

## **TORTUGAS CRUISE 2005**

Measuring the refugia effect of establishing a reserve  
RV Nancy Foster, a NOAA Research Vessel August 1st 2005 to August 13th 2005  
Cruise Number NF-05-15-CCFHR  
Area of Operation: Tortugas Ecological Reserve; Sailing from Key West, FL.

### **Primary Scientific Objectives**

1. Return to the 30 permanent stations (Figure 1) to conduct extensive diver-based surveys, including visual and photo fish censuses, habitat transect Photos, faunal and flora collections for stable isotope analysis, and sediment extractions (qualified crew participation welcome).
2. Conduct light profiles and miscellaneous water column samples at selected stations.
3. Continue coordinated drop camera work and nighttime beam trawling at the northern boundary of Tortugas north in search of evidence for trawling impacts.
4. Deploy and recover herbivory plates at selected permanent stations.

### **Secondary Objectives**

1. Conduct ground truthing for aerial photography using drop cameras around Dry Tortugas National Park (DTNP). May necessitate the use of limited SCUBA diving (qualified crew participation welcome).
2. Fish surveys on Riley's Hump / Tortugas South.

### **Scientists on the Cruise**

- Mark Fonseca (Chief Scientist)
- Craig Bonn (Chief Diver, Biological Technician)
- John Burke (Fisheries Biologist)
- Brian Degan (Biological Technician)
- John Hackney (Biological Technician)
- Shay Viehman (Fisheries Biologist)
- Amy Uhrin (Ecologist)
- Greg Piniak (Ecologist)
- Michael Burton (Fisheries Biologist)
- Abigail Poray (Biological Technician)
- Vanessa Nero (Ecologist)
- Heather Howard (Intern)
- Brad Teer (Biological Technician)
- Eric Treml (Duke University)
- Stopher Slade (FWRI)



**Research Vessel  
RV Nancy Foster**

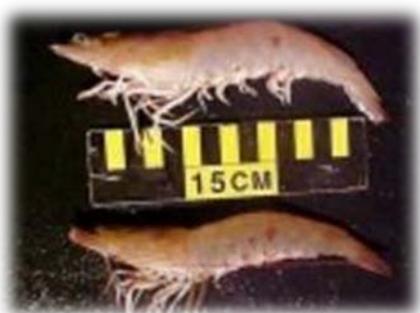
## Day 1, August 1, 2005 TER daily cruise report

After getting under way from Key West and running to the eastern side of the Tortugas Banks we completed two of our permanent stations within the Ft. Jefferson National Park.



**Goliath Grouper**

Divers surveyed the sites and completed censuses of reef and shelf (nearby sand areas) fishes and the attached benthic flora and fauna. Notably we encountered two Goliath grouper one a 5 feet in length that came to see what all the commotion was about. At this size these guys are not shy and we got some good photographs.



**Pink Shrimp**

In the evening we collected video tape records of the bottom habitat at 2 beam trawl sites with our drop video camera . These sites are on the shelf north of the banks located in prime pink shrimp fishing grounds; we are comparing benthic

assemblages of the areas open and closed to fishing. After dark we collected beam trawl samples at two of our permanent sites. We caught a wide variety of crabs and shrimp including some pink shrimp over 8 inches in total length and a variety of benthic fishes; flounders, cusk eels, small sea basses and file fish; we will have to tease out the effects of community complexity to determine the effect of fishing closure. Operations were completed by 1130 PM.

## Day 2, August 2, 2005 TER daily cruise report

The seas around the Tortugas are calm and on the surface 87 F. We took advantage of the calm weather and completed dive surveys of 5 of our permanent sites on the West side of the Tortugas banks. Water at the bottom was considerably cooler than at the surface and very clear.



**Haliophia, and interesting species**

Interesting fish species encountered included midnight and blue parrotfish, spanish grunts, white margate and a school of monster Bermuda chub. We also discovered a meadow of paddle grass, *Halophila decipiens*, on one of our shelf transects. The location of this sea grass at a depth of 82 ft, is a tribute to the clarity of the water of the

region - but the recent passage of hurricane Dennis appears to have disturbed the sand bottom considerably.

Other operations included a cooperative gear recovery effort with Fish and Wildlife Research Institute, a branch of the Florida Fish and Wildlife Conservation Commission. Four sonic tag receivers (VR2 units) were recovered at the location that they were deployed. These receivers, located at depths between 95 and 60 ft, record the location of sonic-tagged lobsters and groupers. Researchers were worried that Hurricane Dennis may have swept away some of 36 that they deployed in April 05. In addition we completed a four fish transect surveys in cooperation with National Marine Fisheries researchers conducting a long term survey of fishes located at permanent sites.



**Horned Sea robin**

During night we conducted drift video surveys and beam trawl samples on the shelf North of the Tortugas Bank. The shelf here is primarily fine sand with areas of silt and clay. Our video records revealed beds of *Caulerpa sertuloides* - a fern like macroalgae that sprouts from runners. At around 150 ft the water is deeper here than at the eastern end of the Reserve. Our beam trawl catches were good, cardinal fishes, cusk and moray eels, sea robins and scorpion fish were abundant. We caught fewer pink shrimp and crabs and more rock

and mantis shrimp than in our shallower eastern samples of the previous night .

### **Day 3, August 3, 2005 TER daily cruise report**

Day break found the RV NANCY FOSTER in calm seas on the west side of the Tortugas Bank. This bank is the smaller and deeper of the two main banks and is located to the west of the larger Monument Bank, near the margin of the West Florida Shelf.



**View from the bridge of the RV Nancy Foster**

The two banks are separated by a trench called the "river", a name derived from the strong currents that occur there. Though the sea surface was glassy at day break, large squalls surrounded us and the deck was wet from a visitation before sunrise. Our third dive of the day was postponed by one of these squalls that can be best described as a frog choker. Today we conducted scuba surveys of five of our study sites; four on the western side of Tortugas Bank and one on the eastern side in the 'River'. We recorded another Goliath grouper today and a number of large mutton snappers. These sightings are encouraging as in our initial surveys,

prior to the establishment of the Tortugas Ecological Reserve, these species were not recorded in our fish censuses.

We are continuing to recover the Florida Fish and Wildlife Conservation Commission sonic tag receivers. Rather than rely solely on a small boat as we did yesterday, today we enlisted the Nancy Foster and picked up the receivers and heavy pedestal with the ship's main winch and J frame. Maneuvering a 186 ft research vessel so the J frame is within boat hook distance of a buoy, with the wind perpendicular to the current, is quite a trick. The men and women of the NOAA corps made it look easy.

Night ops: Drop camera and beam trawl operations were conducted in the NW quadrant of the Reserve and on the adjacent shelf open to fishing. Our stations are closer together in this area and we were able to complete five sets of camera drifts and beam trawl samples. The waters here are around 110 ft in depth and the sediment is fine sand and unvegetated. The bottom is pocked by numerous pits and cone shaped mounds made by polychaete worms and burrowing shrimp. Perhaps the intense bioturbation caused by these benthic animals prevents colonization by macroalgae and seagrass. Pink shrimp were a noticeable part of our catch as were flatfish including a beautiful three eyed flounder, honey comb moray eels, pancake batfish, rock shrimp, portunid crabs and abundant star fish.

#### **Day 4, August 4, 2005 TER daily cruise report**

Awoke to the sound of distant thunder and to find a line of towering thunder heads to our east back lit by the rising sun. Seas were calm and the storms drifted away towards the mainland.



Shay and Brad stowing tanks on board ship

Today we are again scheduled to visit five of our permanent monitoring sites. These survey sites average over 80 feet in depth and require long surface interval between dives to allow nitrogen gas to diffuse from the diver's blood. This prevents formation of bubbles in the blood which can cause decompression sickness or the dreaded 'bends'. As a result, we are constrained in the number of dives we can complete in a day. To maximize the time we can spend at depth we have been using oxygen enriched gas in our SCUBA tanks (32% versus normal, atmospheric 21%). The higher concentration of oxygen in the gas (NITROX 32) that we breathe while diving acts to reduce nitrogen uptake into our bloodstream and tissues.



Hogfish

The afternoon is fair with a light breeze that makes the strong tropical sun bearable for short periods. Dives have gone well with all fish census divers reporting counts of mutton snapper, a variety of groupers, and some monster hogfish. Currently we are retrieving sonar receivers but have two more scuba surveys scheduled . I've got to gear up to visit the deep.

Night ops: Working in the North East quadrat of the reserve we completed video observations and beam trawl samples at four of our shelf monitoring stations. We are consistently finding higher densities of very large pink shrimp within the Reserve than outside it. Such large shrimp are in their second year of life and serve as brood stock for the next generation. We expect that providing these large pink shrimp a sanctuary from fishing mortality will insure the productivity of the shrimping grounds in the future.

### **Day 5, August 5, 2005 TER daily cruise report**

Another five stations are scheduled for sampling today. Our goal in monitoring the fishes and habitats at the interface of bank and shelf in the Tortugas is to document the response of both the bank and shelf communities to the establishment of the Tortugas Ecological Reserve.



**Grazers in the halo**

The study's design focuses on the transition zone (ecotone) between the bank and surrounding shelf in recognition of the ecological linkage of these habitats. One way that energy passes between the two systems is through abundant reef species that shelter on the bank during the day and forage on the shelf at night. Our analysis of the tissue of these species indicates that the benthic micro and macroalgae common to the shelf provides the base of the food web for these reef species. We suspect that an increase in predator populations caused by the establishment of the Tortugas Ecological Reserve (TER) will affect shelf communities through increased predator pressure and an increase in flow of energy from shelf to bank. By monitoring changes in both the bank and shelf communities at their interface we can monitor the larger ecological impact of this marine protected areas (MPA).

One manifestation of the ecological linkage between the bank and shelf habitats is the maintenance of a vegetation-free halo, by foraging reef dwellers, on the shelf immediately adjacent to the banks. We are measuring the amount of grazing activity by herbivorous fishes using Grazing Pressure Assessment Units (aka 'GPAU's'). GPAU's are made by attaching 5cm 2 strips of the seagrass *Thalassia testudinum* ('turtlegrass') to a wire mesh-covered brick. We are

deploying GPAU's at interface stations both in and outside the reserve at distances of 0m, 5m, 15m, and 30m from the reef. Collection of the units will proceed 3-4 days after deployment. Any remaining seagrass will be measured to determine how much plant matter was consumed by herbivorous fishes.



Grazed *Thalassia*

Placing the GPAU's at different distances from the reef will help us understand herbivore feeding patterns and their grazing impact on shelf. By comparing herbivore feeding patterns and intensity in reserve and non-reserve areas we can determine if grazing pressure of herbivores is higher outside the reserve where their predators, fishes such as snappers and groupers, are exposed to fishing.

Night ops. Night operations consisted of drift video and beam trawl sampling around the north central boundary of the Ecological Reserve. Depth was 20 fathoms (120 ft or about 40 meters). Moving north the bottom grades from a calcium carbonate rock plain with a veneer of coarse sand to fine sand, riddled with burrows and landscaped with the mounds and pits of its' benthic fauna. Notable catches included jack knife fish, tattler bass and brotulids with their extravagant pelvic fins.

## Day 6, August 6, 2005 TER daily cruise report

Blazing sun and calm seas this morning. Intense heat on deck has us tracking any available shade as the ship's heading shifts. Five permanent stations are scheduled to be sampled today and a sixth dive will be made to retrieve a set of GPAUs.

Included among these stations are representatives of all three of our sampling strata; National Park, Tortugas Ecological Reserve and Exclusive Economic Zone. To understand why we are sampling in these three different zones a little historical background is required.

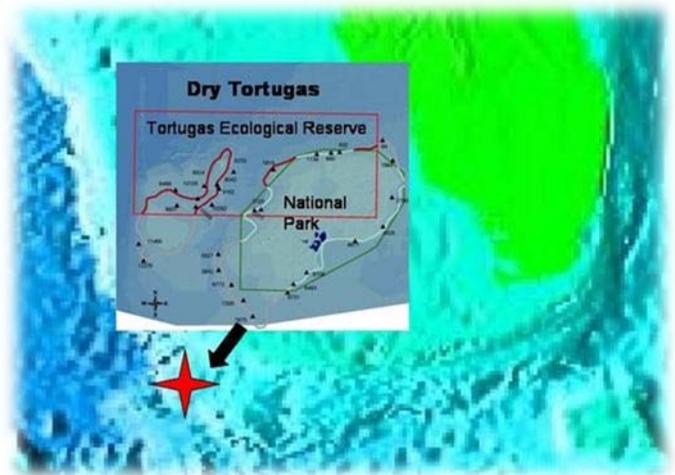


Chart of the Tortugas

The Tortugas Banks consists of the Monument and Tortugas Banks located at the southern margin of the shallow portion of the West Florida Shelf. In 1846 their strategic location in the Florida Straits prompted construction of Fort Jefferson , an artillery fort, on Garden Key one of the seven islands of the eastern bank. In 1935 the eastern bank was designated the Fort Jefferson National Monument and in 1983 harvest of fishes within the boundaries of the National Monument was limited to hook and line recreational fishing. In 1992 the

eastern or Monument Bank was designated as Dry Tortugas National Park, however, fishing regulations remained unchanged. In July of 2001 the establishment of the Tortugas Ecological Reserve, whose boundaries overlapped with portions of the park boundaries, prompted prohibition of any harvest of fishes in about 50% of the Park; the remaining portion remained open to hook and line recreational fishing. The rectangular Tortugas Ecological Reserve also overlapped the northern portion of the smaller Tortugas Bank and surrounding shelf habitat to the north and west of the Monument Bank. Prior to the establishment of the reserve, management of the region outside the park was based on regulations that govern the Exclusive Economic Zone of US territorial waters. Thus, after establishment of the Tortugas Ecological Reserve, three zones, characterized by different fishery management, could be identified; the Exclusive Economic Zone, where commercial and recreational harvest of fishes is permitted, the Tortugas Ecological Reserve where all harvest of fishes is prohibited and the Dry Tortugas National Park where harvest has been limited to hook and line recreational fishing for 20 years and is now currently prohibited in 50% of the Park. By quantifying trends in the fishes and benthic communities in these different zones we can assess the impact of these differing levels of resource management. Although management of these different zones applies mainly to fishing, changes in fish communities are expected to have a top-down effect on the attached invertebrate, plant and algae communities. To monitor these communities we survey two 30m transects-one on the reef, and one on the adjacent sandy shelf. We sample along this transect using high-resolution digital still photography and underwater video. Using these images we determine percent cover and diversity of the

various benthic habitat components-seagrasses, algae, corals, sponges, other attached invertebrates and substrate type. This is accomplished back at the laboratory using image analysis software. By examining the variability of benthic coverage over the years, trends in the health of these communities can be monitored.

Night operations were conducted in the NW corner and just outside the Reserve with the drift camera and beam trawl. Bottom was fine sand, lots of evidence of bioturbation. The beam trawl rounded up the usual suspects. One new species was observed, the pygmy sea bass.

### **Day 7, August 7, 2005 TER daily cruise report**

Day broke on a mackerel sky and a two to three feet swell out of the NE. Six permanent monitoring sites are scheduled to be visited by divers today. A number of these sites are along the northern margin of the National Park.



**Venessa in a cloud of silt from the bottom**

These sites average around 95 ft in depth and have a very fine substrate, referred to by some, as pluff mud. Visibility is generally low, 10-15 ft, unless one of the dive team disturbs the bottom causing everything to vanish in a gray cloud. Returning to monitoring stations like these year after year require very precise navigation as visibility conditions make searching for our site

(marked by a steel rods driven in to the bottom and one small float) once divers are on the bottom a losing proposition. To minimize the need to search for the site we use very precise Global Positioning System (GPS) that relies on satellites, a sophisticated antennae and computer that provided precise position, direction and speed.



Divers returning to the ship

This system allows the dive boat to navigate to a point within three feet of the center of the sites location. As the boat intersects this “point” on the ocean we mark it by tossing out an anchor attached to a dive line and large float. Survey divers descend the line to the anchor which in theory, and often in reality, is next to our survey site marker. This ability, to return to the same spot on the bottom of the sea, is quite amazing. For those interested in the health of our ecological systems, this technology represent a critical step.

### **Day 8, August 8, 2005 TER daily cruise report**

Blazing sun and light breezes; favorable for diving and the application of sun block. The primary task of the day was to complete a series of fish censuses for a National Marine Fisheries Service survey of commercially important fishes.



Goliath Grouper

Like our National Ocean Service survey, these are done in the deep water at the margin of the Banks however are focused on the impact of the reserves on exploited fishes. At each station four 30 meter transects; two along the bank edge, and two up the bank slope are swum and all commercially important species are counted.



Goliath Grouper

These commercially important reef fish include; groupers, snappers, a prized wrasse the hog fish, and the large jacks and mackerels. Like many of our operations, this requires efficiency as our bottom time is limited; for example at a depth of 90-100 feet we have a maximum time of 30 minutes to complete our work.

## **Day 9, August 9, 2005**

### **TER daily cruise report**

Another beautiful day around the Tortugas unless you are a sailor or dislike the heat. Today we investigated a damaged reef within the Tortugas Ecological Reserve.



Several years ago, a container ship anchored illegally at Sherwood Forest, a reef renowned for its high biodiversity and coral cover. The reef gets its name from the form of the coral heads which resemble mushrooms or ancient oak trees. The understory of this forest of corals provides a labyrinth of caves and cubby holes for fishes to hide in and we have observed some truly gigantic black grouper and hog fish holding court in its clearings. The ship apparently had an outdated version of the local charts that did not indicate the area was protected and that anchoring was prohibited. The ship's anchor and chain swung along the bottom, knocking over hundreds of corals. As part of the restoration, marine contractors and biologists from the Florida Keys National Marine Sanctuary stabilized many of the injured corals. We first observed the area in July 2003 when we dove at the injury site to observe the restoration in progress. In September 2004, we again dove on the site to see if recent hurricanes, Charley and Ivan had caused any damage to the restoration effort. Fortunately we did not see any corals

overturned from those hurricanes. During the 2004 trip we used a multi-beam sonar system to record, in a detailed geo-referenced format, the complex surface topology of the injured site, restored site, and surrounding area. Our goal today was to see if there were any impacts from Hurricane Dennis, to observe and collect data on recovery, and to investigate nearby features of interest identified in the multi-beam survey. In case you wondered the US government brought a court case against the shipping company which has been settled.

Our night operations completed our series of drift camera video records and beam trawl samples of the shelf north of the Tortugas Banks. Our preliminary results indicate that the density of pink shrimp is higher in the reserve than outside where fishing is permitted and we have observed as many as 12 shrimp trawlers working.

## **Day 10, August 10, 2005**

### **TER daily cruise report**

All this sunny weather has given us plenty of opportunities to measure light in the sea around the Tortugas.



Lowering light meter

This involves making light measurements at increasing depth (a profile) by lowering a light meter over the side of the ship. The amount of photosynthetically active light, measured in micro-Einsteins, or the flux of photons through a square meter plane (YIKES), is measured at one meter intervals to a set depth. This provides us an estimate of the energy available to water column phytoplankton, as well as seagrass and algae living on the seafloor. Light is reduced as water depth increases and this reduction is increased by the presence of suspended particles in the water column. In the clear water around the Tortugas, the photic zone, or the depth at which plants and algae can survive is quite deep. A consequence of this is that seagrasses, that require a considerable amount of light to survive, can grow on relatively deep portions of the shelf. Algae which require relatively little light can grow at great depths indeed. This allows these benthic (seafloor) plants to grow over much of the area of the shelf around the Tortugas providing food and dissolved oxygen to many of the animals that live on and in the bottom sediments. Benthic animals: worms, crabs, shrimp, snails, clams and starfish in turn provide food for predatory fishes, like cusk eels that live in burrows in the bottom, flounder that live on the bottom and various species of reef fish that rest on the reef during the day and at night move out onto the open shelf to feed.

Tonight we will conduct the first of our evening dives to document the gathering of fishes at the edge of the reef and, as darkness falls, their migration onto the shelf to feed. We will collect information on numbers of fishes, what species undertake this migration, behaviors involved and for evidence of cost in terms of mortality due to large pelagic predators.

## **Day 11, August 11, 2005**

### **TER daily cruise report**

Rain. Towering, closely packed clouds shoulder skylights of deep blue. To the East a shifting gray squall line crowds the ship. 80 miles west of Key West we are rolling a bit but safe aboard the NOAA Research Vessel, Nancy Foster.



**Nancy Foster, starboard side**

The ship has a seasoned crew many of whom we have been working with for years; five NOAA Corps officers, three licensed engineers, a electronics specialist, an excellent cook, steward and seven able bodied seamen. The NOAA Corps is one of the seven uniformed services of the United States and is composed of commissioned officers whose skills support the agency's science and surveying programs at sea, in the air and ashore. They command the Foster, a sizable vessel (187 ft long, 40 ft wide, a 10 ft draft and displaces 894 tons) adaptable to many types of oceanographic research. On deck are two cranes, a J frame, two winches, and four different launches, ranging from a 17-foot inflatable to a 23 foot aluminum boat. Using the cranes the crew can pluck these small boats from their cradles on deck and gently set them in the sea along side. This allows us to work in two or three places at once away from the ship and provides access to shallow water,

greatly increasing the amount and range of work that we can get done in the 13 days we are at sea. The Foster has berths for 15 scientists and we have filled them all. A motley band, the science party consists of five women and ten men whose scientific interests includes; plant ecology, behavioral ecology of fishes, population dynamics habitat restoration, habitat mapping, oceanic transport processes. Critical for team members is flexibility, an interest in collaborative research and the ability to work within a team. Tonight we will undertake our second evening/night dive.

## **Day 12, August 12, 2005**

### **TER daily cruise log**

More fine weather finds us cleaning up some loose ends around the banks. In the afternoon we steam south to Tortugas South a smaller rectangular refuge established to protect populations of grouper and snapper that aggregate to spawn on a deep bank called Riley's Hump.

Our National Marine Fisheries Service colleagues are monitoring these populations closely and the fine weather and efficient operation of the ship has allowed us the opportunity to add to these observations. The very top of the bank rises to about 90 feet and our Grouper Ledge dive has a profile of 110 ft for 30 minutes. The sea here is clearer than in Tortugas North, 60 foot visibility easy and the ledges appear early in the descent in birds eye view. Separated by a narrow sand strip, two gently tilted rectangular outcrops rise from the surrounding sand. The tops are a jumble of rock, honey combed with narrow passages shallow caves. We descend at the deeper end where a school of black and yellow pork fish swirl around and within this jumble like a disturbed nest of giant bumble bees. The deeper edge is ledge, undercut one imagines

by centuries of sheltering fishes. There are lots of big fish here and a high diversity of grouper; big blacks, yellow mouth, yellow fin, coney, rock hind, grasby, a pair of the Federally protected Nassau grouper and turning tail in the distance two tiger grouper. The big snappers are here also, a pair of cubera, giant muttons and dog snapper and the jacks; a greater amber, bar and almaco. It is exhilarating to see this diversity of large predators and to know that here they have a sanctuary. After another dive on Riley's Hump we turn east towards port. Time to break down and pack, sensors for light, navigation, still and video cameras, gear for diving, trawling, coring, repairing, sample preservation and office work. It has been a remarkably successful research cruise. Blessed with perfect weather, without major mechanical or technical failures we were able to complete all the sampling required for our time series analysis of the impact of the Tortugas Ecological Reserve. In addition we were able to collect a series of replicate samples in each of the management zones of the bank top and bank slope communities above our permanent monitoring stations. These samples will provide a link between the deeper communities that we are monitoring and those of the better known bank top. We were also able to collaborate with the National Marine Fisheries Service in their monitoring project of exploited fishes of the Tortugas and assisted the Florida Fish and Wildlife Conservation Commission in recovering 35 of 36 sonic tag receivers that have been collecting data on the movement of tagged groupers. Our job of course, is just beginning.



**Goat Fish**

The data we have collected; still and video images, light measurements, sediment samples, fish counts, trawl samples, fish and invertebrate tissue and macroalgae samples require identification, enumeration, analysis and interpretation. We approach this job with light hearts as the news looks good. The establishment of the reserve appears to be bearing fruit and we feel fortunate to be watching that fruit grow.

## Scuba

The use of SCUBA ( self-contained underwater breathing apparatus ) has become an essential tool utilized by ecologists. For example, without the use of SCUBA, our scientists could not accomplish the goal of fish population assessments which are an integral component to our overall research plan.



There are, however, limits to the use of SCUBA with time-at-depth being the most critical limiting factor associated with its use. The use of oxygen-enriched gas mixes ( i.e. NITROX ) helps us to stay at depth longer than we could if we were to use air. Enriched gas is simply adding more oxygen to the mix while at the same time lowering the nitrogen content. On this cruise, we are using what is called a 32% mix: 32% oxygen, 68% nitrogen, versus what is normally found in air - 21% oxygen and 79% nitrogen - which enables us to stay at depth longer due to the lower nitrogen concentration in the mix. Nitrogen, while basically inert under normal atmospheric pressure, is absorbed into the diver's blood and tissues while at depth and can cause decompression sickness and narcosis.



Using a mix with less nitrogen reduces the potential for a diver becoming “bent” or “narc'd”; terms used in the diving community to describe these maladies. Using NITROX does not eliminate the possibility of the bends or narcosis, it simply reduces the potential for their occurrence. Using a 32% mix, for example, enables divers to stay at a depth of 80 feet for 50 minutes; using normal air, our bottom time would be limited to 40 minutes at the same depth. On the other hand, increasing oxygen content of our gas at depth can be dangerous as oxygen actually becomes toxic at too high a concentration. Therefore, oxygen toxicity also plays a role with the use of enriched mixes, however, by keeping the partial pressure of oxygen below critical limits during exposure, and by limiting exposure times to thirty minutes or less, the potential for oxygen toxicity is virtually eliminated.