Freediver Blackout

Freediver blackout is also known as shallow-water blackout. You might think that shark attacks, line tangles and boat accidents are the freediver's worst fears; in reality those risks pale in comparison to the death and destruction wrought by freediver blackout.

BLACKOUT TYPES: Blackout is the sudden loss of consciousness caused by oxygen starvation. Divers can experience two types of blackout. Shallow-water blackout occurs when divers ascending vertically in the water column undergo pressure changes that influence the body's physiology and trigger a blackout. Static-apnea refers to blackout that doesn't involve a deep dive. It is generally related to breath-hold attempts in a shallow pool.

Shallow-water blackout strikes most commonly within 15 feet (five meters) of the surface, where expanding, oxygen-hungry lungs literally suck oxygen from the diver's blood. The blackout occurs quickly, insidiously and without warning. Due to their lack of adaptation, beginning breath-hold divers are not generally subject to this condition. It is the intermediate diver who is most at risk. He is in an accelerated phase of training, and his physical and mental adaptations allow him to dive deeper and longer with each new diving day—sometimes too deep or too long. Advanced divers are not immune.

Skip Hellen's story is typical of many shallow-water blackout incidents. Skip and I were diving at Ship's Rock, one-half mile off of Catalina Island, California. We were competing in the Long Beach Neptunes' annual Blue Water Meet, hunting for the largest white seabass.

Ship's Rock is shaped like a pyramid. Its sides consist of large boulders cascading to the sea floor 120 feet below. White seabass cruise near the boulders. Earlier in the day, I shot a 50-pound white seabass. Skip, a fierce competitor, saw my fish and got pumped! I'll never forget what happened next.

Skip dives to a boulder 50 feet below. He orients himself in the open water and waits… and waits…and waits. I am anxious to take my turn on the rock. Finally, Skip starts his ascent, and I keep his image in the corner of my eye as I start down. Fifteen feet from the surface, he suddenly arches his back, his gun fires and both arms shoot out from his sides. He sinks backward as if impaled on a cross. I drop my gun and angle my dive to intercept Skip. I release his weight belt and, holding Skip around the shoulders, we ascend together.

On the surface, I hold Skip's head clear of the waves. His face is blue-black. I feel he is close to death. His jaws are clenched on his snorkel. With effort, I rip the snorkel from his mouth, and strike him on the chest. "Breathe!" I yell. Skip takes one ragged breath. His next breath returns him to consciousness and he exclaims, "Hey! Where's my weight belt? Where's my gun?"

Luckily for Skip, he recovered that day without permanent injury. Sixteen years later he realized his goal, spearing a world-record 80-pound white seabass.

When I researched the subject of shallow-water blackout for this book, I was shocked to discover that most of the world's top spearfishers have experienced close calls with shallow-water blackout.

Damiano Zannini, M.D., reports that approximately 70 percent of the Italian divers who regularly compete in national and international spearfishing competitions have suffered one or more blackouts. It's interesting to note that ama divers, with their history of hundreds of years, experience a low rate of shallow-water blackout. They stick to a conservative dive profile by limiting the duration of their dives to one minute and resting between them. They also prefer to make many short dives instead of a few long ones.

Brian Yoshikawa mimics blackout.

Photo by Terry Maas

THE PHYSIOLOGY OF FREEDIVER BLACKOUT

The beginning diver is very sensitive to carbon dioxide levels. These levels build even with a breath-hold of 15 seconds, causing your diaphragm to contract involuntarily and your lungs to feel "on fire." Normal divers reach their "breaking point"—the urge and need to breathe—well before their blood-oxygen levels become dangerously low. Remember, it's not the lack of oxygen, but the rise of carbon dioxide, that signals your brain to breathe.

HYPERVENTILATION: Hyperventilation is the potentially dangerous practice of increasing the rate and/or depth of your breathing in preparation for a dive. Many breath-hold divers reach depths of 80 to 100 feet and achieve bottom times of over two minutes by hyperventilating. The hyperventilating diver has "blown off" massive amounts of carbon dioxide, thus outsmarting the brain's breathing center. Normally metabolizing body tissues, producing carbon dioxide at a regular rate, do not replace enough carbon dioxide to stimulate this breathing center until the body is seriously short of oxygen. Trained divers can also short-circuit the desire to breathe by sheer willpower. Hyperventilation causes some central nervous system changes as well. Practiced to excess, it causes decreased blood flow to the brain, dizziness, and muscle cramping in the arms and legs. But moderate degrees of hyperventilation can cause a state of euphoria and well-being. This can lead to overconfidence and the dramatic consequence of a body performing too long without a breath: blackout.

The use of hyperventilation in preparation for freediving is controversial. No one disagrees that prolonged hyperventilation, after minutes of vigorous breathing accompanied by dizziness and tingling in the arms and legs, is dangerous. Some diving physicians believe that any hyperventilation can be deadly because of its unpredictable effects from person to person and from day to day. Other physicians, studying professional freedivers such as the ama, found that they routinely hyperventilated mildly (two-to-three quick breaths) and then took a deep breath before descending. Their hyperventilation is subdued. They limit it by pursed-lip breathing before a dive.

The problem is in the ascent phase of the dive. During an ascent from multiple atmospheres of pressure, a diver's lungs re-expand and increase in volume as the water pressure decreases. The few oxygen molecules left in the lungs become widely dispersed. This results in a rapid decrease of available oxygen in the lungs to critical levels. The balance that forced oxygen into the body is now reversed. This vacuum effect (the reduced partial pressure of oxygen) is really a net flow of oxygen from the body to the lungs. In many cases carbon dioxide gas—the stimulus for breathing—may also decrease. These changes are most pronounced in the last ten to 15 feet below the surface, where the greatest relative lung expansion occurs. This is where unconsciousness frequently happens. It is the result of a critically low level of oxygen, which in effect, switches off the brain.

While some divers experience warning signs of impending blackout—such as dizziness, light headedness, tunnel vision, seeing stars, sensation of heat, or a sense of euphoria—most do not. Even if these signs do occur, they're often too little and too late. Frequently, the last thoughts of the blackout victim are, "I feel that I'm in trouble but the surface is just a few kicks away, and I'm confident I'll make it…" The blackout is instantaneous and without warning.

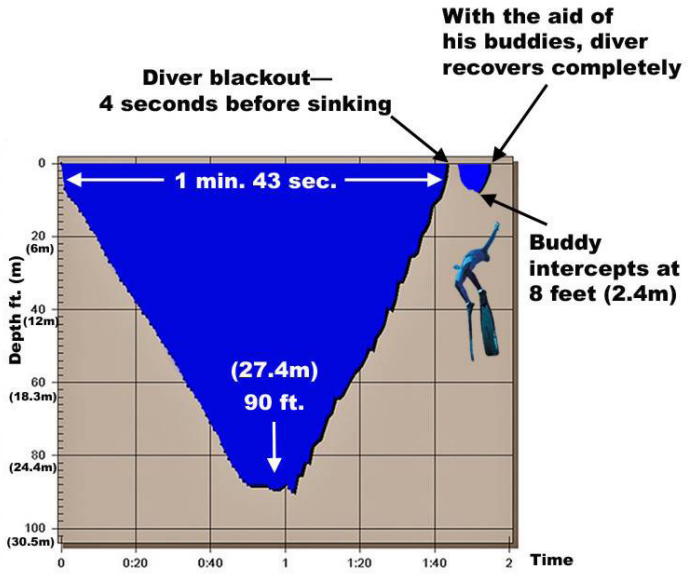
Loss of motor control (LMC) occurs when the diver is semi-conscious but unable to have full control of his muscles, creating the so-called samba experience. During unconsciousness, a diver may continue to kick or swim because the muscles in his arms and legs can function for short periods with less oxygen than the brain. It is therefore important for dive buddies to note the attitude or angle of their friend's path as they come up from the depths. Unconscious divers may suddenly veer off to one side, arch their backs and spread their arms, or sink back towards the bottom. Other victims reach the surface and bob

up and down several times in their vertical plane (the "cork sign") without clearing their snorkel. Then they stop moving and float on their bellies without breathing.

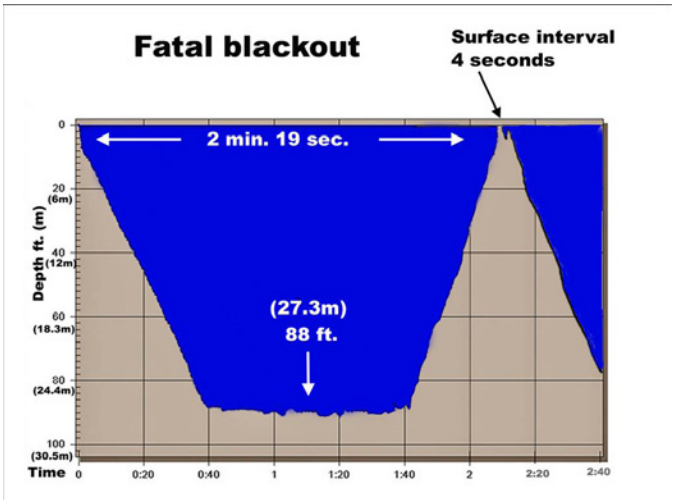
The unconscious diver is now a potential drowning victim. If he floats, the vacuum effect will cease, and there might be enough residual oxygen to allow for consciousness to return. There is no guarantee that the shallow-water blackout victim will reawaken at the surface.

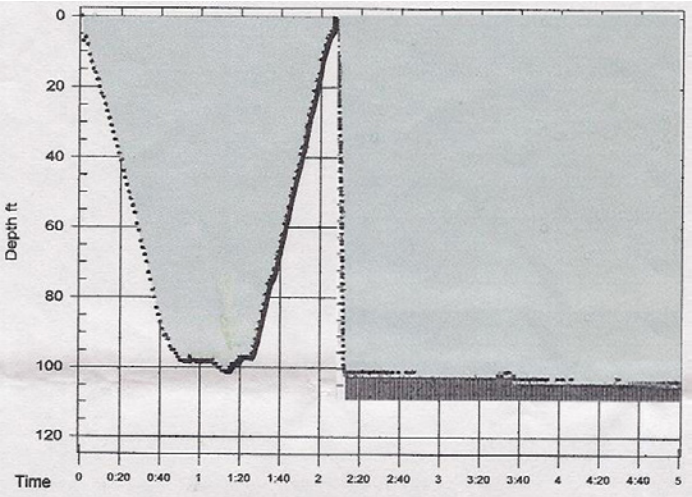
Sinking divers, on the other hand, do not benefit from this tenuous "second chance." Many divers lose consciousness just as they reach the surface. How ironic is it that 99% of the dive was successful, yet the last few seconds lead to disaster? While very close to the surface, or even at the surface, the diver starts expelling air in an uncontrolled fashion and the unconsciousness deepens. As they begin to sink out, with the airway open, water pressure squeezes every last ounce of air from the lungs like a burst balloon. Therefore, the highest safety standard for being properly weighted is for the diver to remain floating on the surface AFTER fully exhaling.

In some cases of freediver blackout, as water starts to enter the throat, the laryngospasm reflex causes the vocal cords to close, preventing water from entering the lungs. Rescuing a diver at this stage might require yanking his snorkel from his clenched jaw muscles, opening his airway, and administering forceful mouth-to-mouth breathing pressure to overcome the spasmed vocal cords. As a trained medical professional, and in agreement with paramedics that respond to drownings, there is nothing gained by the "blow-and-tap" routine taught in many freediving classes. While this procedure does work in the controlled environment of the pool/classroom with healthy students, it has no place in the field. The problem is we do what we are taught. In the field, unconsciousness might be the result of a blackout, but could have also been caused by stroke, cardiac problems, diabetic problems and others.



This graph from a divers watch illustrates surface blackout. Almost immediately upon reaching the surface, this diver became unconscious. Luckily his buddy was alert and close enough to intercept his rapid descent and he made a full recovery.





These two graphs, both from their watch computers, shows their last dives and the same result—blackout at the surface with a rapid, and final descent. Upon reaching the surface, rapid release of a lung full of air may prevent full filling of the heart for a few beats, which coupled with an already low-oxygen level can be catastrophic. The Freedivers Recovery Vest is programmed to recognize this form of blackout and inflate immediately, bringing the victim to the surface is a rescue-ready head position.

RESCUE AND RESUSCITATION: Some freedive trainers teach that the human brain blackout is somehow "protective" yet the disconnection of the body's computer from functional leg and arm muscles that might still propel it to the surface only hinder self-rescue. With the complete shutdown of the conscious part of the brain, your body is defenseless, even while your heart still beats and cramped muscles are still capable of movement toward the surface.

My suggestion is to follow the advice of medical professionals and begin rescue breathing immediately -- do not waste precious seconds with the blow-and-tap. Providing oxygen a few seconds earlier might mean the difference in preserving millions of brain cells and preventing death. Retrain yourself to respond to blackout victims by tipping their chins up and giving mouth-to-mouth breathing immediately. You may have to be quite forceful in order to break possible laryngospasm and drive oxygen past the vocal cords. Also be aware that your unconscious buddy may be so deprived of oxygen that his face turns deep blue or black.

"Dry drowning" is the term used to describe the condition when the laryngospasm reflex keeps water from entering the lungs. "Wet drowning" results from the early relaxation of the vocal cords and the subsequent entry of water into the lungs.

In the un-rescued diver, as oxygen starvation continues, death is so near that even the protective laryngospasm reflex relaxes. Within seconds, water enters the lungs. It is still possible to revive a diver at this stage; however, he will require hospitalization and intensive treatment. Water entering the lungs is very irritating to the delicate lining—fresh water more so than salt water. The irritation causes the lung tissue to swell and fill with fluid. Left untreated, this condition can become severe enough to prevent respiration and cause death by so-called "secondary drowning." This is why it is so important that divers resuscitated from blackout and near drowning seek immediate medical attention. Since this condition may take hours to develop, don't be fooled by the victim's apparent complete recovery.

After six to eight minutes without oxygen, the brain suffers permanent damage, although the heart often continues to beat after brain damage occurs. Providing cardiopulmonary resuscitation (CPR) at this point frequently revives a victim to a vegetative state. CPR should always be

administered to the drowning victim, no matter how much time he has spent underwater, because the diving reflex and a cold environment offer the brain additional protection. Victims resuscitated in the field often experience an unusual recovery. They wake up screaming and then lapse back into unconsciousness, repeating this behavior over and over again. Many patients do not recover completely, suffering mental and physical deficits. For example, they might experience difficulty in speech and walking.

Shallow-water blackout can affect the best of divers. South African Jimmy Uys, a chemical engineer, has the distinction of holding the record for a 533-pound (242-kilogram) black marlin. Here is his chilling, firsthand account of the shallow-water blackout that nearly took his life.

CASE STUDY:

Date: May 1988

The place: The wreck of the "Produce" near Durban, South Africa, where four teammates and I were training for our National Spearfishing Championships. After diving for weeks on end, we felt extremely fit.

The incident: I went down to the bottom at 100 feet (33 meters), just to the north of the main section of the wreck. Using the slight current, I slowly glided upward over the debris, when a 20-kilogram ignoblis (giant trevalley) stopped in front of me. I shot it through its head and tried to fight it off the bottom. No luck! I released the line and just made it to the surface. My teammate Mark warned me not to take chances. His gun was also stuck on the wreck below.

Back on the boat, we planned our strategy. We would dive down together. Mark would pull the fish out of the wreck and kill it. I would cut the line from the spear and swim up with the fish.

We dove down together, hitting the wreck 20 feet (6 meters) down-current from the fish. Using valuable energy and oxygen we swam up-current to the fish. (Mistake No. 1)

It took a very long time for Mark to pull the fish out of the wreck and to stab it in the head. He left for the surface as I stayed behind. (Mistake No. 2) I cut the spearline and started to swim up with the fish on the spear. The nylon line wrapped around my hand. I was almost half-way up when the fish came back to life. This took me by surprise, and the big fish pulled me back down about 20 feet (6 meters). Fighting with the fish, I suddenly realized that I had been down a very long time. I released the fish and headed toward the surface, using all the tricks in the book to save oxygen.

About 30 feet (10 meters) from the surface, I realized that I was not going to make it. My legs turned into jelly. A pleasing calm came over me, and I felt relaxed. I thought, "If this is the way to die, it is good."

The light faded from me, and the last image mirrored in my mind was a soft orange sunset over the Langeberge on my dad's farm. I was gone...

An hour later: The heavy pounding of the speeding boat on the surface brought me round. I was lying on my back in the nose of the boat. When I opened my eyes, I saw a blurred vision of Mark behind the controls. I realized what had happened and said that I was all right just before I faded again.

My teammate's account: Mark saw me pass out, but he was too tired to dive down to me. I sank back to the bottom.

Our boatman also realized that I did not surface and picked up all of the other divers. He took Mark and another teammate, Neil, and dropped them 20 meters up-current from my marker buoy.

Neil, who had never dived deeper than 60 feet (20 meters), made it to the bottom, looked around, and saw a small piece of luminous green—my fin tips—sticking out of a hole in the wreck. He pulled me out of the hole and was met by Mark, who released our weight belts.

They pulled me onto the boat. Another teammate, Barry, the only one to have witnessed shallow-water blackout, said, "Forget it guys, Uys is a goner."

Sergeant Major Kloppers, an instructor in the "Rekkies," calmed everyone and declared that the group must try to save me. At that point, I had no heartbeat, I was not breathing, and frothy blood streamed from my mouth.

Instead of rushing to the beach to get me to a

hospital, the crew applied mouth-to-mouth resuscitation and heart massage on the boat. After 20 minutes, I suddenly stirred, coughed and started to breathe weakly.

The recovery: They stabilized me at the Scottsburgh hospital. They ambulanced me to Addington where I was dripped, strapped, oxygenated and injected for six days, after which I made a complete recovery.

STATIC BLACKOUT : Static-apnea blackout results when a diver depletes all of the oxygen in his system. Unlike shallow-water blackout, there are no pressure changes—the diver simply runs out of air while sitting or lying on the bottom. Unfortunately, alcohol is sometimes involved in static-apnea drowning.

Medical researchers feel that many pool deaths classified as drownings, are really the result of static-apnea blackout. Most occur in male adolescents and young adults attempting competitive endurance breath-holding, frequently "on a dare." Drowning victims, especially children, have been resuscitated from long periods of immersion in cold water—30 minutes or more. The same is not true for victims blacking out in warm-water swimming pools. Warm water hastens death by allowing tissues, especially brain tissues, to continue metabolizing rapidly. Without oxygen, irreversible cell damage occurs in minutes.

James Warnock, the 31-year-old son of champion Ted Warnock, drowned in a warm swimming pool, chest deep. The Warnock family, hoping to prevent such deaths in other young athletes, has graciously allowed me to discuss the events surrounding their son's death. No strangers to shallow-water blackout, the Warnocks discussed this danger many times, especially after James had a near blackout years before.

While studying mariculture in Florida, James was excited to hear that the National Spearfishing Championships would be held in an area he knew well. A three-time North Atlantic Spearfishing Champion, James was eager to start training. He purchased a new stop watch and was practicing breath-hold diving in a medical-therapy pool. A concerned paraplegic patient spotted James' inanimate body and summoned help. Rescuers saw James' new watch fall from his hand as they pulled him from the water. Sadly, attempts at CPR were unsuccessful.

Again, the key to rescuing those suffering blackout and near-drowning is immediate and aggressive resuscitation. If you're in the water, establish buoyancy for the victim and yourself. Yell for attention, and immediately begin mouth-to-mouth or mouth-to-snorkel rescue breathing. Don't worry about swimming to the shore or to a boat. The quality of your resuscitation effort is far more important than the speed of transport. Remove the victim from the water as soon as is practical.

Once on the shore or in the boat, check for a pulse. If you don't find one, start the cardiac-resuscitation phase of CPR. Do not worry about water in the lungs. Do not perform abdominal thrusts in an effort to expel water as is typically shown on television. This procedure may force dangerous, acidic stomach contents into the lungs. Concentrate on rescue breathing. If oxygen is available, use it immediately, even if the victim regains consciousness. Seek immediate medical attention. Remember, don't be fooled by an apparent complete recovery. Lung damage may take hours to develop.

vPREVENTION OF FREEDIVER BLACKOUT

Shallow-water blackout was a hot research topic for diving physicians in the 1960s, when they worked out the basic physiology described above. They also studied the case histories of shallow-water blackout victims, identifying several factors that can contribute to this condition. These include hyperventilation, exercise prior to and during the dive, a competitive personality, a focused mindset, and youth.

I recommend the first step every freediver take in their quest to avoid becoming a victim of shallow-water blackout is to take a professional freediving course where the subject of shallow-water blackout will be a central topic of study.

CONSERVE OXYGEN: Your breath-holding time ultimately depends on the oxygen contained in your last breath at the surface. Therefore, you need to limit the consumption of this most valuable commodity. Underwater, you should move effortlessly and efficiently. Every action must have a reason or you will waste precious oxygen. Remember that all body movements require oxygen and that the thigh muscles, one of the largest muscle groups, require more oxygen than most other muscles. Glide or pull yourself whenever possible. By keeping your external drag down and your swimming profile sleek, you will maximize the distance you can safely cover underwater.

After surfacing from a freedive, rest and continue slow, deep breathing to flush out carbon dioxide and help metabolize the accumulated lactic acid your muscles generated. This takes time. As a general rule, double the total time spent underwater to recover. For example, if you just completed a minute-and-a-half dive at 60 feet, then recover for three minutes before starting your next dive. For dives over 60 feet, your surface interval should increase to five to ten minutes for each minute spent underwater. In shallow water, you may shorten the surface interval as your experience and fitness improve.

AVOIDING BLACKOUT: Know the deadly effects of exercise underwater and plan to account for it. Freedivers learn to prolong their dives by profoundly relaxing their muscles. Most divers make minimval use of their muscles except when they fight a fish or free an anchor. Since exercise dramatically increases your use of oxygen, you need to end such dives early. As a physician writing in an Australian medical journal noted, "A common scenario for diving deaths in Australia is the experienced diver with weight belt on, speargun fired."

Researchers have found that the typical blackout victim is highly competitive and male (females appear to be more tolerant of low oxygen and high carbon dioxide levels than men). Many shallow-water blackout victims are young—teens through early thirties. We don't know if this is because they lack experience or if some other unrecognized factor comes into play. The point is that young freedivers must be wary. Any diver who surfaces with the shakes, tunnel vision, starry vision, or momentary memory loss has missed blackout by the narrowest of margins—just seconds. This should be considered a near-death experience, and the dive should be examined for mistakes. There is more than one story about divers being rescued once from shallow-water blackout, then drowning on a subsequent dive trip.

Focusing on a goal can be dangerous. Many blackout incidents follow the diver's single-minded quest for game or for the freeing of an anchor. Try to leave five percent of your brain free to objectively monitor the progress of the dive. An internal warning should say, "I'm focusing too much. It's time to leave, drop my weight belt, drop my gun."

A good approach is to weight yourself so that you will float on the surface even after you have expelled all the air from your lungs. Your positive buoyancy makes it easier for others to assist you should you black out and prevents sink-out if you black out close to the surface. Also, spontaneous recovery on the surface is not uncommon. Obviously, if you black out and sink, your chances of recovery are complicated and depend on help from an attentive and capable buddy diver. The last thing we want is a double or triple fatality caused by other freedivers over-extending their capabilities in an attempt to recover the primary victim. Whenever it's possible, carry a complete scuba unit for rescue or for anchor retrieval.

When spearfishing, use reels and drag lines to help tire the fish instead of fighting it underwater. Should your fish "hole up," buoy the spot and take your time extracting the fish from its cave. An unfortunate incident occurred in the 1985 United States National Freediving Championships when defending national champion, Phil Wisnewski, drowned after attempting to free a large fish from a deep-water cave in a moderate current.

Dive and train with a buddy. Make sure he or she makes it to the surface and starts to breathe before you dive. Because blackouts can occur even after the diver has taken several breaths on the surface, it is best to watch your buddy for 15 to 20 seconds following a long dive. When

the visibility permits, alternate dives with your buddy. Keep a close eye on each other when it's deep. Deep is relative— it may be 30 feet (nine meters) for some and 80 feet (24 meters) for others. You know it's deep when you feel a tinge of apprehension or when the dive falls out of your usual dive profile. Limit freedives to 90 seconds. Longer dives tremendously increase the risk of blackout. Attempting breath-hold dives longer than two minutes requires a buddy/safety diver. You can make dives this long only by depressing your physiologic alarm or willfully ignoring the urge to breathe. At this point, almost everyone has a very low blood-oxygen level.

ADDITIONAL RESOURCES

TRAINING SITES

Perfromance Freediving International with Kirk Krack

Freediving Instructors International with Martin Stepanek

LINKS FOR BLACKOUT PREVENTION

Dive Wise
Shallow Water Prevention Org
THE FREEDIVER5 RECOVERY VEST

VIDEOS

Freediver Blackout

SUMMARY

1. Take a professional freediving class.
2. Dive with a capable buddy.
3. Purchase a freedivers recovery vest.
4. Do not hyperventilate to excess. Use no more than three or four slow, deep breaths.
5. Recognize that any strenuous exercise will limit your bottom time drastically. When you exercise, head for the surface much sooner than usual.
6. Recognize a dangerous situation when your mind starts to focus on a goal, and drop your weight belt.
7. Treat your weight belt as a disposable item. If in doubt, drop it. Bring a spare weight belt so that you're less hesitant to let it go.
8. Adjust your weight belt so that you will float on the surface AFTER expelling all air from your lungs.
9. Don't attempt dives longer than 90 seconds.
10. If you must make a long or deep dive, make sure you have a buddy standing by on the surface.
11. Rest long enough between dives to flush out excess carbon dioxide.
12. Consider a swimming pool a dangerous place to practice endurance breath-holding. This exercise should only be attempted in the strict supervision of a freedive instructor.
13. Learn the basics of CPR and think about adapting them to your diving arena, whether diving from shore, board or boat.