA 92504
info@ScubaSchoolsOfAmerica.com

Technical Instructors

Amphibious Expeditions
Aiken, SC NAUI, IANTD,
NT, ANT, EX, GB, Intro Cave/Cavern
Ph: 803•507•5450 RKeller@exr.com

Bill "Bird" Oestreich
Florida-see Birds Underwater
CV, NT, ANT, TX, IT, EX, GB, AGB
Bird@xtalwind.net U/W Video

Divers Lodge-Hurghada, Red Sea
tek@Divers-Lodge.com
TDI Inst. Trainer in all levels

Ocean Odyssey Dive Center Inc.
Conrad Pfeifer NSS, IANTD
NT, ANT, R, CV Cranberry Township,PA
724•779•6800 conradetss@msn.com

KEY:
NT = Nitrox • **ANT** = Advanced Nitrox
EX = Extended Range • **R** = Rebreather
GB = Gas Blender
AGB = Advanced Gas Blender
TX = Trimix • **IT** = Instructor Trainer
CV = Cave / Cavern

Foreign

Davco Diving
1219 - 3 Ave., Wainwright
Alberta, Canada T9W 1K9
Ph: (780) 842-5559

Sportech Scuba Windsor
3699 Tecumseh Rd E.
Windsor Ontario N8W1H8
www.Sportech.homepage.com

Mayatech P.O. Box397
Playa del Carmen, Q Roo, Mexico
www.cancunsouth.com/mayatech
011-52-987-32046

Torii Beach Scuba Locker
Okinawa, Japan
Fax. 011-81-98-956-4964
E-mail. haglandg@toriitraining.com

Xanadu Undersea Adventures
P.O. Box F-40118 ph: 242-352-3811
Freeport, Grand Bahama
www.XanaduDive.com

Foreign Distributors

Australia, New Zealand, and Pacific Islands
Richard Taylor, TDI Australia
Tel/Fax: +61-(02)-9958-3469

France, Italy, Belgium
Aldo Ferrucci
011-33-6-07272267

Germany, Austria & Switzerland
Underwasser Kleemann
011-49-6062-913-688

Netherlands, Luxemborg & Benelux
Merchant Marine
Alex Koopman ak@merchant-marine.nl
www.merchant-marine.nl

Advertiser Index

Deep Wall Diving

Bay Islands Beach Resort
Roatan, Honduras

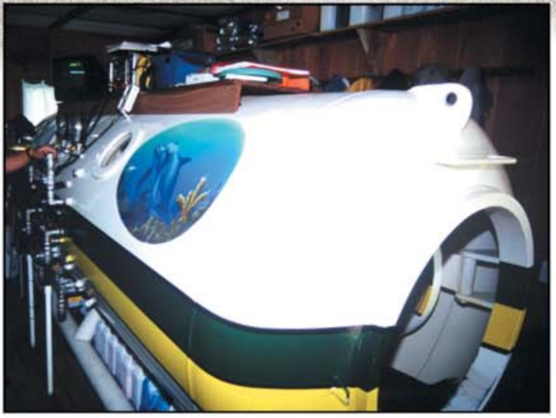
Every October, NAUI Technical Operations and Bay Islands Beach Resort (NAUI Technical Training Center) jointly sponsor two weeks of technical diver training on the island of Roatan, off the coast of Honduras. The setting and facility is idyllic, with helium and oxygen, top side technical diver support, and a 54 inch double lock recompression chamber within a 10 minute boat ride from the deep training sights.

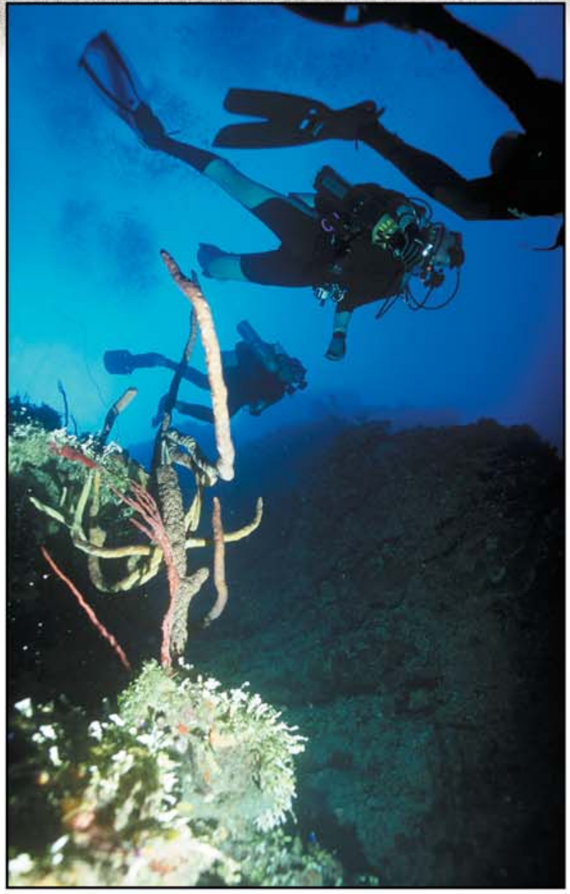
The first week of training was dedicated to technical nitrox, staged decompression, and helitrox (26 % oxygen, 17% helium) training. John Duggan of San Antonio's Duggan Diving conducted this training.

During the second week, attention was placed on deep mixed gas training. The instructors were Tim O'Leary, NAUI Technical Operations and Bruce Wienke, Ph.D., LANL. The deep mixed gas-training week began Saturday night with candidates being briefed on gear configuration, deep stop RGBM tables that had been customized for the week's training, and team assignments. Each team member was required to configure his or her gear the same as those within the entire team. Personal choice was not an option in the team environment. Each dive team was supplied with the customized NAUI RGBM nitrox and trimix tables, by Bruce Wienke, that allowed for the week's exact dive profiles, including repetitive dives, gas mix and switches, NAUI gas management planner, trimix planner, and the trimix team planner.

TECHNICAL DIVER TRAINING CENTER

NAUI TECH OPS DEEP TRAINING FACILITY





Above: A fully staffed hyperbaric chamber is operated 24 hours a day. Located just 10 minutes from Bay Island Beach Resort makes this location perfect for advanced and technical training.

Right: Tec students float along the Roatan wall at 200 feet.

Right Lower: Giant Barrel Sponge clinging to the wall at 225 feet.

Sunday began with breakfast, dive briefings, and team equipment checks. Both dives began in the "classroom," a fifty-foot deep coral canyon with a sand floor and swim through on the north end to a 200-foot wall. All divers performed the following drills on a pass/fail basis:

1. Buoyancy control and trim within 10% of midline.
2. Shutdown failed regulator and isolate for catastrophic gas loss (within 15 sec.).
3. Shut off and switch over to redundant regulator (off 15 sec., on 30 sec.).
4. Gas sharing in mid-water column for a distance of 30 ft.
5. Remove and replace stage cylinder (off in 5 sec, on in 10 sec.).
6. Towing a simulated unconscious diver 30 feet and simulating a rescue ascent.
7. Complete gear exchange between team members.
8. Ascend with reel and lift bag and effect drift decompression (hook-up within 45 sec, full deployment within 90 sec.).

From this point on, each day would end with debriefings, gear cleaning, gas mixing, and staging for the next day's diving. It quickly became obvious that this was not going to be a dive vacation. Instead, it was all about long, labor intense days, with breaks only for dive planning, briefings, debriefings, lectures, Q&A sessions, and, of course, the dives themselves.

Monday's dive was on the spectacular "hole in the wall" on the northwest side of Roatan. The dive teams used 14 % oxygen, 24 % helium mixture, while descending to the second keyway at 170 fsw. Then the teams turned west to look up into deep-water barrel sponges and the gothic architecture of this unique diving site. While the

Left: Bay Islands Beach Resort mascot

Above: View of the Bay Island Beach Resort from their private pier.

Right: Dr. Bruce Wenkie posses for a shot beside a Giant Barrel Sponge.

Above: Dr. Bruce Wenkie posses for a shot beside a Giant Barrel Sponge.

divers were beginning their quest of becoming a disciplined underwater team, the technical support team from Bay Island Beach Resort was busy staging extra oxygen at the 20 fsw stop. On ascent, the teams utilized the sand chute for staging decompression from the keyway through "hole in the wall" and on to the thirty-foot stop, which was on a static line.

Tuesday began with a similar dive into "hole in the wall." Divers descended a little deeper than on the previous day. Evaluators kept watch for controlled descent and ascent rates as well as signals, turn pressures, decompression times, and gas management. The afternoon dive was on the "Eagle," a 600-foot wreck sitting at 110 fsw. The teams used a 26% oxygen mix, with 17% helium and 57% nitrogen. This mix has become known as helitrox and may be used in lieu of nitrox, at depths shallower than 150 fsw.

Wednesday's gas mixture was 16% oxygen, with 40% helium so that both oxygen and nitrogen partial pressures would remain low and the dive could be made well within limits to minimize the risk. Divers descended off the wall, near the "classroom" and continued on to a second wall (that began at 190 fsw), searching for the giant barrel sponges that inhabit these deep waters. Curt Bowen, of Advanced Diver Magazine, found several subjects for his camera within the 200-foot range.

The following morning brought higher seas and more fresh water run off from the jungle mountains than was expected. As the divers descended to the deep wall off of the classroom, the currents picked up. After a dazzling ride along the top of the wall, at around 200 fsw, the divers began their ascent to decompress. During the static decompression, the current accelerated to about a knot and a half, carrying the team over a kaleidoscope of coral reef life.

Technical diver training can be an exhilarating series of learning experiences for all participants, but great care must be taken to insure that all potential risks are reduced. The divers must be dedicated, proper decompression tables must be used, and should the need arrive, a recompression chamber needs to be nearby and available.

NAUI Worldwide has a complete array of RGBM phase model tables that include air, nitrox, constant ppO2, trimix, saturation diving, surface decompression on oxygen, heliox, and altitude tables. For further information contact:

NAUI Technical Training Operations at 956-761-7986 or nauitec@aol.com.

Below: Divers follow a sand chute upwards as they complete their required decompression stops. This makes for entertaining decompression by allowing divers to look around at the reef as they off gas.

DISCOVERY OF LAKE HURON'S ELUSIVE WEXFORD?

By: Steve Lewis

It is mid August. The news is that a group of wreck hunters out of Goderich, Ontario has found the Wexford, one of the most elusive shipwrecks from the Great Storm of 1913, and one of the enduring mysteries of the Great Lakes.

In her time the Wexford was considered to be a big ship: 250 feet long, 2,104 tons, a steel-hulled, ocean-going freighter with her bridge and crew's quarters amidships. On the morning of Sunday, November 11, 1913, loaded with grain and steel rails, she was sighted by the captain of the steamer Kaministiquis about 15 miles north of Point Clark, which would put her close to Goderich. But the Wexford and her crew of 23 did not make harbor. A short while after the five-day storm had died down, masts were sighted three miles south of the town of Goderich. The local newspapers pegged the wreck lying below the lake as being the Wexford. This belief about the ill-fated ship was reinforced after the discovery of several bodies wearing life preservers on a nearby beach. At that point a chapter of the Wexford's mysterious disappearance was closed.

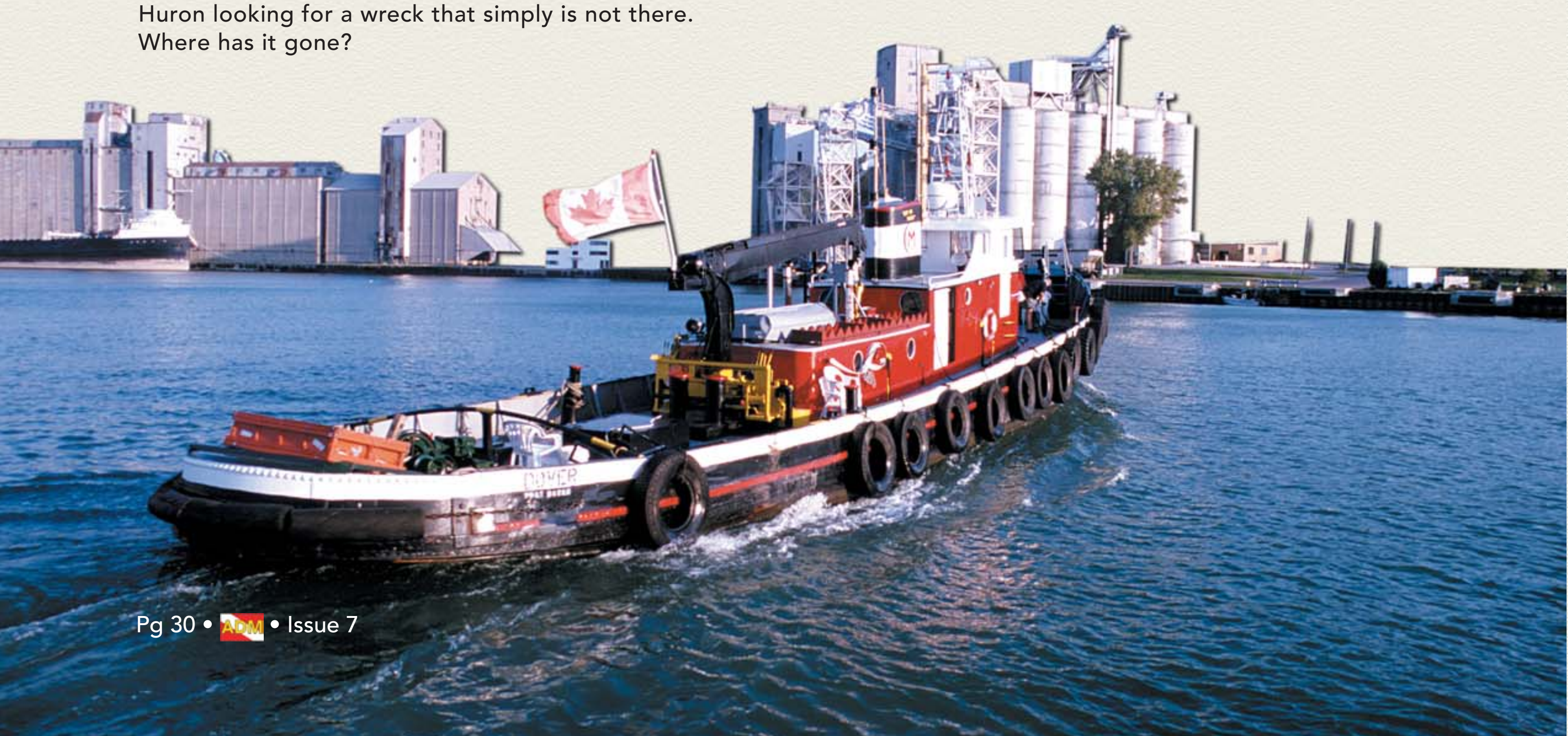
Moving along in time to the mid 1990s, a series of puzzling events seemed to have captured the interest of the public again. Strangely, the Wexford has seemed to disappear again! Two local marine history buffs, Bob Carey and Don Chalmers are among the dozens of wreck hunters who spend countless hours running systematic search patterns across a large area of southern Lake Huron looking for a wreck that simply is not there. Where has it gone?

Five years pass. Carey is now chairman of the Goderich Marine Heritage Committee, a loose but highly focused amalgam of local politicians, city bureaucrats, and wreck divers. Their goal is to turn Goderich, a beautiful tourist town, known for its hiking trails, antique shops, and Sifto salt mine, into a destination for sport divers from across the Great Lakes basin. Finding the elusive Wexford takes on a very high priority.

With the help of money raised, Carey's committee hires wreck sleuth Dave Trotter to bring his boat and side-scan over from the States and help the cause. Trotter has been discovering Great Lakes wrecks for years. The general sense is that if anyone can find the wreck, Trotter can.

Committee co-chair Paul Carrol joined Trotter for the hunt mid-August and everything was looking good.

Don Chalmers went fishing in his 26-foot boat Odysseus to a locale about eight miles offshore, on route to Grand Bend. On August 15, about sixteen miles south of Goderich, in less than 80 feet of water, Chalmer's salmon rig hit something big, way too big to be a fish. The news first hit the internet, then it hit the Toronto and Ontario papers a few days later. One of the headlines reads: The Wexford, the Holy Grail of Huron Wrecks, Is Found.



To check things out, a few rough survey dives are done. It seems the mystery wreck fits the Wexford's description perfectly. How did she move 12 miles south during her 87 years under Canadian waters?

In September, the Heritage Committee invited a group of professionals to board a special charter to view the wreck. More than two dozen divers, underwater photographers, videographers, and wreck surveyors are on hand to see the wreck for themselves. Local newspapers, the city's mayor, members of local council, and the heads of ACUC meet the group. Photos are taken, special information packages are distributed, and the wind is moving at 35 knots. The Canadian Coast Guard tells the group that they are welcome to venture out of the harbor, but they intend to put their feet up and relax. Even the large working tugs in the deep-water harbor are moving around in a disturbing way. Our captain calls the dive and we decide to try again in two weeks.

In late September the group assembles on the dock again. They load the boat and head out of the harbor. Things are looking great until they take a few large parcels of water over the bow. Once again, they turn around and wonder if the Wexford just isn't ready for visitors.

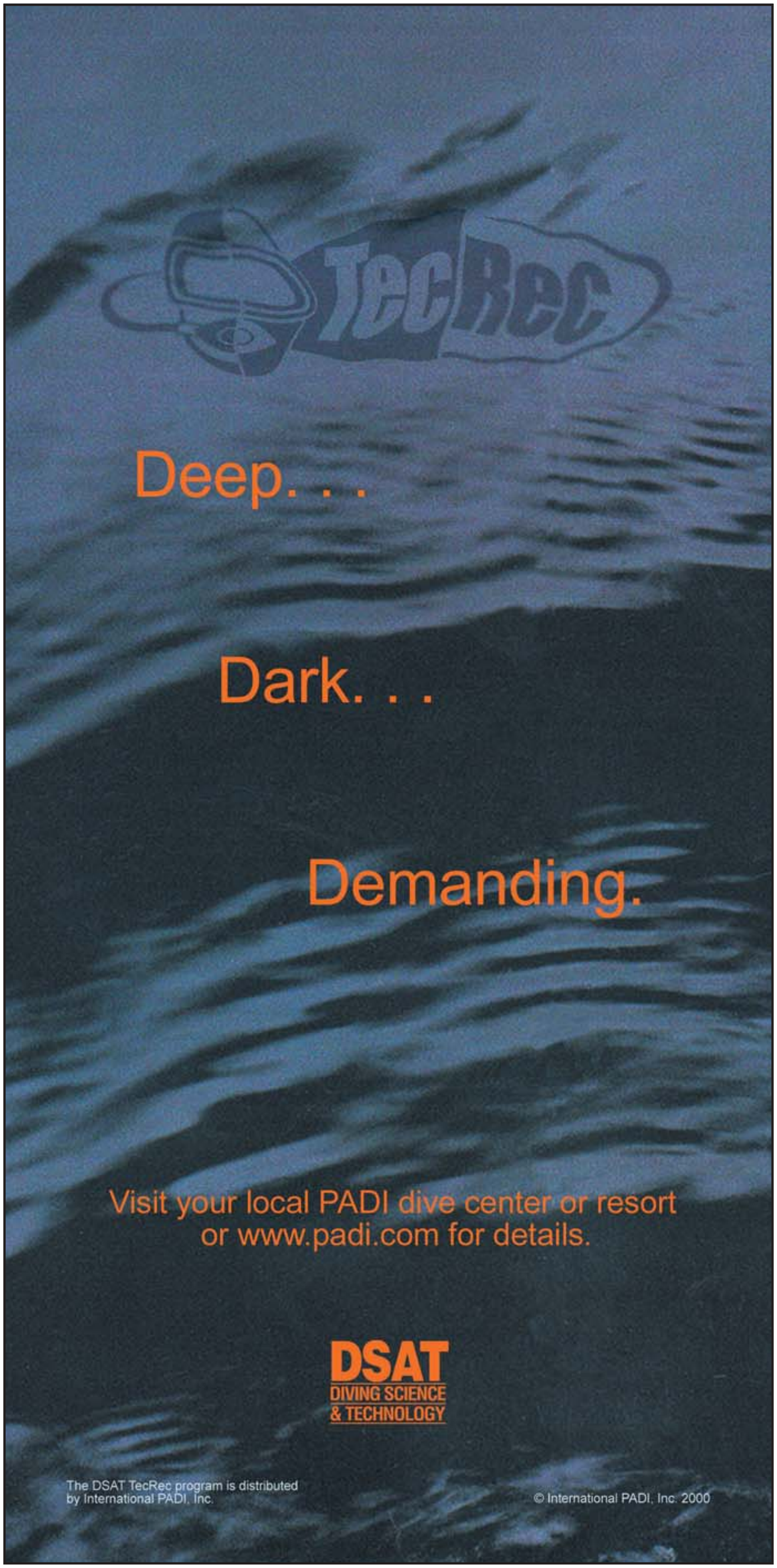
The next day they give it a go. At this point, the roster has diminished and there are just over a dozen divers aboard. My seven-person survey crew is reduced to photographer, Thaddius Bedford; wreck videographer, Terry Irvine; and myself.

We drop into the choppy waters and down to the wreck below. My first impression is that this wreck is not virgin. She is far more intact than many other wrecks on either side of the border. However, it seems obvious that she has been salvaged at some point. There are still many small artifacts (protected under Ontario's law), including tools and gauges in the engine room and personal effects like a shaving mug, plates, medicine bottles, and so on. Yet, several clues point to a salvage operation, including some suspicious damage to the forepeak deck and missing machinery.

We shoot more than an hour of video, a roll of film, and add to the rough survey work already completed by an earlier dive by a team from London, Ontario. Thaddius, Terry, and I spend more than 90 minutes on the bottom breathing EAN38, and have a chance to get close and personal with the 250-foot wreck. Still, try as we might, we see nothing to conclusively say the wreck we are on is in fact the Wexford, and perhaps, that 1913 newspaper article can be explained by something as simple as a typesetting error.

Something that might settle the mystery once and for all is a "Zebracide" project due to start in the late autumn. A small group of divers under the direction of the Goderich Marine Heritage Committee, and with the blessing of Ontario's Heritage Ministry will cover a large section of the wreck's bow with tarpaulin. Left in place over the winter, it is hoped this will kill off the underlying zebra mussels and in the spring, when the tarp is removed, it will reveal bare metal and the name Wexford painted on the vessel's bow. We shall wait and see. ADM

To Dive the Wexford Contact:
murphyco@cgocable.net


TecRec
Deep. . .
Dark. . .
Demanding.
Visit your local PADI dive center or resort
or www.padi.com for details.
DSAT
DIVING SCIENCE
& TECHNOLOGY
The DSAT TecRec program is distributed
by International PADI, Inc.
© International PADI, Inc. 2000


A Technical Diving Tool Kit for the 21st Century
NATIONAL SPELEOLOGICAL SOCIETY
NSS
CAVE DIVING SECTION
2001
Lake City, Florida
May 25th-27th
www.caves.org/section/cds
CAVE DIVING
WORKSHOP

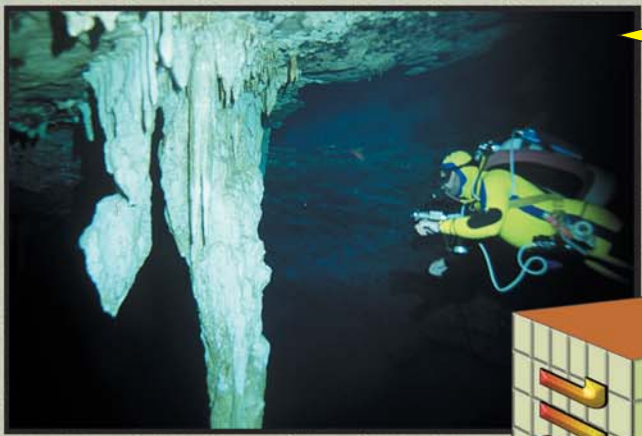
Cave Explorations New Frontier

BRAZIL BONITO

By Curt Bowen

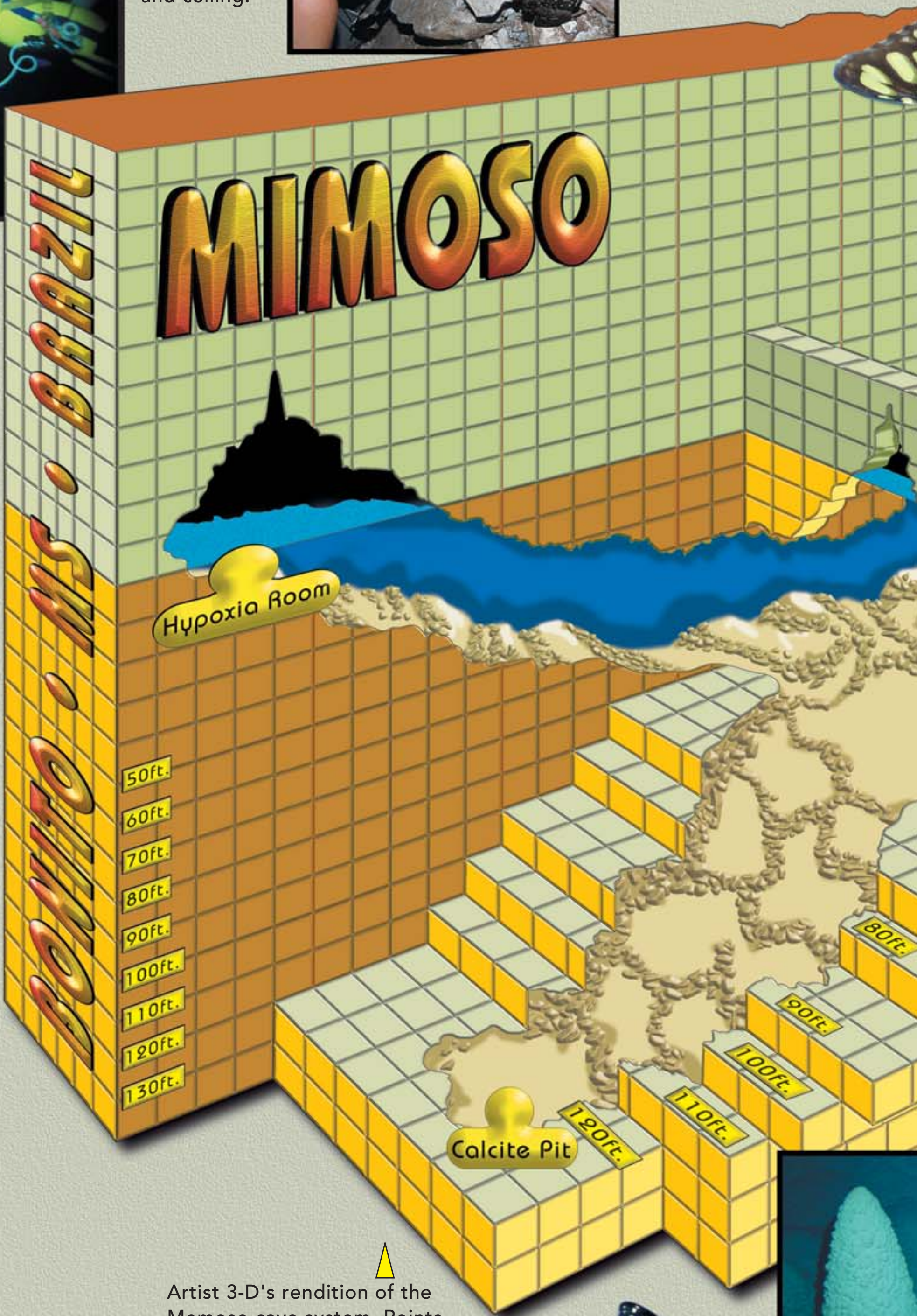
Photos & Illustrations: C. Bowen

Making my way down the steep rock pile towards the water's edge of Mimoso cave, my light drives back the darkness to reveal a coliseum filled with some of Mother Nature's finest works of art. Cobalt blue water fills the bottom of this immense room as the ceiling towers up into the darkness.

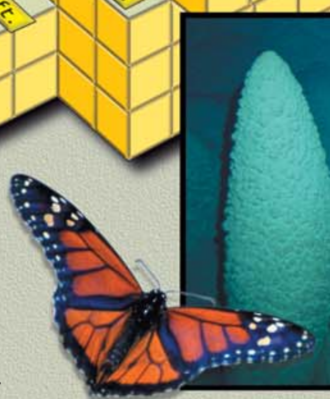


Mimoso cave has several large flowstone formations on its walls and ceiling.

Unique giant toads inhabit the cavern zone in Mimoso cave along with bats and very scary insects.



Artist 3-D's rendition of the Memoso cave system. Points of interest include the large cavern zone, impressive flowstone formations, the large Cone Room, and the Hypoxic room, where the oxygen levels are at dangerously decreased levels. When visiting these dry chambers it is important that the diver always continue to breath from his/her dive cylinders.



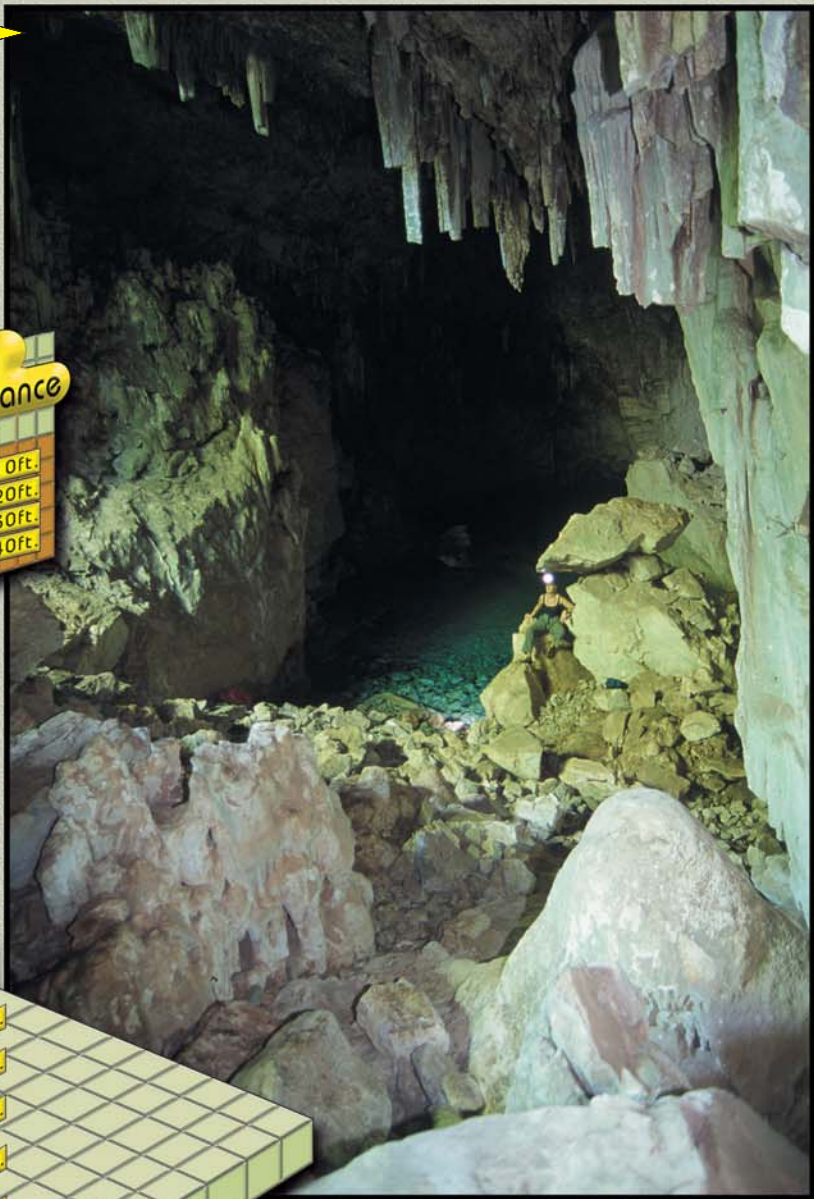
Slowly the dive team reaches the water's edge, toting bits and pieces of their dive and photography equipment. Several more trips by each diver and hired sherpas will be all that is needed before all of our equipment is in place.

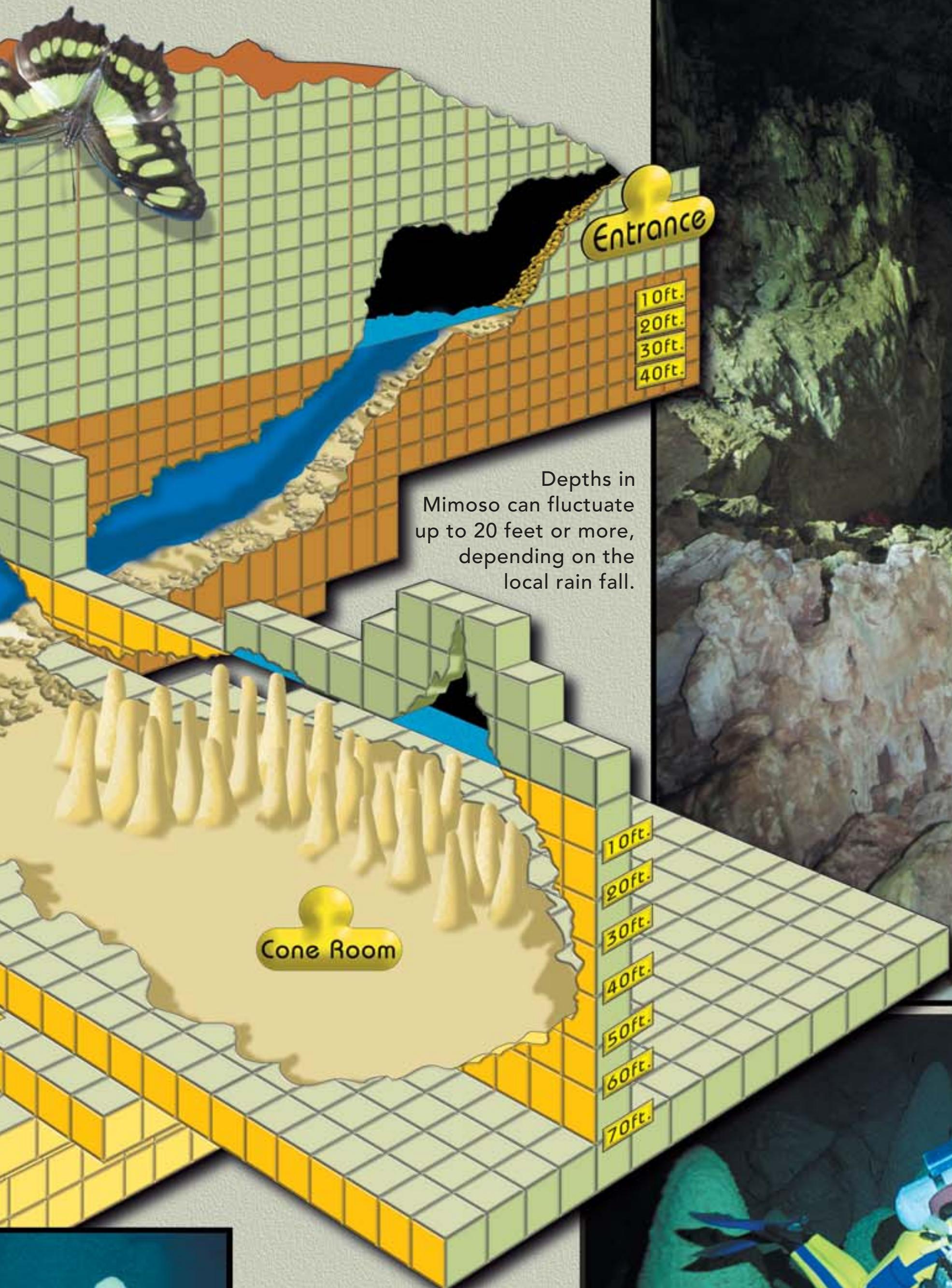
It is refreshingly cool inside the cave as compared to the hot Brazilian sun, now beating upon our vehicles outside the cave entrance.

Gearing up, we slip shoulder deep into the gin clear water (75 degrees) for a quick dive briefing and equipment check. Crossing over a small sand hump, we drop below the water's surface and into an immense tunnel filled with bone white walls and impressive flow stones reaching down from the ceiling. The cave line directs us to the place we have traveled such a distance to see. We turn to the left and descend a sloping bank. Giant pillars of white rock appear into view. These pillars were formed during dry periods. The calcite dissolves from the marble ceilings and drips just one drop at a time, taking millenniums for the pillars to form. These sculptures of Mother Nature tower over 30 to 50 feet high from their base and can be over 10 feet in diameter. No where else in the world do these formations exist underwater, making these southern Brazilian caves unique and a must see by serious cave explorers.

Exploring the rest of Mimoso cave reveals several dry chambers farther back in the system. When visiting these dry air chambers, it is important to continue to breathe the gas from your cylinders since the oxygen content is dangerously low and could cause a working cave diver to pass out.

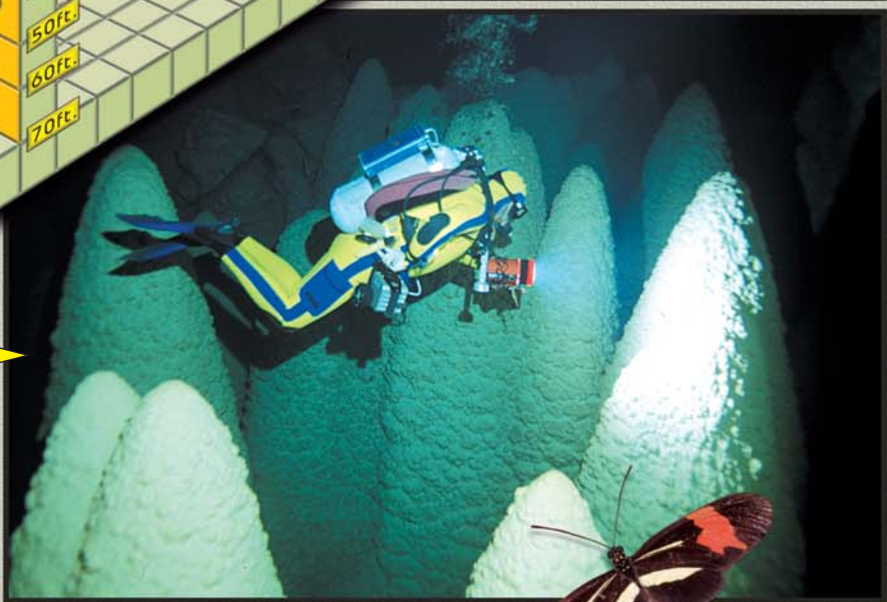
Large cavern zone in Memoso cave creates a challenging obstacle to transporting equipment to the water's surface. Multiple slave strobes are used to illuminate the extremely large cave, creating this unique image.



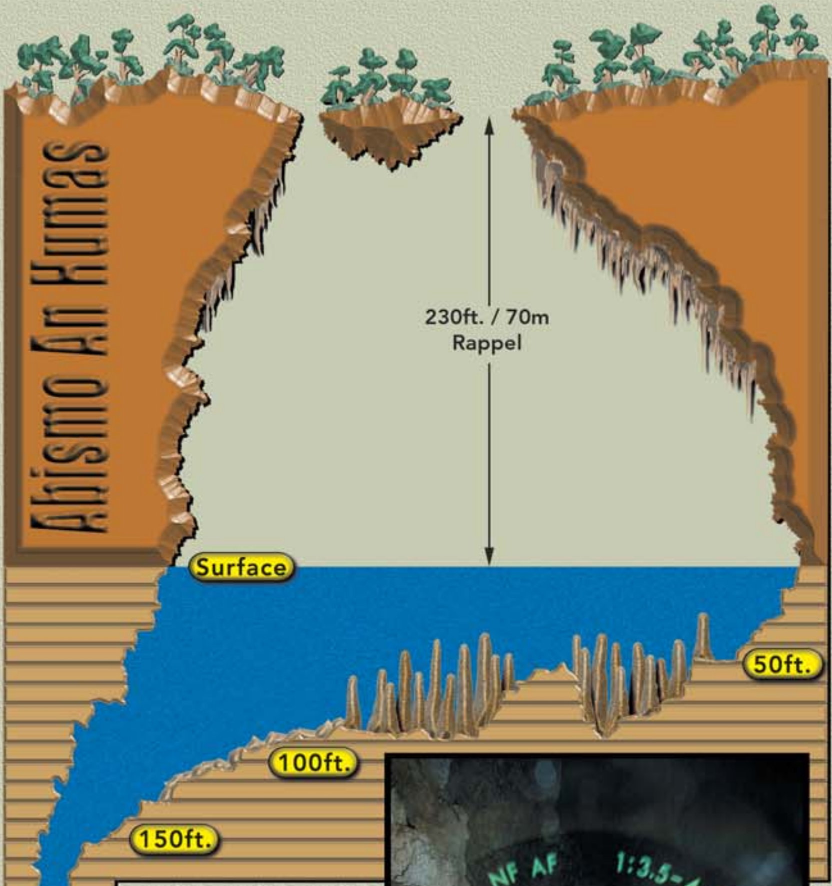


Depths in Mimoso can fluctuate up to 20 feet or more, depending on the local rain fall.

Located at a depth of 50 to 80 feet, these large calcite cones are unique to the caves in the Bonito area. Formed over millions of years, some of these cones reach heights of over 50 feet tall and several meters wide at their base. Explorer Jeff Bozanic assists in illuminating the Cone Room with a ikelite 400 watt slave strobe.



Photos & Illustrations: C. Bowen



Above: Cutaway view of the Abismo An Humas cave system. A 230 ft. repel from the entrance to the waters surface is required to gain access.
Right: Diver Jeff Bozanic, assisted by sherpas gears up for an exploration dive into Abismo.

Abysmo An Humas: (above)

Located high in the hills, this giant pit drops through a small crack on the surface to over 230 feet to the water's surface. A local company provides ropes, harnesses, and climbing ascenders for the drop into the pit and more importantly, the exit out.

Hooking onto the dynamic rope, the diver will slide 20 feet down through some tight restrictions and through the cave's ceiling. The immense room opens up leaving the diver hanging in open space, 200 feet from the water. A small wooden dock has been constructed for a divers base and tenders busy themselves with lowering and raising dive equipment. Once having reached the dock, it is possible to climb up onto a rock ledge to work on your camera or video equipment.

The water in this cave is several degrees cooler (65 degrees) than the surrounding systems. Sloping from the left wall down to the right, the room's floor is covered with giant calcite cones. Several skeletons of unfortunate animals can be found on the cave floor after they had obviously fallen into the pit. Ducking under the right wall of the cave, the bottom drops into a giant crevasse. This pit's depth has been recorded to over 260 feet and still descending.

After the dive and a short rest, the equipment is hauled to the surface, Then it's time for the long 30 minute plus self climb with the use ascenders to exit the cave. It's a good idea, to practice climbing skills prior to this dive.

Ceita Core: (not shown)

A small crystal clear spring flows into a pond located on a beautiful Brazilian cattle ranch. A 4-foot diameter entrance drops into a small room, where hundreds of catfish and small colorful fish hide in the shadows. At 15 feet, a restricted tunnel, just large enough to squeeze through with doubles, goes down for 30 feet until it opens on the top of a giant fisher crack. The crack is narrow, normally 3 to 15-feet but very wide, 50 to over 100 feet. The pit drops straight down to 265 feet then separates into two tunnels that bypass a breakdown pile. At a depth of over 350 feet, the two tunnels join back together. The visibility in this system is always over 100 feet and there is a nice blue mineral color to the water. To date, this cave has been explored by a Brazilian deep cave explorer to almost 500 feet deep, where it is said to clamp down too tight for any further exploration.

FORMOSO CAVE SYSTEM

Gustavo Sallum & Larry Cohen gear up for a dive into Formoso cave system which is known for attracting thousands of tropical butterflies.

Formoso and Formosinho:

Different than the other local systems, Formoso Cave resembles more like a typical North Florida high-flow cave. While rigging up equipment the diver will be pleasantly tormented by thousands of muti-colored butterflies, which visit this spring daily. Formoso's water visibility (20 to 100 ft.) is directly effected by the amount of local rainfall. The cave passage is typically 10'x10', with an occasional slight restriction. The walls are dark gray in color with sharp rocky edges, great for pull and glide techniques. A permanent line follows the main tunnel, with few off shooting gaps. swimming less than 20 minutes into the cave, it quickly gets deep as it twists and turns. Coming to a major junction at a penetration of 793 feet from the Formoso entrance, the main passage from spring Formosinho entrance joins in. Turning to the left, the main tunnel enlarges and quickly drops to an explored depth of over 280 feet.

The Bonito area offers other interesting sites to visit, such as beautiful waterfalls, crystal clear rivers, and an array of unique wildlife to the region. ADM

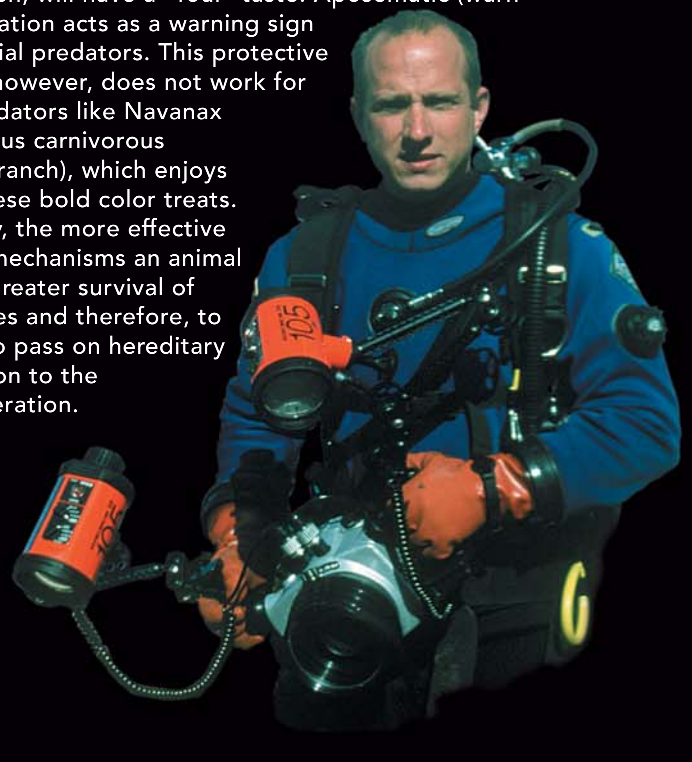
NUDIBRANCHS

By: William M. Mercadante

As opposed to land snails and slugs (subclass Pulmonata), nudibranchs (subclass Opistho branchs), commonly called "sea slugs," are among the most beautiful and colorful mollusks found only in marine habitats. Two extremes of coloration are demonstrated: animals that purposely stand out due to their outlandish bold coloration and animals that appear almost invisible within their surroundings as a result of camouflage of color, form, and / or texture.

Insight as to why the nudibranchs display these two extremes in coloration can be gained from their ancestors. Opisthobranchia belongs to the class of animals known as Gastropods "stomach foot" in the phylum Mollusca. Most Mollusca, including the Prosobranchs (typical marine snails), possess external shells. In terms of evolution, there has been selection towards internalization and reduction, or complete loss of this external shell in the Opisthobranchs (hence the common nudibranch name "naked gills"). A great evolutionary saving of energy is realized when construction of a calcified shell does not need to be formed. The protection from having an external shell was replaced by other methods of protection. The Opisthobranchs' solution to this problem was by having protective coloration. It is easy to comprehend how a camouflaged animal benefits from blending in with its surroundings. Cryptic coloration is the term applied to this defensive mechanism.

Some species blend in with a disruptive background, or they may resemble a feature of the substrate itself. Less easy to understand is the second mode of protective cryptic coloration, which is when the specie purposely stands out from its surroundings. The wild, bright, bold coloration in animals is usually indicative of a poisonous species (eg. Coral snakes), or of a species that when eaten, will have a "foul" taste. Aposematic (warning) coloration acts as a warning sign to potential predators. This protective scheme, however, does not work for some predators like Navanax (a voracious carnivorous Opisthobranch), which enjoys eating these bold color treats. Obviously, the more effective defense mechanisms an animal has, the greater survival of the species and therefore, to be able to pass on hereditary information to the next generation.



Besides coloration, many Opisthobranchs emit toxic chemicals like sulfuric acid or contain stinging cells (nematocysts) that are incorporated from their food source. Movement in most Opisthobranchs is generally conducted by coordinated motion of cilia on the ventral surface of the foot. However, some members have the capability of swimming. The only other mollusks capable of this feat are the squid and octopus, which have also lost their cumbersome external shell.

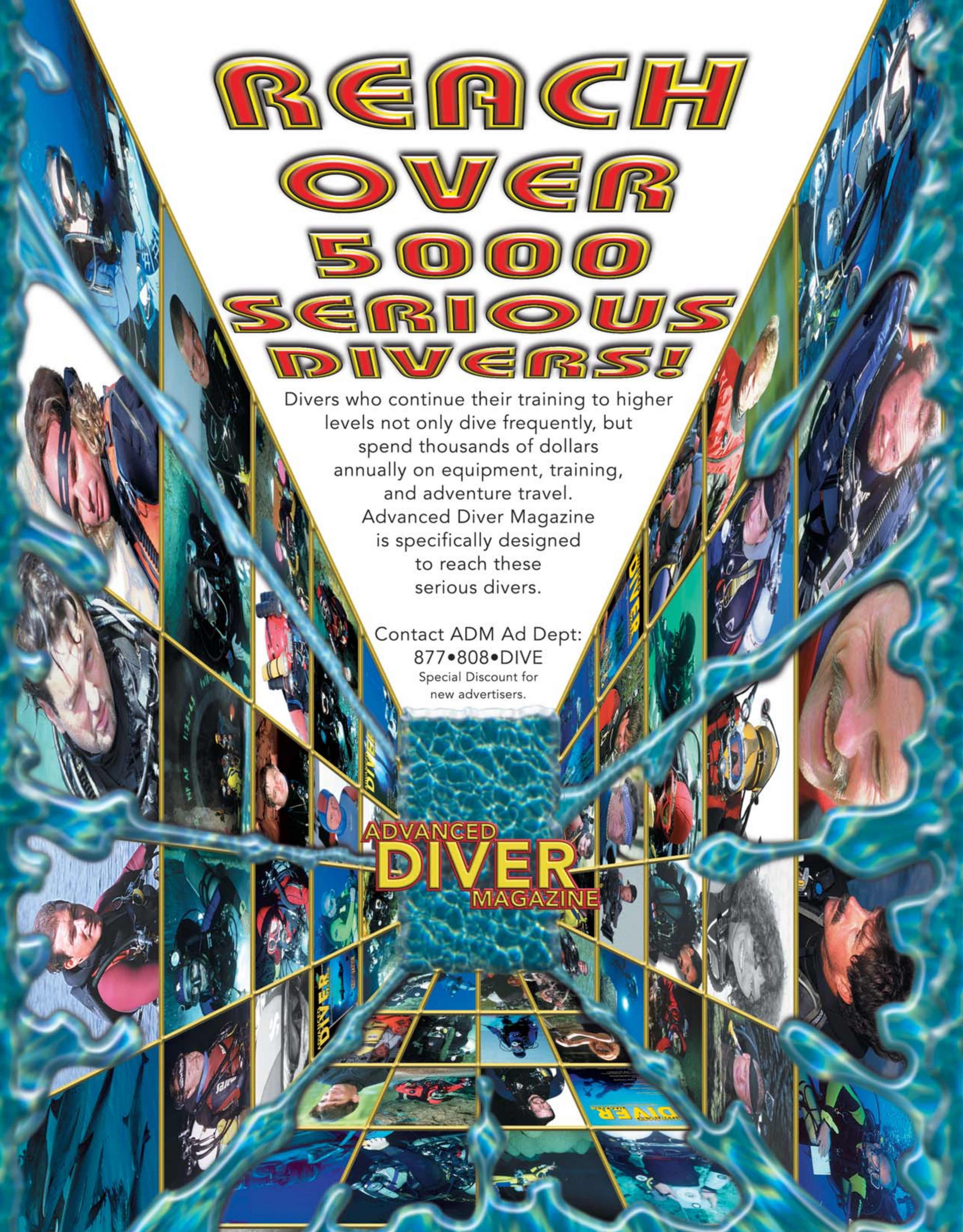
Another difference between the Prosobranchs (typical marine snails) and Opisthobranchs is that the later are hermaphroditic, as opposed to having separate sexes. The benefit of being hermaphroditic is that any encounter made with another individual of the same species can result in an exchange of genetic material. Even though each individual has both male and female sex organs, self-fertilization has only been observed in two species. As with any rule in nature there are always exceptions, and some Opisthobranchs are not strict hermaphrodites. Rather they start out as male when they are young and become females when mature. The egg masses that are produced as a result of copulation are characteristic in color, size, shape and distribution, whose measures can be used in identification and classification. Just one spawn may result in up to a million eggs being produced. Hatching times are temperature dependent and may take up to two months. In warmer waters hatching times tend to be shorter in duration due to the resulting increase in metabolic function and development rate with increased temperature. Also, the size of an individual is directly proportionate to the number of eggs that an individual can produce. Large individuals produce large numbers of eggs whereas, smaller individuals generate fewer eggs.

Since most nudibranchs are sessile, the animal's redistribution to new locations is most likely to occur when planktonic embryos hatch and are carried away from their nursery substrate into the water column by currents. Settling of the larval form will not occur until a suitable substrate is located. At this time metamorphosis into the adult form will occur.

As far as diet is concerned, Opisthobranchs are herbivorous, carnivorous, or parasitic and usually feed upon a single species of plant or animal. Just like their "land cousins," they possess a scraping organ known as a radula, which consists of a ribbon of teeth. Growth of radular teeth can be extremely rapid and up to five rows of teeth may be added on a daily basis. The pattern and distribution of the individual chitinous teeth (up to 75,000 in some species) are used in identification of different nudibranch species. However, as always, variability exists so this trait should be used in combination with other physical features for positive species recognition. Just like the beak shape in birds, the teeth that comprise the radula function to effectively enable feeding on a specific substance or prey. A set of jaws is also sometimes found anterior to the radula.

An Opisthobranch monitors its environment in the search for food and suitable substrate with a major sensory organ known as the osphradium. This highly folded structure (folds increase surface area) is bathed in water currents and determination of the water's chemical composition is performed there. Some of the less primitive Opisthobranchs have sensory mounds, oral tentacles or horn-like appendages called rhinophores. The shape and color of the rhinophores is yet another species-dependent characteristic that can be used for taxonomic determinations. The exact function of the rhinophores is not known; however, scientists believe they are used to find food and/or a mate. There does not seem to be a difference in tissue structure of the rhinophore compared to the body's tissue composition, except that secretory glands are absent.

Continued on Page 47


REACH
OVER
5000
SERIOUS
DIVERS!
Divers who continue their training to higher levels not only dive frequently, but spend thousands of dollars annually on equipment, training, and adventure travel.
Advanced Diver Magazine is specifically designed to reach these serious divers.
Contact ADM Ad Dept:
877•808•DIVE
Special Discount for new advertisers.
ADVANCED
DIVER
MAGAZINE


SeaVision®
From TEC to REC
Bridging the Gap in Lens Technology
Color Correcting
"Shooter"
Intensifies Light
• RX Includes Correction for Astigmatism
• Custom Ground Lenses
• Single Vision / Bifocal
• Gauge Reader®
• 100% UV Protection
• 48 Hour Delivery Available
• No Bonding or Gluing
Phone 1•800•732•6275 Fax 1•800•659•0284
Web Site www.SeaVisionUSA.com


Sea Dwellers of New Jersey
Wreck Diving Charters
for all certification levels
• Nitrox, Tech Nitrox & Trimix Instructor Training
• Manufacturers of Custom Dive Equipment
• Experts in Oxygen Cleaning & Service
• Advanced Wreck Diving
TECHNICAL DIVER TRAINING CENTER
TECHNICAL DIVING INTERNATIONAL
Career Development Center
132A Broadway, Hillsdale, NJ 07642 Ph: 201•358•0009 Fx: 201•358•1519
800•861•0009 www.seadwellersnj.com

GAINING ACCESS

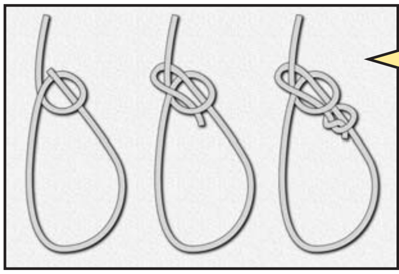
By: Curt Bowen

PART I

I have a saying, "The harder it is to get to, the better the adventure." It may not seem like it while packing through the jungle, getting bit by every known insect and sweating like a drunken driver at a DUI checkpoint. Yet, after the adventure, sitting in a cool pub, sipping a cold long neck with those adventure buddies, the stories alone seem to make the whole thing worth the while.

The major obstacle exploring new frontiers is not only reaching the site, but rather, getting into the site. Not all sites can be easily accessed. In fact, some can be more of a challenge getting in and out then the dive itself. There are some basics for repelling and lowering of divers and equipment.

A skilled rigger does not need to know a vast variety of knots. In fact, it is better to be more proficient with just a few of the more important knots. This will help insure that the knots will be tied correctly each time, preventing a possible accident. The three basic knots (bowline, figure eight on a bite, and a double figure eight) described here are all a good rigger may need to know.



Bowline with a safety

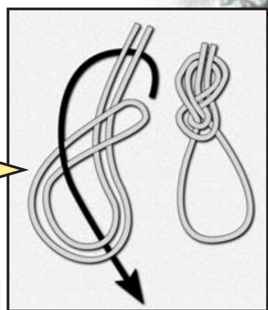
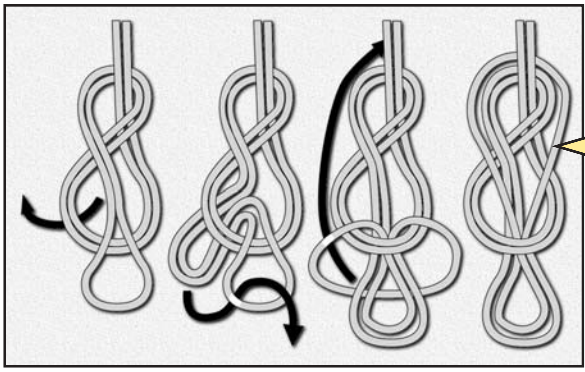


Figure Eight on a Bite



Double Figure Eight

Part One
Lowering of Equipment and Personnel

Part Two
Retrieving Equipment and Personnel

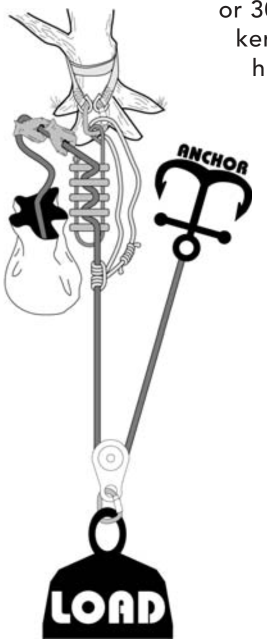
Part Three
Gas Blending in the Jungle

Selection of the proper rope is of utmost importance when the potential of human injury is involved. Only two types of rope should be considered.

High-Stretch Kernmantle (dynamic), which has a high-strength inner core allowing the rope to stretch when shock loaded. This will lessen the shock absorbed by the climber, anchors and knots in the system. The only downfall of this type of rope is its poor abrasion resistance on hard surfaces.

Low-Stretch Kernmantle (static) sacrifices stretch for superior strength and abrasion resistance. Low-stretch kermantle is used by most emergency rescue units. Its main down fall is the possibility of sever shock loads placed on the climber, anchors and knots in the system if a fall should occur.

All ropes used as life safety lines should have at least a 1/10 breaking strength, with a 1/15 recommended. Example: A diver who weighs 200 pounds would require the minimum rope strength of 2000 lbs. (1/10) or 3000 lbs. (1/15) to insure safety. Most kermantal life safety ropes have a much higher manufacturer's strength rating.



Lowering and raising of divers and equipment is much safer than allowing the inexperienced to rappel or climb with unfamiliar equipment. Simple mistakes can cause serious complications.

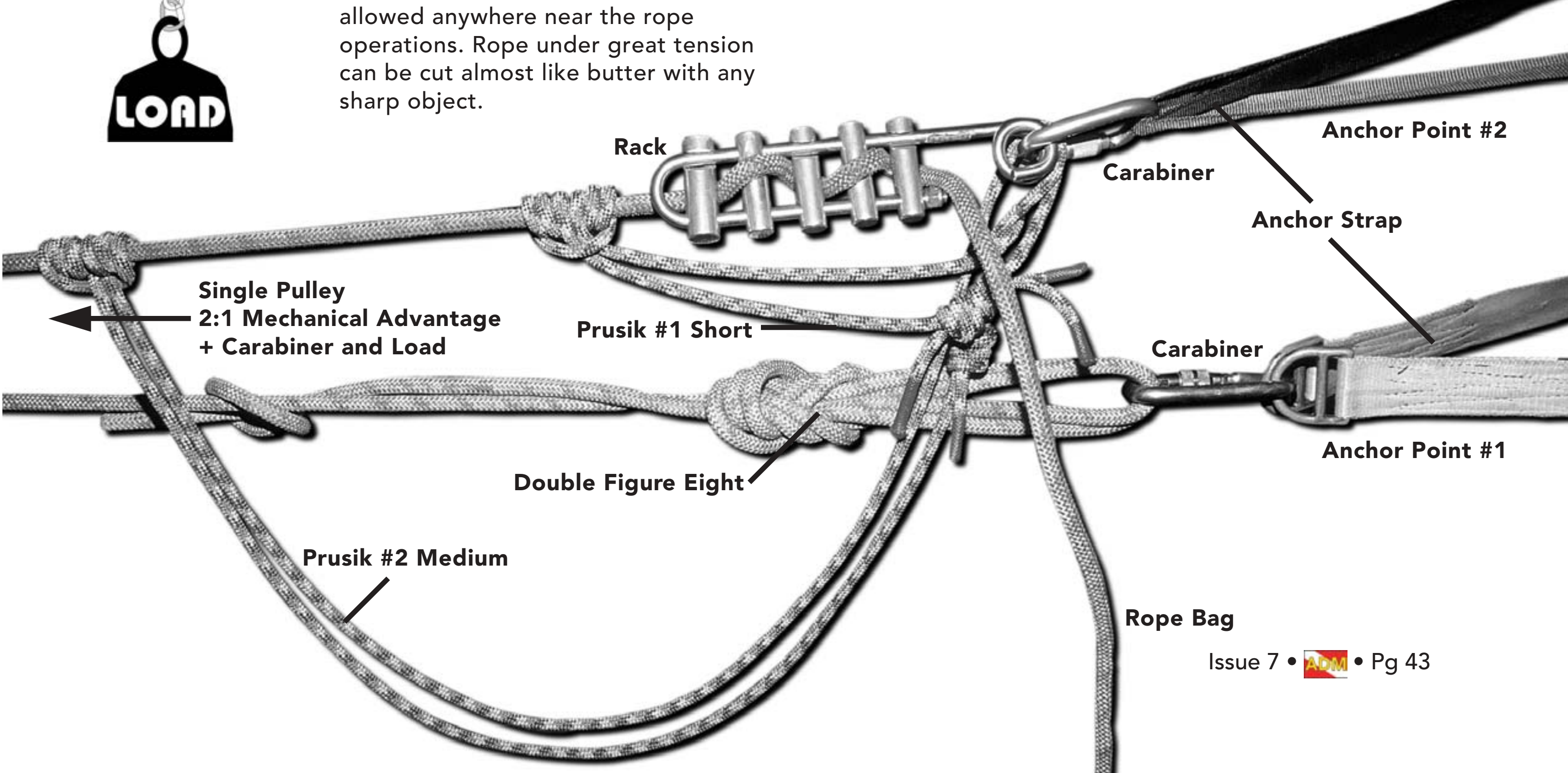
Safety is of utmost importance while ropes are under tension. One person should be appointed in charge (rope master) of the whole operation. Absolutely no sharp objects such as knives, machetes, etc. should be allowed anywhere near the rope operations. Rope under great tension can be cut almost like butter with any sharp object.

Minimum Equipment needed for lowering divers and their equipment:
2 - 150 to 200 ft. sections of life safety rope
5 - Assorted length Prusik's
1 - Rack
6 - Locking Carabiners
2 - Anchor Straps
2 - Seat Harnesses
Assorted Edge protection
Duct Tape
Large Mesh Bag

Anchor: The anchor is the starting point from which all stress and weight is applied. Natural anchors can be large tree trunks, boulder, building structures, truck frames, etc. The anchor should be much stronger than the rope, with the absolute certainty that it will not move or break.

Anchor Strap: An 8-15 ft. 10,000+ lbs., 2-in. webbing with end D-rings. It is used to wrap the anchor securely and attach the rack and prusik cords.

Below: This illustration demonstrates the proper rigging for lowering equipment and personnel with a 2:1 mechanical advantage figured in. Two anchor straps are secured to a solid base. A double figure eight is attached to anchor point #1 and a pulley is placed on the line as a 2:1 mechanical advantage. The load is attached to the pulley with a locking carabiner. A rack is attached to anchor point #2, and the long end of the line is woven through the rack. Two prusiks are attached to the line just in front of the rack for safety and secured into the carabiner at anchor point #2. Edge protection is placed, if needed.



Locking Carabiners: Aluminum or steel, carabiners are used to attach pieces of equipment or personnel together. Only locking carabiners should be used when personnel are involved.

Rack: Device used to cause friction in the line while weight is applied. Proper use of a rack will allow one person to lower or stop several hundred pounds with ease.

Prusik Cords: High strength, smaller diameter line tied into a loop. Used as a soft rope grab, shock absorbers in the case of a fall, and equipment tie lines. An assortment of lengths and sizes are required. One can never seem to have enough prusiks available.

Edge Protection: When sliding a rope over any hard or sharp surface, edge protection should be used to help prevent damage to the rope. Edge protection can range from professional rollers to old Mexican blankets folded together and duct taped to the edge. Anything that will prevent rope damage or burning will work.

Rappelling Harness: Coming in all different shapes, sizes, and price ranges a seat harness is one of the most important pieces of climbing equipment. Proper fit and comfort is of utmost importance when considering a harness purchase.

Large Mess Bag: Used to lower loose equipment such as mask, reels, fins, etc. to the water.

When lowering, one person keeps the prusiks loose, while the tender slides the line through the rack. If a problem should occur, the tender can stop the line by pulling the rope back tightly into the rack. If the tender should accidentally drop the rope or the rack should break, the prusik lines will grab the line, stopping the whole process.

Part Two of Jungle Mix will cover how to raise equipment and personnel with the use of mechanical advantages and climbing ascenders. See Issue #8

OXYGEN MANAGEMENT

MATHEMATICAL COMPUTATIONS

By: Dr. Bruce Wienke

Decompression sickness could be avoided by breathing just pure oxygen. And the usage of higher concentrations of oxygen in breathing mixtures not only facilitates metabolic function, but also aids in the washout of inert gases such as nitrogen and helium. Despite the beneficial effects of breathing oxygen at higher concentrations, oxygen proves to be toxic in excessive amounts, and over cumulative time intervals. Too little oxygen is equally detrimental to the diver. As practised, limits to oxygen partial pressures in breathing mixtures range, 0.16 atm to 1.6 atm, roughly, but symptoms of hypoxia and hyperoxia are dose dependent. Or, in other words, symptom occurrences depend on oxygen partial pressures and exposure times, just like inert gas decompression sickness. The mixed gas diver needs to pay attention not only to helium and nitrogen in staged decompression, but also cumulative oxygen exposure over the dive, and possible underexposure on oxygen depleted breathing mixtures.

The neurotoxic actions of high pressure oxygen are thought to relate directly to biochemical oxidation of enzymes, either those linked to membrane permeability or metabolic pathways. The list below is not exhaustive, but includes the following mechanisms:

1. The inability of blood to remove carbon dioxide from tissue when hemoglobin is oxygen saturated.
2. Inhibition of enzymes and coenzymes by lipid peroxides.
3. Increased concentration of chemical free radicals which attack cells.
4. Oxidation of membranes and structural deterioration reducing electrical permeability for neuron activation.
5. Direct oxygen attack on smooth muscle fibres.
6. Oxygen induced vasoconstriction in arterioles.
7. Elevation of brain temperature due to lack of replacement of oxygen by carbon dioxide in hemoglobin.
8. And, simple chemical kinetic redistribution of cellular carbon dioxide and oxygen with high surrounding oxygen tensions.

Fortunately for the diver, there are ways to avoid complications of hyperoxia. Careful attention to dose (depth-time) limitations for oxygen exposures is needed.

Despite the multiplicity and complexity of the above, limits for safe oxygen exposure are reasonably denied.

Table 1 below lists NOAA CNS oxygen exposure time limits, t_χ, for corresponding oxygen partial pressures, pO2. Below 0.5atm, oxygen toxicity (CNS or pulmonary) is not really a problem.

Figure 1 depicts these oxygen partial pressure limits for pulmonary and neurological toxicity manifestations, suggested by the US Navy and Lambertsen. Recent working NOAA limits, tabulate by Table 1, track closely.

Table 1. Oxygen Dose-Time Limits

Oxygen partial pressure pO2 (atm)	Oxygen time limit tx (min)	Oxygen tolerance (OTU) (min)
1.6	45	87
1.5	120	213
1.4	150	244
1.3	180	266
1.2	210	278
1.1	240	279
1.0	300	300
0.9	360	299
0.8	450	295
0.7	570	266
0.6	720	189

The CNS data in Table 1 is easily fitted to a dose time curve, using least squares, yielding,

$$t_x = \exp\left[\frac{3.0 - PO_2}{.36}\right] = 4160\left(-2.77\ PO_2\right) \quad \text{fig 1}$$

or, equivalently,

$$PO_2 = 3.0 - .36\ ln\ (t_x) \quad \text{fig 2}$$

in the same units, that is *pO2* and t_χ in *atm* and *min* respectively. The last column tabulates a pulmonary exposure dose, Υ, for divers, called the oxygen tolerance unit (OTU), developed by Lambertsen and coworkers at the University of Pennsylvania. Formally, the oxygen tolerance, Υ, is given by,

$$\Upsilon = \left[\frac{PO_2 - 0.5}{0.5}\right]^{0.83} t \quad \text{fig 3}$$

and can be cumulatively applied to diving exposures according to the following prescriptions:

1. Maintain single dive OTUs below 1440min on the liberal side, or allow for 690 min of that as possible full DCI recompression treatment on the conservative side, that is, 750 min.

2. Maintain repetitive total dive OTUs below 300min.

The expression is applied to each and all segments of a dive, and summed accordingly for total OTUs, and then benchmarked against the 750 min or 300 min rough rule. The 750 min and 300 min OTU rules are not cast in stone in the diving community, and 10% to 25% variations are common, in both conservative and liberal directions. Formally, if Υ_n is the oxygen tolerance for the n^{th} the segment of a dive, with segment time, tn , and oxygen partial pressure, p_nO2, the total OTU accumulated, Υ, is.

fig 4

$$\Upsilon = \sum_{n=1}^{N} \Upsilon_n = \sum_{n=1}^{N} \left[\frac{P_nO_2 - 0.5}{0.5} \right]^{0.83} t_n$$

with N the total number of dive segments (multilevel, deco, repetitive). Originally, Lambertsen defined a unit pulmonary toxicity dose (UPTD), Φ, given by,

fig 5

$$\Phi = \left[\frac{PO_2 - 0.5}{0.5} \right]^{1.2} t$$

weighing oxygen partial pressure more than the OTU, but the definitions share the same basis, though slightly different fits to oxygen dose data. In the diving community, both representations have their proponents, favoring the oxygen partial pressure or time in oxygen dose estimations. For exceptional and multiple exposures, the USN and University of Pennslyvania suggest the limits summarized in Table 2, where for multiple exposures, N, and segment times, $t\chi$

fig 6

$$T_\chi \sum_{n=1}^{N} t\chi_n$$

Table 2. Oxygen Exceptional Exposure Time Limits

Oxygen Partial Pressure PO_2 (atm)	Single Exposure $T\chi$ (min)	Multiple Exposures $T\chi$ (min)
2.0	30	
1.9	45	
1.8	60	
1.7	75	
1.6	120	15
1.5	150	180
1.4	180	180
1.3	240	210
1.2	270	240
1.1	300	270
0.9	360	360
0.8	450	450
0.7	570	570
0.6	720	720

Note the severe reduction in multiple oxygen exposure time at 1.6 atm in Table 2. For this reason, technical divers generally restrict mixed gas diving exposures to $PO_2 \leq 1{:}6$ atm throughout any sequence of dives.

There are many ways to measure oxygen, with devices called oxygen analyzers. They are employed in chemical plants and refineries, hyperbaric chambers, intensive care units, and nurseries. The paramagnetic analyzer is very accurate, and relies on oxygen molecular response to a magnetic field in displacing inert gases from collection chambers. Thermal conductivity analyzers differentiate oxygen and nitrogen conduction properties in tracking temperatures in thermistors, with difference in temperatures proportional to the oxygen concentration. Magnetic wind analyzers combine properties of paramagnetic and thermal analyzers. Polarographic analyzers measure oxygen concentration by resistance changes across permeable oxygen membranes. Galvanic cell analyzers are microfuel cells, consuming oxygen on touch and generating a small current proportional to the amount of oxygen consumed. In all cases, analyzer response is linear in oxygen concentration.

Although it is tempting to avoid problems of oxygen toxicity by maintaining oxygen partial pressures, pO2 , far below toxic limits, this is not beneficial to inert gas elimination (free or dissolved state). Higher levels of inspired oxygen, thus correspondingly lower levels of inert gases, are advantageous in minimizing inert gas buildup and maximizing inert gas washout. Coupled to narcotic potency of helium and nitrogen, and molecular diffusion rates, balancing and optimizing breathing mixtures with decompression requirements is truly a complex and careful technical diving exercise.

For the diver, all the foregoing translates into straight forward oxygen management protocols for both CNS and pulmonary toxicity. They are similar to inert gas management, but individual susceptibilities to oxygen seem to vary more widely, though reported statistics are more scattered.

Consider CNS oxygen management first, using the CNS clock as it is popularly termed, and then pulmonary oxgen management, using the OTU as described.

1. CNS Toxicity Management

The various oxygen time limits, $t\chi$, tabulated in the Tables, obviously bound exposures, t, at oxygen partial pressure, PO_2 . Converting the exposure time to a fraction of the limit, Ξn, we can define a CNS oxygen clock, Ξ, that is over N exposure levels,

$$\Xi = \sum_{n=1}^{N} \Xi_n$$

fig 7

where,

$$\Xi_n = \frac{t_n}{t\chi_n}$$

fig 8

for exposure time, t_χ, at level, n, with oxygen time limit, $t_{\chi n}$. Tabulating Ξ is most easily done by a computer. The prescription might be, depending on degree of conservatism,

fig 8
$$0.7 = \leq \Xi \leq 1.3$$

and where Ξ = 1 is the nominal choice. The fit equation for PO_2 and t_χ suffices to range estimates of Ξ across all depths.

For repetitive dives, a surface interval penalty, similar to the nitrogen penalty in the USN Tables, can be levied for oxygen. A 90 min halftime is employed today, that is, the decay constant for residual oxygen CNS management, λO_2 , is,

fig 9
$$\lambda O_2 = \frac{0.693}{90} \min^1 = 0.0077 \min^1$$

For surface interval, t, initial CNS clock, Ξ, and for 90 min folding time, the penalty (or residual) CNS clock, Ξ, is simply,

fig 10
$$\Xi = \Xi_i \, exp\,(-0.0077t)$$

The residual value is added to the planned repetitive dive additively, just like nitrogen penalty bottom time.

2. Pulmonary Toxicity Management

Pulmonary oxygen toxicity, ϒ,follows a similar management scheme. As described, the total exposure, ϒ, is the sum of interval exposures, Υ_n,

fig 11
$$\Upsilon = \sum_{n=I}^{N} \Upsilon_n = \sum_{n=I}^{N} \left[\frac{P_nO_2 - 0.5}{0.5}\right]^{0.83} t_n$$

and is limited,

$$300 \text{ min} \leq \Upsilon \leq 750 \text{ min}$$

depending on the desired degree of conservatism, and multiplicity of repetitive dives. Variation of 15% to 25% in the exposure limits are common.

Nudibranchs • Continued from Page 39

Respiration in the Opisthobranchs is accomplished with organs called cerata, brachial plumes, or gills. Cerata are thin bulb-like projections that are arranged along the dorsum (back) of the individual. These projections increase the surface area of the organs that come in contact with the surrounding water and therefore, increase respiratory potential. As extensions of the body tissue, the cerata sometimes contain branches of the digestive glands. A unique consequence of this fact is that some species of nudibranchs that prey upon hydroids and anemones, can pass the unfired nematocyst (stinging cells used by hydroids and anemones to deter prey) to branches of the digestive glands in the cerata. Scientists still do not know the exact mechanism of how transportation of the unfired nematocysts to the cerata occurs, however; as a result, the Opisthobranch is able to effectively utilize its prey's stinging cells for its own defense. In fact, some Opisthobranchs in Australia are very dangerous to humans due to the storage of nematocysts after feeding on the Portuguese man-of-war jellyfish (Physalia). The cerata can also be discarded (just as a starfish can loose an arm) and a new one regenerated. Of course this increases the animals chance of survival if a predator manages to just get a hold of the nudibranch's cerata. Regeneration time for cerata is only a few days, and there is no loss of midgut material after separation from the body.

The more then 3000 species of Opisthobranchs worldwide have the promise of providing much more then aesthetic appeal to the human race. Several species are currently under investigation to gain insight into the physiological functioning of ganglia and nerves. Also several Opisthobranchs are capable of harboring and utilizing organelles used for photosynthesis. In addition, there is hope for the discovery of many pharmacological agents from the secretions of these beautiful creatures.

Edited by:
Dr. Robert J. Feller
Cheryl Stacy
Jessica Stephen

THE DAWN OF A NEW AGE IN EXPLORATION
MIXED GAS PERSONAL DIVE COMPUTER

The call was unexpected.

"Would you like to be one of the first people to dive an Abyss Explorer?"

"Who is this I asked?"

"I represent the R&D division of Abysmal Diving. As you know we have been developing a multi-gas dive computer, and my question only requires a yes or no answer."

"Yes," I replied.

I gave the mysterious caller my fax number and she hung up. Within moments fifteen pages appeared in my machine, including instructions and non-disclosures I would need to get notarized. The document in short said: "We trust that you will not disclose what you are about to see or use.

Within two days a big box arrived. It seems that the people at Abysmal Diving were not going to be satisfied with my just testing the Explorer Computer. They included a variety of other tools for me to use to conduct these Explorer test dives.

I thought it was my birthday! In the box was the Abyss Explorer Mixed Gas computer and a 200 page manual; a small laptop and a serial cable; Abyss Dive Planning Software CD; the OxySPY analyzer; a pair of high performance Abyss breathing regulators, with low profile SPG's set up for DIN; two Abyss stage bottle regulators, one of their new Argon inflation system; an Abyss dry suit in just my size; and a little Cannon waterproof camera with film loaded. (Please note the Explorer does NOT come with all of those other items.)

I am not known as one who reads instruction manuals. So, I pushed the buttons. After pushing the first one, nothing happened; I pushed two of the buttons together and Explorer came to life. At first I thought the buttons or, should I say pegs, were too hard to press. Then as I read.... it said; "The switch pressure is high because: first, your gloves are thick; second, your fingers may be numb from cold water diving; and third, we want you to be 100% SURE you intended to press the button so there is NO chance of an accidental gas switch." This made sense to me. Since on my first attempt at using the Explorer, the manual answered my question, I decided to take this one step at a time just as it suggested. Armed with a highlighter and some good coffee, I knew I would be in for a long night.

I have a set of criteria for using new equipment. I refuse to call the company while testing. If I can't understand it, then no one else will, and that makes it junk to me. If it meets that one simple rule, then I can be a happy diver. The first 12 pages of the manual are devoted to warnings and installation of the software, both the simulation/programming software for the Abyss Explorer Mixed Gas Decompression Computer and the Abyss Dive Planning Software. These went off without a hitch. I inserted the CD-Rom and let it do its thing. I had to register the software, and with a single e-mail, I had my registration code in minutes. I was then given a choice to program the unit either with its "button interface" or the "laptop interface."

Not much time will be spent in explaining all the steps in programming the unit. However, the diver tells Explorer which of the ten algorithm choices to use, depending on the level of conservatism the diver wants for the decompression calculations. I chose the one that is as close to the Abyss 120 since I am most familiar with that one as a result of having used it for years. Next, I needed to tell it the "planned" gases I would dive and in the order in which they will be switched. I use standard gases, 17/50/33 trimix for descent and ascent and enriched air 50% and 100% oxygen for ascent. I programmed these in as gases 2, 3, 4, (# 1 is default for air). Additionally, I added in some extras, just to see how they would function if I switched to them out of my primary dive plan. Make note that Explorer will allow the diver to use the planned gases as well as any others that are in the memory. This allows the diver to "Bail-Out to a buddy's gas or to an emergency gas supply from the surface.

For the past few years I had all but abandoned flying a dive computer, except for warm water, single tank multi-level nitrox dives. I have been using helium in most mixes for dives in the 100 fsw+ ranges and for existing multi-gas nitrogen-based units, like the Cochran Nemesis IIa and Dive Rite Nitek III. Although fine units for air and nitrox diving were just unable to manage accurate trimix calculations. With no mixed gas computers available, I resorted to dive tables I would generate with Abyss Dive Planning Software or custom tables from Hamilton Research.

After spending the next two hours reading the manual and playing with the dive simulator, I made some notes on a slate, put the unit back in its protective case, and hit the sack. Tomorrow I would be heading out for a day's travel before starting a series of dives. This trip had been planned for a while, so the Explorer showing up was quite serendipitous. Upon arriving on site, I knew that I had to take extra precautions to keep my Explorer under wraps. Since divers are curious little buggers, I made sure I kept it low key. If it didn't work, it would be all over the net before I could tell Abyss what needed tweaking, and I did not want that to happen.

We were diving in some dark water so I had set the Explorers' back light to "on." In this mode it would light up for three seconds whenever I pressed one of the buttons. I knew it would burn batteries in that mode, but I also knew I wanted to see the screen. Bigger than life, the Explorer displays numbers and information larger than any other unit I have ever used. The dive depth and time are displayed in numerals an inch high. The information on the screen is complete, with no windows to scroll through, nothing to tap to change modes. The display includes: Dive #, Depth, Bottom Time, Battery voltage, Decompression Ceiling, Maximum Depth, Average Depth (this is good for bail out) Total Time to Surface, Conservative Factor, Current Mix Composition, and PO2 at current depth. What is also so special about the Explorer display is that it shows true decompression time using all the planned gas switches. When switching to bailout mode, it will show total time to surface on the current breathing gas.

Checking over my gear as a pre-dive flight check, I duck into the head for pre-dive relief and to confirm my mixes in the Explorer. I set the unit for my descending mix, zip up, get into my gear, flash the okay to my partner, and over the side we go. At 30 feet we do our safety check, and I glance at the Explorer. Mix is confirmed, screen is lit, and depth matches my back up bottom timer. On the bottom we get to explore some interesting shipwrecks in dark yet clear water. The information from the Explorer screen was accurate. All information was matching up to the planned dive profile tables I had generated with the Abyss Dive planning software. The Explorer deviated when we did some multi-level excursions. Nevertheless, this is where the "average depth" information came in that would match up nicely to a slightly more shallow table. (I had cut my tables in 5-foot increments from 190-220 feet just to view this feature).

At 30 minutes, my body was still warm but the fingers were getting chilly in the 40ºf water. We headed up. The average depth for the dive was 210. The ceiling, for the first deep decompression stop, was at 140 feet with a time to surface of about 40 minutes. We dilly-dallied along on the ascent to see what the Explorer would do. It tracked along like as it was supposed to do. As I approached the 70-foot gas switch, the Explorer started to flash in the gas panel. It wanted me to confirm the mix switch. Checking my decompression bottle to be sure I had the 70-foot gas, I confirmed it with the correct regulator once I opened the bottle. I confirmed the

- Adible alarm for, any button pressed, Gas Switch, Deco Violation.
- 10 user selectable algorithms. (Abyss 100, Abyss120, Abyss 150, ZHL-16A, ZHL-16B, ZHL-16C, etc..)
- Glass reinforced Lexan case and crystal
- 50 decompression stops, max decompression at 500ft.
- 660 ft. / 200m maximum-operating depth.
- Large (2.50" x 1.50") easy to read LCD showing, Dive number, Date, Time, Battery, Ceiling, Ascent Rate indicator, Depth, Bottom Time, Time to Fly, Max Depth, Average Depth, Surface interval, Time to surface, Temp, Decompression Stop Depth, Decompression stop time, Algorithm, Current Gas.
- O2 percent, PPO2.
- Dive Planning: Abyss Advanced Dive Planning Software & Explorer Dive Simulator included.
- 10 programmable gases, all available all the time during the dive for on the fly gas switching.
- Gauge Mode: No lockup on decompression violation, no gauge mode underwater. o Serial interface for uploading dive plan / mix table downloading your logged data.
- User activated, hi-intensity white LED.
- Log Mode 25hr basic, 50hr optional, (records in five-second increments).
- Dive Mode: Open circuit or Closed circuit (constant PPO2 with live on the fly adjustments). Mode may be changed on the fly underwater, open to closed, closed to open, etc. (Closed circuit mode supports 5 diluent mixes and 5 open circuit mixes)
- User replaceable 3.6v lithium battery.
- Explorer can be reprogrammed as new operating software or algorithms are developed.
- No product obsolescence.
- 599 minute maximum bottom time, 99 hours 59 minute maximum decompression time.
- Total Time to Surface, including planed decompression gases.
- Nitrox Explorer can be upgraded to the Trimix Explorer.
- User selectable, Imperial or Metric.
- Nitrox supports open circuit SCUBA & closed circuit rebreather (any Eanx).
- Mixed Gas supports open circuit SCUBA; closed circuit rebreathers (any Eanx, heliox, trimix).
- MSRP - Nitrox $750.00 Mixed Gas $1,250.00

Explorer gas switch and it stopped flashing. I had been on the bottom mix a few minutes longer than planned on the ascent and the Explorer made the appropriate adjustment. One more switch to make and the first dive would be complete.

Around 20 feet it was time to make the switch to oxygen. On cue, the Explorer asked for the confirmation. I decided not to confirm and see what happens. I waited 60 seconds. It defaulted to my last mix (50%) and readjusted the remaining decompression time up from 25 minutes to 35 minutes. This was so cool. Explorer allowed me to switch on the fly out of my planned dive mode to use other gases. I decided on the fly to further test this feature. For fun, I manually switched to my back gas 18/50/33 trimix. I pressed through the confirmation buttons and the deco time shot up to another hour. Now I knew that I had proper decompression gas, but Explorer proved that I could have options on the fly. I reconfirmed back to 100% oxygen and the decompression remaining dropped to 26 minutes

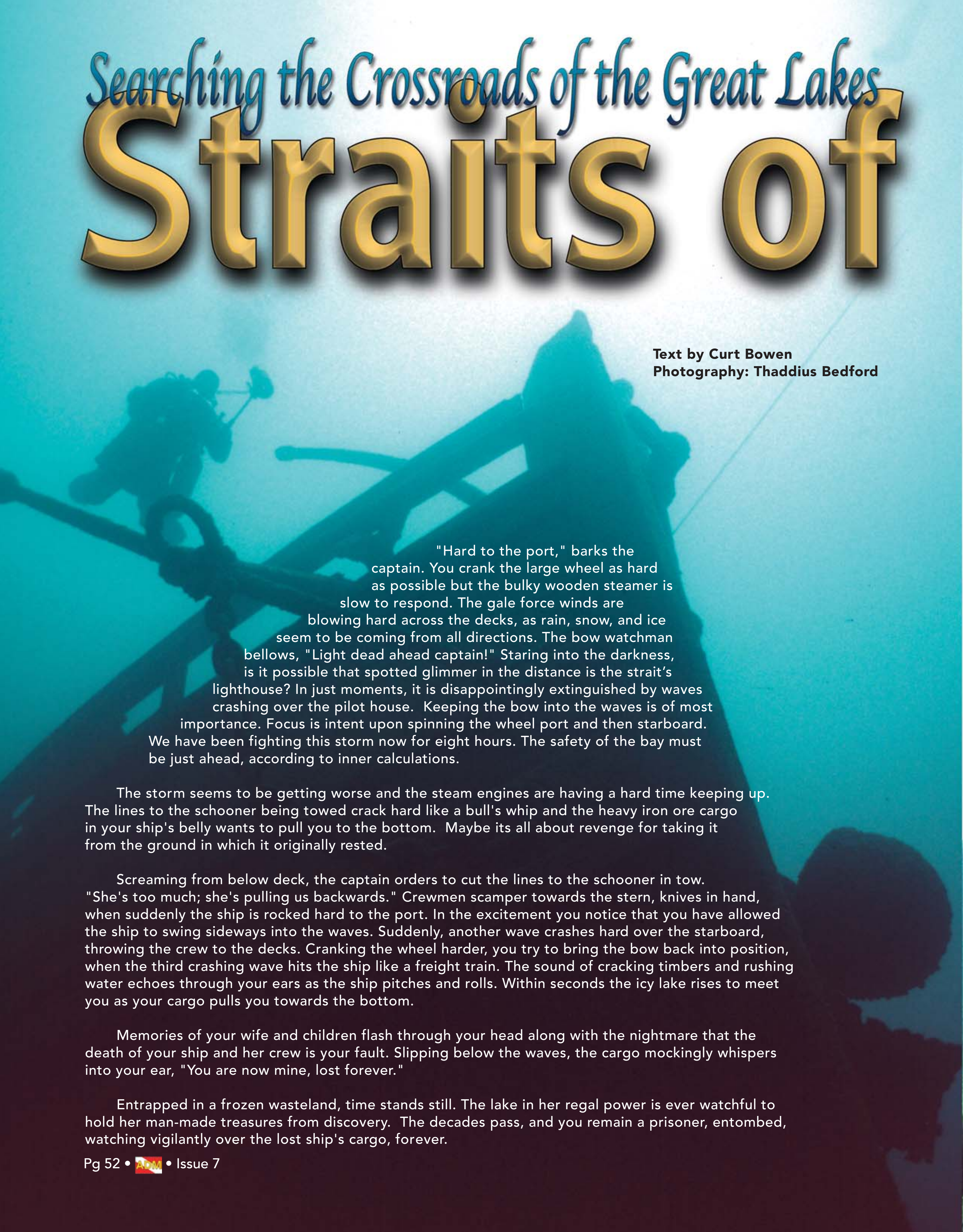
Back on board, I put the little bugger away in my dive box after securing my gear. Just as I placed it in the box, the unit switched back to Mix 0 (air) to start to calculate the surface intervals.

The next dive was planned as a HOTx dive in only 110 feet of water. The Explorer wants to be reprogrammed before a repetitive dive. I thought it would be a pain, but they made it easy. If you recall, earlier, I had programmed in some gases that I normally used. Since my decompression gases are standard ones, I only entered three of them, but my bottom mix changes depending on the dive, so I had added a few different ones as well. Instead of firing up the laptop again, I used the button interface on the Explorer to select the depths where I would start with the new bottom gas, and the decompression gases. Within a few minutes I had confirmed my new dive plan's gasses to 30/30/40 trimix, 50% enriched air, and an option for 100% oxygen, and I was set. We entered the water about 145 minutes after the previous dive and once again, Explorer did all the work. A quick glance at the back up tables every once in a while helped me to confirm that Explorer was on track and the dive went as planned.

Even though it took me a few hours to read the manual, learn the simulator, and learn how to program the unit, I was very pleased with the results. Explorer managed both deep, shallow, repetitive and multiple gas switches flawlessly. Since those first dives, I have changed the battery once, replaced the protective lens guard, and put over 25 hours of dive time on the unit. It really will be the last dive computer I buy.

Contact:
Abysmal Diving Inc.
6595 Odell Place Suite G • Boulder • Colorado • 80301
Ph: (303) 530-7248 • Fax: (303) 530-2808
http://abysmaldiving.com


Zeagle: When you're ready for the best
Our Regulators have been top rated in every objective evaluation.
Now we have something better.
Much better.
zeagle
ZX second stage
The all new ZX second stage is smaller, lighter, and more comfortable, without compromising performance.
Let your Zeagle dealer show you how our new regulators can leave you breathing easier than you ever thought possible.
1st Stage
HF
50D
HF
DS-IV
The new 50D, and DS-IV have been updated with an ever higher performance valve design.
zeagle
For a Zeagle dealer near you call (813) 782-5568 or see our complete line of products on our web site
www.zeagle.com
© Copyright 2000 Zeagle Systems, Inc. All rights reserved ZX Second Stage, 50D, and DS-IV



Searching the Crossroads of the Great Lakes

Straits of

Text by Curt Bowen
Photography: Thaddius Bedford

"Hard to the port," barks the captain. You crank the large wheel as hard as possible but the bulky wooden steamer is slow to respond. The gale force winds are blowing hard across the decks, as rain, snow, and ice seem to be coming from all directions. The bow watchman bellows, "Light dead ahead captain!" Staring into the darkness, is it possible that spotted glimmer in the distance is the strait's lighthouse? In just moments, it is disappointingly extinguished by waves crashing over the pilot house. Keeping the bow into the waves is of most importance. Focus is intent upon spinning the wheel port and then starboard. We have been fighting this storm now for eight hours. The safety of the bay must be just ahead, according to inner calculations.

The storm seems to be getting worse and the steam engines are having a hard time keeping up. The lines to the schooner being towed crack hard like a bull's whip and the heavy iron ore cargo in your ship's belly wants to pull you to the bottom. Maybe its all about revenge for taking it from the ground in which it originally rested.

Screaming from below deck, the captain orders to cut the lines to the schooner in tow. "She's too much; she's pulling us backwards." Crewmen scamper towards the stern, knives in hand, when suddenly the ship is rocked hard to the port. In the excitement you notice that you have allowed the ship to swing sideways into the waves. Suddenly, another wave crashes hard over the starboard, throwing the crew to the decks. Cranking the wheel harder, you try to bring the bow back into position, when the third crashing wave hits the ship like a freight train. The sound of cracking timbers and rushing water echoes through your ears as the ship pitches and rolls. Within seconds the icy lake rises to meet you as your cargo pulls you towards the bottom.

Memories of your wife and children flash through your head along with the nightmare that the death of your ship and her crew is your fault. Slipping below the waves, the cargo mockingly whispers into your ear, "You are now mine, lost forever."

Entrapped in a frozen wasteland, time stands still. The lake in her regal power is ever watchful to hold her man-made treasures from discovery. The decades pass, and you remain a prisoner, entombed, watching vigilantly over the lost ship's cargo, forever.

Mackinac

Motoring slowly in a systematic search, modern day explorers pull high-tech equipment in search of lost ships. Sonar waves bounce off the lake's bottom sending back a visual drawing of what she is attempting to hide. But the lake is old and very wise, hiding her belongings in valleys and deep crevasses, disguising her bounty by covering them with decades of sand, mud, and silt.

Days, months and years pass, still the modern day explorer presses on, ever searching for the lake's treasures. Just the right angle, just the right distance, and just the right day of calm seas are all that is needed for discovery.

Thaddius Bedford is among a long line of other modern day explorers. Pulling his side scan sonar unit for thousands of miles, he searches for any blip, bump, or scratch that might appear on his screen. Deciphering readings from lost buoys, bottom ridges, sunken trees to shipwrecks is his passion.

The Straits of Mackinac was known for its treacherous waters, heavy shipping congestion, and dangerously shallow shoals. Since the middle 1800s, hundreds of ships have met their demise in and around the Straits. That makes this area of the Great Lakes prime searching grounds for Thaddeus and his band of eager adventurers.

Daring the icy cold waters, they descend into the darkness to see what the lake has given up for discovery. Could it be another pile of logs, discarded ballast stones, or the mother load, a virgin shipwreck?

For over a hundred years you have paced the sunken decks of the lost ship. The only visitors have been a few cold water fish, now taking residence in what was once the crews' quarters. A new commotion on deck refocuses your attention. It seems to be a large metal grappling hook with a rope ascending towards the surface. The ropes tension pulls tight, and faint splashes can be heard from the surface.

Beams of flickering light descend towards you, filled with new sounds of heavy breathing. What appears to be foreign, yet human from another world, grasp the ship's railing for the first time in a hundred years. Excited, you attempt to catch their attention, hoping they can rescue you from the ship's shackles. But the light beams continue to scan the decks as the intruders move along the passageways, not seeming to notice your presence.

Blinding flashes of light burst out as the intruders enter the old pilot house, reminding you of those distant memories of both family and crew. As quickly as they appeared, the intruders now have moved back to the line. Pulling the grappling free, they start to ascend away from the ship. Grasping at their bodies, you frantically attempt to gain their attention. They float off, leaving you once again in the darkness, ever lost.

1. J. H. Tiffany: Depth 103 feet
137-foot wooden schooner sank in 1859 due to a collision.
Five casualties

2. Cayuga: Depth 98 feet
290-foot steel freighter sank in 1895 due to a collision.

3. Uganda: Depth 208 feet
291-foot wooden steamer built in 1892, sank on April 19, 1913.

With ice still crowding the straits in mid April, the Uganda's captain made the decision to chance an early passage. Bound for Buffalo with a full cargo of grain, the Uganda made its way slowly west, followed by the steamer, John A. Donaldson. Soon after passing the White Shoals, light ice crowded the Uganda and cut through her haul. Luckily for the crew of 22, the Donaldson was able to rescue all before the vessel sank.

4. Maitland: Depth 84 feet
133-foot wooden sailing ship, built in 1861, sank on June 11, 1871.

Loaded with corn, the Maitland was heading to Buffalo. Late in the evening, the bow lookout spotted the schooner, Golden Harvest on a direct collision path. Turning hard to port, the two ships slammed together, starboard to starboard. Unbeknownst to the Captain of the Maitland, the schooner Mears was running off the starboard side and slightly behind the Golden Harvest. With a massive blow, the Mears bow cut deep into the starboard bow of the Maitland, sending her to the bottom in less than 5 minutes. All the crew was amazingly able to escape onto the Mears before the Maitland disappeared into the dark waters below.

5. Sandusky: Depth 83 feet
110-foot wooden sailing ship, sank on September 20, 1856. Seven casualties.

The Sandusky left the Chicago harbor on September 16, 1856 enroute to Buffalo. According to the record, a violent gale pounded upper Lake Michigan and the Straits on September 18th. The Sandusky never made it to Buffalo and was reported missing with all hands onboard.

6. Northwest: Depth 73 feet
223-foot wooden schooner, sank on April 6, 1898. Cut by ice.

7. Eber Ward: Depth 145 feet
213-foot wooden steamer ship, sank on April 20, 1909. Five casualties

Enroute for Port Huron, the Eber Ward motored slowly towards the east when she ran directly into an ice flow just to the west of Mackinaw City. The ice cracked the haul of the vessel and it sank below the waves in less than 10 minutes, taking five of her crew down with her.

Illustration: C. Bowen

8. Minneapolis: Depth 124 feet
226-foot wooden steamer ship, sank on April 4, 1894. Cut by ice.

9. M. Stalker: Depth 85 feet
135-foot wooden schooner, sank Nov 5, 1886. Collision

10. Cedarville: Depth 105 feet
588 foot Steel Ore Freighter, built in 1927, sank on May 7, 1965.
Ten casualties

Upon approaching the Mackinac Bridge in heavy fog, the Cederville contacted the German vessel Weissenburg, which was headed towards the Cederville via radio. A port to port passing arrangement was made, but confirming whistle signals were not made.

At 9:38 a.m., The Weissenburg contacted the Cederville and reported that there was a Norwegian vessel between them in the fog. The Captain of the Cederville drastically attempted to contact the mystery ship but could not hail it.

The Cederville captain immediately ordered a 20 degree starboard turn to avoid a possible collision. Suddenly the bow of the Norwegian ship appeared off the port side of the Cederville. With a killing blow, its bow ripped into the midship of the Cederville, almost ripping the ship in half.

The two ships parted and faded back into the fog. Taking on massive amounts of water, the captain of the Cederville ordered full steam ahead, attempting to ground the freighter in shallow water.

Suddenly the Cederville twisted, rolled towards the port and plummeted below the waves. In the sinking, most of the crew was thrown from the vessel into the water. In all, 27 crewmen where picked up by lifeboats from the Weissenburg, which launched their life boats in an attempt to rescue the crew. Two of the recovered had already drowned. Within a few days, five of the missing crewmen bodies were discovered. The remaining three are still missing.

11. W.H. Barnum: Depth 70 feet
No Data Available

12. St. Andrew: Depth 61 feet
135-foot wooden schooner, sank June 26, 1878. Collision

USCG Captain Thaddius Bedford, dive charter routinely travels to many of the more impressive wrecks in the straits. Ph. 231•590•8808

Shipwrecks of the Straits of Mackinac
337 page, very informative book on the wrecks of Mackinac, their history, and current condition

Seajay Publications
P.O. Box 2176, Dearborn MI 48123
ISBN 0-9609014-1-8

USS SAUFLEY DD-465

Text by: Barry Lawson, Scott Maclean, and Bert Wilcher

Following her shakedown off New England, Saufley commenced participation in the Guadalcanal campaign in December 1942. During the Japanese withdrawal from Guadalcanal in January and February 1943, she patrolled the waters north and west of the island, sweeping for anti-ship mines and provided coastal bombardment.

In March, Saufley transported troops, towed landing craft to the target islands, and provided shore bombardment in support of troops as they landed on Pavuvu. Saufley was engaged in the assault on the Green Islands, which broke the Japanese Rabaul-Buka supply line and provided the Allies with another strategic airfield near Rabul.

After sailing to Pearl Harbor, Saufley was reassigned to operation "Froager" and provided escorts and shore bombardment for operations in the Saipan-Tinian area. Saufley moved south for the invasion of Guam. Here, the destroyer provided call fire support for the assault troops.

Proceeding to Leyte Gulf, Saufley soon found herself engaged in antisubmarine action. For the next two months, Saufley engaged in escort duties between Leyte Gulf and Ulithi, until the end of hostilities in mid-August.

She participated in many Pacific campaigns and earned 16 battle stars during WWII.

In January 1951, the escort destroyer was reclassified an Experimental Escort Destroyer and was assigned to experimental work under the control of Commander, Operational Development Force in Key West. For the next twelve years she engaged in the development and testing of sonar equipment and antisubmarine warfare weapons.

In July 1962, Saufley was redesignated a general-purpose destroyer and regained her original designation, DD-465. She participated in the filming of the movie "PT 109," and participated in patrols off the Cuban coast during operation Cuban Quarantine.

Saufley was decommissioned on January 29, 1965. Her use as an experimental ship continued, instruments and gauges were placed to register stress from explosions and in February 1968, as a result of these tests, she was sunk off Key West.

Saufley now rests upright in 420 fsw off Key West. After the recent NAUI Technical conference, an attempt to dive the Saufley was planned. A three-diver team, consisting of Barry Lawson, Scott Maclean, and Bert Wilcher planned and executed a successful dive to the Saufley on October 8, 2000.

Key West, Florida 420 fsw

With a length of 376'6" and beam of 39'4," the first challenge became hooking a secure anchorage to the vessel to have a stable dive platform. With this accomplished, the challenge of a dive to this depth with open-circuit dive systems required coordination of bottom gas mixes, dive team logistics, and safety diver timing to ensure a safe outcome.

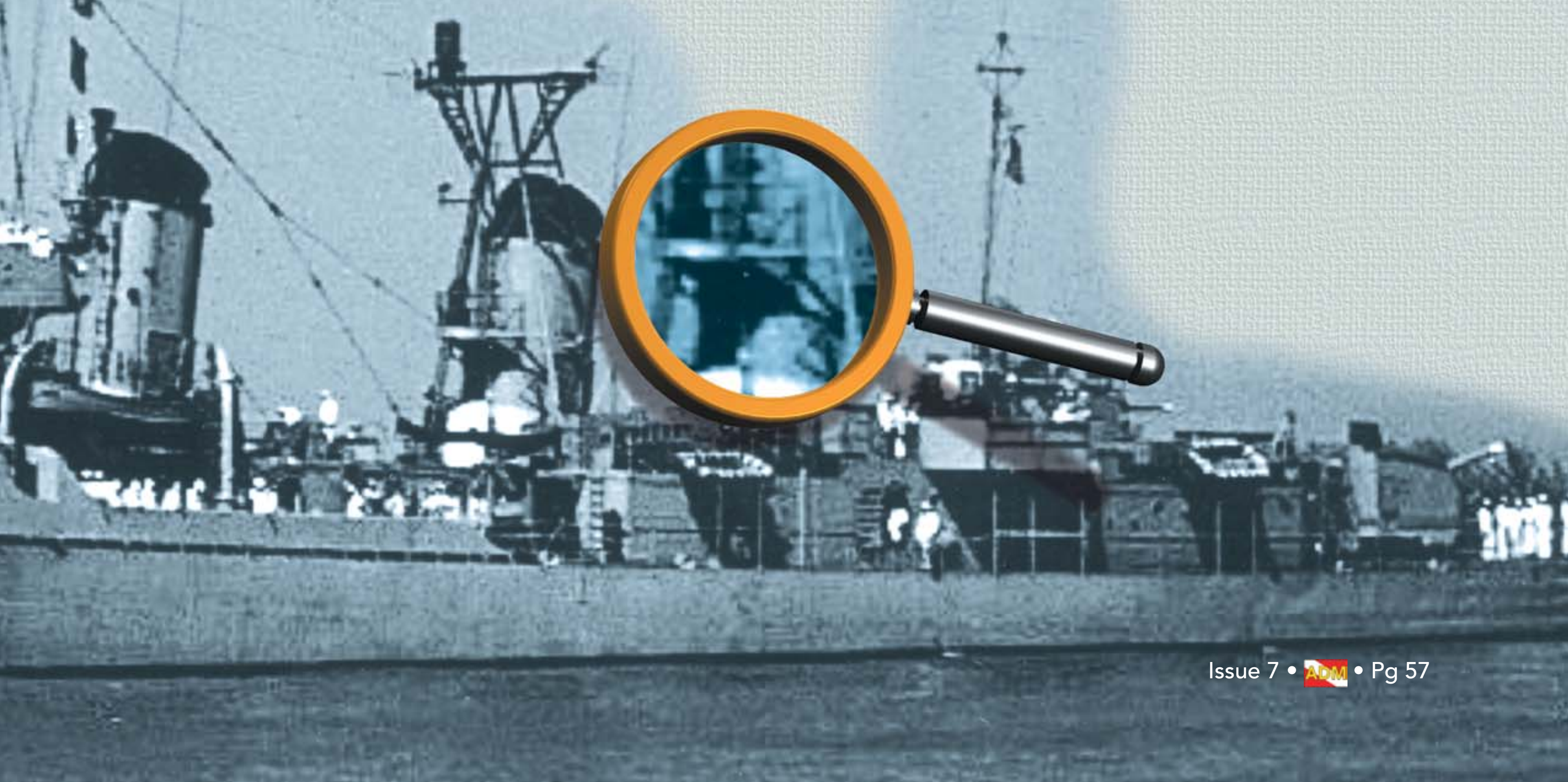
Best mix was determined to be a tri-mix 10/(55-60), EADs of 158-131, with deco gases being EAN32 and 100% O2 from 20 feet. Run times were planned using Abyss and Z-planner for run times of 12 and 14 minutes to ascent. The dive team descended onto the fantail of the ship, checked the anchor, and explored the aft section of the ship, returning to the ascent line at 12 minutes.

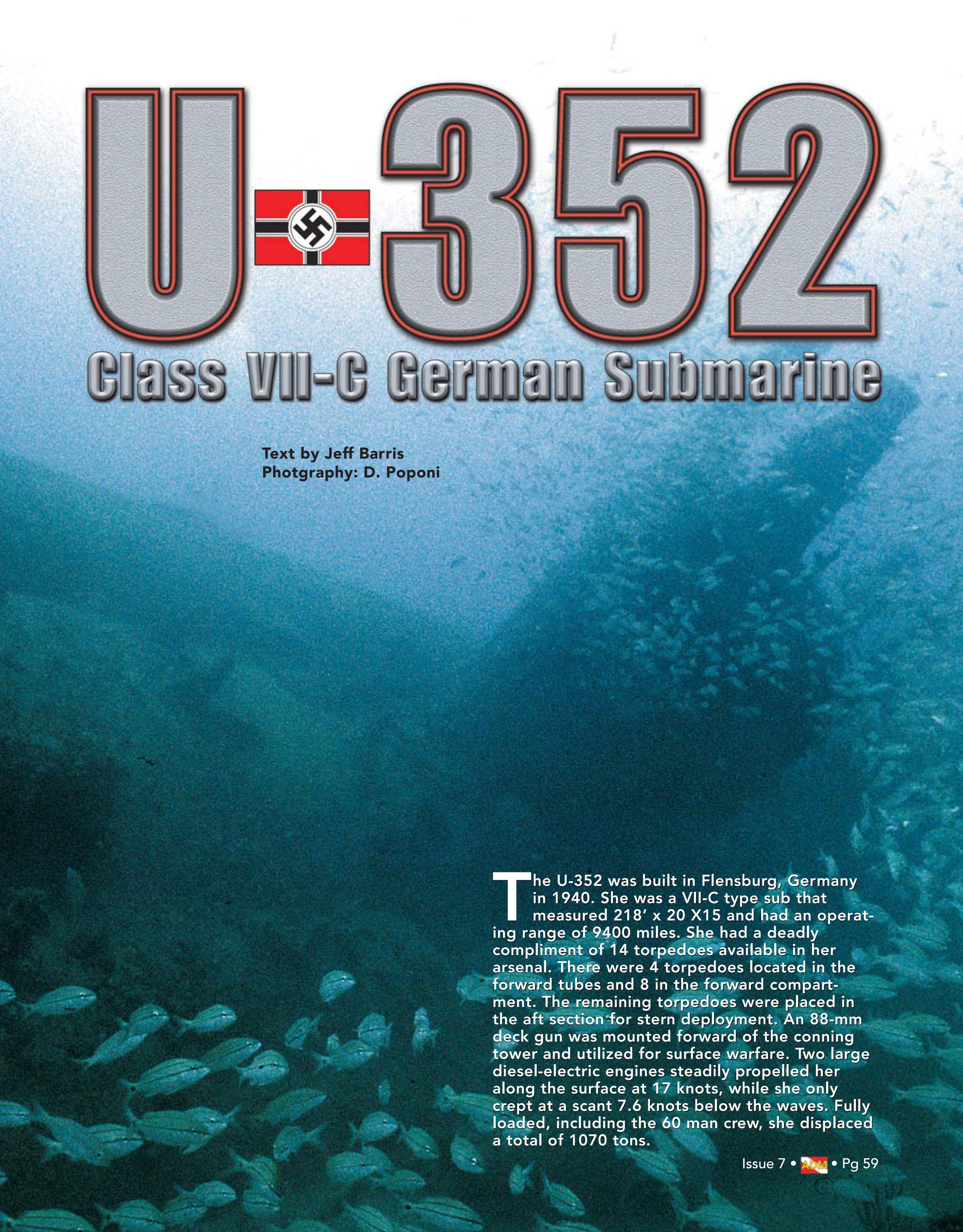
Uncoupling of the ascent line from the Soufley was completed and deep tri-mix decompression stops were taken while the ascent line was secured to the surface dive boat. Intermediate decompression was completed on EAN32 and final decompression, from 20 fsw, was completed on 100% oxygen.

The team was assisted by safety divers who continuously monitored the team after starting intermediate, (130 fsw), decompression stops, and during the oxygen.

Additional information on Saufley can be found in Dictionary of American Naval Fighting Ships and Ships of the U.S. Navy, 1940-1945.

Builder:	**Federal Shipbuilding Company**
Laid Down:	**January 27, 1942**
Launched:	**July 19, 1942**
Commissioned:	**August 28, 1942**
Fate:	**Stricken September 1, 1966**





U-352

Class VII-C German Submarine

Text by Jeff Barris
Photgraphy: D. Poponi

The U-352 was built in Flensburg, Germany in 1940. She was a VII-C type sub that measured 218' x 20 X15 and had an operating range of 9400 miles. She had a deadly compliment of 14 torpedoes available in her arsenal. There were 4 torpedoes located in the forward tubes and 8 in the forward compartment. The remaining torpedoes were placed in the aft section for stern deployment. An 88-mm deck gun was mounted forward of the conning tower and utilized for surface warfare. Two large diesel-electric engines steadily propelled her along the surface at 17 knots, while she only crept at a scant 7.6 knots below the waves. Fully loaded, including the 60 man crew, she displaced a total of 1070 tons.

Once a year, during the month of July, I gather a few good dive buddies, and we make the nine-hour drive south from our homes in southern New Jersey to the town of Morehead City, North Carolina. Diving in the clear blue warm water, while exploring a multitude of shipwrecks that rest in the graveyard of the Atlantic, is the reason for our yearly return.

Since the early days of sail, mariners have navigated these treacherous waters and lost their vessels to the fury of the sea. Nearby, are those warm Gulf Stream waters, which often fueled the storms causing those lost vessels. However, it was the advent of the Second World War, which resulted in an even deadlier end for these men of the sea.

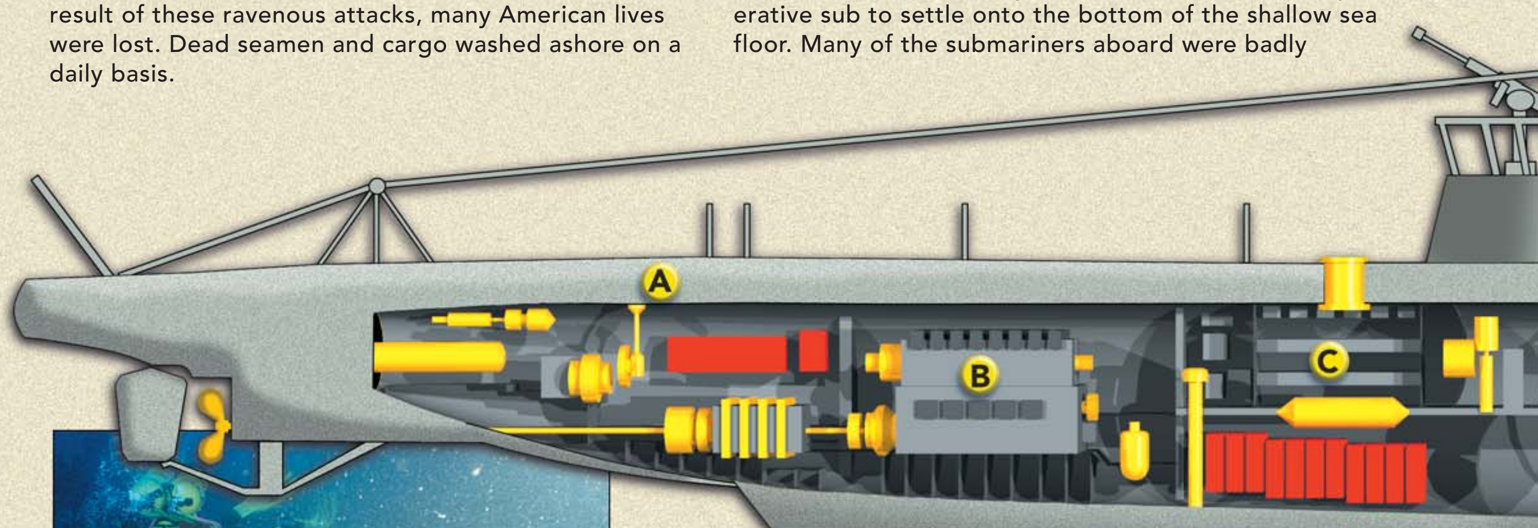
During World War II, ships of various shapes and sizes transported crucial supplies to the many ports around the world, including the United States. The German Navy was busy around the globe in an attempt to cripple this system of transportation and rule supreme.

Not far offshore of the American coast, packs of these German submarines closely patrolled our waters in search of easy prey. They strategically hunted and brutally destroyed practically anything that floated. Oil and gasoline-filled tankers that provided energy for the allied war machine were their most prized targets, not to mention that they were large and easy to sink. As a result of these ravenous attacks, many American lives were lost. Dead seamen and cargo washed ashore on a daily basis.

For protection, most ships carried armed guards aboard and some even had deck guns; however, these were no match for the heavily armed German U-boat. When the carnage off the eastern seaboard finally subsided, a total of 114 merchant ships, along with most of their crews, were sent to their watery graves.

On May 9,1942, twelve miles off the North Carolina coast, Commander Rathke of the U-352 was busy combing the sea looking for a target to sink. Rathke, who was having a bad luck streak, was quite desperate to sink anything that he could sight. Out in the distance he spotted a small vessel cruising near Cape Lookout. Overly anxious, he fired a lone torpedo at the unsuspecting ship and assumed he had made a direct hit, but as his luck would have it, the torpedo malfunctioned and exploded on the ocean floor. Unbeknownst to the U-boat commander, the intended target was the United States Coast Guard cutter Icarus, commanded by Lt. Commander Maurice D. Jester.

Icarus was part of a convoy that was enroute from Staten Island, New York to Key West, Florida. Upon hearing the detonation of the torpedo, the Icarus immediately responded to the area of the explosion and fed the water with a set of five depth charges, followed by a "v" pattern of three more charges. After a short period of time, Icarus apparently hit her mark. Intense hull damage from the explosives caused the now inoperative sub to settle onto the bottom of the shallow sea floor. Many of the submariners aboard were badly

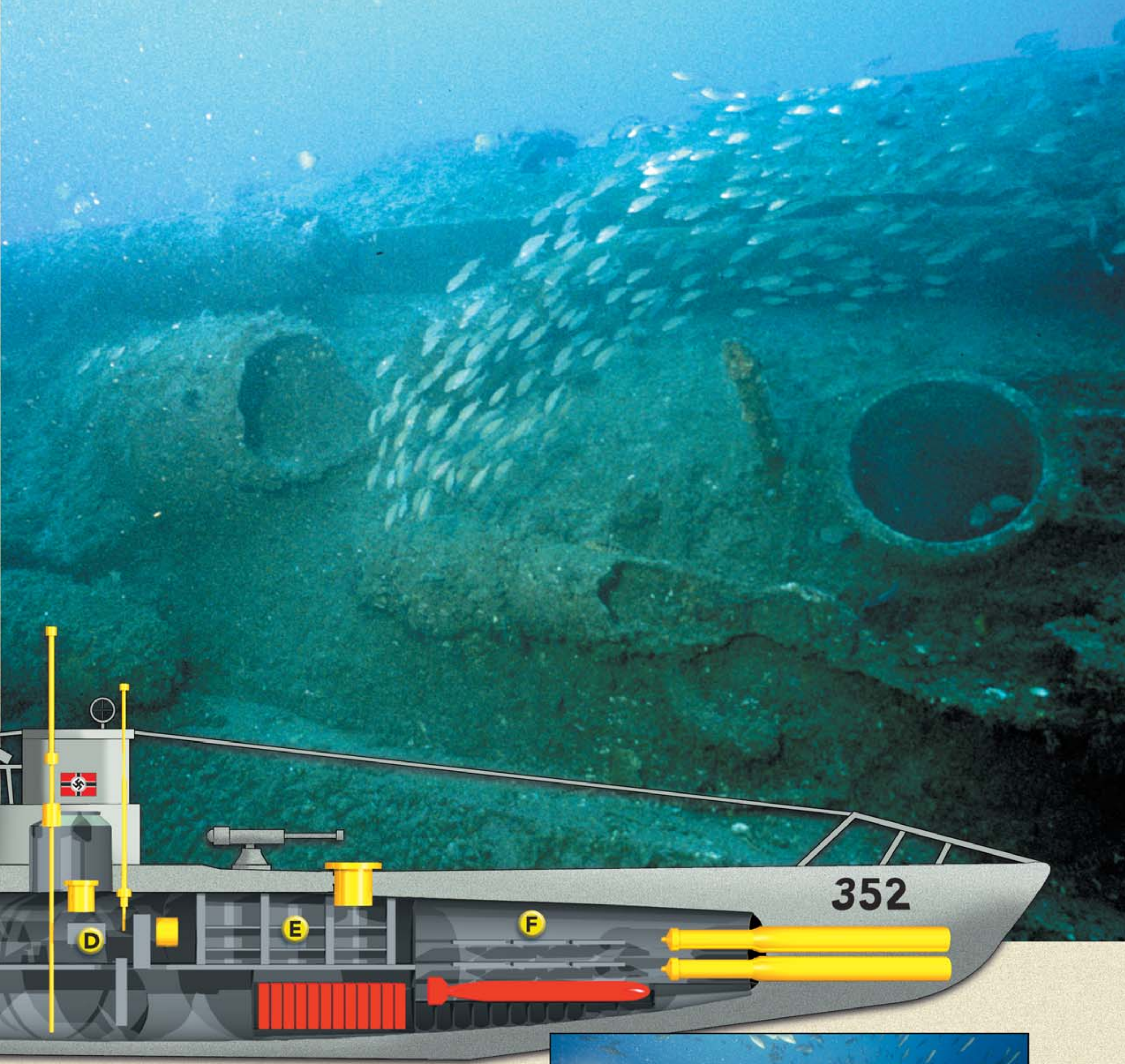


Left: Divers inspect one of the hatches leading to the interior of the U-352.

Above: Illustration of the standard interior layout for a German Class VII-C type World War II Submarine. These subs were packed full with supplies and ammunition when leaving Germany for their expected several months stay at sea.

Above Right: Years of strong currents, hurricanes, and marine growth has taken their toll on the U-352. Laying on her side penetration into the subs interior through the narrow hatches is extremely difficult and dangerous. Years of rust and silt can turn inside visibility from 15 feet to zero in seconds with just a few fin strokes.

Illustration: C. Bowen



A: Electrical Room with Electric Motors
B: Diesel Engines
C: Radio Room and Captain's Quarters
D: Control Room with Periscope
E: Crews Quarters
F: Torpedo Room with more crew bunks.

Right Lower: With the outer hatch removed by salvagers. Access into the interior of the U-352 is possible.

injured along with some fatalities. With both engines disabled, Rathke's only option was to surface. He calmly ordered his men to don their escape gear and to blow all ballast tanks. As the maimed and partially flooded sub finally broke the surface, gun crews from the Icarus manned their deck armament, consisting of a three-inch gun, a 50, and a 30-caliber machine gun. These highly trained guardsmen opened fire, perforating the crippled U-boat with pinpoint accuracy. This offensive action neutralized several of the scrambling crew as they exited the conning tower in an attempt to place their own deck gun into action.

When Icarus ceased fire, the remaining crew quietly surrendered without further resistance. Five minutes later, the U-352 slipped below the surface with two officers and 11 crewmen leaving Commander Rathke and his remaining crew floating in the Atlantic Ocean. With a long swim back to the fatherland, they quietly watched with reverence as Icarus slowly steamed away.

Upon receiving orders from the 6th naval district, Icarus was ordered back to the scene some 45 minutes later to take the German personnel into custody and transport them to Charleston, South Carolina as prisoners of war. They were further turned over to the authorities on Paris Island and incarcerated at Fort Bragg. These German submariners were the second foreign prisoners to be captured off the American coast since the War of 1812.

Currently, this wreck lies in 115fsw, 22 miles out of Morehead City. She is resting on her starboard side amongst a white sand bottom. After patiently waiting two days for the winds to die and the seas to calm, we finally managed to load our gear aboard the 47-foot crew boat known as the Seaquest Two. She's berthed at the Discovery Diving Company in Beaufort, North Carolina. Our excitement increased, while the engines roared as we pulled away from the dock towards our objective. The sun was out and conditions were great. Upon clearing the drawbridge, we motored out of Bouge inlet. Our skipper opened up the throttles and headed southeast towards the wreck site. The jade colored water of the inlet quickly turned to a pretty azure blue as we ventured further away from land. We passed several large seagoing vessels at anchor, waiting their turn to enter the state port. There was also a contingent of U.S. Marines awaiting transportation to a helicopter carrier anchored in the same area.

As the shoreline disappeared, several small pods of dolphin appeared from the depths and playfully danced in the bow wake of our boat. Flying fish could be seen gracefully soaring in and out of the smooth chop as the diver-laden crew boat skimmed easily over the calm seas.

We arrived an hour later to the site and our mate quickly hooked the wreckage. Because of their smooth construction, submarines can be a little tricky to grapple into, but the decaying hull of this particular wreck made snagging her relatively simple. Upon gearing up, we stepped off the boat and quickly descended the line. Current was minimal and the visibility was a pleasant 60 plus feet. Our bottom mix on this site was 32% nitrox, which gave us a PPO of 1.40 at 115 feet. We planned a total run time of 60 minutes. This included a 10-minute deco stop at 10 feet and 5 more minutes for additional safety. This is not hard to do in warm, fish infested waters.

The sub began to come into view at around 60 feet. Her presence was surreal resting below, slightly poised towards her starboard side. We were hooked in just forward of the conning tower, where the deck gun used to be located, until its recovery by G. Purifoy of Olympus Diving in Morehead, City.

What a spectacular sight it was eyeing this huge metal killing machine now frozen in time on the sea floor. The excitement was paramount, to say the least. At 105 feet we gently settled onto her narrow deck and carefully checked our gear.

Her ghostly outer skin was badly corroded, exposing an intact pressure hull. We further revealed that all hatches were open to the sea, which invited penetration.

Torpedoes were seen protruding from the forward broken section of the hull and within easy access. Some of these were disarmed by United States Navy divers years ago, but few still remain live. As a word of caution, divers should never tamper with any ordinance encountered while diving this wreck or at any other dive site. Many years of being underwater makes explosives quite unstable; besides, the boat captain will get a little upset if you board his boat wielding a live shell.

I would also strongly advise against any penetration into this wreck. The hatches are small and extremely tight to enter, especially with doubles on. You may get lucky and squeeze in, but even worse, you might get stuck trying to exit. Believe me, I realize the allure of open hatches, but it is not worth losing one's life. Additionally, the interior is filled with fine silt, which when slightly kicked up will reduce visibility to zero, causing even further problems. So without a second guess, we decided to play it safe and remain on the outside of this steel war grave. Hard and soft corals now surround the rusted remains, providing a living, breathing underwater ecosystem. The transformation from a device of destruction that took life, to an artificial reef that now sustains life, is a diver's dream come true.

A large four-foot amberjack slowly cruised by us as massive clouds of silversides were safely grouped together. During the course of the dive, I found myself, along with a few other divers, completely absorbed into their mobile colony. The feeling was unique as they quickly surrounded your entire body, blocking out the majority of ambient light. As they performed their undulating dance, you felt slightly off balance with no fixed reference to maintain equilibrium. Black Sea bass and grouper were also seen in and around the structure, along with many mini schools of small brilliantly colored tropicals. We even spotted some ling, which reminded us of our New Jersey underwater world. Leaving the sub's deck, we slowly descended to the sand, reaching a maximum depth of 115 feet, where we slowly swam aft on the underside of the hull, shining our lights against its corroding carapace. There hiding in a decayed pocket of the hull was a medium sized slipper lobster. Unlike its clawed and spiny relatives, this crustacean had two small, flat, slipper-like appendages protruding forward from its head, hence the name. It slowly retreated as my light illuminated his prehistoric looking exoskeleton. I understand they also taste good!

There were also microcosms of macro subjects on every inch of the wreck's covering. Further aft, half buried in the sand was the remaining propeller, which was secured to the shaft with the largest brass nut I have ever seen. Only a single blade of the three-bladed bronze propeller was exposed. Several years ago the other prop was recovered by a group of divers that worked for over a year to salvage it.

Our time to return topside was inevitable. Returning to the line, we slowly ascended hand over hand towards our first deco stop. I was still mesmerized at the magnificent sight of the U-352, as its presence slowly faded away.

During our decompression, several four-foot barracudas accompanied us, while our computers did their magic. One member of our group switched over to 70% oxygen to speed his deco, but the rest of us were in no hurry to leave this remarkable underwater world. Memories of the dive were permanently etched into our minds as we sadly exited the water. All aboard seemed equally impressed with diving the U-352.

One can not forget that wreck is also a war grave. Remains of the men who died fighting for their country are still present. When visiting this wreck, it is important to please respect this site, taking only photographs.

Several charter boats from the Morehead City and Beaufort areas will gladly take you to this wreck and many others.

For your credit card number security please fill out the desired card, cut out and mail in an envelope to:
Advanced Diver Magazine
P.O. Box 21222 Bradenton, FL 34204-1222
Call Toll Free 877•808•3483 Fax at: 941-753-6419
E-Mail: AdvDvrMag@aol.com
www.AdvancedDiverMagazine.com

Advanced Diver Magazine Subscription Card

Complete Card, place in enclosed envelope and mail:
Adavnced Diver Magazine
P.O. Box 21222 Bradenton, FL 34204-1222
or Call Toll Free: 877•808•3483
or E-Mail: AdvDvrMag@aol.com
or Subscribe Online: www.AdvancedDiverMagazine.com

CHECK BOX
- ☐ 1 Yr (4 issues) $25.00
- ☐ 2 Yrs (8 issues) $45.00
- ☐ 3 Yrs (12 issues) $65.00

Canada and Mexico add $15.00 per year, other foreign add $25.00 per year

PLEASE PRINT CLEARLY

Name ____________________

Street ____________________

City ____________ State ________ Zip ________

Country ____________________

Phone ____________ Email ____________

Payment Method ☐ Visa ☐ MC ☐ AMX ☐ Discover ☐ Check

Card No. ____________ Exp. Date ________

Signature ____________________

Advanced Diver Magazine Retail Card

Become an ADM retail facility and receive both a FREE DIVE FACILITY LISTING, a FREE INTERNET LISTING on ADM ONLINE and a FREE ONLINE LINK from ADM's web site to your web site. (free web site link requires a free link from your site to ADM Online also)

PLEASE PRINT CLEARLY

Instructions: Fill in the boxes below. Each line is allowed 30 characters only. Text should be entered as you would like it to read in the magazine and web site.

ADM P.O. Box 21222 Bradenton, FL 34204-1222 Ph: 941•751•2360

Dive Facility Name

Street Address

City, State, Zip

Phone / Fax or Email

Web Site Address

For your credit card number security please fill out the desired card, cut out and mail in an envelope to:
Advanced Diver Magazine
P.O. Box 21222 Bradenton, FL 34204-1222
Call Toll Free 877•808•3483 Fax at: 941-753-6419
E-Mail: AdvDvrMag@aol.com
www.AdvancedDiverMagazine.com

Imagine a dive computer so small you can wear it all the time.

(And, yes, you can even use it to *tell* time.)

The new NiTek C packs nearly all the features of our standard NiTek into a convenient package that's small enough to wear all the time — just as you would a watch. Among the first things you'll notice about the NiTek C is how incredibly light it is. This is because its case is carved from a solid block of titanium. As with all Dive Rite computers, you access NiTek C functions through the use of two, readily accessible push buttons. The NiTek C is so easy to use, you can quickly get up to speed on its functions by consulting a simple flow chart.

Unique to the NiTek C is its Timepiece Mode, in which it displays date, time of day and day of the week. Because of this feature, most NiTek C owners wear theirs all the time, in lieu of a watch.

For diving, the NiTek C's FO_2 can be set to Air, EAN22 through EAN50, or a Gauge Mode in which it functions solely as a depth gauge and bottom timer. This makes the NiTek C a valuable companion to Dive Rite's NiTek³, providing users with backup depth and time information when making multi-gas dives.

SINCE 1984 • ALWAYS THE GENUINE ARTICLE • "EQUIPMENT FOR SERIOUS DIVERS" •

Dive Rite

www.diverite.com

117 West Washington Street • Lake City, Florida 32055
Phone (904) 752-1087 • Fax (904) 755-0613

Dive Different. Dive Better.