Humpbacks

— The Tale of a Drive-by Fluking

Text and photos by Scott Jahnson

CLOCKWISE FROM ABOVE: Humpback calf watching its mom and their escort; Humpback calf at the surface; The massive fluke of an a adult humpback. PREVIOUS PAGE: Humpback whale slowly swims by for a close look

Humpback whales (*Megaptera novaeangliae*) are intelligent, communicative, aerobatic, social, curious, playful and sometimes devious mammals that can grow to 16 meters in length, weigh 41tonnes (41,000 kg) and live over 50 years. The Dominican Republic's Silver Bank and Tonga are the prime destinations to snorkel with these magnificent creatures. North Atlantic humpbacks annually migrate thousands of kilometers south to the Silver Bank, a relatively shallow (less than 35 meters in depth), 500 square kilometer area located almost equal distance (105 kilometers) between Grand Turk, Turks and Caicos and the northern coast of the Dominican Republic. The whales may stay there from mid-December to mid-April to mate or have calves. The Dominican Republic wisely recognized the importance of this national treasure by establishing the Sanctuary for the Marine Mammals of the Dominican Republic via legislative acts in 1986 and 1996.

CLOCKWISE FROM ABOVE: Humpbacks regularly slap their flukes at the surface (called tail lobbing); Calves are often more inquisitive than their mothers or any accompanying male escort. Humpbacks breach more than any other species of whale

My visit to Silver Bank is aboard the *Turks and Caicos Aggressor II*, one of only three vessels with the necessary permit to enter the sanctuary. Amanda Bryan, the *Aggressor II's* captain and my inflatable boat guide for the day, spots a mother and calf slowing swimming toward us.

Inflatable guides are invaluable in facilitating safe and successful encounters for both humans and whales. A guide looks for a whale or whales that might be receptive to the presence of snorkelers, positions the inflatable near the humpbacks projected path, then instructs the six to eight guests to slowly enter the water and wait for the whales to approach. Humpbacks dictate the proximately and duration of any encounter.

Amanda tells us to get ready as she moves the inflatable a little further from the whales. I am the last snorkeler to slip over the side. After retrieving and adjusting my camera system, I look back to Amanda to see if the whales are still headed our way. She smiles, nods in the affirmative and then quickly turns to her right and points excitedly. I do not see anything on the surface, so stick my head in the water to scan the area. In seconds, two adult humpbacks are almost upon me.

The largest whale is a 13-meter female and the second is her 10-meter male escort. She is obviously in the area looking for a mate, and he is trying to convince her of his prowess. The male is more cautious and does not approach me, but the lady is a different story.

She makes a long, lazy circle around me at the surface and then submerges for a dive. As I watch her slowly swimming back up, I am in awe of her sheer size. The whale stops about five meters below me and then begins to turn this thrilling encounter into an episode of the Twilight Zone.

The female humpback turns upside down and stays that way as she resumes swimming in circles. She gets a little closer to me with each passing turn. Next, I hear high-pitched sounds emanating from her and see her belly ripple from one end to the other as if in sync with the sound vibrations. I have no clue what

COUNTER-CLOCKWIISE FROM LEFT: Humpback's bright while pectoral fins seem to glow in sunlight—pectoral fin slapping, like tail lobbing, is another attention-grabbing ploy of humpback whales; Humpback breathing at the surface; Breaching humpback at ploy

this means, but my toes are curling in my fins at the thought of capturing point blank images of this mesmerizing beauty.

When she is only 2.5 meters from the surface, she veers slightly to move directly underneath me. My eyes widen as I see her four-meter fluke (tail fin) behind bend sharply down and then quickly accelerate up towards me. The next thing I know is... impact.

The whale's fluke slams into my chest and simultaneously knocks $15,000.00 worth of camera gear out of my hands, the air out of my lungs, all thoughts from my head and my body up and out of the water. I shake my head to clear it and breathe deeply as the world stops spinning. It dawns on me that something is missing, so I look down to see my hands are no longer grasping the handles on the Aquatica camera housing. Instead, the slightly negatively buoyant housing and attached strobes are sinking.

I gulp a big breath of fresh air and dive. When I reach the housing, it is only a couple of meters from the mischievous whale's head. I warily grab the housing and kick to the surface. As my face feels air once again, I open my eyes to see Lauren, my dear wife, with a camera stuffed in her face. Either she thinks I am dead and is attempting to document the fluking for the life insurance company, or she knows I survived and thinks it is awesome that a 33-tonne (33,000 kg) whale just kicked my ass.

Humpback attempting to defeat gravity, yet again

As I pat my chest and abdomen to make sure I am indeed still in one piece, the female humpback returns to the surface upright and starts another game of ring around the human piñata. Still breathing hard, I keep my eyes on her and wonder what comes next. She is only a few meters away when she comes to a stop and rolls ever so slightly to her right. The whale looks at me, into me, with her large, twinkling left eye and in my mind, I hear her say, "Now you know your place in the scheme of things." Then, she slowly swims away. I feel both deeply honored by her attention and pretty ticked she did not stick around for a few parting pictures.

In retrospect, my humpback admirer or assailant (take your pick) clearly knew what she was doing. If she intended to harm me, she could have crushed my body almost effortlessly. I still have no idea why she singled me out. Maybe she saw a reflection off the dome port of my housing. Maybe she had just left a wild whale party and was looking for some kinky action. I really do not know. Even so, I feel blessed to have been soundly fluked by a humpback whale because I now have one whale of a tale to share with others. ■

Lauren Johnson, Piers Van der Walt and a guest watching me get fluked

Scientists baffled by stunning accuracy of 10,000-mile migrations

Do humpback whales use the stars to navigate?

Traveling thousands of miles in an astonishingly straight line, humpback whales may be utilizing the sun, moon and stars for assistance.

Using satellite technology, scientists have tracked 16 tagged whales as they migrated thousands of kilometres northwards from the South Atlantic and South Pacific but have, until now, been baffled as to how they manage this feat with such uncanny accuracy.

Straight course

New research has revealed that the huge mammals may use a combination of the sun's position, Earth's magnetism and even star maps to guide their journeys, which can be up to 10,000 miles.

In a series of experiments conducted between 2003 and 2010, the majority of the tracked whales maintained a virtually arrow-straight course, never deviating more than five degrees from their migration courses despite the effects of weather and ocean currents. Writing in the Royal Society journal, *Biology Letters*, Travis Horton from the University of Canterbury stated: "They are orienting with something outside of themselves, not something internal."

Most long-distance travelling animals are believed to navigate using a compass based on either the Earth's magnetic field or the position of the sun. However, scientists have stated that neither method could account for the extraordinary navigational ability of humpback whales, suspecting the mammals use a combination of all three. The Earth's magnetism varies too widely to explain the straight lines and solar navigation needs reference points not available in the water.

They wrote in their paper: "It seems unlikely that individual magnetic and solar orientation cues can, in isolation, explain the extreme navigational precision achieved by humpback whales. The relatively slow movements of humpback whales, combined with their clear ability to navigate with extreme precision over long distances, present outstanding opportunities to explore alternative mechanisms of migratory orientation based on empirical analysis of track data."

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Humpbacks feed during the summer near polar oceans and migrate to warmer tropical oceans for the winter where they mate and calves are born. ■

Edited by Kelly LaClaire

Over the past decade, the number of white dolphins has continued to drop due to over fishing, pollution and loss of habitat resulting from previous land reclamation projects for industrial projects

Endangered dolphins collide with industrial growth in Taiwan

TAKORADEE / GNUFDL / CREATIVE COMMONS

You may have heard of the Chinese white dolphin, especially due to recent environmental efforts to protect their dwindling numbers. But did you know that the island of Taiwan has its own sub-species of resident white dolphins? Did you know there are less than 100 left? Neither did I.

While looking over worldwide cetacean news, I happened upon a few small stories printed in a Taiwan newspaper following the chronicles of a genetically distinct population of critically endangered white dolphins, also called Sousa Chinesis or Indo-Pacific humpbacks. According to reports, these incredibly rare dolphins live only in shallow waters three to five kilometers off the island's western shore and do not cross the Taiwan Strait to mate or feed with other white dolphins that reside near mainland China's rivers. Instead, this isolated group lives in two "hot spots" of a relatively small section of Taiwan's coast and migrate back and forth in small pods throughout the year.

Chinese white dolphin

What's at stake?

Directly in the center of this migration path lays the proposed sight of Kuokuang Petrochemical Technology Company's new oil refinery that would require reclaiming roughly 4,200 hectares of coastal wetlands and is estimated to produce 12 million tons of carbon dioxide a year.

Removal of such shallow waters or intertidal waters reduces the size of their habitat

"Removal of such shallow waters or intertidal waters reduces the size of their habitat," said Peter Ross, chairperson of an advisory committee working to protect the dolphins. "The removal of wetlands can destroy fish habitats and thereby reduce food availability."

Ross and his team recently submitted a comprehensive report to the government detailing new surveys conducted in part by Taiwan University's Institute of Ecology and Evolutionary Biology. Their findings concluded that over the past decade the number of white dolphins has continued to drop due to over fishing, pollution and loss of habitat resulting from previous land reclamation projects for industrial projects. Exact numbers could not be obtained but estimates put the number of extant dolphins at only 60-90.

The removal of wetlands can destroy fish habitats and thereby reduce food availability

The paper went on to suggest that all areas of shallow waters used by the dolphins, including channels of migration need to be protected from industrial encroachment and large scale fishing or Taiwan could see that number drop fifty percent by 2025. "For such a small, isolated and threatened population, priority habitat should not be limited to areas of particularly intensive dolphin use or high dolphin density."

Further exacerbating the problem is the small number of babies females have during their 30-40 year life span. White dolphins don't reach sexual maturity until around ten years of age and only deliver calves every three to four years.

What's the solution?

Ross's group and other conservationists are asking Taiwan to designate a section of western coastal waters—including the two hot spots and the migration corridor between them—as "major wildlife habitat" under the Wildlife Conservation Act. According to the act, the original ecological functions of such habitats should be maintained, while construction and land use should be carried out in the manner that least affects the habitat.

Providing greater protection would not only benefit the environment but the commercial activities that depend on it in other ways, said Ross. "Many examples exist where marine protected areas actually lead to increased fisheries production because fish spawning habitats have been protected."

ZUREKS / CREATIVE COMMONS

One group of local environmentalists, meanwhile, are moving ahead with their own conservation efforts. Last April, Tsai Chia-yang of the Taiwan Environmental Protection Union initiated a project to raise money for an environmental fund that intends to purchase the site that Kuokuang wants to reclaim land for development. The Republic of China currently holds the title to that area and is awaiting the results of an environmental impact survey before determining how it will be used.

Under Tsai's plan, individuals pledge to buy shares based on the cost of one square meter of land—NT$119 (US$3.84). That price is about 15 percent higher than what is being offered by Kuokuang Co.

The first phase of Tsai's plan was completed in June 2010, at which time 50,000 people had signed up to buy 200 hectares of coastal wetlands. The second phase of the campaign was launched in September 2010 and is aimed at the eventual purchase of another 800 hectares. The first 200 hectares form a coastal strip along which the white dolphins live and the remaining 800 hectares are essential habitat for the fish the dolphins prey on, as well as for native bird species.

So far more than 6,000 people had registered to purchase shares in the second-phase of the conservation project, Tsai said. "We hope we can get a total of more than 200,000 participants by enlisting other environmental groups, academics and religious groups. Accumulating that number of supporters is a way to tell the government how many people are willing to protect the wetland."

If you would like more information about the conservation efforts or would like to contribute, please visit www.wildatheart.org.tw. ■

SOURCE: TAIPEI TIMES, TAIWAN REVIEW, BBC NEWS

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DAVE GLICKMAN / NMS

Researchers discover whale's breeding grounds larger than expected

Scientists from the Hawaii Institute of Marine Biology and the National Oceanic and Atmospheric Administration have always known that the primary humpback breeding ground for the North Pacific was the main Hawaiian Islands.

However, with the aid of a network of underwater microphones known as ecological acoustic recorders (EARs), researchers from both groups have discovered these breeding grounds extend all the way throughout the Hawaiian Archipelago and into the Northwestern Hawaiian Islands, also known as the Leeward Islands.

Marc Lammers, a marine biologist at the University of Hawaii, said, "A mystery for whale researchers has been where the whales feeding in the summer in the Bering Sea and in the Aleutians off Alaska went in the winter to breed—many just didn't show up in the known wintering grounds. This area in the northwestern Hawaiian Islands might very well be the missing wintering ground people are talking about."

These remote islands extend 1,000 miles northwest from Kauai and are seldom visited by people. Altogether, the area is part of Papahānaumokuākea Marine National Monument, one of the largest marine-protected areas in the world.

"These findings are exciting," continued Lammers. "They force us to re-evaluate what we know about humpback whale migration and the importance of the (Northwestern Hawaiian Islands) to the population."

The endangered humpback whale was once on the brink of extinction because of the whaling practices of the first half of the 20th century. Now, thanks to international protection, their numbers have dramatically increased to about 20,000 whales with 8,500-10,000 of those visiting the Hawaiian waters for breeding purposes.

Scientists are now analyzing the characteristics of the recorded whale songs from the Leeward Islands to see if the humpbacks in this new area are an extension of the existing population—the ones known to breed around the main Hawaiian Islands—or a completely distinct group.

"Understanding if they're separate populations or not is very important, as right now regulatory agencies are discussing whether humpback whales should be delisted from the Endangered Species Act or not, and they want to get a good idea of all the stocks of whales out there for such a decision," Lammers said. ■ SOURCE: UNITED PRESS INTERNATIONAL

World's only known hybrid wholphin gives birth

On December 23, Kekaimalu, the world's only known whale-dolphin mix, gave birth to a playful female calf at Sea Life Park Hawaii. The baby has yet to be named but is in perfect health and already the size of a one-year old bottlenose dolphin.

The young wholphin is one-fourth false killer whale and three-fourths Atlantic bottlenose dolphin. Her skin is an even mixture of a dolphin's light gray and the black coloring of a false killer whale. Trainers say she is very energetic and playful as well as being twice as large as her playmate—a "pure" baby dolphin who, along with her mother, share the mom-and-baby pool.

The calf is still dependent on her mother's milk, but has already been seen taking capelin from the hands of trainers and playing with the fish. All nursing takes place underwater, and typically continues until the calf is 12-18 months old.

About the whales

Kekaimalu, whose name means "from the peaceful ocean," is a 19-year-old wholphin—the result of a surprise coupling between a 14-foot, 2,000-pound false killer whale and a 6-foot, 400-pound dolphin. The whale and dolphin were living together in a shared tank at Sea Life Park when the mating, unseen by the trainers, took place. No one knew it had even happened until the hybrid species was born.

Although false killer whales and Atlantic bottlenose dolphins are different species, they are classified within the same family by scientists. "In terms of taxonomy (the science of classifying animals by characteristics) they are not that far apart," said Louis Herman, a leading expert in the study of marine mammals. He also stated that there have been unconfirmed reports of wholphins in the wild.

Kekaimalu is a perfect mixture between the two species: she has the coloring of both parents, weighs 600 pounds, is ten feet long and has 66 teeth (false killers have 32-44 and bottlenose dolphins have 72-104). She is also very smart. John Oakley, a Sea Life Park trainer, has worked with the wholphin since she was young and commented, "She's one of the brightest animals I've ever worked with."

Kekaimalu's calf was sired by another Atlantic bottlenose from the park but until researchers do genetic testing they will not know exactly which one.

"We are extremely excited about the birth of the baby wholphin. Mother and calf are doing very well," said Dr Renato Lenzi, general manager of Sea Life Park. "We are monitoring them very closely to ensure the best care for them."

The training and veterinary staff have spent long hours at the park over the first few months of the calf's life collecting a tremendous amount of data and ensuring that mom and calf were provided with the best care possible.

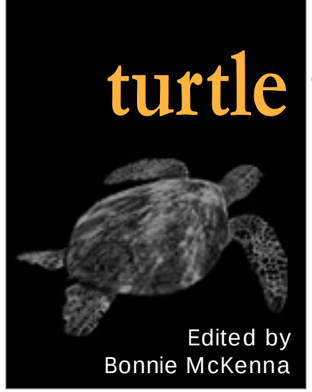
"Over the first 100 days of life of this calf, we had invested more than 2,400 hours of trainers and veterinary time to ensure the best care for mom and baby," Lenzi said.

Sea Life Park officials said they hope to decide on a name for the baby wholphin soon and move her to a large display tank in a few months. ■ SOURCE: USA TODAY, CBS NEWS

MARK INTERRANTE / CREATIVE COMMONS

Wolphin, Kawili Kai, seen here at nine months old, was born at Sea Life Park in Hawaii. Her mother, Kekaimalu, is a wolphin and her father is a bottlenose dolphin

turtle tales



Edited by
Bonnie McKenna

The number of animals killed or sickened by the BP oil spill underestimated

According to the Center for Biological Diversity, an environmental group based in Arizona said in a study they recently released that they found five times as many sea turtles, ten times as many birds and 200 times more marine animals were injured or died as a result of the BP oil spill.

BP faces civil penalties based, in part, on the number of wildlife and fish killed or harmed by the spill.

The U.S. government's counts have not been updated this spring. The group added the numbers of birds, turtles and dolphin carcasses that are washing ashore to the official tallies. Those numbers have been multiplied by "accepted scientific multiplication factors" to reach the Center's "mortality counts".

By the Center's estimate, the spill caused harm or death to 6,165 turtles, 82,000 birds and as many as 25,900 marine mammals.

Tallies released by the United States in mid-February indicate 1,146 sea turtles, 9,209 birds and as many 128 dolphins and whales were harmed or killed as a result of the oil spill.

Scientists say that studies relying on multipliers for exact counts are impossible due to the number of carcasses that sink into the ocean, rot unseen in the marshes or are consumed after death by predators. ■

Leatherback nests increasing in Florida

There are 68 beaches in Florida that are known leatherback sea turtle nesting site. Although some beaches saw an increase in the number of nests as high as 16 percent, the average number of nests increased by 10.2 percent a year since 1979.

The Duke University Center for Marine Conservation said the news is very encouraging for the Atlantic leatherback populations.

The growth has been, in part, as a result of better monitoring and protection of the nesting beaches over the past 30 years. Surprisingly, nesting is increasing even where beach protection is not enhanced. Climate change and the changing ocean may be altering the marine food web and creating a more favorable environment that favors the leatherbacks by reducing the number of predators and increasing the number of jellyfish.

Kelly Stewart, lead author of the study, said with plenty of jellyfish, breeding-age females may be able to build up fat reserves quickly and nest with more frequency.

Reduced populations of large predators such as sharks may be playing a role in the turtle boom by decreasing at-sea mortality for juvenile and young adult turtles.

Despite being a small population, scientists estimate fewer than 1,000 leatherbacks nest of Florida beaches.

The news for leatherback populations elsewhere is not encouraging. Populations in the eastern and western Pacific have plummeted to the point that species extinction may be imminent. ■

150 turtles trapped in net, die

Approximately 150 Olive Ridley turtles were trapped in a single net and found dead on Kothapeta Beach in Bangalore, India. The village leader said he never saw so many dead turtles in his life and blamed fishermen for not taking preventative measures. The founding chairman of Visakha, the society for the prevention and care of animals, said the disaster took place because the trawlers did not use the turtle excluding devices. ■

Cities like San Francisco and countries like Italy and Australia as well as businesses like Target are banning the plastic bag.
See video >>>

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Our plastic food chain — or the turtle that pooped plastic

In March, ocean pollution experts met in Hawaii, among the discussions was a new report chronicling the effects of decades of plastic pollution, its effect on sea turtles and what we can do about it.

In 2009, marine biologists with Disney's Animal Programs discovered a green turtle that was having difficulty digesting food. Upon examination they found that a piece of plastic had lodged in the turtle's gastrointestinal tract. After removing the obstruction, the turtle defecated 74 foreign objects in the subsequent month. Among the items were four types of latex ballons, five different types of string, nine different types of soft plastic, four different types of hard platic, a piece of carpet-like material and two tar balls.

The list of items from this one turtle read like a catalogue of a growing concern for virtually all marine animals. Single-use-plastics are having a lethal effect on animals living in the sea.

NOAA

At the meeting scientists laid out the entire disturbing history of plastics in the ocean, from the first reports in 1972 to the latest surveys of today. The report was grim, but it provided a ray of hope in the form of proactive ways that should be undertaken to curtain the overproduction and careless discard of single-use plastics.

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While the scientists acknowledge that certain plastics have done good in the world, they lay the blame at the feet of the so-called "disposable" plastics: water bottles and caps, grocery bags, plastic utensils, etc—all intended for single use then thrown away. Although these plastics are cheap and convenient, they are durable and buoyant, leading to a potent and deadly combination in water.

Though plastics do break down from exposure to sunlight and other elements, the molecules of plastic never fully biodegrade, they just break into smaller pieces never to disappear. Many of these small pieces and particles eventually find their way into tributaries that feed into the oceans where plastics coalesce into the ocean currents. Here, they remain floating virtually forever and are often ingested by the creatures of the sea. Once in the guts, they can do harm or even kill, animals such as sea turtles.

The facts are: more than 1 billion single-use plastic bags are distributed free of charge—daily. An estimated 0.2 to 0.3 percent make their way to the ocean. Even this small percentage means hundreds of millions of bags each year are floating in the sea. This crisis has had a deleterious effect on sea turtles who mistake the plastic for jellyfish, their favorite food.

All seven species of sea turtles are listed as endangered on the World Conservation Union's "Red List" of species in danger of extinction. A situation made worse by the pollution of plastic in the oceans.

Worldwide, plastic pollution is adding to the stress on all endangered ocean wild life. Plastic can be ingested or ensnare sea turtles and can physical interfere with their nesting activity on beaches where plastic pollution accumulates in large amounts.

Approximately half of all sea turtles surveyed had ingested plastic, and micro-plastics are accumulating in mollusks and crustaceans that turtles eat.

Corrective measures to ameliorate or end the plague of plastics in the oceans, according to scientists, are simple personal behaviors, including:

- Avoid plastic-bottled beverages
- Purchase products with minimal or reusable packing materials
- Buy in bulk to reduce the packaging
- Buy used items
- Use reusable shopping and produce bags
- For coffee and tea, bring your own mug
- For food, bring your own reusable container

■

On August 2011, the whole globe becomes one huge underwater festival...

Text by Sharon Rainis

Epson Red Sea is known worldwide as the international underwater photography Olympics and has awarded photographers with prizes worth more than US$450,000 during the past six years. Following the success of the competition, as well as the full HD underwater live broadcasts carried out at the recent Photokina Fair, producer David Pilosof has now decided to break all boundaries, introducing an international competition as never featured before.

We are proud to announce the World Shoot-Out and would like to invite all of our media partners to take part in one of the most innovative, creative, international and festive events ever produced!

During the week of the shoot-out, the whole underwater world will be performing as one huge festival, hosting professional and amateur photographers competing with each other for some very worthy prizes, including cash prizes, luxurious diving trips, diving equipment, photo gear and more.

The eight-day World Shoot-Out will take place 1-8 August 2011, in any natural water resource found around the world, including seas, oceans, lakes, rivers, under the ice and more. Any photographer can take part in the competition by diving in a familiar or favourite destination during the days of the shoot-out.

This will be a wonderful opportunity for underwater photographers all around the world to either take a few days off for the sake of some diving in their local area, or to finally book the holiday they've been dreaming of in an exotic dive destination, on a live aboard or in a dive resort.

For more information, visit: ***www.eilatredsea.com*** ■

The Turtle Hospital sign (left)
Turtle ambulance (right)
The hospital (below)

The Turtle Hospital

Text and photos by Bonnie McKenna

Half way down the tiny islands that comprise the Florida Keys is the island of Marathon. There, located in a non-descript area on the main highway is The Turtle Hospital; the only state certified veterinary hospital in the world exclusively for sea turtles.

Behind the pale green façade of the two buildings that make up The Turtle Hospital is a story of determination and survival.

In 1980, Richie Moretti, decided that since he had "a very fast boat" he needed to go to the Keys to assist Cubans, fleeing to the United States, during the Mariel Boatlift. The following year, he returned to Marathon to fish.

Soon he found that he was making the trip to Marathon with more frequency so, he decidedto purchase a small motel that was going into foreclosure.

"I realized the folks living in the motel were happier than I was operating the largest Volkswagen repair shop in the country, so I decided to move down to the Keys full-time," said Moretti.

The motel, built in the 1940s, included a saltwater swimming pool. Moretti soon turned the swimming pool into a home for marine animals. The first resident was a tarpon. Before long, he began adding more fish; a school of tarpon was followed by a snook, a sawfish, grouper, lobsters and eels.

The local schools learned of the pool's residents; they asked Moretti about bringing students for educational tours.

"The groups would come and we would put a conch or starfish in the kid's hands so they could see it was a living animal," he said.

In the mid-1980s, when the Teenage Mutant Ninja Turtles were popular Moretti decided to put a turtle in the pool. Moretti became interested in sea turtles because he had seen many turtles crippled by fishing line, paralyzed by boat collisions, choked by rubbish and suffering with deadly growths. Fibropapillomas were covering the eyes, necks, flippers and the lungs of an estimated half of all the world's sea turtles. He decided, since he had success with other marine animals he could do something to aid these most ancient of creatures that is an endangered species.

The state objected, but Moretti continued to lobby for a turtle to include in the educational program. The state objected because there was no turtle rehabilitator in the Florida Keys.

Moretti then recruited Dr. Elliott Jacobson from the University of Florida, who later became the Turtle Hospital's first veterinarian.

Today, The Turtle Hospital is the only facility of its kind in the world. Moretti and his staff treat injured sea turtles and, when possible, return them to the sea. If release is not feasible, the turtles become permanent residents.

Educational tours are offered four times daily to introduce visitors to the resident sea turtles and to the hospital's programs for loggerhead, green, hawksbill and Kemp's ridley turtles.

In addition to turtle rehabilitation and public education the hospital's goals include conducting and assisting in research that aids sea turtles world-wide.

THE FOUR MAIN GOALS
—of The Turtle Hospital

- Rehabilitate sick or injured sea turtles and return them to the wild.
- Educate the public through outreach programs.
- Conduct and assist with sea turtle research in conjunction with state universities.
- Work for environmental legislation to make the beaches and water safe and clean for sea turtles. ■

CLOCKWISE FROM LEFT: Richie Moretti; Florida sea turtles poster, Operating room; Recovery tanks and saltwater pool; Hawksbill turtle in recovery

"I look at every turtle as something special," Moretti said with a smile, "I love them all."

Moretti funds the hospital with grants, donations from the public and with profits from the motel, Hidden Harbor, which he leases to the hospital foundation for $1 a year.

The Turtle Hospital (Hidden Harbor Marine Environmental Project, Inc) is a 501(c)(3) charitable corporation. The motel provides the space and buildings needed to house and care for the sick and injured sea turtles.

The hospital contains up-to-date equipment enabling veterinarians to perform a variety of surgeries. Most of the equipment has been donated, some by local hospitals, doctors and environmental organizations.

A range of turtle ailments that are treated at The Turtle Hospital include flipper amputations, shell damage repair and the removal of intestinal impactations caused by the ingestion of foreign materials. The most common surgery performed is the removal of debilitating viral fibropapilloma tumors that affect more than 50 percent of the sea turtles in the Keys and around the world.

The Turtle Hospital and the University of Florida are doing cooperative research into the causes of fibropapilloma. It is currently the only known disease affecting wild animals on a global basis. The virus in infectious and is successfully transmitted among sea turtles.

"This is what it takes to kill a turtle," says Moretti as he opens a box and dumps out, on to a table, an eraser, a chocolate wrapper, the insole of a shoe, a pen cap, several sizes and lengths of blue and green twine and rope, a green clothes pin, a crab claw, several pieces of plastic and rubber, a metal grommet and a bag of "Australian milled rice."

"You could see the turtle liked things that are blue and green," said Moretti. "This rice bag was wrapped around the grommet and that is what killed the turtle. All the rest of the stuff was behind it."

Since its founding the hospital has successfully treated and released more than 1100 sea turtles.

For more information on The Turtle Hospital, go to www.turtlehospital.org. ■

THREATS TO SEA TURTLE SURVIVAL

- Monofilament entanglement — Carelessly discarded fishing line can entangle the turtle's flippers and cut off the blood supply. Turtles that ingest the fishing line may die from the hook and/or the line cutting through the intestines.
- Rope and net entanglement — If a turtle becomes entangled underwater and cannot reach the surface, it will drown. The rope and net entanglements also cause flipper injuries.
- Boat hits — The propeller can cause severe damage to the shell, head, flippers and internal organs.
- Oil spills and tar — Chemicals can harm sea turtles by getting into their eyes, mouth and lungs causing suffocation, drowning, toxicity and ultimately death.
- Intestinal impactation — Turtles ingest debris, such as cigarette filters (which look similar to shrimp) and plastic bags (which look like jellyfish); these items can impact the intestines causing death.
- Coastal development — Development along coastal areas can result in damage to nesting sites and cause disorientation from artificial lighting.
- Fibropapilloma tumors — These are soft tissue tumors caused by a herpes-like virus. Green turtles are especially vulnerable, but it has been documented in all species. Tumors may form on the soft tissue, the carapace and/or plastron, internally or on the eyes leaving the turtle blind. ■

Text and photos by Christian Skauge

Space Diving

—*Preparing for a walk in outer space*

THIS PAGE: At the Astronaut Center European Space Agency in Cologne, Germany, Christer Fuglesang and other European astronauts are practising spacewalk

The European Astronaut Centre (EAC) is located just beside the airport in Cologne. The center was founded in 1990 to train astronauts for ESA's manned space missions, in particular in connection with the European Columbus module, which is part of the International Space Station (ISS). Ahead of them, the next batch of trainee astronauts have a 16-month basic training program, and an integral part of this is to dive. Astronauts need to be under water to practice spacewalks, also known as Extra Vehicular Activities (EVA). Diver and underwater photographer, Christian Skauge, paid ESA's Neutral Buoyancy Facility a visit.

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Inside ESA's large compound, there is a number of fitness facilities including a large, specially built pool measuring 22 x 17 meters. This is where EAC's Neutral Buoyancy Facility is based, and this is where the astronauts get their diving certificate. The plant is also used to practice space walks. At the bottom of the ten-meter-deep pool is a mock-up of the Columbus module and an air lock from the Russian MIR space station—both built in a 1:1 scale. The temperature of the water is a pleasant 28°C (82°F).

"Astronauts usually practice in white overalls, full face mask, helmet and using surface-supplied air and communication," explained Uwe Köhler from the company Space Diving Training and Support Ltd., which is responsible for EAC's astronaut training.

The custom-built space suits are too expensive and complex to be used in the general training, and are only used for practising specific tasks to be performed in space. The suits are big and heavy, and preparing for a dive can take a long time. To achieve neutral buoyancy underwater, weights are attached on up to 18 different places on the suit, and the astronaut is constantly being followed by a team of safety divers and specially-trained astronaut trainers in the water. Usually, the astronauts practice basic skills such as moving around in a three-dimensional and weightless environment, the use of safety lines and communication with the control room and other astronauts.

Important training

All astronauts have to go through the

THIS PAGE: To simulate work in space, astronauts practice maneuvering equipment and gear underwater

Space Diving

"Fuglesang is one of several astronauts we've had in the pool with us," explained Sabine Klassen. She is a PADI instructor and part of the team that is responsible for training the astronauts. On weekends, she often works with curious onlookers to guide divers around the facility, providing the necessary introduction to scuba dive with overalls and surface-supplied air. Often, she goes into the pool to make sure everything is okay.

Spacewalk under water

The apprehension was tangible as the first two divers entered the pool. They kitted up on a special submersible platform in the end of the pool, checked their kit and rehearsed the tasks ahead.

The dive was not to swim to enjoy the scenery—all training pool, which is seen as very important. On the ESA's website, the Belgian ESA astronaut Frank de Winne writes:

"Learning the controls underwater is an essential part of the basic training needed to conduct a spacewalk. Everyone going through this programme needs to get a diving certificate, because the conditions under which you work in space are similar to those found under water."

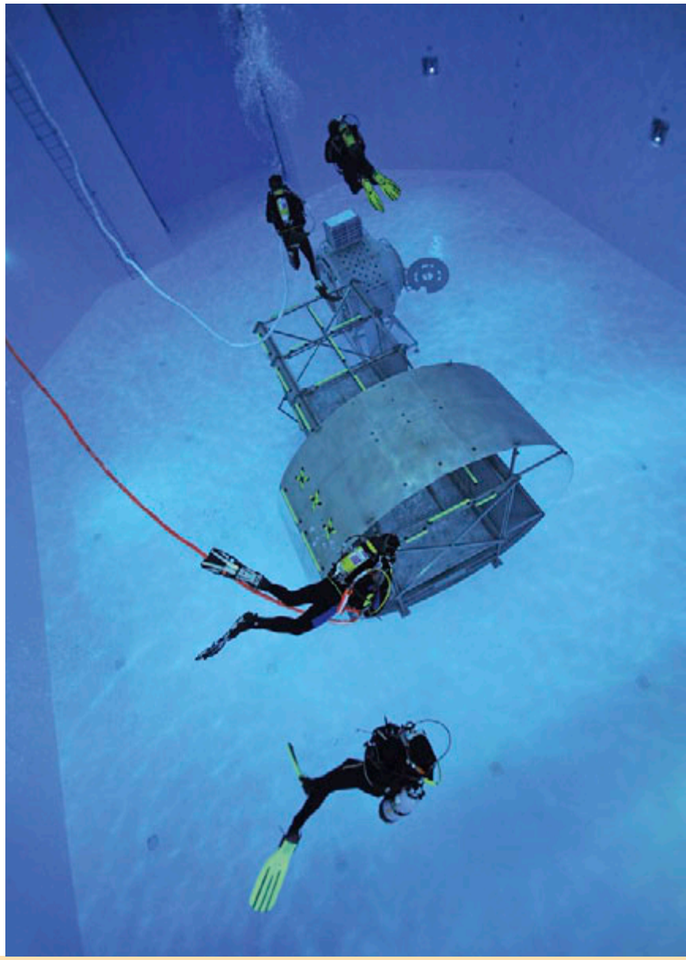
Also for regular divers

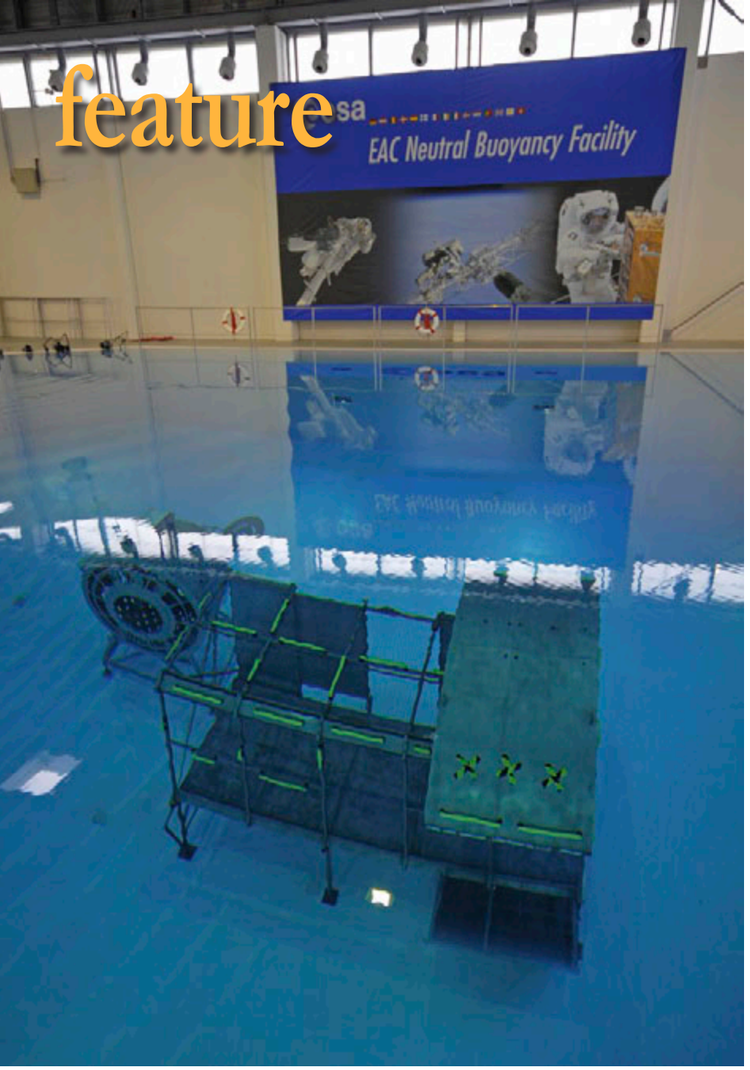
Some fellow divers and I were at ESA's Neutral Buoyancy Facility for a photo workshop held by the German nature and underwater photographer, Eckhart Krumpholz. There were unfortunately no genuine astronauts present—one of them was actually up in space—but time in the pool is offered on weekends to regular divers, who can come and enjoy the pool and workout facilities at close range. Every day, a group of ten to 12 dive tourists from various locations in Germany and Switzerland were given a tour of the facility with the option of playing astronauts in the pool, giving us good opportunities to shoot some footage.

A day at the Neutral Buoyancy Facility costs 399 Euro and lasts for nine hours, and, despite the rather stiff price tag, space diving is very popular. Many dive clubs organize annual trips to this place, as it provides an interesting and fun diversion from diving in lakes, especially for those who have a long way to the ocean.

Fuglesang in space

Christer Fuglesang of Sweden is one of the astronauts who has been trained at the Neutral Buoyancy Facility EACs. When we visited the center in September, Fuglesang was in space, where he performed a repair on the space station. Parts of the training and preparations for the repairs had been done in the pool we dived in, putting an extra edge to the diving.





divers are given a specific task to solve underwater, just like the astronauts. The assignment may be to deploy and retrieve a bag of tools, folding out a solar panel that will not open up or move around different types of equipment at the Columbus module mock-up, which is placed on the bottom of the pool.

In order to make it as realistic as possible, divers did not wear flippers and had to move around in the pool and on the mock-up by using their hands. At all times, they need to remember to clip on the security line that they had attached onto their vests, and they had to always hold on with at least one hand. The astronaut who forgets to do either one of these things risks drifting off helplessly into outer space.

The divers tested communications in full face masks, breathing and making sure the air cylinders on their backs were open and ready for action, just in case anything should happen to the air supply from the surface. Then, they gently descended along the ten-meter-high ladder at the edge of the pool leading down towards the bottom. Once there, they were escorted to the Columbus module by the safety divers and the mission could begin.

The solar panel is defective

The first two divers in the water were probably given the most exciting mission this weekend; they had to "fix" a solar panel that had not deployed. To achieve this, they first had to retrieve a bag of tools that were attached to the roof of the Columbus module, and then move to the top of the MIR module where the solar panel was placed.

Meanwhile, safety lines had to be clipped on, and it was a laborious journey before they were ready for action. Out of the tool bag came a suitable wrench and one of the divers unfastened the bolts that held the solar panel in place. Once the bolts were loosened, the panel unfolded like an accordion and shot towards the surface. Hence, the power supply to the module was secured.

Mission Control

When the mission was accomplished, the divers were guided back towards the ladder and strenuously climbed up to get to the surface. Up on the platform, they received well-deserved applause from both diving and non-diving friends, who had watched it all from the control room

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next to the pool. From here, the entire pool was monitored by a number of video cameras, images from which were displayed on a wall of monitors.

The water boils

Photographers in the workshop were diving with regular diving equipment, and so did several of the visiting divers. Even if the pool was huge, there was at times quite heavy traffic, with both astronaut trainers and spectators in the water at the same time. Everyone was scrambling around the "astronauts" to see what they were doing, and the amount of air bubbles was impressive. From the surface it looked like the water was boiling!

In space, astronauts probably have considerably fewer spectators—but here, they are also on their own and must be capable of coping with tasks unassisted while managing challenging and time-consuming labor handling hardware costing billions. If something goes wrong in space, the consequences are slightly larger than in a pool at the Cologne airport.

For the underwater photographers, it was sometimes crowded, and sometimes sharp elbows were encountered in order to get the good shots. With the limited depth, good time was assured, and with several other "astronaut-pairs" entering the water, good opportunities were provided for wide-angle photography without including too many divers in the background.

Try astronaut diving!

Getting to Cologne was relatively easy and inexpensive, at least for Europeans. The nearby city of Düsseldorf, where trains depart for the Cologne Airport, is one of the major hubs in Germany and in my case, was only a one-hour flight from my residence in Norway. From here, it was only a short taxi ride to the Art Hotel in Porz district, which is just a minute's drive from the entrance to the ESA complex. If you fancy a different kind of diving, space diving is highly recommended! ■

THIS PAGE: Scenes from EAC space diving

FACTS ABOUT SPACE DIVING

TRAVEL / LODGING: We flew to Düsseldorf and took the train that runs between the airports of Düsseldorf and Cologne (approximately 1 hour). Accommodation was found in the affordable Art Hotel just a few minutes drive from ESA headquarters.

DIVING: Diving in the pool's maximum depth of ten meters. Yet, one must be aware of no flight times—use the computer. It is always safest to wait at least 12 hours before flying home.

PRICE: One day (about nine hours) of space diving costs 399 Euro. This includes a guided tour of the facility, the introduction of ESA's activities, a dip of approximately 90 minutes in "astronaut equipment" and the opportunity to dive with standard equipment in the pool.

SEE: www.spacediving.de or www.esa.int

20 years on... *AquaCorps* ...What has changed?

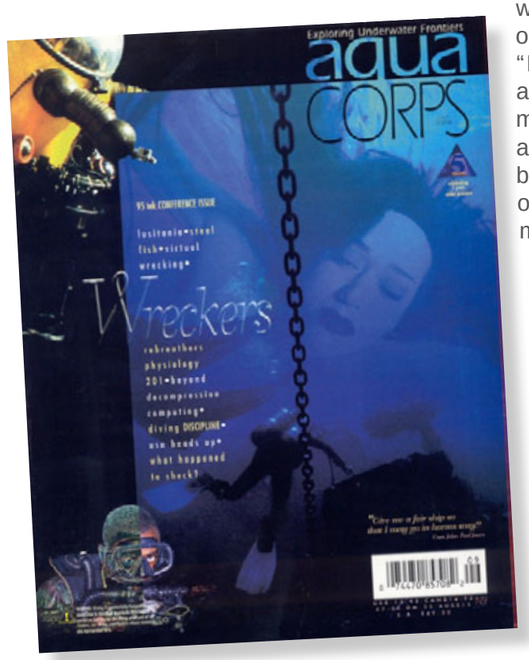
— Reprinted from AquaCorps, *Issue No. 1, February-March 1990*
The Independent Journal for Experienced Divers

Call it "High-Tech" Diving

Some of the most experienced leaders in the scuba world are dead set against releasing information—let alone encouragement—on the diving methods under discussion here.

Text by R.W. Bill Hamilton, PhD.

A new category of diving is taking shape in the recreational diving world that sparks controversy and is a cause of great concern. This, in general terms, is diving deeper and staying down longer than the traditional limits. Although by no means new, for many years it was a cause for concern more than controversy. There was general agreement that it was surely dangerous, was not approved by anyone, and one could say with a clear conscience, "Don't do it". Now methods are coming along that, for the price of extra effort, make it possible to extend both depth and bottom time with what is regarded by some as an acceptable degree of risk, and in comparison with older methods, some tempting efficiencies.



This article describes the new technology, setting the stage for future articles that explore some of these methods in more detail, but it also contains a serious caveat about all this: It has to be done properly, or it should not be done at all.

Limits of traditional recreational diving

Recreational diving is defined by the so-called *training agencies*—the organizations of diving instructors (NAUI, PADI, etc.)—as no-stop scuba diving with air to 40 metres, or 30 feet. Many more experienced divers push beyond that envelope, either by doing longer bottom times that require decompression stops or by going deeper. Although there are often some definite objectives for these dives, they are nevertheless being done for fun, so it still comes under the recreational label. It does not, however, fit within the traditional definition. A new term is needed.

The training agencies discourage the use of the term, *sport diving,* because it implies some sort of competition. A colleague mentioned that he saw two young divers holding onto the bottom with their BCUs inflated, then letting go and racing to the surface. It is appropriate to discourage that sort of competition, just as it is the equally risky practice of seeing who can swim the farthest underwater in breath hold

So, what is *AquaCorps*?

Text by Rosemary E. Lunn

Corey Mears from Light Monkey mentioned it when I was interviewing him. You never know what connections you are going to make through diving, and the path each individual relationship will follow. Flying into Sydney early Saturday morning, I had no idea that a few hours later I would meet Michael Menduno at OzTek 2011. Some of you will be reading this and wondering—and yes, it was him, the one and only Michael Menduno—the rest of you will have absolutely no idea of who I am talking about. Let me fill you in...

Jump back to the summer of 1996 and British Cave Diver Mike Thomas presents me with a copy of aquaCORPS magazine, (and I still have this issue in my office today). It was a defining moment in my diving career. Mike had taken me under his wing, showing me there was more than 30 metre, single tank, recreational, air diving. The aquaCORPS issue was N11, October / November 1995 and I vividly remember being thrilled to learn of a brave new world of diving.

The Man

The power behind *AquaCorps* was Menduno. He conceived and edited "the independent journal for experienced divers", commissioning a crème da la crème stable of knowledgeable diving pioneers to write for him. The resulting prose was greedily consumed by every diver wanting to know more about the evolution of sport diving—the new and exciting movement—high-tech diving.

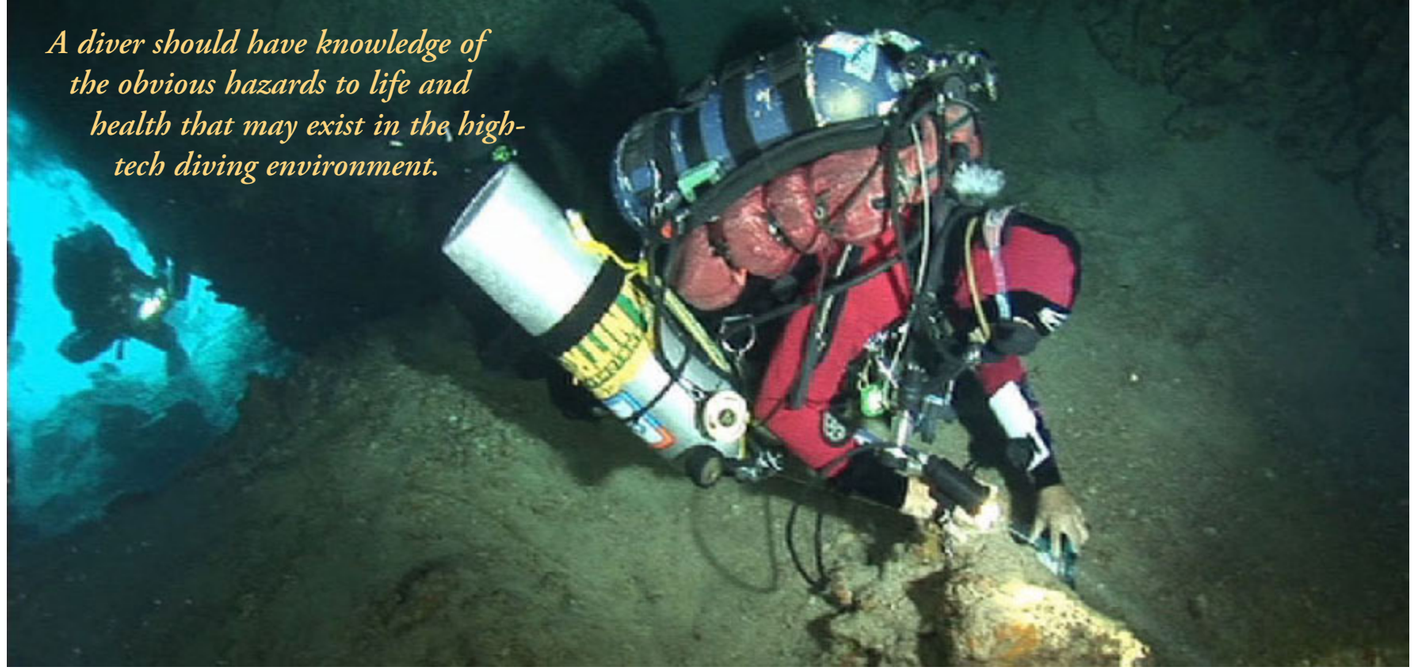
AquaCorps was born at a very exciting time, and it certainly greatly influenced the technical diving revolution of the late 80's to early 90's. *Wired Magazine* described it as "The Sea Geek's Bible", and if you ever wanted confirmation of this, just talk to pretty much any technical diver of note today. They will all agree on one thing—the publication that greatly influenced their personal diving was *AquaCorps*.

Bumping into Menduno at OzTek was the moment I met a personal diving hero. Later, over a game of pool, I was delighted to discover he was an utterly charming, approachable and generously spirited man. We talked about *AquaCorps*, writing, rebreathers, diving and magazines. Sometimes all the very best things happen over a beer. "Would it be okay for *X-RAY MAG* to republish articles from *AquaCorps*, starting with issue one, Michael?" I asked. "Yes, sure Roz," said Menduno.

High Tech Renaissance

Ironically, we are now enjoying a renaissance in high-tech diving. In the last two years, there's been an explosion in side-mount diving. PADI is now moving into rebreather training, with other agencies wanting to follow the same path, hot on their heels. So, grab a cup of coffee, take your phone off the hook, indulge yourself with a moment of peace and discover what influenced so many of today's leading technical divers. Some of these articles are just as pertinent today as they were when they were penned, and others are a charming look back at how we were. Either way, enjoy this slice of diving history, with many grateful thanks to Michael Menduno and *AquaCorps* magazine. ■

Michael Menduno of *AquaCorps* magazine



A diver should have knowledge of the obvious hazards to life and health that may exist in the high-tech diving environment.

What does it take to be prepared for high-tech diving? Knowledge, practice, the right kit and good planning.

dives. Certainly, advanced divers can practice their sport without dangerous interpersonnal competition, so the term, sport diver, does not meet our needs. Competition is indeed a motivation, not so much for the depth and time records—since nowadays they are limited to those willing to make exceptional efforts—but to be the first in an unexplored cave, or the first to look into a virgin wreck. *Sport* does not fit the bill here.

Two other names seem to be suitably descriptive. One is the possibly underused term, *advanced* recreational diving, which already has many specific meanings, but is perhaps valuable for its ambiguity. This applies to a diver working outside the no-stop, 40-meter (130-foot) limit, regardless of the technique used. The other, *high-tech* diving, relates to the new methods but does not include all situations, since the traditional limits can easily be exceeded with standard gear. The task of picking a single all-inclusive term can be left to others; for now, I am calling dives outside the traditional limits advanced, and those done outside those limits using equipment other than standard wetsuits for thermal protection, as high-tech.

This includes the use of dive computers and new decompression techniques, dry suits, scooters, multiple or over pressurized tanks, as well as special gas mixtures. Use of dry suits and dive computers within the traditional depth and decompression limits can be considered traditional diving, although some special training is needed. While some of these high-tech items are relatively new to recreational diving, many of the terms are old stuff to commercial divers.

The need for competence

Considering the unforgiving nature of mistakes in diving, just talking about advanced and high tech diving has to be done with caution, lest it lead innocent lambs to the slaughter. Therefore, this general topic has to lead off with a note on competence. We cannot proceed without such a caveat.

Somehow it seems unnecessary to warn a novice skier against trying an international head-over-heels flip (some of us do them occasionally without intending to, but that is another matter). But novice divers, it seems from the accident reports do equally risky things, apparently without recognition of the risks involved. Something that may involved just a little extension beyond standard limits, if it seduces a diver into running out of air at depth, can be a great deal more risky than trying a flip on skis. Divers do these things. Therefore, allow me this bit of preaching on competence.

Novice divers, it seems from the accident reports do equally risky things, apparently without recognition of the risks involved.

Before doing a new and dangerous thing, one must be highly experienced in it. The way around this double-bind is practice, something one can do at any level of experience.

High-Tech Diving

Many things can be done with acceptable risk, even flips on skis, by someone competent to do them. But in advanced and high-tech diving, there are many things that seem easy and indeed are easy for experts, but which can involve unacceptable risk for ordinary divers. The bottom line is: divers must become competent in new diving practices before sticking their necks out.

The need for proper knowledge and training is not a new idea. When numerous commercial diving fatalities swept the early days of offshore oil exploration in the North Sea, a number of regulations were issued that addressed proper equipment and procedures. But they had no great impact on the safety record.

The thing that brought about a sharp reduction in fatalities was an emphasis on competence. Although this is hard to define, it was followed by specific requirements for training, certification, and updating of divers and their supervisors. And it has worked. Many of the early accidents were human error, and while it is difficult to legislate that people must not make mistakes, it is possible to ensure that they at least know— and know well—the right way to do risky things.

All this is merely a prelude to a difficult task: to discuss what is happening in advanced, high-tech recreational diving without encouraging people to try things they are not prepared for, and thus, to lead them into situations they cannot handle.

So, in very general terms—you heard it here—don't do it if you do not know what you are doing.

Training and then competence

What does it take to be prepared for high-tech diving? Knowledge, practice, the right equipment and good planning.

First, a diver should have knowledge of the obvious hazards to life and health that may exist in the high-tech diving environment. In addition to knowing when an oxygen mix can be expected to explode, this includes an understanding of the body's physiological limits, first in the classic *black and white* limits, but also in the duration of exposure as well as other environmental and physiological factors.

Necessary knowledge includes the procedures and practices to be used—not just what they are but what they mean, the consequences of deviation, and how best to proceed when things are not going to plan. Familiarity with equipment is also critical—how it works, how to use it, how it should be maintained, and what to do when it malfunctions.

Considering the unforgiving nature of mistakes in diving, just talking about advanced and high-tech diving has to be done with caution, lest it lead innocent lambs to the slaughter.

Next is practice

And I offer this as the proverbial Catch-22: before doing a new and dangerous thing, one must be highly experienced in it. The way around this double-bind is practice, something one can do at any level of experience.

An aspiring advanced diver should practice all the various steps that are required, from reading a table to connecting apparatus. Practice things in parts, then link them together. Practice first with everything right, then with some various different, and finally, with some things out of order. And take small steps; perhaps it is best not to try to stage bottles and oxygen in the water the first time you use your new dry suit.

Consider the pilot of a high performance jet; it may take only a few months of round-the-clock training to learn to fly it, but this practice must go through many stages before real proficiency is achieved. What some world-class divers do is every bit as challenging as flying *Top Gun*; divers have a different task, but they will be just as dead if they screw up.

Much of the high tech in high-tech diving has to do with equipment. It need not be the most expensive, but it has to be right for the job. Know that it is right, and know that it is working and in good shape. Pilots may not take their own planes apart, but they do have to know when the aircraft needs fixing. Likewise, whether or not you design, build

High-Tech Diving

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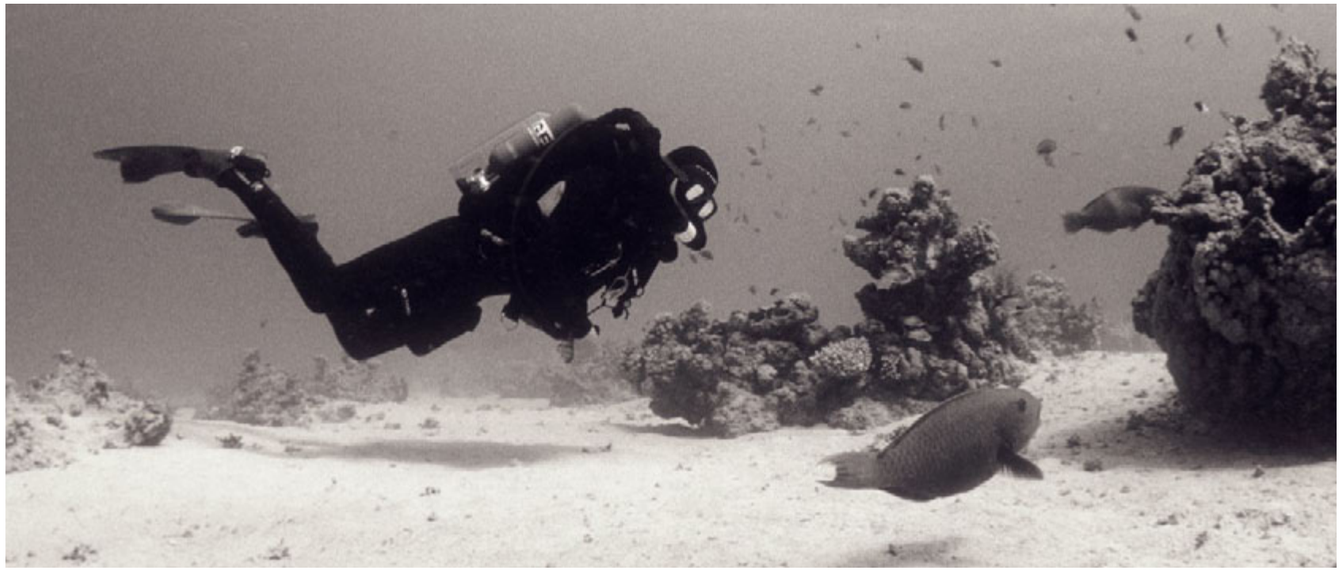


or maintain your own dive gear, you do need to know how to tell when it is—or it is not—right.

The last item on this list is planning, but it may be first in importance. All modern divers get some training in dive planning, and let us hope that they all use it. Planning a high-tech dive is no different in principle, but it can be a great deal more complex. Not much more needs to be said here, just be sure to make planning a fundamental part of every dive.

Getting the technology

It is one thing to instruct new high-tech divers on the importance of learning, it is something else to provide the necessary information.

Likewise, preaching about *the right equipment* does not make it available, nor does it define what is needed. How does one go about getting the information—the knowledge—do to advanced and high-tech diving?

There is no easy way. Some of the most experienced leaders in the scuba world are deadset against releasing information—let alone encouragement—on the diving methods under discussion here. And they are right to be. The word-of-mouth network that gives someone just enough information to get started but not enough to do it right, is extremely dangerous.

Proper textbooks and courses are hard to come by for several reasons. First, most recreational divers shouldn't consider advanced, high-tech diving because they cannot—or will not—get the necessary knowledge and training to do it safely. Second, those who train divers as a profession don't want to add to their own woes; and the average instructor seldom has the specialized knowledge anyway.

Third, the scientific diving community, who, while diving professionally, generally use recreational diving practices; they are not eager to see an excess of recreational diving accidents threaten their programs. A final point is perhaps the most important, things are not well enough developed that a crisp textbook can be written; we basically do not know as much about this as we would like.

Even so, state-of-the-art does exist, and because high-tech diving is here to stay and is going to continue to be used, books and courses will become available in time. Several university diving programs are beginning to move into advanced diving practice, standards are being developed, and the documentation is slowly taking shape.

Organized programs are another approach. At present, virtually all of the high-tech divers are individuals

working alone. Each has his or her own equipment and procedures, maintenance, and planning practices; only when diving with partners will he or she follow the same dive profile as someone else. So in organized groups, individual divers can follow the group's practices and can gain experience with risk reduced to the practical limit. This is not widely available yet, but it is coming.

Another tried and true way to learn new tricks is from someone who already knows how. How do you know if a diver already knows how?

How do you know when your expert is telling you the right things? Obviously you check his track record, find out how he got his training, and how he is regarded by the community.

Our contribution is to offer more specific details in future articles, including a review of the activities being carried out by high-tech diving programs.

Risk

At some point, it is necessary to discuss risk. Diving is a risky enterprise. Like anything else, the risk involved is directly related to the style of the practice. Some automobile drivers go their entire lives without accidents, others have them all the time. Most of the factors that influence driving risk are well-known, with attitude—the strong desire to drive safely—being the most important item. Diving is the same, and the consequences of an accident—a loss of control—are just as serious as in driving.

In a recent talk on fitness to divers, Dr Fred Bove said, "The first guy to be eliminated should be the one who runs out of gas on the freeway." There is no such thing as perfectly safe diving, any more than there is a decompression table with a true zero-bends incidence. The only way to be perfectly safe underwater is to stick to cold showers. But diving can involve an acceptable risk.

Recreational diving, as currently practiced, has less risk than many other activities, both sport and occupational, and the risk is acceptable to most. Advanced high-tech diving will involve a higher risk than routine diving, but the risk can be kept within acceptable limits by having the right attitude and by following guidelines like those given above. If you do not intend to do it in a safe way, then for goodness sake, don't do it at all.

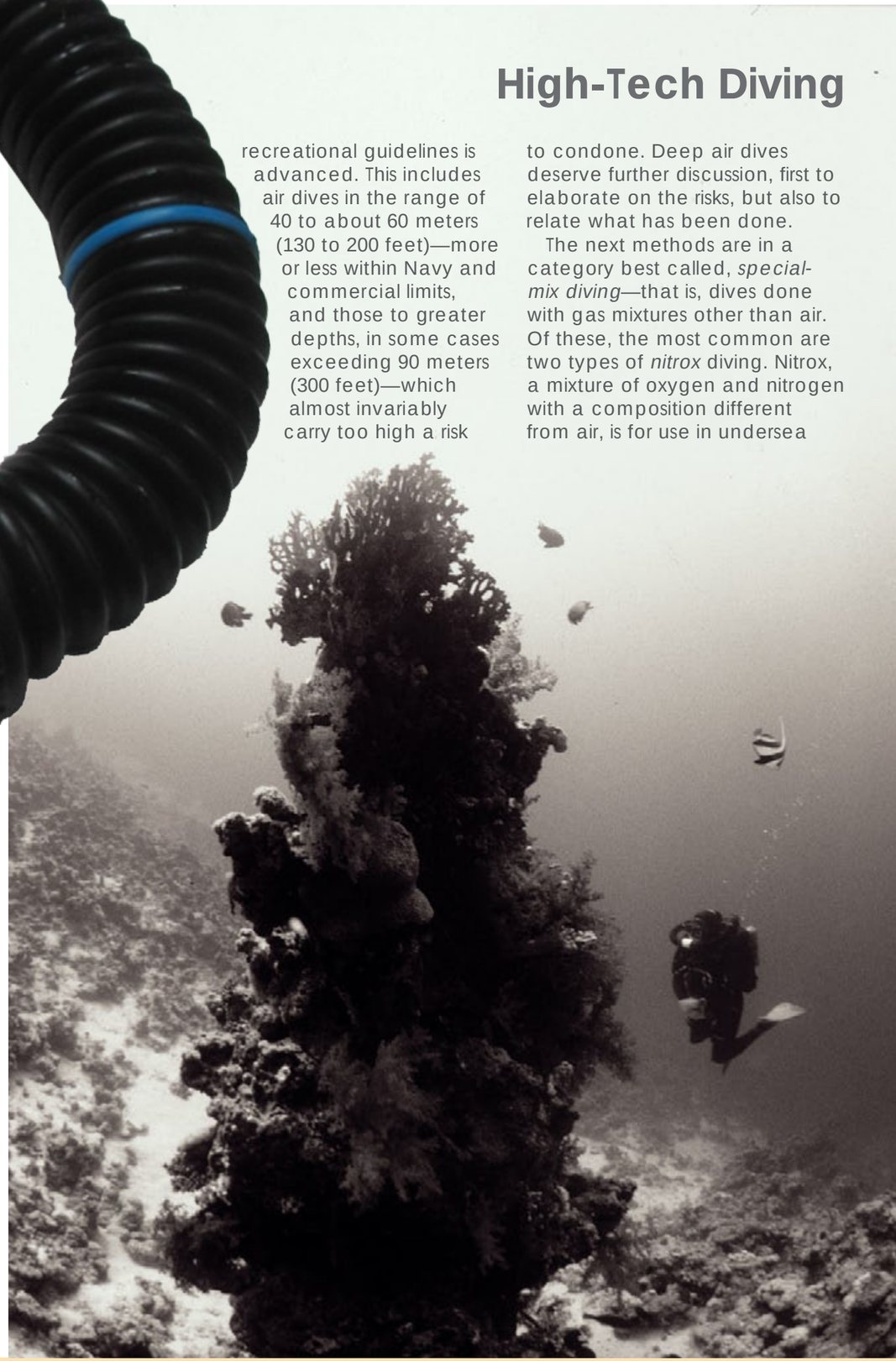
Experience deserves a special emphasis here. Whether they be metallurgy or medicine, practices that work on numerous occasions are generally regarded as *acceptable*. This is certainly the way decompression tables become validated, and other diving practices might follow the same path. Although this is a complex issue, since real depth of experience is generally lacking, the principle holds.

Running out of gas is more serious in diving than in driving, but the point was made. The guy who runs out of gas or suffers frequent fender benders has no business in high-tech diving.

Current high-tech diving practices

For those who have paid their dues and bravely read the sermon, it is now time for a brief discussion of what this is all about. As explained, any proper diving outside the recreational guidelines is advanced. This includes air dives in the range of 40 to about 60 meters (130 to 200 feet)—more or less within Navy and commercial limits, and those to greater depths, in some cases exceeding 90 meters (300 feet)—which almost invariably carry too high a risk to condone. Deep air dives deserve further discussion, first to elaborate on the risks, but also to relate what has been done.

The next methods are in a category best called, *special-mix diving*—that is, dives done with gas mixtures other than air. Of these, the most common are two types of *nitrox* diving. Nitrox, a mixture of oxygen and nitrogen with a composition different from air, is for use in undersea



habitats and has less oxygen than air. This method offers certain specific advantages, the main one being access to the depth range of from 10 to 60 meters with very long bottom times, and little or no decompression following excursions (depending on the depth of the habitat).

The term, nitrox, is also used for a mixture of air and oxygen more properly called, *enriched air nitrox*. This method, or *EANx*, is useful in the range from 10 to about 35 or 40 meters, and allows greatly increased bottom times with no increase in decompression time. It is being used by some university diving programs, is described by the NOAA diving manual, and is beginning to be embraced by recreational divers.

There are two main hazards to EANx, both related to its oxygen content. Since excess oxygen is being breathed, the possibility for toxicity must be accounted for, and handling mixtures rich in oxygen is a fire and/or explosion hazard. Decompression tables for EANx diving can be derived from existing air tables by the *equivalent air depth* calculation, but some advantage can come from custom table computation.

Perhaps the most exciting of the special mix methods are *trimix* and heliox diving. Trimix involves the use of mixtures of helium, nitrogen and oxygen that are appropriate for diving in the range of 50 to 100 meters. At the deeper end of this range, a mixture of helium and oxygen, with little or no nitrogen, is better. Trimix or heliox diving takes considerable operational planning and preparation because of gas logistics, problems and, in most cases, special decompression tables are needed. Logistics applied first at the level of mixing—which takes both skill and equipment—and later, at the level of breathing, since all the gas needed for a deep Trimix or heliox dive cannot normally be carried by the diver.

Still another special mix method involves the use of rebreathers. These supply gas to the diver in a closed or semi-closed loop from which CO_2 is absorbed. They are not readily available to recreational divers, but some scientific diving programmes are beginning to use them, and they have been used for years by many navies. In addition to long in-water times, rebreathers offer the possibility of optimal oxygen level to gain decompression advantages. The need for redundancy in the event of system failure is a problem in some applications.

As mentioned, other high-tech items are having an impact on diving. Dive computers make variable depth diving (multi-level) and repetitive diving more accessible, albeit with meaningful risk of decompression sickness unless certain precautions are taken. Dry suits are making all types of diving more comfortable, and with proper training this is probably with less overall risk. Dry suits are essential for the long dives possible with special mixtures.

With all of these warnings issued, and all of the described parameters met, advanced high-tech diving offers the prepared, knowledgeable diver a change to experience a realm not previously accessible to humans. And there is every reason to think—as our technology and knowledge advance—that we will be able to push the envelope even further. ■

Bill Hamilton, a physiologist with 25 years of specialization in the diving aerospace and environmental fields, has spent much of his professional effort bridging the gap between the laboratory and the field. A resident of Tarrytown, New York, USA, he is the principal in his consulting firm, Hamilton Research, Ltd., where his work includes the development and assessment of commercial, institutional, and government decompression procedures.