International Training Organization of Recreational Scuba Diving

OPEN WATER DIVER (DIGITAL VERSIÓN)

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ACUC

Important: The training exercises described in this manual should not be done if it is not under the supervision of an qualified ACUC Instructor. ACUC assumes no responsibility for incidents or accidents caused if this is not followed. ACUC advises that doing some of these training exercises without the correct supervision could endanger the life of the reader and the life of others.

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ACUC

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Please note: the male gender has been used in some parts of this book for easier reading

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ACUC

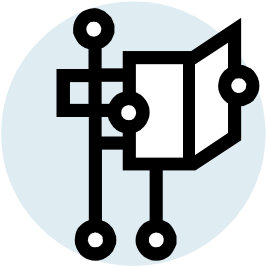
OPEN WATER DIVER

INTRODUCTION

ABOUT THIS MANUAL

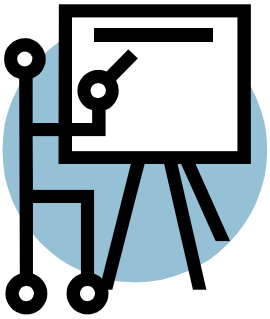
This manual, as other ACUC manuals, was designed as a training aid for the ACUC Instructor giving an ACUC Open Water Diver course.

It is up to the Instructor to ask the student to read a specific chapter before or after the Instructor talks in the classroom or pool about that chapter. Some Instructors prefer that the student reads the chapter as a **preparation** to the next classroom or pool lesson; some other instructors prefer that the student read the chapter after the Instructor has given the classroom or pool lesson about that chapter, as a form of **review** of what the Instructor has taught. Regardless of the method used, the student should read the manual. You will notice that some chapters have a sign similar to the top one shown in the right side. This sign means that this chapter **could** be a “Reading Assignment” only.



Reading assignment

In other words, the Instructor **might** decide not to talk about this specific chapter in the classroom or pool. The Instructor might feel that is sufficient if the student reads about it. Regardless whether the chapter is taught by the Instructor or not, it should be read by the student because it contains important and interesting information. Also, the final written exam could contain questions that reference that chapter. All other chapters show the other sign, the one called “Teaching Assignment”. This means that the Instructor must teach about this chapter in the classroom or in the pool.



Teaching assignment

Once you finish your Open Water Diver course, keep this manual around, so that you may consult it in your coming years, as an active diver, or if you decide to take more advanced diver courses.

Thank you for choosing an ACUC course. We hope you enjoy your ACUC Open Water Diver course and this manual.

As the reader of this book, you are on the verge of an adventure in an activity that will change your life. Recreational scuba diving, an incomprehensible activity to some, will not only fill parts of your leisure hours and vacations, but will help improve yourself as a person.

After completing the diving program and becoming certified, when you explore the underwater part of your world, you will realize what you have been missing. As of that moment your life will be changed. When you leave the water you will want to talk with your diving buddy about the experience you have just completed.

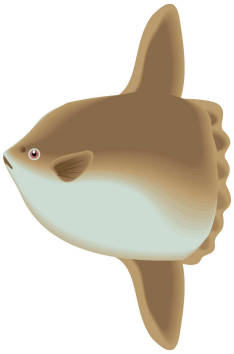
When you arrive back home and speak to your friends and family you will want to tell them what you have seen. When you go out for a drink with your friends it will be impossible not to have a conversation related to diving.

Little by little you will make new friends among your diving companions and, we are sure, you will try to convert many of your friends into divers.

The next time you plan your vacation you will not make it simply for sun, heat and fun. All this becomes secondary and the vacation where there is a Diving Centre and good dives near will become your first priority. When there finally comes a time on vacation that you do not have the opportunity to breathe compressed air from a tank and you suffer "withdrawal symptoms" you will have been converted to a true "diveaholic".

Introduction (continued)

Then you will laugh at yourself for all the dread and anxiety that, before taking the course, you had in your mind. You will realize that the myths, negative for the most part, that people associate with diving were no more than that: Myths. While before you were fearing an encounter with a shark, now you can not wait for the moment that it happens and, in fact, will encourage you to go great distances, if necessary, to increase the possibility that it will happen.

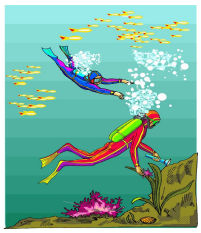


You will learn that the false belief people have that scuba diving is a "high risk" activity is in reality one of the safest activities that you can partake in, and statistically, less accidents occur than most other recreational activities. What are required are a little common sense and good training.

If you have acquired this book in order to learn a little more about diving, read on and then sign up for a scuba course. This book, used within a diver training program, taught and supervised by a qualified Instructor, will open the door to a very promising future for you. If, on the contrary, you already have completed a diving course and you have received this book as part of a student kit, congratulations on completing an investment in your future.

You are entering into a world that is fun, relaxing and exciting at the same time.

But this book alone is of little value. What is most important is the training that you will receive during your course. This training must be complete to be effective. It will prepare you so that your first experience will be enjoyable and unforgettable and you, the student, will have sufficient confidence so that the first, and most important experience, will be beneficial.
For that reason, the ACUC Policy is that our divers will be thoroughly prepared before receiving their first diving certification. A diver prepared adequately from these principles is a diver that has confidence and enjoys diving and therefore, is a diver that will stay active.



At ACUC, it is not enough to teach a basic course, simply to increase our numbers of certifications. This would result in having a diver who is insufficiently prepared, and after one or two dives, moves on to something else because those first experiences in open water were not enjoyable and comfortable. At ACUC we believe in quality rather than quantity.

Finally, we wish to thank Manolo Salsas, an Instructor Trainer Evaluator with ACUC and principal author of this book, who, in spite of not having a computer (an indispensable tool today) when he began to write this manual, managed to finish the text within the agreed time.

Most people without the dedication of Manolo would prefer to be doing something more fun than sitting at a table writing a book on diving. Especially if you consider that Manolo wrote this book while living in the Paradise Island of Cozumel (Mexico), in the beautiful Caribbean Sea. If Manolo is not an example of a "Diveaholic" nobody is.

We hope that this book helps to change your life and that the investment in your future that you are making with this diving course that you are taking or soon will take will be very pleasurable and you will enjoy diving for many years.

Welcome to the world of recreational diving - Enjoy!!

Press on this bar to go to the next chapter

BRIEF HISTORY OF DIVING

There is evidence that diving, with snorkelling equipment, has been practiced during thousands of years to obtain food and riches (pearls), and also with military objectives. Professional diving, using a helmet and breathing air provided from the surface, started being developed at the beginning of the 19th century and even today, it continues using very similar techniques. Nevertheless, these methods limited the mobility of the diver, because he was “hooked” to the surface by an air hose.

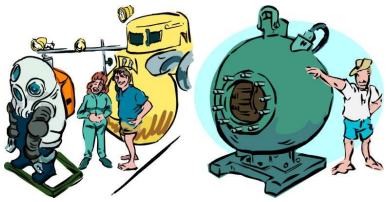
The past

It was not until 1943, when Emile Gagnan, an engineer employed by “L’Air Liquide” of Paris, a company that was owned by Jacques Cousteau’s father in law, impulsed by Cousteau’s himself, invented the “underwater lung”, which was tested and used by Cousteau and by Frederick Dumas. The underwater lung used a number of previous inventions, to combine a tank full of compressed air and a regulator that gave air to the diver when he required it. This was the first real “**S**elf **C**ontained **U**nderwater **B**reathing **A**pparatus - SCUBA-”.

From this moment on, the diver was freed of the umbilical chord that kept him tied to the surface.

Since these inventions, many improvements and innovations have been done in the design and quality of diving equipment, but the basic principle remains the same.

Surprisingly, this technology has hardly changed in the last 50 years.



The future

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ACUC

BASIC DIVING EQUIPMENT

LESSON OBJECTIVES

At the end of this chapter the student will be able to:

- Choose a mask and describe the main characteristics
- Choose a snorkel and describe the main characteristics
- Choose fins and describe the main characteristics
- Choose a protective suit and describe the main characteristics
- Choose a weight belt and describe the main characteristics
- Choose a buoyancy compensator and describe the main characteristics
- Choose other instruments and describe the main characteristics



Masks

1.1. - BASIC DIVING EQUIPMENT

1.1.1. - THE MASK

The mask is an indispensable part of your equipment, since it would be impossible for you to see clearly underwater without it.

Your eyes, adapted to seeing in air, would be unable to see correctly due to light refraction, a physical phenomenon that will be discussed later. For now let us just say that vision underwater would be blurred without a mask. The mask partly corrects this problem and allows you to see underwater. However, there are a number of factors to take into account when choosing and purchasing a mask, which we will look at in detail. In the first place, the mask should sit well on your face, with equal pressure all around the edges. Without this, a wrong adjustment would permit water to enter the mask and make for an uncomfortable dive. To test this, bend over slightly from the waist and hold the mask against your face, without using the mask strap, and inhale slightly through your nose.

Trying the mask on

The mask must remain against your face, without falling off, and only detach easily when you exhale through your nose into the mask. This will ensure that there are no gaps that permit air to enter around the edges of the mask, when your face is in a relaxed position and will also keep water out while diving.

Another factor to consider when choosing the style of mask that you will use, is the internal volume of the mask. A mask with a large internal volume will require a large amount of air to equalize the pressure inside the mask, as you descend and also to empty if it gets flooded with water. This will be discussed in more detail later, but is sufficient for now to know that a low volume mask is more desirable, especially when snorkel diving, by making it easier to clear water from the mask. It is important that the mask you choose includes a nose pocket, not only to clear water from the mask, which would be uncomfortable during the dive, but also to equalize the pressure created on the mask as you descend, by allowing you to exhale through the nose lightly into the mask periodically.

1. Basic diving equipment (continued)

Ear equalization using the nose pockets of the mask

It is also important that you be able to pinch your nose from outside the mask. If you have difficulty equalizing the pressure in your ears, it will be necessary to pinch your nose while trying to exhale gently, to equalize the pressure (it should be noted here that this method is not without some risk of injury). This topic will also be discussed in more detail later on.

The glass must be tempered and shatter proof to avoid glass getting into your eyes, should the lens break for some reason. This can be checked because the glass of the mask will have "TEMPERED" or "SAFETY" printed on it. Sometimes only the letter "T" will be printed on the glass.

The skirt of the mask should have a double seal in order to get a better seal against your face, and the material should be soft and flexible. Usually, the mask skirt is made from soft rubber or more often, hypoallergenic silicone, which is much more resistant to the degrading action of the elements. Sometimes this will be black silicone or translucent silicone - which gives a sensation of greater visibility. Personal choice is up to you. Only as a commentary, if you are taking photographs of a model underwater, a translucent mask will permit better lighting of the face.

Neoprene strap

The mask strap should have buckles that are easy to manage even while wearing gloves, in order to adjust the mask fit with minimum of effort and difficulty. The strap should be split at the back, so that it will hold better to the form of the back of the head and resist slipping. There are now mask straps available with a strip of neoprene, similar to suit material, at the back of the strap, which avoids your hair being pulled when you are putting the strap on your head. The hoop that holds the glass to the body of the mask should be rigid and made of materials that are resistant to corrosion. The most common hoops are made of rigid plastic.

Purchasing a mask with a single lens or several lenses will be your choice, and will depend on what you wish to use the mask for. The most important thing will be the internal volume of the mask.

You may choose a mask with only one front lens, two lenses similar to eyeglasses, or even masks with lateral lenses, which increase the field of vision towards the sides.

Some models are available with purge valves, which permit you to remove small quantities of water from the mask with a soft exhalation through the nose, without having to go through a mask clearing exercise. These valves can be very comfortable, but you should inspect them before every dive to be sure that sand or dirt has not caused the seal to leak. This would allow water to enter the mask and you could ruin an enjoyable dive, by having to clear water from the mask frequently.

Corrective lenses

For those who require corrective lenses, there are a number of different brands and models that have a wide range of glasses available to meet almost every need. Consult your Instructor to find an optician who can fill your prescription.

A newly purchased mask usually has a light protective coating, that you will have to wash off before you use it. If you don't, the inside of your mask will fog up and hinder your vision. This is caused from the difference in temperatures between the cold water on the outside face of the mask, and the heat from your body on the inside face of the mask. To eliminate this protective coating, wash the mask with a mild detergent, letting the mask soak for a few hours.

1. Basic diving equipment (continued)

Some Instructors recommend using toothpaste instead of a mild detergent or using a soft drink, such as "Coca Cola". The results are excellent.

Before each dive, to prevent the mask from fogging, you should clean the inside lens of the mask with an anti-fogging agent. There are many products available at dive shops, or you can use a mild shampoo. Other methods such as saliva, a piece of potato, tobacco juice, or a handful of algae (all inexpensive), have been used and get the same result. In all cases, the anti-fogging application must be done BEFORE getting the mask wet.

After the dive, wash the mask with plenty of fresh water and let it dry in a clean, dust free area, that is out of direct sunlight. Store the mask in a clean, dry, protected area, when it is not in use.

To put on the mask, place it against your face and then lift the strap over your head and place it on the back of your head, taking care that the strap is not twisted. Be sure that you have no hair or part of the wet suit hood, under the edge of the mask. Failure to do this will cause the mask to leak.

When on the surface, learn to talk with your mask on if you wish to speak to someone. The more you wear your mask, the more comfortable it will become. One of the single main causes of stress while diving is getting water on your face.

Do not place the mask on your forehead, as an unexpected wave could knock the mask off. If you must remove your mask while in the water, place it down around your neck.

1.1.2. - THE SNORKEL

The "snorkel" derived its name from the pipe on a submarine, which was used to ventilate the submarine without coming to the surface. Its usefulness is evident when you think of a diver, who is out of air at the end of the dive and has to swim on the surface, back to shore or the vessel. If the diver must lift his head to breathe every few seconds, the diver will tire very quickly. On the other hand, if the diver is able to swim with his face submerged while breathing through the snorkel, the diver will be able to arrive back at his destination much more relaxed and less tired. For this reason, you should never dive without carrying a snorkel.

The length of the snorkel should not be too long or too short, too wide or too narrow. Each time you exhale into the snorkel, a dead space will be created equivalent to the snorkel capacity. This dead space is filled with air that has been expired from your lungs, which you will breathe in again on your next breath.

The greater the length or thickness of the snorkel, the more exhaled air you will breathe in again. By the same token, too short a snorkel will allow water to enter the snorkel from the top in rough seas. A snorkel with a small diameter or bore, will increase the effort required to take a breath. The snorkel should be about 12 to 14 inches (30 to 35 cm) long and have a bore of about 0,75 inches (2 cm) in diameter. The mouthpiece should be flexible and comfortable, since occasionally you may have to carry it in your mouth for extended periods of time. It should be made of hypoallergenic silicone, since the mucous membranes on the inside of your lips are very sensitive and some materials could cause irritation and ulcers.

The snorkel

1. Basic diving equipment (continued)

You will have to put the snorkel in your mouth, when trying it out, to be sure that it doesn't pull or deform.

The interior face of the snorkel must be as smooth as possible. If not, when the snorkel gets flooded and then cleared, droplets of water will hang up in any creases and eventually, get into the mouthpiece and be inhaled with a breath. The curves of the snorkel must be pronounced to make clearing water from the snorkel easier. The snorkel is carried on the left side of the head, so that it won't get in the way of the regulator, which comes over the right shoulder.

The snorkel can be carried permanently in this position by using the keeper that comes with the snorkel, fastening it to the strap of the mask. It can also be carried under the knife straps, when not in use, and tucked up under the mask strap, when being used.

Other types of snorkels

Some models of snorkel are shaped like a “J” or “L”. Some have a flexible section between the tube and the mouthpiece. Others are shaped to conform to the shape of the head. The snorkel selection will be up to you. However, keep in mind that the simpler the snorkel design, the fewer problems will arise.

Some snorkels have a purge valve which permits the expulsion of small quantities of water, that remain in the snorkel after an incomplete exhalation. The purge valve must be inspected before each use to ensure that it is in good condition, since it will allow water to come into the snorkel with each breath if it is stuck open. Other snorkels have incorporated different systems to stop water from entering from the upper part of the snorkel, while diving in surge, where the snorkel is frequently submerged. Be careful with these last ones, as there are very good systems and there are very bad systems. Listen to the advice of your Instructor or your local Dive Shop.

The snorkel should be washed with fresh water after every dive and allowed to dry, in a clean area away from direct sunlight. Occasionally, wash with a mild detergent to remove any dirt that may have accumulated. Store the same way as was described for the mask.

1.1.3. - THE FINS

Full foot fin

The fins are another important piece of equipment, since they allow you to move through the water in a comfortable and relaxed condition and are less tiring than having to swim with bare feet, while carrying the weight of all the diving equipment, something that would be almost impossible to do. Good fins will increase the efficiency of your swimming permitting you to travel further in a shorter time. Remember, however, they do not allow you to go faster without getting tired. While diving you should always move slowly, so that you can fully enjoy this activity and get the most out of a dive. You will learn more during the course, about the effects of an excess of Carbon Dioxide due to increased exercise.

Basically, there are two types of fins used. One is the full foot fin, which is worn like a shoe and covers the full foot. The other is a fin which has an adjustable strap at the back of an open end foot pocket.

The full foot fin offers better protection for the foot, since it covers the whole foot, but does not allow for wearing thermal protection footwear with a sole.

1. Basic diving equipment (continued)

This type of fin is recommended for diving in warm water, but they are not very useful in cold water, where thermal protection is needed. If you decide to purchase this type of fin be sure that the fins fit perfectly. If they are too loose they will come off while swimming. If they are too tight and pinch the feet, they can cause cramps while swimming. If you should develop a cramp from excessive effort or tight fins, stretch your leg out straight and pull on the leg by grabbing the end of the fin of the cramped leg, while massaging the cramp with the other hand.

Adjustable fin

The cramp should disappear soon. However, the cramp is a warning that the muscle is not working at its optimum condition and therefore, if you do not change what you are doing, the cramp may appear again in a few minutes.

The adjustable fin offers less protection, but this is compensated by wearing a bootie. They should be chosen with a system of adjustable fasteners (buckles), which are easy to manage. This is the model recommended for diving with SCUBA. They can be used with thin booties in warm water, or thick booties when diving in cold water. You are advised not to use them with bare feet, since the material used in the construction of the foot of the fin, tends to be hard and could cause blisters on bare feet.

Fins are manufactured in various lengths. It is important that you choose the correct ones for the activity in which you intend to use them. You must feel comfortable with them. Ensure that they are not too large, so as to tire you out quickly or cause cramps. The length of the fin and its flexibility will depend on the muscular power in your legs. In general terms, fins with a soft, flexible blade are preferred for snorkel diving, while stiff, broad fins are preferred when using scuba. Due to the various types of materials used in the manufacture of fins, you will see some that are very flexible, such as those made from rubber, while others are very stiff, such as those made using stiff fibres that makes them inflexible. Your choice of fins will depend on your leg strength and your physical conditioning. Normally, short spade fins, broad and hard, would be recommended for seasoned divers, who have exercised their leg muscles.

Another type of adjustable fins

The most important thing is to be sure that the fins are comfortable and properly adjusted, to make your dives enjoyable.

In an effort to reduce one of the causes of cramps, the blade of the fin slopes down from the foot to reduce the effort angle. Many fin blades come reinforced longitudinally with ribs, to increase the stiffness of the blade, giving you more power on the fin stroke. Some models of fins have an orifice or channels on their surface, whose objective is to create a venturi effect (similar to jet propulsion), that increases the power of the down stroke of the fin, with less effort during the up stroke.

Some fins are manufactured with materials which float in the water, these can be useful in the event that the fins fall off of the vessel, but can be a problem if you must remove your fins underwater for some reason (such as removing sand from the foot of the fin).

Since most fins used while SCUBA diving tend to be the adjustable type, we will only discuss this type of fin, and how to put them on correctly.

First put on the booties, and then wet the fins and your feet, to make it easier to put on the fins.

1. Basic diving equipment (continued)

Slide the retaining strap below the foot, to leave easy access to the fin pocket. Put your foot into the fin pocket and bring the retaining strap up over your heel. Be sure that the strap is not too tight since it may cut off the circulation of blood to the foot. The fin should not be too loose, since the pressure from the strap will be reduced as you descend, due to pressure on the bootie material. To make this manoeuvre easier and safer, use your buddy for support while doing this, alternating from one side to the other. When your fins are on, help your buddy in the same fashion.

You should always remember NOT to take your fins off when in the water, since it is extremely difficult to swim back to a vessel while wearing all of the scuba equipment, especially against a current or in rough seas.

Also, the fins should be the last item of equipment to put on before entering the water, especially on unstable, moving surfaces, such as a vessel. If you have to walk while wearing fins, always walk backwards or sideways, but NEVER forward. As well, if you wish to stand up in the water where the bottom slopes while wearing fins, such as in a pool or shallow water, it is easier to turn 180 degrees and bend your legs, so that the heel of the fin touches bottom first.

Be sure not to mix (for example in your dive bag), equipment that is made of rubber with those made of clear silicone. The rubber will cause the silicone to stain.

1.1.4. - PROTECTIVE SUITS.

Dry suits, for cold water

Depending on the area in which you are going dive, you will need some form of thermal protection, or protection from the environment in which you are diving, such as for example, coral. When diving in cold water, your body loses heat to the water, due to the difference in temperature between them, more quickly than when in air (some 25 times), and this makes it necessary to use some type of insulation that stops, or at least, slows down the rate of heat transfer. This is achieved by wearing one of various types of suits that delay the body cooling to avoid hypothermia, a very dangerous condition that will be discussed later. There are various types of suits which we will describe, in falling order, from the greatest protection to the least.

Dry suits: To be used in very cold water. As the name indicates, the body of the diver remains dry by sealing up the body from the water, and permits the wearing of clothing under the suit to increase the protection. The suit is connected through a hose to the low pressure port on the 1st stage of the regulator, permitting air to be introduced into the suit to increase the insulation value. It is equipped with a valve to allow excess air to be expelled. The position of this valve is normally at chest height, although the preferred place is about shoulder height, on the upper part of the arm. Due to the complexity of using a dry suit, it is not recommended that you use one until you have completed a course in Dry Suit use. ACUC has a specialty course on dry suits, for those who dive in very cold water. In this course you are taught how to use a dry suit safely.

One and two piece wet suits

Wet and semi-dry suits: This type of suit permits water to enter the suit and slows down its flow, so that the water inside the suit is heated by the body and acts as a thermal insulator. A too tight or too loose fitting suit would either restrict water coming into the suit, or allow too much water to enter the suit, thereby reducing the efficiency of the suit.

1. Basic diving equipment (continued)

These suits are made of "neoprene", which is a form of spongy rubber and some type of cloth such as "lycra", glued to the outside and inside walls of the material, which protects the neoprene from tearing and makes the suit easier to put on and take off.

Bubbles of gas are imprisoned within the neoprene during the manufacturing process, which provides a good thermal protection. The insulating function of these bubbles decreases with an increase in depth as you dive, due to the increase of pressure on the suit, which reduces the insulating power of the suit.

Suit thicknesses found on the market range from 1 mm to 8 mm, depending on the area you are diving in. The most common thicknesses are 5 or 6 mm. Before choosing a suit, you should talk to an Instructor or Dive Shop, about the types and models of suits available and ask them to give you advice on which suit to purchase, for the conditions you will be diving in.

Suits come in many varieties depending on the environmental conditions. Suits are manufactured in a wide range of models, from short sleeves and pants (called a "shorty suit"), suits with pants and jacket, bib type overall suits called "farmer johns", to suits that are one piece including the hood. Again you should seek the advice of your Instructor or a Dive Shop.

Various zippers can be installed in the suit to make it easier to put the suit on and off. You must remember, however, that each zipper is a potential place for water to get into the suit and decrease the thermal protection. You will have to decide how many zippers you wish.

Shorty wet suit

Accessories for the suit include boots, to protect your feet from cold and also from the friction caused by adjustable fins. There are several types of neoprene boots in use. Some boots have a hard sole that help to protect your feet when diving from a beach or over rocks. Others have no hard sole and quickly wear out when in rough terrain, but are good when diving from a boat, where walking around is on smooth surfaces. Most types of boots offer good thermal protection.

Be sure that your fins have sufficient room in the foot to facilitate the type of boots you are wearing. Some boots have zippers in them to make them easier to get on and off, especially if they are made of thick neoprene. One technique that has been used is to put plastic bags or nylon stockings on your feet, before putting the boots on to make it easier to put them on.

Hood

Wearing gloves while diving offers protection for your hands. Your skin becomes soft, due to contact with the water and it is easy to get cuts that, once dry, can be annoying and painful. Although you are told not to touch anything underwater, especially living things, there are times when, by reflex, you will reach out to protect yourself from projections, or support yourself against a rock.

As your hands become less sensitive due to the lower temperature it is easy to cut yourself. This is one of the reasons you should wear gloves. This is especially important when diving on wrecks where the environment is full of metal plates, made rough by the oxidation that takes place underwater.

The type of gloves to use will depend on the temperature of the water you are diving in.

Heat vest

1. Basic diving equipment (continued)

Different types of booties

Cold water gloves

Gloves for normal temperature water

Lycra suit or Dive skin

In warm and temperate waters, you can use a light type, as long as they are resistant to tearing and have some form of non-skid material on the palms, to provide a better grip. In cold water, gloves made of neoprene material will offer better protection from the cold.

However, these will decrease your sense of feel. In extremely cold water, three finger gloves give better thermal protection for your hands, but they decrease your manual dexterity. These have a thumb and forefinger separate from the rest of the fingers, enclosed in a mitt portion.

Lycra Suits (Body Skins): Used in tropical waters, this type of suit protects your body from contact with coral and marine animals. These suits cover your torso, legs and arms and are thin enough that you won't become overheated while diving. There are many models available in various designs, colours and quality. Sometimes this type of suit is worn under a neoprene wet suit, to add a bit of additional thermal protection, and they also make it easier to put on and take off the neoprene wet suit.

Before venturing out to buy a diving suit, you are best to seek advice from your instructor or a dive shop. As a general rule, if you are diving in cold water, the suit should protect your head, groin and under the arms because these are the areas of your body that lose heat fastest in water Except with dry suits, a diving suit should be sized so that it moulds to your body perfectly, without restricting blood flow or breathing and not too large so that it allows water to flow in and out of the suit easily and lower the thermal protection, decreasing it's efficiency. Be sure that the suit is not baggy at the elbows or knees, since air can accumulate and when descending, this air volume will decrease, due to the increase in pressure outside the suit and cause a "Hickey" or blood vessel rupture at the knees or elbows.

Purchasing a coloured suit will make you more visible on the surface and they are also attractive if you are modelling for underwater photography. As a final comment, neoprene knee pads and elbow pads are manufactured to protect the parts of the suit that get the most wear. These help to increase the life of the suit.

After using, wash the suit in fresh water and allow it to dry. Wash the suit in warm water and a mild detergent, from time to time, by hand. Use a lubricant on zippers, that is sold for that purpose. The suit should be stored on a wooden or plastic hanger, and ensure that there are no folds in the suit.

1.1.5. - WEIGHT BELT

The weight belt is necessary to compensate for your body's natural buoyancy. This need is increased considerably when you are wearing a neoprene wet suit.

The belts are made of canvas or plastic woven material. The most important part of the belt is the buckle, which is designed so that it can be released quickly with one gloved hand. In the event of an emergency, the weight belt is dropped allowing for a buoyant ascent to the surface. You should practice this technique so that you will be able to do it easily, if the need arises. The need to become buoyant quickly can happen on the surface, as well as at depth.

One form of belt consists of a buckle having a lever type closure, which holds the belt in place when closed and when opened the belt can easily be undone.

1. Basic diving equipment (continued)

Another type is the "Double D" system. This consists of 2 D shaped rings fastened to one end of the belt. The free end is passed through both of these rings and then looped back over the outside of one ring, and then through the middle of the second ring. There is a tail left which is not fed through the second ring which, when pulled, allows the belt to become undone and the free end can fall through the 2 rings.

A third type is similar to an automobile or airplane type fastener, consisting of two plastic or metal fasteners which, when pushed together, lock and then release, by opening the outside lever on one end of the belt.

Weight belts

Using a weight belt while snorkel diving can be dangerous, due to the decrease in your body's buoyancy, caused by the increase in pressure.

More on this subject will be discussed later in lessons about the gas laws.

The aim is to obtain neutral buoyancy

The lead weights are manufactured in various sizes. Usually these are 1, 2, 3, 5, 6 and 8 pound weights. Some are flat, while others are shaped in a curve to better fit the contours of your waist. Some weights are coated with plastic and can be purchased in many different, attractive colours. The plastic also reduces friction when against your skin.

Often the slots or grooves in the weights which the belt slides through, are larger than the belt and the weights have a tendency to slide around, or fall off the belt, when you are not using it. You can purchase loops that fasten between the weights to stop them from slipping, or you can slide the belt through one slot, twist the belt and then slip it through the second slot. This will also help to hold the weight in place. There are also belts available with pockets in them, for you to put the weights in, so that they remain in one place.

Ankle weights

The weights should be distributed evenly on both sides of your body so you will have better stability while swimming. You should also avoid placing weights in the small of your back, as this could cause an injury when you are wearing a tank.

Because the thickness of the neoprene suit decreases with depth, your belt may become loose and you may have to adjust it tighter during the dive and then loosen it again when you are surfacing. Some models of weight belt have a flexible strip built into them, which automatically tighten and then loosen while you are diving.

Belt maintenance consists of washing the belt in fresh water after the dive and checking the buckles, from time to time, for fraying or cuts.

1.1.6. - BUOYANCY COMPENSATORS

It has been said that the buoyancy compensator is the most important piece of equipment in scuba diving, since it allows you to be buoyant at any depth by varying the amount of air in the compensator, so that you have a sensation of weightlessness, which is one of the large attractions of recreational diving and permits you to enjoy your dive with minimal effort, at any given depth.

ACUC makes the use of buoyancy compensators mandatory at all of its diver levels, due to the important safety factor that compensators add to the practice of our activity.

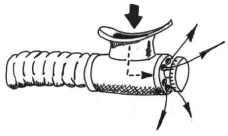
Different types of weights

1. Basic diving equipment (continued)

Jacket type Buoyancy compensator

We believe that, not only is it useful for controlling buoyancy at depth, but it also permits you to increase your buoyancy on the surface, without the effort of swimming while waiting for the vessel to pick you up. The compensator is also very useful in rescue situations, for both the safety of yourself and your buddy. There are several types for different uses, which are described below.

Snorkelling Vest: This type of jacket is smaller than a scuba jacket and is similar to those used on airlines. Another name for it is "Horsecollar". It has an opening in one end for your head to fit through and sits on your chest, with straps attached to hold it in place. There are two ways to inflate the vest. One for manually inflating through a mouthpiece located on the left side of the vest, and the other, a mechanical device with a carbon dioxide cartridge attached. When fired, the carbon dioxide is released into the vest. It must have sufficient buoyancy to keep the diver's head above the surface of the water, if the need arises.



Oral Inflator

Jacket Buoyancy Compensator: This type of jacket is used while Scuba Diving. Its main purpose is to compensate for the decrease in buoyancy of the diver, due to the increase in pressure. As mentioned previously, it is also very important as it increases the diver's safety on the surface and can act as well, as a tool in rescue operations.

Oral and pneumatic Inflator

The jacket must have a manual inflation hose with a large diameter, to allow you to orally inflate or deflate the jacket quickly. This hose is connected on the left side of the jacket, near the shoulder and hangs down the left side of the jacket.

An integral part of the jacket is a power inflator. This consists of a hose attached to low pressure port on the 1st stage of the regulator, comes over the left shoulder of the jacket and has a quick connection fitting, which fastens to the manual inflator hose on the left side. The hose has a button which, when pushed, allows air from the tank to enter the jacket, thereby increasing the buoyancy. Some more sophisticated models incorporate a 2nd stage mouthpiece, allowing the diver to breathe from the jacket through the hose, instead of breathing air from the tank.

Overpressure relief valve

The jacket must be equipped with an overpressure relief valve or "dump valve", which will release any overpressure on the BC, due to the decrease in pressure and increase in volume of air in the jacket while ascending, therefore preventing damage to the jacket.

These overpressure relief valves usually have a button or cord attached, to allow you to dump air from the BC quickly. Sometimes, this relief valve is located in the manual inflator hose, near the top of the shoulder. Another way to release air from the BC, is to raise the manual inflator hose over your head and press the deflate button.

Another type of compensator

In addition, you should carry a whistle attached to the inflator hose on your BC. A whistle is more noticeable on the surface than shouting or waving your arms, especially in rough seas. There is, on the market, a whistle that connects to the power inflator, near the manual inflator hose that, when you press a button, emits a low shrill sound, without having to manually blow a whistle. This has an advantage when you are in rough seas and are concentrating your efforts on breathing, rather than trying to manually blow a whistle.

1. Basic diving equipment (continued)

Modern compensator jackets have their own tank harness incorporated in their design. This harness is made of the same materials as the jacket and usually has a Velcro strip sewn to it, to hold down the portion of the strap that is left over after fastening to the tank. There is another short loop at the top of the jacket that fits over the tank valve. This stops the tank from falling out of the harness, or falling towards your head if, for some reason, the tank strap should come undone while diving.

Some of the older models or "Horsecollar" BCs have a power inflator and overpressure relief valve incorporated in them. This type of jacket does not have the tank harness attached and therefore the tank must have its own backpack, separate from the BC.

Most jackets have a series of pockets in them, to carry some of the added equipment you carry while diving, such as dive tables, empty carry bags, slates, etc., to name a few. Some pockets are designed to carry the Octopus second stage so that it will not drag in mud, bang on rocks, or get damaged while diving

Wings type compensator

A good jacket will keep your head out of the water and your body in a vertical position, in an emergency situation. The air bags or flotation should be located above the waist and near the shoulders. There is a model of jacket whose air bags or "wings", are located next to the tank on the back of the diver. This type is great for swimming underwater since the diver hangs from the air bags, but is a problem on the surface, since the air bags are in the back, there will be a tendency for you to be forced into a face down position on the surface.

During your diving course you will be taught the correct method of inflating and deflating the buoyancy compensator, both on a dive and in an emergency. It is important that you practice these techniques under the supervision of an instructor.

It is important to clean the jacket thoroughly after the dive. Not only must you wash the outside of the jacket with fresh water, but you must also put water inside the bladder, to remove any salt water that may have gotten in during the dive. This is accomplished by pouring fresh water into the bladder through the inflator hose and then filling the jacket with air. By tumbling the jacket back and forth, you can wash any salt that may be present. Repeat this process a few times. Some divers tell you to taste the water to ensure that there is no salt present but we do not recommend this. Due to the warmth of the jacket, bacteria can grow inside the jacket over time. Every few months, or more often if you dive frequently and the jacket is subjected to warm tropical climates, introduce an anti bacteria cleaning agent into the jacket bladders, along with fresh water and rinse this around. Then flush the jacket with fresh water. Once the jacket is clean, put some air in the bladder of the jacket and put the jacket on a hanger in a dry, airy place away from direct sun. To store the jacket leave it on a hanger, partly inflated so that the sides of the bladder cannot stick together.

1.1.7. - FLAGS AND FLOATS

For the safety of the submerged diver it is recommended that a warning system on the surface be used, so that vessels operating nearby will be aware that there are divers in the area and that they should take caution. For this purpose the dive flag is used.

1. Basic diving equipment (continued)

Dive flag and float

You are best to use the dive flag that is common for the area that you are diving in. A local instructor or Dive Shop will inform you on which flag to use. There are various types of floats and flags on the market.

The most recommended one, of course, is a dive boat with a person on board, who can help in an emergency and also, warn other vessels away from the area. If there is not a dive boat available (in some countries a dive boat is mandatory, so check it out first), you should use a float that is air filled and brightly coloured, with some form of tower or flag that sticks out of the water and can be seen from a long distance, so that it is identifiable and does not look only as a lost object abandoned in the sea.

Not only is the float useful to support the flag, but it also can be used to carry other equipment such as a camera, while you are snorkeling.
The float is also useful for decompression stops (which will be discussed later), or for a safety stop at a desired depth, by hanging on to the rope suspended from the float. This is much easier than trying to maintain a constant depth without this aid.

There is a type of buoy on the market that comes rolled up in a pouch, has a rope attached to it and is carried in the pocket of the BC. When you get close to the surface, you take it out of the bag and inflate it from the regulator.

This can be done when you reach the depth of your safety stop. It projects about 5 feet (1.5 metres) above the surface of the water and makes it easy for the dive boat to see where you are.

You should always dive with some form of divers' flag. There are two common flags in use.

Alpha flag

The most popular in North America and now becoming popular in Europe, is a red rectangular flag with a white stripe running from the top of the hoist (the side of the flag nearest to the pole), to the bottom of the fly (the loose end of the flag).

The International Dive Flag is the "Alpha Flag". This is a flag with a notch in the fly end. It is blue and white in colour.

1.1.8. - DIVE KNIFE

Dive knife

When we talk about knives we automatically think about a weapon. This is not the case in diving. The knife must be a versatile tool that can be used as a hammer, saw, screwdriver, lever or prying tool.

Serrated edge and flat tip

It must be manufactured in stainless steel so that it will last a long time. Unfortunately, if it is true stainless steel it will loose its edge very quickly, because it is not hard enough. The solution already exists on the market: titanium knives, which are totally stainless and very hard, but they are very expensive.

One edge of the knife should be very sharp, while the over edge should have saw teeth. The tip of the blade should be squared off, to use as a screwdriver and the hilt end should be of steel, so that it can be used as a hammer.

The steel should run completely through the handle and be hard enough to be used as a pry lever.

1. Basic diving equipment (continued)

The handle should be a bright colour so it can be found easy if it falls to the bottom.

The sheath should have some way of locking the knife to it, so that the knife cannot fall out when you dive in a head down position. The type of fastening will depend on which part of your body you wish to carry it. Most models come with straps long enough for you to fasten the knife to your arm or your leg.

Another type of dive knife

Some divers carry the knife fastened to the outside of the leg, while others carry the knife on the inside. Some prefer to fasten it to their arm, while others fasten it to the harness of the BC.

Some divers carry two knives, a large one on the arm or the leg and a smaller, sharp one fastened to the instrument console.

The proper maintenance of the knife requires special attention to the cleaning and drying, to avoid rust, as well as applying a film of silicone once it is clean and dry.

It will need to be sharpened frequently, since a knife that will not cut will be useless if the need arises.

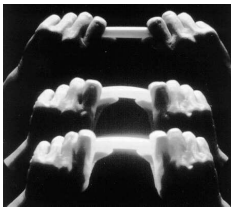
Often, while diving, you will run across abandoned monofilament fish line that can get tangled around your legs. You will require a knife with a serrated edge to cut it.

If you think you will be diving in an area where there may be abandoned fish nets, it would be wise to carry a small sharp knife with a serrated edge, as well as your regular dive knife.

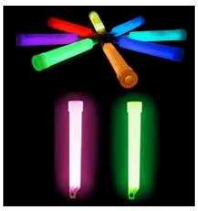
1.1.9. CHEMICAL LIGHTS

Flares are available which give off a red smoke, as well as a very bright red light that can be seen by day or night, in the event of an emergency. They cannot be lit underwater. They can be carried on a belt or fastened to the sheath of the dive knife. They are available in most navigation shops, but are not in common use in scuba diving.

For night dives, the chemical light or "cyalume" is an auxiliary light which adds an extra element of safety to a night dive. The chemical is contained in a glass vial, inside a plastic pipe. Simply by bending the plastic pipe, the glass vial will break and cause the chemicals inside to mix and produce a florescent light, which is visible underwater at night. The chemical lights normally come in green, blue or red.



A common practice is to fasten the chemical light to the valve of the tank. In this position, they will float up and not impede the night vision of the diver carrying it. The dive buddies activate their lights at the beginning of the dive, so they will not lose sight of each other. The Divemaster can carry a different colour light so that everyone will recognize him.

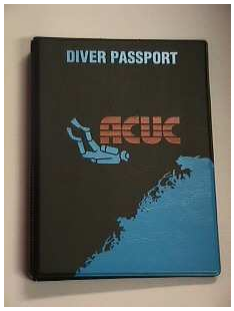


Chemical lights

Some dive plans only use the chemical light as an emergency procedure. The lights are only activated if a diver gets lost or in the event of an emergency.

1. Basic diving equipment (continued)

1.1.10. THE LOG BOOK



ACUC log book

Your log book is the place where you record all of your dives. It is not only a place where you can record the enjoyment of a certain dive, but is also a place you can go to when you are planning a future dive and want to have accurate information.

The log sheet can contain a description of the dive site, the depths, the visibility, other conditions, the dive times and your total accrued hours and anything else that you wish to register in it. The log sheet is also vital in the event of an emergency, and the information that it contains is important to guarantee adequate medical treatment. Recording the water temperature for example, can help in planning next year's dives.

ACUC decompression tables

The information from the first dive of the day is absolutely necessary in planning your repetitive dives. If you have recorded the information it will avoid committing mistakes, due to wrong information.

One of the latest trends in the diving industry is the requirement of a log book in addition to your certification cards, when you wish to dive from a boat or rent equipment, as proof that you have been diving recently. ACUC requires completed log book records, in order to qualify for some advanced courses.

Taking a slate and pencil underwater can be used to record depths times and other observations, so that you can transfer these to your log book later on. It can also be used to communicate with your buddy during the dive

1.1.11. REPAIR KIT

Repair kit items

The loss or breaking of a fin strap can finish your dive for the day. A simple repair kit, with tools and spare parts carried in a plastic bag, will permit you to maintain your equipment in operation and enable you to dive. The typical components of a repair kit are as follows:

SPARE PARTS

- Fin strap and buckle
- Mask strap
- Spare tank O ring
- Regulator mouthpiece
- Tie Wraps
- High pressure hose
- Low-pressure hose

CONSUMABLES

- Batteries
- Medicines such as Solarcaine and ointments.
- Anti bacteria solution
- Solar protection
- Current, not expired, medicines
- Waterproof tape
- Silicone

1. Basic diving equipment (continued)

- Thread and needle
- Neoprene Glue
- Nylon cord
- Surgical tubing

TOOLS

- Pliers
- Adjustable Wrench
- Allen keys for regulator connections
- Small screwdriver

Note: A physician can advise you better on what medicines you should carry.

1.1.12. THE EQUIPMENT BAG

An equipment bag helps you to move your equipment from one place to another in an orderly fashion. The bag you purchase should be large enough to carry all of your equipment, except the tank and weight belt. The seams and handles should be strong and the zippers must be made of strong, non-corrosive material. Cotton, linen, nylon reinforced vinyl, and plastic are some of the materials that bags are made of.

The straps should be part of the handles and go completely around the bag to add strength.

The fins, booties, suit, gloves, knives and less fragile items should be put in the bottom of the bag. Items such as the mask, regulator, and instrument console should be put in a separate, rigid compartment to protect them. The tank is always carried separate.

Wet articles should not be put in the bag, unless it is designed with drainage capabilities. It is always best to dry your equipment, especially the wet suit, before storing it to avoid the growth of mildew and bad odours.

When diving from a boat, you should store your equipment loosely in your bag, except when you are using the equipment in the water.

Dive bags

Press on this bar to go to the next chapter

ACUC

PRACTICES WITH BASIC EQUIPMENT

LESSON OBJECTIVES

At the end of this chapter the student should be able to describe the theory regarding:

- How to clear the mask
- How to clear the snorkel
- How to enter the water
- How to ascend from the bottom
- How to swim with fins
- How to equalize your ears
- How to do a surface dive
- How to drop your weight belt

The reader will find next the description of some of the most important skills that will be done during the scuba course. The ACUC Open Water Diver video offers an excellent visual description of these exercises. All these exercises must be done under direct supervision of an ACUC Instructor. Many of these exercises will be done later with full scuba equipment.

Clearing the mask

2.1. - MASK CLEARING

This exercise should be practiced often until you master it easily. Being able to clear your mask easily will avoid stress when your mask floods unexpectedly. Very simply, mask clearing involves pulling the mask slightly away from your face on the side furthest away from the surface and exhaling gently through your nose to displace the water in the mask with air. When the water is all gone, allow the mask to seal completely against the face again.

This exercise can be done while you are in the upright position in the water or when you are in a horizontal position. In the upright position, look towards the surface, ease the mask slightly away from your face around the bottom of your nose, while holding the top of the mask firmly against your face. Exhale slightly through your nose. The air will travel to the top of the mask and push the water out of the bottom. Continue to blow gently until all of the water is gone and then seal the mask to your face again.

In the horizontal position, turn on your side; hold the mask against your face on the side closest to the surface. Separate the lower portion of the mask from your face and exhale gently through your nose. The exhaled air will rise and force the water out of the bottom of the mask. Continue to blow gently until all of the water is gone and then seal the mask to your face again.

2.2. - TWO METHODS OF SNORKEL CLEARING

When breathing through the snorkel while on the surface or while skin diving, you will be required to clear the snorkel efficiently many times, either due to doing descents and ascents or from rough water while on the surface.

2. Practices with basic equipment (continued)

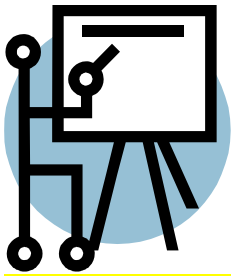
2.2.1. - THE BLAST METHOD

This is the most common method used to clear the snorkel. Consists of blowing a sharp blast of air into the snorkel when you reach the surface to displace the water. This blast of air causes the water to shoot upwards similar to a whale. You will need to practice this method a number of times in order to master it. Use caution when you inhale through your snorkel after blasting the water out to avoid aspirating any water into your lungs just in case you haven't gotten all of the water out. Some snorkels have a purge valve incorporated at the bottom of the tube that helps to drain the water from the snorkel.

2.2.2. - THE DISPLACEMENT METHOD

When you are on your way to the surface after a dive, tilt your head back and look towards the surface so that the snorkel is inclined downwards. Just before you reach the surface, exhale a little air into the snorkel to displace the water in the snorkel. Continue to exhale gently until your head is above the surface and then move your head to look down so that the snorkel is completely out of the water and empty of water. If done correctly, you should now be able to breathe with an empty snorkel.

2.3. - THREE METHODS OF ENTERING THE WATER



Common to all these entries is the need to move away from the entry point as soon as you can after entering, so that your buddy or another team can enter the water

There are three common ways to enter the water using snorkel equipment. You should practice these methods in calm water from the side of a pool or ledge that is close to the water so that you are comfortable with them before trying these entries in rough water and higher entries.

2.3.1. - STEP ENTRY

Often referred to as the “Giant Stride Entry”. Standing at the edge of the pool, first look down to be sure that your entry point is clear of objects or other divers. While looking straight out in front of you, hold your mask against your face with one hand and step out from the edge as if you were stepping into space. By not looking down, you will avoid the water hitting against your face. This type of entry is used when entering from platforms, docks, etc. in addition to entries from the deck of boats which are high above the water. Done correctly, you can use this entry from higher heights without problems.

2.3.2. - SEATED ENTRY

Sit at the edge of the pool with your legs in the water. Place your hands about 6 inches apart to one side of your body (either left or right side) with your fingers facing away from the water. Push down with your hands while turning your body 180 degrees so that your back is now to the water. Then, slowly lower yourself into the water. This type of entry allows you to enter the water in a gentle manner with full control over your position in the water. It can only be done from flat surfaces that are close to the water. To try this entry in any other condition could be dangerous.

2.3.3. - BACK SEATED ENTRY

While seated with your back to the water, look over both shoulders to be sure that there is no one or any objects below you. Hold your mask with one hand, tuck your chin against your chest, keeping your body in a tuck position, and allow yourself to fall backwards into the water so that you land on your back. This entry is used to get into the water from vessels that sit low in the water such as inflatable boats. The only drawback to this entry is that it can leave you disoriented for a few seconds.

2. Practices with basic equipment (continued)

2.4. - PROPER ASCENTS

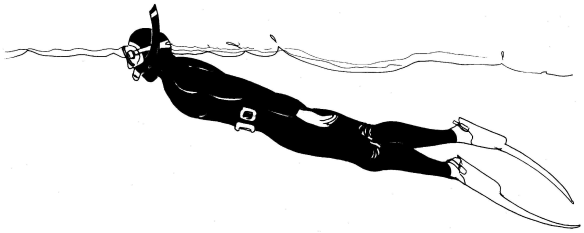
As you ascend toward the surface, you should ascend very slowly and rotate 360 degrees looking to the surface for any signs of boats or obstacles overhead. You should also listen for sounds of propeller noises close by. As an additional caution, extend your arm above your head so that it breaks the surface first. It is better to take a blow to your arm rather than your head. If you are using SCUBA, remember to breathe normally while ascending and **do not hold your breath**.

2.5. - FOUR FINNING METHODS

While snorkeling or using SCUBA it is very seldom that you would use your hands and arms while swimming. They are used to hold your instruments or are used in other ways. You will be using the force of your legs equipped with fins to propel yourself through the water.

2.5.1. - THE FLUTTER KICK

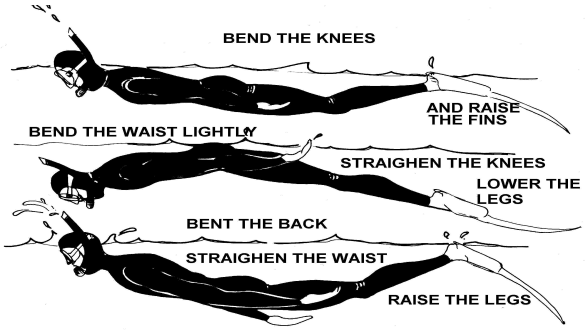
The basic finning style used is the **Flutter Kick**, which becomes more effective when you are using fins. With fins on, it is best to keep the knees locked and move the legs from the hip in a nice, wide, comfortable flutter, and a slow flexing of the ankles. It is important to keep your fins submerged while finning on the surface. Raising the fins out of the water decreases the efficiency of the fin kick. Remember that it is the motion of the fin up and down that moves you forward. If your fin is out of the water, you loose much of the force. It is important to use only a slow full kick. Trying to kick rapidly will only tire you out very quickly. You should be more interested in enjoying yourself for a long period of time rather that having great speed, except, of course, when you are in Fin Swimming competitions, which requires a lot of practice to build up the leg muscles to sustain rapid use of your fins.



Flutter kick

2.5.2. - THE DOLPHIN KICK

This kick is similar to the butterfly style in swimming except that you do not use your arms. Keep your legs together and move them up and down bending at the waist. This style is recommended if you loose a fin or as a change from doing the flutter kick to avoid tiring your legs and increasing the chance of cramps during the dive. A different set of muscles is in play during the dolphin kick.

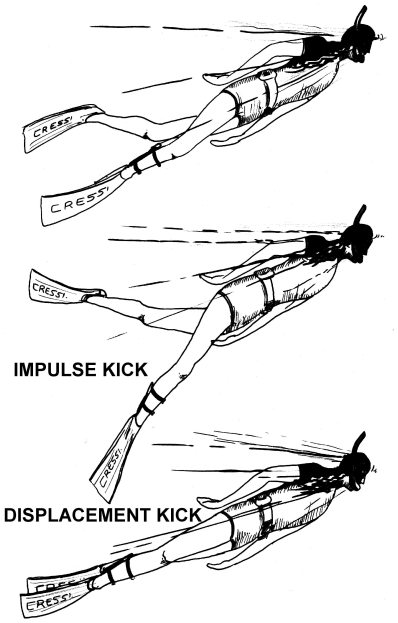


Dolphin kick

2. Practices with basic equipment (continued)

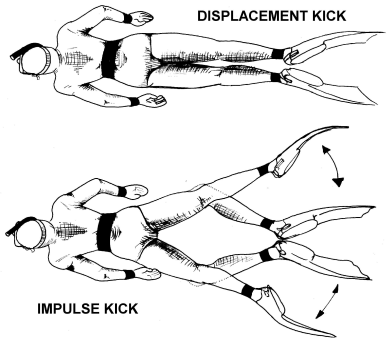
2.5.3. - THE BICYCLE KICK

This is a very relaxing style, which is normally done while you are returning to your entry point on the surface. Bend your legs at the knee and then push out, one leg at a time, similar to riding a bicycle. As a change, you can also use this kick while finning face down. Stand up in the water, lean slightly forward and then bring your legs up one at a time in a bicycle riding fashion. This will propel you forward but very slowly. Photographers use this kick while looking for photo subjects. It can also be used as a change from the flutter or dolphin kick.



2.5.4. - THE FROG KICK

Although it is not commonly used, this is another style of kick worth mentioning. As its name suggests, bend your knees up as close as is comfortable to your thighs with your finned feet out at each side of your body. Thrust your fins to the rear and bring them together when your legs are fully extended. Glide from the thrust as you bring your legs forward again for the next thrust. You will find that this is a very relaxing kick that moves you forward very efficiently. A good change up from the flutter kick.



2.6. - CLEARING THE EARS

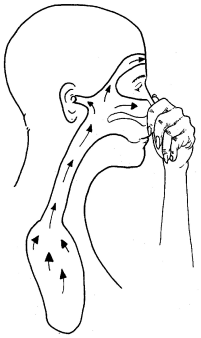
We are sure that you have felt some pain or discomfort at times while diving down to the bottom of a swimming pool or a lake. You may also have felt this to some extent while in an airplane or descending from a mountain or high hill.

2. Practices with basic equipment (continued)

This is due to a difference in pressure between the water and your inner ear (this topic will be discussed in more detail later).

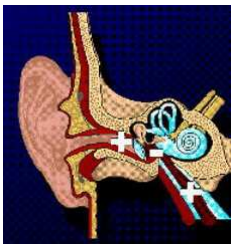
There are numerous methods used to equalize this difference in pressure or "Squeeze". The objective is to move air from your mouth up your Eustachian tube to your middle ear. You should work from the gentlest method to a more vigorous method with caution so that you do not hurt your eardrum. You can try to equalize by wiggling your jaw or swallowing.

If this does not work then try the "Frenzel" method. Place your tongue at the back of your mouth against the roof of your mouth and bring it down sharply making a "khhhhh" sound. With practice, this method is very effective to equalize the ears.



The Valsalva method

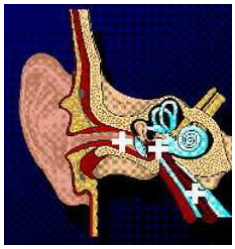
The most common method, known as “Valsalva”, has the potential of being the most dangerous if you are not careful. It consists of pinching your nose through your mask and then gently trying to blow air out your nose. This method forces air up the Eustachian tube and equalizes the pressure on both sides of the eardrum. The danger is in blowing too hard and doing damage to the ear drum or middle ear. Another danger is that you could force water or mucous up the Eustachian tube and this could cause infection in the inner ear. **The key is to blow gently**.



Non compensated ear

At the first sign of pain or discomfort, stop your descent. Ascend until the discomfort disappears and then clear your ears. Do not descend unless you can clear. You are best to clear your ears while on the surface and then every few feet as you descend. This will keep you away from pain.

If you find that you cannot equalize the pressure in your ears, you should cancel your dives for the day. The inability to clear is usually caused from congestion or inflamed and swollen sinuses. By trying to force your ears to equalize you could wind up with an infection in your inner ear which could stop you from diving for weeks. It is better to miss one or two dives than to miss a season of diving.



Compensated ear

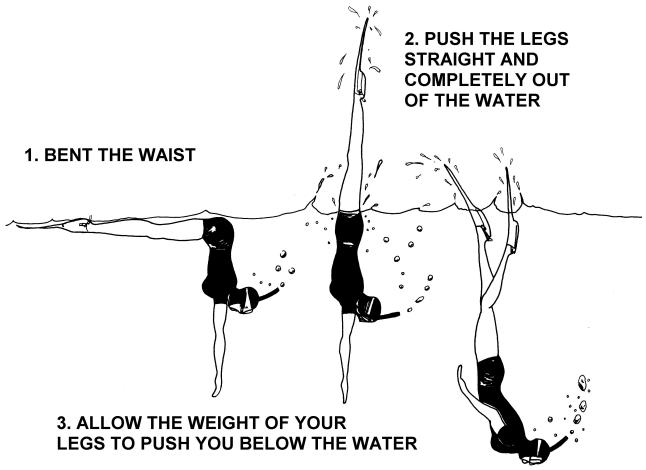
2.7. - TWO TYPES OF SURFACE DIVES

While you are snorkeling on the surface in a horizontal position, you are normally neutral or slightly buoyant due to the distribution of your body weight over a large area. The most efficient way to dive under is to change your weight distribution so that your body weight covers less area. This is accomplished by moving to a vertical position. To dive effectively you can either move to a vertical position with your head down - Duck Dive - or your feet down- Feet First Surface Dive.

2.7.1. - THE DUCK DIVE

Sometimes also called the "Head First Dive", is done from the horizontal position in the water. While moving slowly forward with your arms out in front of you, bend at the waist 90 degrees and sharply bring your legs up so that they are out of the water and directly above you. The weight of your legs out of the water will force your body down under the surface. As soon as your fins are underwater, begin to fin downwards to increase your depth. You can help by sweeping your hands and arms to the side to increase your initial downward thrust.

2. Practices with basic equipment (continued)

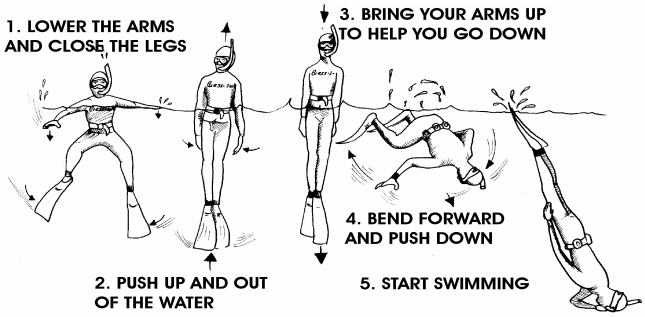


Duck dive

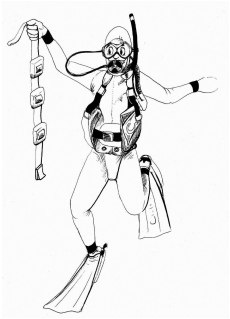
2.7.2. - THE FEET FIRST SURFACE DIVE

This dive is done from the vertical position. Kick upwards with your fins and push down with your arms to bring your head and torso out of the water as far as possible. As soon as your upward motion stops, when your neck is under the water, swing your arms above your head and allow yourself to drop down below the surface. When your body is completely submerged, bend at the waist and turn yourself so that you are facing downward. Begin finning downwards making sure that your fins stay submerged.

Both methods are simple and easy to use, although it is simpler to demonstrate than to describe them. The “feet first” method is perhaps recommended because is less disorientating for the diver. You should practice these two types of dives until you master them, not because it is required during your course but to give you the satisfaction of mastering these skills.



Feet first dive



Releasing the weight belt in case of an emergency

2.8. - CORRECT METHOD OF RELEASING THE WEIGHT BELT

In the vertical position, undo the weight belt buckle with your right hand. Grasp the belt and pull it completely away from your body. Extend your arm to ensure that the weight belt will not get entangled with your equipment and release it. Be sure there is no diver directly below you before you drop the belt. As a safety precaution, hold the hose of your vest with your left hand in case you have to deflate the vest quickly if you start to ascend rapidly.

Press on this bar to go to the next chapter

SCUBA DIVING EQUIPMENT

LESSON OBJECTIVES

By the end of this chapter the student will be able to:

- Define the word SCUBA
- Name and describe the different types of equipment used in SCUBA
- Name and describe two types of tanks
- Name and describe two types of valves
- Name and describe two types of valve connections
- Name and describe the different parts of a single hose regulator
- Define the minimal amount of air a diver must have in the tank at the end of a dive
- Name and describe other equipment

3.1. - SCUBA EQUIPMENT

Depending on the source of the air supply, the breathing equipment used underwater can be put into two classifications, Self-Contained and Surface Supplied. The surface supplied system, as its name implies, receives the breathing air from a compressor or storage tanks situated on the surface and delivers it to the diver through a long hose. Air is fed through a manifold on the surface to a hose leading down to the diver where a second stage regulator supplies air to the diver at ambient pressure. This is also known as a "Hookah" system and is normally used in commercial diving, where divers are at a fairly shallow depth for a long time. Presently there is a system consisting of a small gasoline compressor floating in an inner tube or float that is popular in some tourist areas. This system allows 2 divers to go to a depth of 20 to 30 feet (6 to 9 metres) while being supplied from the surface air.

Unfortunately, the owners of this type of equipment do not always require previous training and allow non-trained divers to use it. We believe this could be the cause of unfortunate accidents.

The self-contained systems are broken down into two further classifications: Closed Circuit and Open Circuit. The **closed circuit system** uses pure oxygen and is called closed circuit because there is no exhaled gas exiting into the surroundings. The pure oxygen is connected through a valve to a sack or tank located on the diver's chest. This sack is connected through a regulator to the diver's mouthpiece. The exhaled gas laden with carbon dioxide passes through the same regulator and enters a container filled with soda lime which is used to scrub the carbon dioxide from the expired gas. The oxygen from the exhalation returns to the breathing sack where it combines with the fresh oxygen and is breathed by the diver. Due to the complexity of its assembly, operation, and the inherent risk associated with breathing pure oxygen, it is primarily used by technical divers and the military and in some cases, commercial divers. Other closed circuit systems use different gas mixes that permit divers to work at greater depths, but these are topics will not be discussed in this manual, which is intended for RECREATIONAL diving.

The **open circuit system** is called that because the gas exhausted in respiration is released into the water after each breath. This is the system that is most familiar with Recreational Divers and is called SCUBA which stands for Self Contained Underwater Breathing Apparatus. It is this system that you will be trained to use during your course and consists of several components, which are described below.

3. Scuba diving equipment (continued)

3.1.1. - TANKS

The first component of the SCUBA system is the tank or cylinder which contains the pressurized air that you breathe while underwater. Tanks are manufactured in two types of materials, steel and aluminium, each of which has its advantages and disadvantages.

SCUBA tanks

Aluminium tanks are lighter but, due to metal strength compared to steel, the size of the cylinder is slightly larger. This is due to the greater wall thickness of the aluminium. Aluminium is the most popular material used today in many countries because it causes fewer problems with corrosion versus steel. Normally aluminium cylinders have a flat bottom, which allows them to stand on end. It is recommended that you always lay the tank down when you are not using it so that it will not fall over causing damage to the valve or hurt persons nearby.

Steel tanks or cylinders are heavier than aluminium but are usually smaller because the strength of the steel allows for thinner cylinder walls. Although they are more susceptible to corrosion than aluminium, the corrosion is easier to see. Another advantage over aluminium is that it is heavier and does not float when empty as aluminium does. The base of the tank is convex or curved so it requires a boot over the end in order for the tank to stand up.

Both aluminium and steel cylinders are manufactured in a wide range of sizes and capacities. Each cylinder has a rated pressure that it can be filled to and this is stamped on the cylinder. Presently, the most widely used cylinders have a capacity of 3,000 psi (pounds per square inch).

The dimensions of cylinders will vary depending on the material they are manufactured with. It is important to mention that, since air has weight, a full cylinder will weigh more when it is full than when it is empty. You will learn to take this into consideration when you are learning about buoyancy. The difference in weight is somewhere around 6 to 8 lbs.

Some steel cylinders are coated both internally and externally with an anticorrosion material depending on the manufacturer. Sometimes the interior of the cylinder is coated with an epoxy-resin, which is very effective in preventing rust, but it is difficult to determine if rust has begun under the coating. On the outside, steel tanks are usually galvanized to resist rusting.

Protective tank mesh

Normal maintenance of the tank requires washing it after every dive with fresh clean water. Every once in a while, remove the boot, if it has one, and check for rust forming under it. When storing your tank, be sure there is some air in the tank so that nothing can get inside it.

Once each year, you should have your tank visually inspected. This consists of taking your tank to your Dive Shop where they will examine the outside of the cylinder for rust and pitting, remove the valve and inspect the inside of the tank for rust or pitting or for any foreign material that may have entered the tank. ACUC has a Visual Inspector Program that trains Dive Store personnel in the proper performance of doing Visual Inspections.

Depending on the legislation in each country, every tank is required to have a "Hydrostatic Test" completed on it. Normally, this is every 5 years but may be different in the country in which you reside. You can learn the requirements from your local Dive Shop.

3. Scuba diving equipment (continued)

The hydrostatic test consists of removing the tank valve, filling it completely with water and placing it in a chamber that is also filled with water. Water is forced into the cylinder until its pressure is equal to 50% over the tank's normal working pressure (may be different in your country). This increased internal water pressure will cause the cylinder to expand forcing some of the water in the outside chamber into a calibrated tube.

This overpressure is held for a certain length of time and then released. The water that was forced into the tube during the overpressure must drop back to a certain specified tolerance margin in order for the tank to be approved before filling with air to the marked pressure on the tank. As you would expect, a qualified testing centre can only do this test. The registered examiner will then stamp the tank with his /her inspector number and the date of the inspection.

Not having your tank visually inspected or hydrostatic tested at the proper times would be irresponsible. When you consider the high pressure of the air in the tank, there is a risk of an explosion if something is wrong with the tank. All filling stations pay particular attention to the last hydrostatic test date which is engraved at the neck of the tank and must, by law, refuse to fill the tank if it is out of test. Tanks are normally filled at stations designed for that purpose.

Sometimes, especially in vacation areas, small portable compressors are used. These compressors are usually of a low CFM (cubic feet per minute) rating and it takes a long time to fill a tank to 3,000 psi. Regardless of how they are filled, the tanks should be placed in a tub containing water while filling. If, for any reason, the tank should rupture, the water will absorb some of the shock of the explosion. In addition, forcing air into the tank will cause the tank to heat up. The water will help to cool the tank back down. Caution should be taken when filling so that you do not fill the tank over its marked pressure.

Some filling stations, in order to speed up the filling process, will have a bank of previously filled, large, high pressure cylinders connected to each other with valves and hoses. Then, when they are filling your tank, they fill it from this bank of tanks. This allows the tank to be filled much faster than waiting for the compressor to fill it. Later, when business is slower, the bank is refilled from the compressor. This type of system is called a "Cascade System."

Situated at the neck of the tank is a series of letters and numbers. This information includes the manufacturers name, tank serial number, type of metal the tank is made of, working pressure and the date of hydrostatic inspection. Before using a tank you are unfamiliar with, be sure to check that the tank is within its hydro date. You should also be aware of the type of metal the tank is made of since this will affect the amount of weight you carry on your weight belt.

3.1.2. - THE VALVE

The valve is threaded into the neck of the tank and permits you to fasten various pieces of equipment to the tank. There are several types of valves in use today. The "J" valve is equipped with a positive reserve valve. The valve design includes a piston that, when the pressure in the tank reaches a certain pressure (usually 300 psi), will close and stop the flow of air to the diver's regulator. By activating the reserve lever, the balance of the air in the tank can be breathed by the diver. This type of valve was designed as a safety feature so that a diver would be aware that he was getting low on air and would have enough air remaining in the tank to make a safe ascent to the surface.

Very frequently, the diver would forget to activate the reserve lever before diving and would wind up running out of air at depth because the lever was left open. Sometimes, the lever got inadvertently knocked open during the dive and the diver would discover this only when he had run out of air at depth.

Another disadvantage of this type of valve is that it requires high maintenance especially when diving in salt water. Contact with salt water causes corrosion to occur quickly in the moving parts of the valve and it will seize.

3. Scuba diving equipment (continued)

The «J» valve

The "J" valve should not be used as a substitute for using a submersible pressure gauge (discussed later on) which should be carried by the diver and monitored to see how much air is remaining in the tank. The "J" valve, when it is in the activated position will cause the reading on the submersible pressure gauge to fluctuate during breaths.

The "K" valve is a simple on and off valve and does not have a reserve mechanism. You use this valve to turn your air on at the beginning of your dive and turn it off at the end of your dive.

The «K» valve

"J" and "K" valves did not get their names from their general shape as many people believe. The names came about through a catalogue put out by a well-known diving equipment manufacturer. The article marked "J" was the valve with a reserve mechanism and the article marked "K" was the valve with no reserve mechanism. It was easier for divers to refer to the catalogue numbers rather than give the long description of each valve.

The valves are manufactured of brass, which is a relatively soft metal, and therefore must be protected from being hit hard and damaged, especially during transportation. Due to the high rate of electrolysis when brass is in direct contact with steel or aluminium, the brass valve is coated with chrome. It is extremely important that the valve threads keep their chrome coating since this is the area that comes in contact with the metal tank. At the end of the valve that threads into the tank, there is a 3 to 4 inch tube or standpipe fitted into it that extends down into the tank. This ensures that any foreign bodies such as water, rust, or any dirt that happened to get into the tank will not get into the valve and cause a blockage in the valve or your regulator.

Valves are equipped with a rupture (or burst) disc set at a specified pressure that will blow if the tank is over pressurized for some reason. This rupture disc is usually made of copper and is held in place by a threaded plug that has a series of holes around its edge to disperse the air in all directions if the disc should rupture.

The high pressure «DIN» valve

The connection to the regulator will be an "INT" fitting or a "DIN" fitting. The most common connection in use is the INT fitting which permits the connection of a yoke from the regulator.

The valve seat holds a rubber or silicone "O" ring that lines up with the regulator connector and forms a tight seal when the air is turned on. The DIN fitting is a threaded fitting direct to the 1st stage of the regulator. The DIN fitting is gaining popularity in North America especially by technical divers due to its positive connection feature, especially for high pressure tanks.

There are also valves on the market that allow for two independent air systems to be connected to two independent regulators. These types of valves are used in activities such as cave diving and other higher than normal risk specialties.

3.1.3. - BACKPACKS

The Backpack

Backpacks are designed to hold the tank to the diver. The older style backpacks consisted of a hard plastic or metal plate formed to fit the divers back. A strap fastens the tank to the plate. Straps from the plate go over each shoulder of the diver and another strap goes around the waist. Adjustments are made by tightening the shoulder and waist straps. This style of backpack is still in use when an independent buoyancy compensator or "Horsecollar" is used. It is also used extensively in cave diving.

3. Scuba diving equipment (continued)

The most popular backpacks now are those that are incorporated into a jacket buoyancy compensator that has the tank directly fastened to the BC with a wide band of canvas and buckles or Velcro. These are much more comfortable on the shoulders and the main adjustment is made at the diver's waist.

When fastening the tank to the backpack, care should be taken that you do not mount it too high. If this happens, you will hit the back of your head on the valve when you are wearing the tank. If you mount it too low, it will interfere with your hips. Your instructor will show you the correct position during your first pool session with the SCUBA equipment.

As a last comment, if a backpack with a metal strap is used for securing the tank to the pack, you should put a strip of rubber between the metal strap and the tank. This helps to stop the tank from sliding out of the backpack while carrying the tank or while underwater. It is also important if aluminium tanks are used due to the potential of electrolysis between the two metals in contact with each other.

3.1.4. - TANK BOOT

The boot, usually made of moulded rubber or hard plastic, slides over the bottom of the tank and gives the tank a flat base to stand on. This is helpful with steel tanks with a round or convex bottom. It also protects pool tiles and the tank bottom if the tank is dropped in error.

The tank boot

The boot should be removed from the tank periodically and cleaned. Examine the tank to be sure that no rust has been allowed to build on the tank under the boot. Boots designed with ribs on the inside help to remove this problem. Holes can be drilled in the bottom of the boot to help remove moisture also.

Wash the tank and boot with fresh water after every dive. Remember to lay your tank on its side when not in use. Never leave your tank standing up unattended.

3.1.5. - THE REGULATOR

The basic mechanism of the demand regulator has not changed since Jacques Yves Cousteau did his original testing in the Marne River in 1943. The function of the regulator is to take high-pressure air from the tank and deliver it at ambient pressure to the diver on demand. This decrease in pressure is accomplished in one or two steps ("**stages**") depending on the internal mechanism of the regulator. Regulators that decrease the pressure in one stage are called "**two hose regulators**" due to their construction. Regulators fasten to the tank valve by means of a yoke screwed to the "O" ring fitting on the valve where, through a series of springs, and valves, the pressure is reduced from tank pressure to the pressure of the water up against a diaphragm. Air travels, at ambient pressure, over the right shoulder of the diver through a soft hose to the diver's mouth where the diver breathes it in. Exhaled air travels through a soft hose over the divers left shoulder back to the regulator where it is exhausted into the water. A series of rubber valves in the soft U shaped hose stops water from getting into the hose. This type of regulator is little used at present by recreational divers, but, now that the technical divers are working with rebreathers and more technical equipment, you will see more of them in dive stores. One advantage of the two hose regulator is that the air is exhausted at the back of your head rather than at your face. Photographers are able to get closer to their subjects underwater without scaring them. A disadvantage is that when the diver turns over on to his back, the regulator will free flow. You will learn the reason for this later under pressure changes.

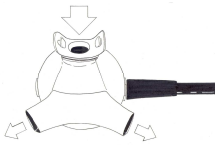
The regulator 2nd stage

3. Scuba diving equipment (continued)

The regulator that decreases the pressure in two stages is called a "**single hose regulator**", again, due to its construction. The regulator fastens to the tank valve by means of a yoke screwed to the "O" ring fitting on the valve. This portion of the regulator or 1st stage reduces the tank pressure, by means of a spring and valve to approximately 150 psi over the ambient pressure surrounding the valve. The air, at this pressure, travels by means of a hose to the 2nd stage that is located near the diver's mouthpiece. Inside this 2nd stage the air is stopped from continuously flowing by a spring-loaded valve with an arm attached to it. The other end of this arm rests against a diaphragm that, as you breathe in, pushes against this arm allowing the valve to open and air to flow into the space at the mouthpiece and your mouth. At the end of your inhalation, the diaphragm goes back to its original position and shuts off the air in the hose. This process repeats itself each time you breathe. On the external case of the 2nd stage is a button, called the "Purge Button", which when pressed against the diaphragm, allows air to flow continuously into the mouthpiece. This allows you to clear water from the mouthpiece before breathing in. Also on the 2nd stage there is a set of projections, usually below the mouthpiece that are known as exhaust ports. The exhaled air from the diver passes through these and out into the water. These exhaust ports are equipped with flapper valves which close off and do not allow water to flow up into the mouthpiece. Care should be taken to protect the 2nd stage so that dirt, sand or other foreign materials do not get under these valves and allow water to flow in to the mouthpiece.

Other regulator's 2nd stage models

Some regulators have a clear plastic 2nd stage casing that permits you to visually see inside the 2nd stage without taking it apart. This is a description of the 2nd stage in its simplest form. Manufacturers have developed more sophisticated models that increase the flow of air to the diver as the demand increases and have incorporated other mechanisms to improve their own brands. It is important that you talk with a knowledgeable person at your local Dive Shop before purchasing a regulator so that you get one that is right for the type of diving you wish to pursue.



The air exhaled by the diver exits to the water through the exhaust ports of the regulator's 2nd stage

Fastened to the 1st stage yoke is a "Dust Cap" that is used to protect the membrane in the high pressure connector that fits on to the tank valve. This cap keeps out dust, impurities and water that could damage the interior of the 1st stage. It is very important that the dust cap be put in place any time the regulator is not fastened to the tank, especially when you are washing the regulator.

On most regulator 1st stages you will find several threaded and plugged connections. Some are "High Pressure (HP)" connections. That is, they are connected on the tank pressure side of the 1st stage.

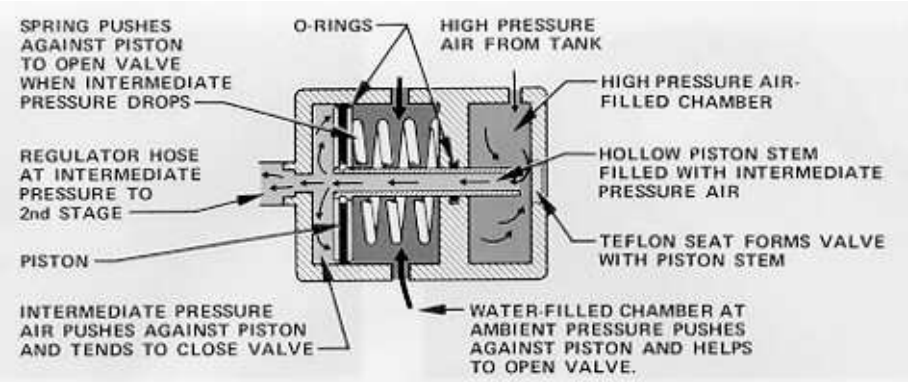
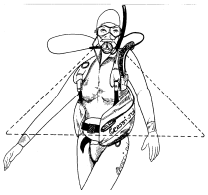


Diagram of a balanced (or compensated) piston regulator's 1st stage

3. Scuba diving equipment (continued)

These are used to connect such things as the submersible pressure gauge that gives you a reading of the amount of pressure in psi remaining in your tank. These connections are usually labelled HP on the plug.



The «Golden Triangle» concept, related with the most important diving equipment placement

Others, at least two, may be marked with an LP "Low Pressure" which is connected to the low-pressure side of the 1st stage. These are used to connect your additional 2nd stage hose or "Octopus Regulator", the power inflator hose for your BC, or the inflator hose for your dry suit.

The "Octopus" consists of an extra 2nd stage complete with hose that is tied into the low-pressure port of the 1st stage. It is used in a situation where your primary 2nd stage malfunctions or to share air with your buddy if his regulator fails or your buddy runs out of air. The length of the octopus hose should be much longer than your primary hose to allow for more flexibility when sharing air with your buddy.

This extra 2nd stage should also be a different colour than your primary so that it is easy to identify (Most octopus regulators are red, yellow or orange).

Hose protectors

The following are some suggestions to keep your regulator in good working condition when you use it. Your regulator contains a series of delicate mechanisms which can be damaged by corrosion or bad treatment.

1. Replace the dust cap on the regulator after every use. Use air from your tank to blow water from the external parts of the regulator. Use air to blow water from the face of the dust cap. Do not blow air into the membrane of the 1st stage. This could force water into the first stage and cause corrosion.
2. Clean the regulator with fresh, clean water after every dive. Run water into the mouthpiece and the exhaust ports. Do not push the purge button when washing the 2nd stage as water could travel up the hose and damage the 1st stage.
3. Drain the water from the 2nd stage after washing and hang to dry by the 1st stage. Never hang the regulator by the hoses. Have hose protectors put on the regulator hoses at the connections. This will reduce the chance of the hose breaking or leaking.
4. Never store the regulator in a wet or damp place and never leave the regulator connected to the tank.
5. Do not carry your tank by the regulator.
6. Check your regulator for leaks and that it is operating properly before you use it. Improper storage can cause rust or deterioration of the hoses.
7. Have your regulator serviced often, at least annually, by a qualified technician.
8. Do not attempt to service your regulator yourself unless you have had the proper training.
9. Crack the tank valve to blow out any impurities that may have accumulated in the valve before connecting the regulator to it.
10. Have your tank filled only at reputable air stations. Any contaminated air may do damage to your regulator. Always leave pressure in your tank when storing so that no foreign bodies can enter the tank
11. Check the filter in the 1st stage connector for change of colour. Colour changes can indicate that the regulator needs servicing. Do not attempt to change the filter by yourself. You could cause alterations in the regulator pressure mechanism.

During your dive, keep the octopus fastened but easily available. Do not let it hang where it can drag on the bottom or get hung up on obstructions.

Octopus holder

3. Scuba diving equipment (continued)

A popular alternative air system, very popular for emergencies, especially in self rescue situations. It can also be used to give to a buddy in an out of air emergency

Be sure that it is in a place that you can reach it easily if needed. Some instructors advise you to carry it loose, while others tell you to fasten it at your chest area on the BC with a safety connection. Many BCs now come equipped with a pocket for the octopus or an alternate air source.

Some divers carry a completely separate air supply and regulator rather than an octopus system. The most important thing is to carry some form of alternate 2nd stage in case of emergency. There are several types of independent air sources available.

These supply enough air for the diver to return to the surface in the event of a failure of yours or your buddy's principal air source. In an emergency, the advantage of this system is that it can be given to the diver in difficulty without establishing direct contact. In a panic situation, close contact could be dangerous.

3.1.6. - SUBMERSIBLE PRESSURE GAUGES

The gauge is connected through a hose to a High Pressure port on the 1st stage of the regulator and indicates the amount of air in psi remaining in the tank. With a little practice, you will be able to estimate how much longer you can stay underwater.

Submersible pressure gauges

The area between 500 psi and 0 psi is usually marked in red to remind you that this is the reserve area for emergency purposes and you should always pay close attention to your gauge so that you never return to the surface with less than 500 psi in your tank.

It can be fastened to your BC so that it does not get damaged from being dragged along the bottom.

ACUC requires all divers to carry and use a submersible pressure gauge and get used to looking at it regularly to avoid any surprises especially on deep dives and those that require decompression stops.

When choosing a gauge, be sure that the gauge housing is made of material that is resistant to breaking if banged against rocks or sand. Also, be sure that the face is large enough to read it without effort even in poor lighting.

If you dive in countries that use a different pressure measurement, choose a dial that shows pressure in psi as well as bars or kg/cm2.

Maintenance of the gauge includes washing thoroughly after use, the same as the rest of the equipment. Check the hoses frequently to be sure there are no breaks or cracks. If you find one, change the hose immediately since this is high-pressure hose.

3.1.7. - DEPTH GAUGE

Depth gauge

The depth gauge is an important piece of your equipment as it indicates what depth you are at, which in turn, controls your dive. For this reason, ACUC makes it mandatory for all divers to have and use one. There are several types in use, each with its own construction.

3. Scuba diving equipment (continued)

The **Capillary Tube** is the simplest and most economic. Based on Boyles Law, it consists of a transparent, graduated, capillary tube (usually made of plastic), which has one end open to the water. When you increase depth, the pressure is increased and the air inside the tube is condensed allowing water to enter the tube so that the point where the air and water meet in the tube is the depth you are at. It is very accurate in the first few feet since the graduated markings are far apart at this depth and get closer together as you go deeper. This will be explained in more detail when Boyles Law is discussed in class. It does have some problems, especially in salt water where the salt can dry and crystallize from previous dives. This will change the internal volume of the gauge and thereby change the reading. Also, you can get air bubbles in the water within the tube that will make it impossible to get a correct reading.

The **Diaphragm Gauge** as its name implies, has a membrane in contact with the water and as the pressure increases, the membrane bends which pushes on a mechanical lever that indicates the depth on a calibrated face. It is of stronger construction than the capillary tube but is subject to failure in its mechanical parts and must be calibrated frequently.

The **Bourdon Tube** consists of a coil made of two different types of metal strips that distort under pressure at different rates. When the pressure increases, the coil begins to unwind and a needle that is fixed to the coil moves on a graduated scale indicating the depth at that point.

The last two systems mentioned can also have a second needle attached which is dragged by the pressure needle and remains at the deepest depth attained when you ascend. They can be very useful when working out the maximum depth attained on the previous dive when you are calculating the no decompression limit for the second dive.

The **Electronic Gauge** uses a pressure sensitive input and an output that is digital on a Liquid Crystal Display (LCD). This can be used as stand alone gauge or it can be incorporated in a console. This type of gauge is very accurate.

3.1.8. - THE DIVE WATCH

One of the most important pieces of information in planning or conducting a dive is the dive time. It requires you to use an instrument which can measure the time elapsed during the dive. It is also necessary to have a watch to determine your air consumption as well as to measure the time of any safety stop before surfacing. The Dive Watch should be guaranteed to a depth of at least 300 feet (90 metres).

Dive computer watch

Good diving watches incorporate a revolving bezel with notches in it that can be turned even with a gloved hand. This allows you to dial in the time at the beginning of the dive and at a glance tells you how many minutes you have been diving.

The straps should be constructed of a material that will allow you to adjust the length so you can put it on over your exposure suit.

Another type is called a "Bottom Timer" which consists of a pressure resistant chronometer that activates and begins counting the moment you go beneath the surface and indicates on a digital screen the length of time spent until you reach the surface again. At this point, the timer automatically stops.

3. Scuba diving equipment (continued)

Different types of consoles incorporating several instruments

Some consoles incorporate electronic clocks in them that do the same thing but also give information on the surface interval time at the end of the dive.

3.1.9. - UNDERWATER COMPASS

A compass can be very useful when diving but only if you know how to use it correctly. You should practice "dry" until you master the technique before attempting to use one underwater.

Some models of compass are flat and require that they be held perfectly horizontal to avoid the needle sticking and giving a false reading. Others are semi spherical and allow for some tilt when reading. Some models are provided with a lateral window that allows you to take a direct reading of the course. They also carry a revolving bevel to set a fix on a given course.

The compass can be very useful in planning a dive and an excellent tool in search and recovery operations. We will not go into the operation of a compass now.

ACUC has a Specialty Course on compass reading that you will find interesting. Contact your instructor to find out when the next course is being run.

Compass

It is enough for now to know that compass face is split into 360 degrees. When you set your course in one direction, by subtracting 180 from your forward reading you will be returning in the exact opposite direction. For example, if your compass heading was 360 degrees on your initial course, then by setting your compass to 360 - 180 = 180 degrees, you will return to your original spot.

Using the side window compass to maintain a course

3.1.10. - DIVE COMPUTERS

A Dive Computer is capable of giving you all of the necessary calculations to dive safely. It will give you, at all times, data of your dive and the length of time you may stay at your current depth without having to decompress. Dive Computers come in a variety of models and many different brands.

As a minimum a Dive Computer should give you the following data: current depth, maximum depth, dive time elapsed, dive time available for no decompression, or at what depth and for how long if you are in a decompression situation. They also have visual and audible alarms to warn you if you are ascending too quickly or when to stop for decompression.

The Aladdin, a popular dive computer

On the surface, the dive computer shows you your residual nitrogen time remaining as well as the no decompression limits for various depths with your existing residual nitrogen.

Recently models have come on the market that, in addition to all of the preceding, can also tell you how much air is remaining in your tank, calculate your air consumption at your current depth and can also give a reading of the water temperature.

Dive Computers are very accurate but you must remember that they are complex electronic instruments and you should follow the manufacturer's directions on operating them.

3. Scuba diving equipment (continued)

Do not forget that in spite of all of the information they can give you they can fail or the battery can run low and leave you without information during a dive. For this reason you should always carry a watch, depth gauge and dive tables.

Your ACUC instructor or the Dive Shop can give you more information about different models, their advantages and disadvantages.

Remember that no manufacturer of dive computers guarantees that using their model will avoid a decompression accident. Each diver must be conscious of his limitations and stay well within the maximum limits of the computer he is using.

Another type of dive computer

3.1.11. - UNDERWATER SLATES

A useful tool to carry in the jacket pocket of your BC is an underwater slate with an indelible pencil attached to it. You can record information regarding your dive as it happens, converse with your buddy rather than using hand signals, and use it to calculate no decompression data if your dive plan changes unexpectedly. Some slates have a set of dive tables on one side complete with a dive profile work sheet that you can use underwater if your plans change.

Underwater slate

3.1.12. - UNDERWATER LIGHTS

To fully appreciate the underwater life, you should consider purchasing an Underwater Light. It is also useful when looking into holes and crevices and is indispensable when night diving or in limited visibility.

You should purchase a light specially manufactured for use underwater. There is an almost endless supply of types and price ranges of lights available on the market. The price is usually based on the amount of candlepower the light produces. Be sure that the head of the lantern has an "O" ring seal to ensure you have a tight seal and no water leaks in to ruin the batteries or the lamp. Some lights take standard batteries while others have rechargeable batteries. The latter tend to be more expensive. However, if you use the light a lot, this type may wind up being more economical in the long run, since changing batteries frequently can be expensive.

The range of available power is immense, from small lights for close inspection to large powerful lights used in underwater photography and video depending on what you wish to use the light for.

One word of caution, if you are using interchangeable batteries, it is wise to remove them after each use to avoid corrosion which is produced when batteries sit for a long time without being used.

Underwater lights

Press on this bar to go to the next chapter

ACUC

DIVING PHYSICS

4

LESSON OBJECTIVES

By the end of this chapter the student will be able to:

- Define Matter
- Define three types of buoyancy
- Explain why colours disappear underwater
- Explain sound underwater
- Define the gaseous components in air and their percentages in the mixture
- Define Pressure and its relationship to Depth
- Name the Gas Laws, their relationship to diving, and their physiological effects.

4.1. - MATTER

4.1.1. - TYPES OF MATTER

Matter can be defined as anything that occupies space and has mass. Matter can be found in three different states: Solids, Liquids and Gaseous, depending on its reaction to environmental stimuli. Solids have a definite shape, have little or no reaction to pressure; the density of a solid remains constant and are affected very little by changes in temperature.

Liquids take the shape of the container they occupy but fill it only to the extent of the liquid's volume and have little or no reaction to pressure. The density of a liquid is affected by changes in temperature. Most liquids will increase in density as temperature decreases and expand as temperature increases. Water is a special case in that it reaches a point of maximum density just above freezing and then begins to expand slightly.

Gases take the shape of the containers they occupy and expand to fill them completely. They are greatly affected by changes in pressure. In a flexible container, as pressure increases on the gas, volume decreases and as pressure decreases, volume increases. Density is also affected by changes in pressure, as pressure increases, density increases; as pressure decreases, density also decreases. Temperature changes also have a directly proportional effect on the volume of a gas. As temperature increases, volume increases, as temperature decreases, volume decreases.

4.1.2. - PROPERTIES OF MATTER

Temperature can be measured in matter. For diving purposes, temperature is measured normally in degrees Celsius or degrees Fahrenheit. To change from degrees Fahrenheit to degrees Celsius, you would subtract 32 from the Fahrenheit Temperature and then multiply by 5/9.

For example, a temperature of 122 Fahrenheit degrees would equal 50 degrees Celsius.

(122 - 32) x 5/9 = 50

A temperature of 50 degrees Celsius, would equal 122 degrees Fahrenheit

50 x 9/5 = (90+32) = 122

4. Diving physics (continued)

The weight of matter is represented as an amount per unit volume. For instance fresh water has a weight of 62.4 pounds per cubic foot (62.4 lbs/cu.ft.).

Salt water has a weight of 64 lbs/cu.ft. These two measurements will be important to remember when doing buoyancy calculations.

4.2. - BUOYANCY

A topic of great interest to divers is "Archimedes' Principle" because it affects your ability to sink or float when you are in the water.

Archimedes' Principle states: *A body submerged in a liquid is buoyed upward by a force equal to the weight of the volume of water it displaces*.

Archimedes

In simpler terms, if you fill a container completely full of water, place an object that will sink in the water, the object will take up space in the container and the water will overflow (is displaced). If you weigh the water that was displaced, you can calculate the cubic feet of the object. For example:

An object you placed in a tank of fresh water displaced 62.4 lbs of water. You know that 1 cubic foot of fresh water weighs 62.4 lbs. (Properties of Matter), therefore, the object displaced 1 cu. ft. of water.

Positive buoyancy

1. If that object weighed 62.4 lbs dry, when you placed it in the water it would not sink lower or float higher. It would stay at the place where you placed it in the water. This is called Neutral Buoyancy.
2. If that object weighed 60.4 lbs. dry, when you placed it in the water it would float. This is due to the fact that it weighs less than the water it displaced (1 cu.ft.; 62.4 lbs). You would have to add 2 lbs of weight to the object in order for it to stay in an exact position in the water. If you cannot add weight, you would have to decrease the volume of water displaced (remove air from the BC.) This is called Positive Buoyancy.
3. If that object weighed 64.4 lbs. dry, when you placed it in the water it would sink. This is due to the fact that the it weighs more than the water it displaced (1 cu.ft.; 62.4 lbs). You would have to take 2 lbs. of weight from the object in order for it to stay in an exact position in the water. If you cannot remove weight, you would have to increase the volume of water displaced in order to be able to stay in an exact position in the water (add air to the BC.) This is called Negative Buoyancy.

Using the Properties of Matter for salt water (1 cu.ft. weighs 64 lbs.), you can see that you would have to add weight in examples 1 and 2 and you would be very close to neutral buoyancy in example 3. Using this information we can work out how many cu. ft. of volume we are going to have to displace in order to lift a sunken object (negative buoyant) from the bottom and float it to the surface.

An old boat that weighs 624 lbs and is 3 cu. ft. in size is lying on the bottom of a fresh water lake and you wish to float it.

Actual weight of boat	=	624 lbs.
Displacement wt. of boat (. ft. x 62.4 lbs.)	=	187.2 lbs.
Negative Buoyancy	=	436.8 lbs

4. Diving physics (continued)

Cubic Feet of air required to attain neutral buoyancy = 436.8 / 62.4 =7 cu. ft.

Using this form of calculation you will be able to take most of the heavy work out of lifting an object from the bottom of a lake, etc. There are dangers that must be considered before you take on this type of exercise. This example is used only to show you how Archimedes' Principle works.

As a diver, there are many factors that need to be considered when calculating your buoyancy. Your lung volume, the size and shape of your body, diving equipment such as neoprene suits, tank construction and weight of air in the tank, air in the BC and the amount of weight carried on your belt, all affect your buoyancy.

Fortunately for divers and swimmers, the human body has its own flotation device called the lungs, which allow you to float in the water.

The lungs hold between 5 and 6 litres of air when completely inflated. Most people have enough lung capacity to float with their eyes and nose out of the water. By controlling the amount of air in their lungs, most people can float on the surface without getting tired.

Remember, however, that if you lift your head out of the water, your buoyancy changes and you will sink down. A person's ability to float depends on several factors. Among these are the bone structure, fat content, muscle, and the size of the lungs of the diver. Fat weighs less than muscle so obese people generally tend to float more than muscular people. Some people cannot float even by using flotation techniques simply because their body weight is greater than the water displaced.

Most thin people cannot float without aid. To enjoy comfortable and relaxed diving and also to protect the environment, it is important to obtain neutral buoyancy which will allow you to stay at a given depth with no effort. One of the ways to achieve this is to descend to the bottom (careful not to land on coral) and stop. Take a good breath of air and begin to inflate your BC slowly using the 1 and 5 method. (Push the power inflator for 1 second and wait 5 seconds to gauge the result.)

Due to the inertia effects in water, it will take a few seconds for any changes to buoyancy to take place. When you feel your feet begin to ascend from the bottom, exhale and you should sink back down. If this doesn't happen, repeat the process again until you are able to ascend by taking a breath and descend by exhaling. This is neutral buoyancy.

Another method for achieving neutral buoyancy is called the "Pivot Method". Lay flat on the bottom of the pool or in the sand. Add air to the BC in short bursts as above (1 and 5) until you reach a point that you rise slightly when you inhale and when you exhale you sink again. During this exercise your fins remain on the bottom and you pivot on your fins.

It is not easy to master this skill but it is vitally important that you practice until you can do it well. Not only will you enjoy more relaxed diving but you will consume less air while diving (you are not continually trying to stay down or stay off the bottom) and you will be able to avoid ruining the marine environment by banging into it.

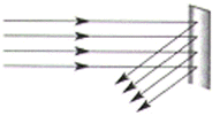
It is **important** to master buoyancy control and management of the BC because misuse of the BC could cause a rapid ascent which could in turn cause other accidents which we will discuss later.

To inflate the BC manually hold your primary 2nd stage in your right hand and hold the BC jacket mouthpiece in your left hand. Take a full breath from your regulator, press the manual inflate button on the BC and blow <u>one half (1/2)</u> of your inhaled air into the BC. The remaining air in your lungs is used to clear your regulator mouthpiece before you take a breath again, similar to the 1 and 5 method with power inflating, wait for the reaction before adding another oral inflation to the BC.

4. Diving physics (continued)

To deflate the BC, turn yourself to a vertical position with your head towards the surface. Hold the jacket manual hose in your left hand and raise it above your head. Press the oral inflation button. Since air is lighter than water it will raise and exhaust through the oral inflate mouthpiece. From this same position in the water, you can also use the air dump valve to achieve the same effect.

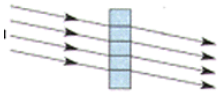
4.3. - LIGHT

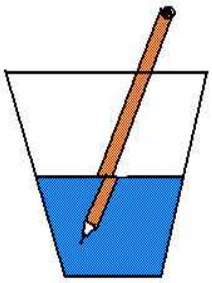


The greater density of water compared to air causes vision to be altered when trying to look into or through the water. This is due to the change in light path and intensity in water versus air. First, light rays tend to bounce off water or **reflect** off water similar to a mirror.

Reflection

In the first or last hours of daylight, when the water is calm, the reflection is greater due to the angle of the sun. Also, when the water is not calm, the light rays make the water appear to sparkle due to the reflection. Much of the light's rays are reflected off the water so that it is always darker underwater than it is above water.



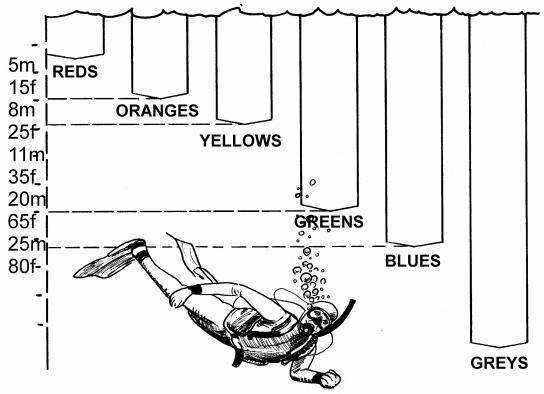


Refraction

Light rays that are not reflected and do penetrate beneath the surface are subjected to other phenomenon due to the greater density of water versus air (water is about 800 times more dense than air). **Refraction** is what causes the optical effect that makes a straight rod appear bent at the point it passes into the water.

The “Refractive Index” is a quotient that expresses the change in the speed of a ray of light due to a change in density as it passes between air and water. Refracted light rays meet other obstacles in the water. One obstacle is that light intensity decreases and the other is that the light tends to reflect off of particles in suspension in the water.

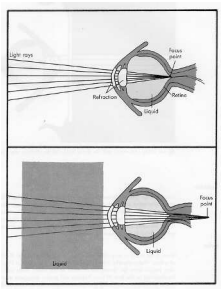
As the intensity of the light decreases with depth, different colours lose their intensity at different rates (**absorption**). For instance, the colour red is lost by the time you reach 15 to 18 feet (4.5 to 5.5 metres) of depth. Orange is lost after 25 feet (7.5 metres), yellow at 35 feet (11 metres), green at 65 feet (20 metres) and blue at 80 to 85 feet (25 to 26.5 metres). After this depth only greys and blacks prevail. At 65 feet (20 metres), for instance, blood appears to be a dusky-green colour.



The disappearance of colours underwater

4. Diving physics (continued)

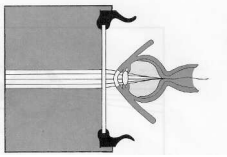
The ability of various colours to penetrate that far is also dependant on the turbidity or amount of impurities in the water. The more particles suspended, the less the light will penetrate.



Vision on the surface and underwater

Our eyes, accustomed to working in an air environment, act as a corrective lens refracting light rays to meet in the retina (sensitive membrane at the back of the eye). This gives you a clear picture of the impression transmitted by the optic nerve to the brain.

When submerged in water, the light refracted by the water does not allow the eye to act as a corrective lens and the reflected light rays do not meet at the retina. This causes objects to appear out of focus (**diffusion**). The solution to this blurred vision is to place a pocket of air directly in front of the eyes so that the light will again hit the retina correctly. This, however, causes a double refraction, once when the light hits the mask and again when the light hits the eye and refracts to the retina. This double refraction causes the eyes to visualize an object as being 1/3 larger than it really is and 1/4 closer.



Underwater vision through a mask

To recap, we have talked about:

REFLECTION:	Mirror effect. Water reflects some light rays
REFRACTION:	Light rays are bent as they enter the water because of the different densities of air and water
ABSORPTION:	Light is absorbed by the water (lose colours with depth)
DIFFUSION:	Colours are diffused by the particles in suspension in the water

4.4. - SOUND

The fact that water has a greater density than air causes sound waves, which are a system of vibrations, to travel much faster and farther than in air. Sound that is transmitted at a speed of 330 m/sec in air, travels at a rate of 1100 to 1500 m/sec. (4 to 5 times faster) depending on the salinity and temperature of the water. This difference in the speed of sound in water prevents you from locating the direction of the sound.

Your brain is programmed in air and calculates the millisecond difference in time that the sound takes to reach one ear and then the other and allows you to detect the direction the sound is coming from. In water, your brain cannot interpret the time interval between reaching each ear due to the increased speed so that the sound is perceived to be coming from all directions. This greater speed also stops you from calculating the distance away the cause of the sound is.

4.4.1. - HAND SIGNALS

Since it is impossible to speak underwater, a system of hand signals is needed to communicate. There is a series of internationally used and understood hand signals. However, there are sometimes local variations, so it is best to discuss the hand signals used in the area you are going to dive in and practice them before the dive.

4. Diving physics (continued)

Next you will find some of the most commonly used hand signals. The signs should be made clearly and slowly making sure that the person you are communicating with understands them.

The signal should always be answered with an OK sign indicating that it is understood.

In night diving, the signal should be made with one hand while the other hand holds the light and displays the sign being used. Avoid shining the light into the person's eyes making it impossible to see the sign.

Low on air

Followed by >

Let's go up

Out of air

Followed by >

Give me air

Or by >

Let's go up

Danger

Stop

Ear problems

Ok (underwater)

Buddy?

Look

Ok (surface)

Something is wrong

Your Instructor will inform you of other signs

4. Diving physics (continued)

4.4.2. LOCATING A SOUND

To locate your buddy or to call your buddies attention, the best method is to take your knife and rap on your tank. This is repeated at intervals until your buddy responds. If you hear a banging noise, stop; then look around 360 degrees and above and below yourself until you find the source of the noise. Also, try to rap your knife when your buddy is not exhaling, otherwise the noise of the bubbles might make it difficult for your buddy to hear you.

4.4.2.1. Some practical advise

- The diver making the call should never place himself directly below or directly above of the diver he wishes to call. These are difficult angles to see underwater.
- You should not abuse of this underwater calling system. We must remember that sound travels very fast underwater and if there are other divers, it will only cause confusion. Some dive centres prohibit rapping the tank when diving in a group, except for emergencies. Usually, the Divemaster or Dive Guide is the only one that can do so in non-emergency cases.
- You must remember that your buddy will only hear the rapping when he is not exhaling bubbles, in other words, during the inhalation phase, so it is during this phase when you must do your rapping call. This is easy to do by just watching your buddy's bubbles.
- If there are several divers and when they hear the call they turn to look at you, you should point to the diver you wish to call by extending your arm and pointing at him with your finger (similar to the underwater sign for "danger", but with a extended finger) and then, when you are sure your buddy has seen you, do the sign of "come here". If you are trying to call everybody, then instead of doing the "come here" sign, do several full circles with your extended arm and finger and then, do the "come here" sign.
- Continue the call until you are sure that you have been seen or until you feel is no longer needed.

"Come here" sign

4.5. - AIR COMPONENTS

Atmospheric air is a mixture of several gases, and each one acts independently according to its nature. The following is a short explanation and importance of each one.

4.5.1. - OXYGEN (O2)

This gas represents 20.94 (21) % of the air we breathe and is extremely important in our metabolic functions. Oxygen must be present in order to sustain life. This gas supports combustion. Oxygen is produced as a waste product of photosynthesis in plants. Oxygen in the air combines in our lungs with the blood haemoglobin and is transferred throughout the body where it is used to support many processes. Although oxygen is indispensable in sustaining life, breathing pure oxygen at greater than atmospheric pressure becomes toxic and is a threat to life. More on this subject will be discussed in later chapters.

4. Diving physics (continued)

4.5.2. - NITROGEN (N2)

This gas represents 78.08 (78) % of the air we breathe. It is considered an inert gas since it is not used by the body. When inhaled and dissolved in the blood, it only passes through the body and is expelled back out through the lungs.

4.5.3. - CARBON DIOXIDE (CO2)

This gas represents 0.03 % of the gas found in air. It is a by-product of combustion and the respiration process in the body. Plants take in Carbon Dioxide and produce Oxygen in photosynthesis. In your body, Carbon Dioxide controls the respiratory reflex mechanism in your nervous system. In other words, your urge to breathe is not due to a lack of oxygen but an excess of carbon dioxide.

4.5.4. - OTHER GASES

There are a number of other gases that make up the composition of air but they are only found in minimal amounts. They make up the balance of 0.95%. Among these are Carbon Monoxide, Hydrogen, Neon, Helium, Argon (content 0.93%), Radon, etc. Since these other gases are in such small concentrations and they act as inert gases, we normally do not use them when doing pressure calculations (more later). They are grouped together as part of the nitrogen percentage so that when working with partial pressures we say that Oxygen is 21% and Nitrogen is 79% of air.

4.6. - PRESSURE

Torricelli

One of the terms used frequently throughout this text is PRESSURE due to the great importance it has on recreational diving activities. Pressure is defined as the force applied on a unit of surface area.

A given amount of pressure will have more effect on a small surface than it will on a large surface. An example of this is a skier. The pressure on the snow applied by the skier without skis will cause the skier to sink into the snow. When you transfer the weight (pressure) of the skier on to a pair of skis, the skier is able to skim over the top of the snow since the pressure is transferred over a large surface area. TORRICELLI, the inventor of the barometer discovered that a glass pipe closed at one end and attached to a source of mercury at the other end always maintained a level of mercury of 760mm no matter how long he made the glass pipe.

Torricelli's experiment

Later testing showed that a column of air 1 in. by 1 in. (1 sq. in.) in size projected upwards from sea level to the atmosphere weighed 14.7 lbs (1 bar). This is known as ATMOSPHERIC PRESSURE or ATM. The atmosphere exerts an average pressure of 14.7 psi (pounds per square inch) (1 bar) at all times at sea level.

Since water is more dense than air, the height of a 1 sq. in. column of salt water would only have to be 33 feet (10 metres) high to have a weight of 14.7 lbs. (14.7 psi - 1 bar). Another 33 feet (10 metres) would give another 14.7 psi (bar) and so on. Each 33 ft. (10 meter) increment is the same as an atmosphere. In fresh water, it requires 34 feet (10+ metres) of water to reach 14.7 psi.

For every 33 feet (10 metres) you descend in salt water, the pressure will increase 1 Atmosphere. By dividing 14.7 psi by 33 = 0.445 psi, for every 1 ft. you descend in salt water the pressure will increase 0.445 psi.

4. Diving physics (continued)

When wearing a pressure gauge, the gauge will read:

- 0 psi (0 bars) at surface level.
- At 33 feet (10 metres) in salt water it will read 1 ATM (14.7 psi) (1 bar).
- At 66 feet (20 metres) it will read 2 ATM (29.4 psi) (2 bars)
- At 99 feet (30 metres) it will read 3 ATM (44.1 psi) (3 bars)
- At 132 feet (40 metres) it will read 4 ATM (59.8 psi) (4 bars), etc.

This is known as GAUGE PRESSURE.

ABSOLUTE PRESSURE (ATA) is the sum of Gauge Pressure plus Atmospheric Pressure. To calculate the Absolute Pressure (ATA) you have exerted on your body is simple:

Just multiply the depth you are at by 0.445 psi and add 14.7. For example, at 50 feet, = 50 X 0.445 = 22.25 + 14.7 = 36.95 psi absolute.

See the following pressure table

PRESSURE TABLE				
DEPTH	**ATMOSPHERES (BARS)**	**GAUGE PRESSURE**	**ABSOLUTE PRESSURE**	**PSI**
0	1	0	1	14.7
33’ – 10m	2	1	2	29.4
66’ – 20m	3	2	3	44.1
99’ – 30m	4	3	4	58.8
132’ – 40m	5	4	5	73.5
165’ – 50m	6	5	6	88.2

As you can see by the table, the first time that the Absolute Pressure doubles is from the surface to 33' (10m) (from 14.7 to 29.4). It requires **another** 66' (20m) before the Absolute Pressure doubles again. It is important to remember that changes in pressure are greater near the surface.

4.7. - GAS LAWS

To better understand how gases behave when exposed to pressure there are four gas physics laws we need to understand: Boyle's, Dalton's, Henry's and Charles'.

4.7.1. - BOYLE'S LAW

"At a constant temperature, the volume of a gas is inversely proportional to the pressure exerted on that gas and directly proportional to the Density". To put it in simple terms, as pressure increases, the volume of a gas will decrease by a proportional amount. As the pressure decreases, the volume of a gas will increase by a proportional amount. The density of the gas will increase as the pressure increases and decrease as the pressure decreases.

$P1 \times V1 = P2 \times V2$

This formula is always used in Dive Manuals to explain this Law but this writer has found that the formula tends to confuse the issue rather than explain it.

4. Diving physics (continued)

However, if you look at the formula this way: P1 = the original pressure, V1 = the original volume, P2 = is the second pressure and V2 = the second volume. Now, If the quotient of P1 x V1 = 8 = the quotient of P2 x V 2 (unless P2 and V2 are the same as P1 and V1), then if you raise the pressure P2, you will have to decrease the volume V2 in order to have the result equal to 8

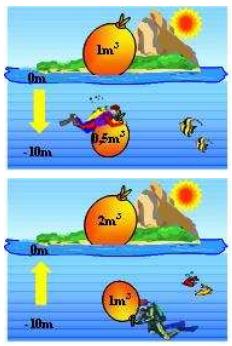
Boyle

Example: (2 = P1) x (4 = V1) = 8 = (4 = P2) x (2 = V2)

If the pressure doubles, the volume will decrease by half. If the volume doubles, the pressure will decrease by half.

Within your body there are a series of cavities - sinuses, lungs, stomach, and ears which are filled with air. These will all be affected by the changing pressure as you increase the depth of your dive. If these cavities are connected to your respiratory system which contains air at ambient (surrounding) pressure there will be no prejudicial effect on these cavities. Any cavity connected to your respiratory system should equalize with ambient pressure as you breathe.

BOYLE'S LAW				
DEPTH	**ATA**	**VOLUME**	**DENSITY**	**PRESSURE**
0	1	1	1	14.7
33' – 10m	2	1/2	2	29.4
66' – 20m	3	1/3	3	44.1
99' – 30m	4	1/4	4	58.8
132' - 40m	5	1/5	5	73.5
165' - 50m	6	1/6	6	88.2
198' - 60m	7	1/7	7	102.9
231' - 70m	8	1/8	8	117.6



Boyle's law

If there is no connection, then as the pressure increases, the volume of air in these cavities will decrease causing suction on the surrounding tissues. The effect this suction will have depends on the type of material in these cavities, their location and how much difference in pressure there is.

Boyle's Law applied to diving gives you a clear explanation of what happens to the air in your BC as you descend and also your neoprene wet suit. As the ambient pressure increases, the volume decreases. Remembering Archimedes' Principle, as the volume of water displaced by an object decreases, the buoyancy will also decrease making you heavier as you descend. Similarly, the insulating abilities of the neoprene wetsuit decrease as the pressure increases and squeeze the air in the neoprene.

This also explains the greater air consumption at depth. For example, if you consume 20 litres of air per minute at the surface, then at a depth of 33 feet (10 metres) where the pressure is double, it will take double the volume of air to fill your lungs since with each breath you will breathe 2 X the amount of air used at the surface.

The increase in the density of the air at depth will make it progressively more difficult to breathe. You will not normally notice this due to the fact that you descend slowly and the change is not noticeable.

4. Diving physics (continued)

It is, however, an important factor when assessing a diver's medical fitness to dive.

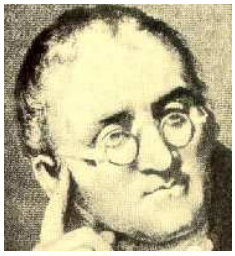
NEVER, never hold your breath while ascending

On ascending, all of these previously stated effects reverse as the pressure decreases and the volume increases. The BC expands due to the increase in volume makes you more buoyant so you should be prepared to deflate your BC as you ascend so that you do not come up too quickly.

Boyle's Law also explains one of the most serious accidents that can happen to a SCUBA diver, an Arterial Gas Embolism. This accident occurs when, after inhaling, you hold your breath due to panic or inexperience. By holding your breath you block the exit of air from the lungs and due to the decrease in pressure the volume of air in the lungs expands. An overexpansion will cause the lungs to rupture and air bubbles can enter the arteries leading to the heart and brain.

4.7.2. - DALTON'S LAW

"The pressure exerted on a gas is equal to the sum of its Partial Pressures".



Dalton

That is, in a mixed gas such as air, the sum of the partial pressure of each gas in the mix is equal to the total pressure exerted. This means that each gas is given the percentage part of the total pressure in the mixture.

As an example, what would be the partial pressures of the Oxygen and Nitrogen at 66 feet (20 metres) in sea water? We know that air is composed of 21% oxygen and 79% Nitrogen.

At the surface the atmospheric pressure is 14.7 psi.

21% of that pressure is Oxygen:

14.7 / 100 x 21 = 3.087 psi

79% of that pressure is Nitrogen:

14.7 / 100 x 79 = 11.613

At 66 feet (20 metres) the Absolute pressure is:

3 x 14.7 = 44.1 psi

21% of that pressure is Oxygen:

3.087 x 3 = 9.261 psi

79% of that pressure is Nitrogen:

11.613 x 3 = 34.839 psi

It is important to know this law since at certain pressures each component or gas can become harmful to the body.

The Nitrogen can produce NITROGEN NARCOSIS, the Oxygen can produce PULMONARY HYPEROXIA and the Carbon Dioxide can produce HYPERCAPNIA or asphyxiation. We will look at these in greater detail later.

4. Diving physics (continued)

4.7.3. - HENRY'S LAW

Henry

"At a constant temperature, the quantity of gas that will dissolve in a liquid is directly proportional to the pressure exerted on the gas".

Simply stated, the amount of gas that will dissolve in a liquid is equal to the pressure exerted on the liquid. As pressure increases, more gas will dissolve in the liquid. As pressure decreases, the gas that was dissolved in the liquid under pressure will come out of solution.

When the pressure is increased, gas is not dissolved in the liquid all at once. It begins at the onset of the pressure increase and continues at a decreasing rate for a period about 12 hours before the liquid becomes saturated at that pressure.

If you increase the pressure on the liquid again after this 12 hour period, the saturation process begins again over the next 12 hours.

When the pressure is decreased, gas does not come out of solution all at once. It begins to come out of solution at the beginning of the pressure decrease and continues at a decreasing rate for a period of about 12 hours before the liquid gets back to a state that it was in before the pressure increase began. If you were to reduce the pressure on the liquid quickly, the liquid would become supersaturated with gas and the gas in solution would come out of solution quickly causing the liquid to appear to boil.

A classic example to explain Henry's Law is a bottle of carbonated beverage. The liquid in the bottle is filled under pressure and when you look at the capped bottle you see only a liquid. If you quickly take the cap off the bottle, the sudden decrease in pressure on the liquid in the bottle will cause the gas dissolved in the liquid to come out of solution and the beverage will foam. If you slowly remove the cap and the pressure inside the bottle is allowed to decrease gradually, you will notice that there are only small bubbles formed that disappear quickly causing very little upset to the liquid.

The importance of this law in diving is when we replace gases with nitrogen and liquids within the human body.

As with the soda, this is a clear example of the diving malady called "Decompression Sickness".

4.7.4. - CHARLES' LAW

Charles

"At a constant volume, an increase in temperature is directly proportional to an increase in pressure".

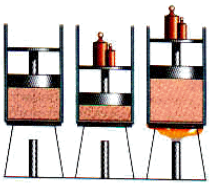
Simply stated, if you have a fixed volume (such as a tank), and you increase the temperature of that volume, the pressure will increase accordingly. If you decrease the temperature, the pressure will decrease. When filling a scuba tank there is a temperature increase as the pressure increases. This is one of the reasons it is preferable to have the tank submerged in water during filling.

If you check the pressure on a hot, filled tank and get a reading of say 3,000 psi and allow this tank to cool to the temperature of the water you will be diving in, you will find that the pressure in the tank has dropped quite a bit. This means that you will have less available air in your tank for your dive.

4. Diving physics (continued)

Conversely, if you have a cool tank filled to 3,000 psi and you leave the tank out in the hot sun, the pressure will increase as the temperature increases and could cause the overpressure rupture disk on the tank valve to rupture.

You should never leave your tank out in the hot sun. Put it under a tree or cover it with a wet towel in order to keep the tank cool.



Charles' law

4.8. PHYSICS LAWS, THEIR RELATIONSHIP AND THEIR EFFECTS

To simplify the relationship between the gas laws and the accidents related to volume, temperature and pressure, the following tables should help to understand the concepts.

RELATIONSHIP	BOYLE	HENRY	DALTON	CHARLES
PRESSURE	X	X	X	X
VOLUME	X			X
GAS DISSOLUTION		X		
TIME		X		
PARTIAL PRESSURES			X	
TEMPERATURE				X
EFFECTS	**BOYLE**	**HENRY**	**DALTON**	**CHARLES**
BAROTRAUMA	X			
LUNG OVERPRESSURE	X			
DECOMPRESSION		X		
OXYGEN POISONING			X	
NARCOSIS			X	
TANK FILLING AND STORAGE				X

NAME	LAW	RELATIONSHIP
BOYLE'S LAW	*At a constant temperature, as pressure increases, volume decreases, and density increases.*	Buoyancy, Squeezes, Arterial Gas Embolism, Barotraumas
HENRY'S LAW	*At a constant temperature, the amount of gas that will dissolve in a liquid is directly proportional to the pressure on the liquid.*	Decompression, Decompression Sickness.
DALTON'S LAW	*The total pressure of a mix of gasses is equal to the sum of the partial pressures of the gasses of the mix*	Nitrogen Narcosis, Oxygen Poisoning, Carbon Monoxide Poisoning, Anoxia, Hypoxia
CHARLES' LAW	*Pressure and volume changes are directly related to changes in temperature.*	Filling storage tanks

4. Diving physics (continued)

There is one final law that is not found in Physics texts but it is an important law in diving. However, we believe that it is a very important law as it refers to experience.

4.8.1 BOB'S LAW

Bob

"The depth a diver should descend to is directly proportional to the depth of his training and experience".

As to its RELATIONSHIP, it takes into consideration the amount of experience you have in the water in terms of your comfort zone. As you become more comfortable in the water, you can increase the depth you dive to. The effects of not following this law can be that you wind up in a situation that is out of your zone and therefore becomes stressful rather than enjoyable.

Press on this bar to go to the next chapter

DIVING PHYSIOLOGY: MEDICAL ASPECTS

LESSON OBJECTIVES

At the end of this chapter the student will be able to:

- Define Barotrauma
- List the parts of the human body affected by diving
- Define the physiological problems associated with descending
- Define the physiological problems associated with ascending

5.1. - BAROTRAUMA

Barotrauma is defined as any injury due to pressure. As you have seen from previous chapters, variations in pressure produce proportional variations in the volume of air content in the cavities of the body that, unless compensated adequately can produce injuries of varying severity depending on the area that the injury occurs.

There are two types of barotraumas; those produced by the pressure increase on descending and those produced by the pressure decrease on ascending. The most common injuries will be squeezes of the ears, mask, and sinuses but there are other areas that can suffer serious injury if the proper precautions are not taken.

5.2. - BASIC ANATOMY

5.2.1. - THE HUMAN BODY

The torso is the part of the body from the neck to the hips. The bones of the chest and the ribs protect the internal organs: the lungs, the respiratory system, the heart and the diaphragm. Under the diaphragm are the organs of the abdomen which include the stomach and intestines (the digestive system) and also the kidneys, liver and bowels.

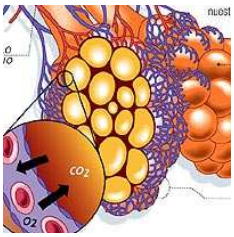
The bronchial tree

5.2.2. - ABDOMEN

The abdomen and its organs are massive and are not normally affected by changes in pressure since they usually have very little gas content and therefore suffer very few barotraumas.

5.2.3. - THORAX

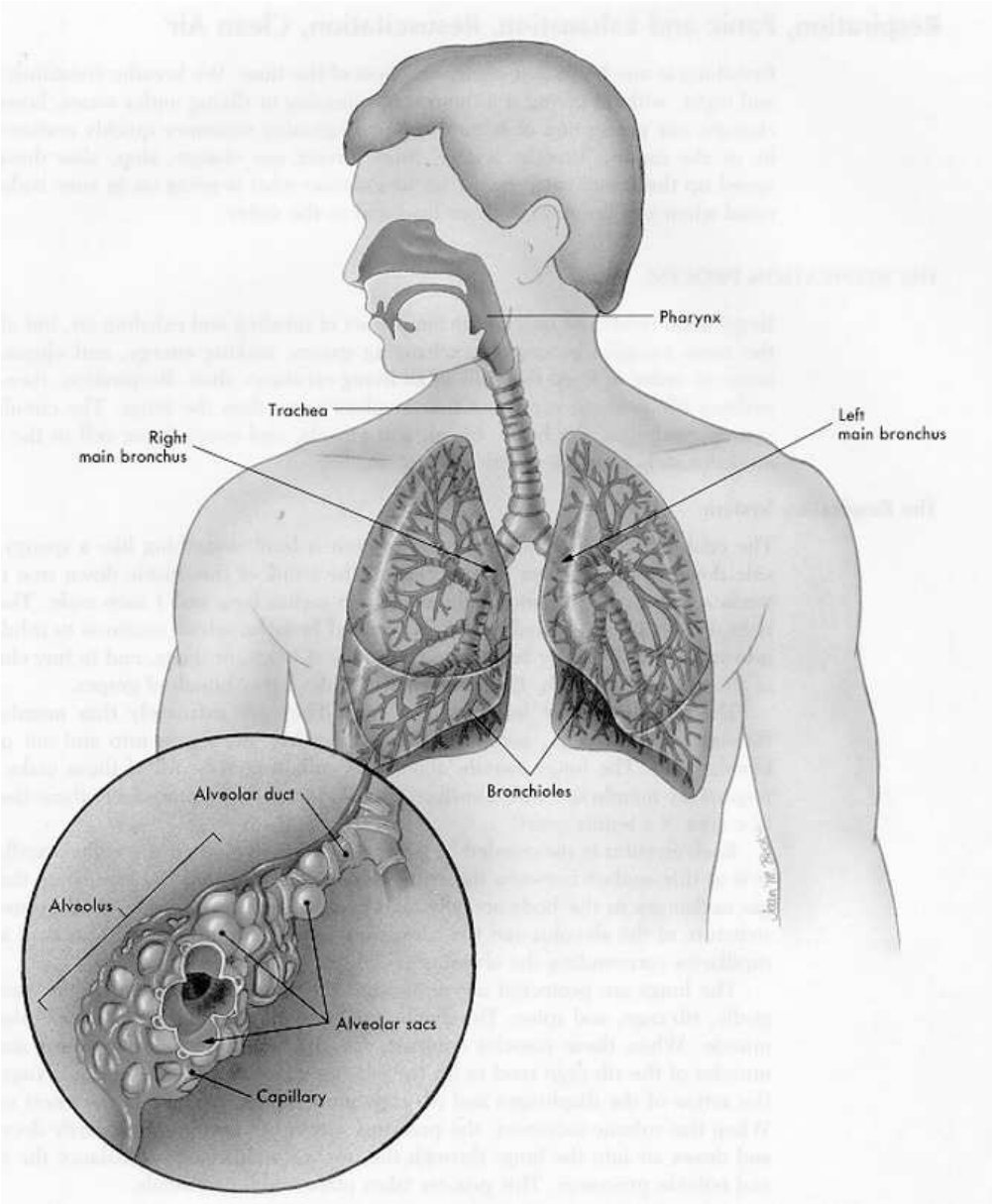
The thorax is part of the respiratory system and, since it is normally full of air, is affected by changes in ambient pressure. The respiratory system begins at the mouth and nose where air is drawn in. The inspired air travels through the larynx, which is similar to a ringed pipe, to the thorax where it branches into the bronchial tubes. Bronchial tubes are again subdivided into more tubes of various sizes and end at the alveolus. At the alveoli the transfer of air into the pulmonary system takes place.



The alveoli and the haematosis process

5. Diving physiology: Medical aspects (continued)

The alveoli also transfer carbon dioxide from the pulmonary system to the respiratory system for exhalation. This process is called haematosis.



The respiratory tree and the alveoli (from Thibodeau CA and Anthony CP: The structure and work of the body, 8th edition, St Louis, CV Mosby)

The average lung capacity is 5.5 litres, though this will vary depending on a person's anatomy and lung size. This great capacity is not normally used in full in the respiratory process. It depends on the amount of effort the person is using and his or her emotional state.

The TIDAL VOLUME is the amount of air your lungs are capable of taking in.

5. Diving physiology: Medical aspects (continued)

The INSPIRED VOLUME is the amount of air you breathe in a normal inhalation. (Normally 1 litre at rest.)

The EXPIRED VOLUME is the amount of air left in your lungs after a normal exhalation. *(*Normally 1 litre at rest).

The RESIDUAL VOLUME is the amount of air left in your lungs after you have exhaled as much air as you possibly can on an exhalation. The balance of air left after a forced exhalation is approximately 1 litre. As it was stated before, these quantities are not exact. Each individual has a lung capacity that is different based on their conditioning, age, physical fitness, and emotional state.

The respiratory process is normally carried out automatically without any conscious thought. The urge to breathe is not caused by a lack of oxygen as you may believe. It is triggered by the increase of partial pressure of carbon dioxide.

This signals the Central Nervous System (CNS) to exhale used air and inhale fresh air in order to lower the partial pressure of carbon dioxide. If the level of Carbon Dioxide is not reduced after inhalation, the alarm in the CNS will continue and the person will begin to "pant" (breathe rapidly) in order to lower the CO2.

Breath hold or “free” divers use hyperventilation to increase the length of time they can remain underwater without taking a breath. This method frequently causes the “free” diver to become unconscious and drown. The method consists of taking a number of deep breaths followed by deep exhalations, in order to lower the partial pressure of carbon dioxide in the respiratory system, thereby delaying the respiratory reflex

Since hyperventilation does not increase the amount of available oxygen, the body will use up the available oxygen before the alarm to breathe is activated by the increase in CO2. Once there is not enough oxygen to sustain life (hypoxia), the diver will lose consciousness underwater. This is very dangerous as it could lead to drowning. This type of accident is known as "Shallow Water Blackout".

For this reason, hyperventilation is a method that should only be used after you have gained a lot of experience in free diving. Even then, you should limit your forced inhalations to three as a maximum and only practice this method under the watchful eye of another person who can rescue you if you should become unconscious.

If a free diver becomes unconscious, administer fresh air, or if possible Oxygen. If the person is not breathing, AR should be started immediately.

As was stated before, to avoid this type of accident, never take more than 3 breaths, and start ascending when you feel the urge to breathe. Avoid deep free diving.

Sometimes you may find yourself in a condition called "Hyperpnoea" or panting, which is characterized by rapid, shallow breathing. This can be caused by one single factor or several combined. Such things as vigorous exercise, physical exertion, cold water, problems in the water, panic, etc., can all cause hyperpnoea.

Inspiration and expiration processes

Free diver

5. Diving physiology: Medical aspects (continued)

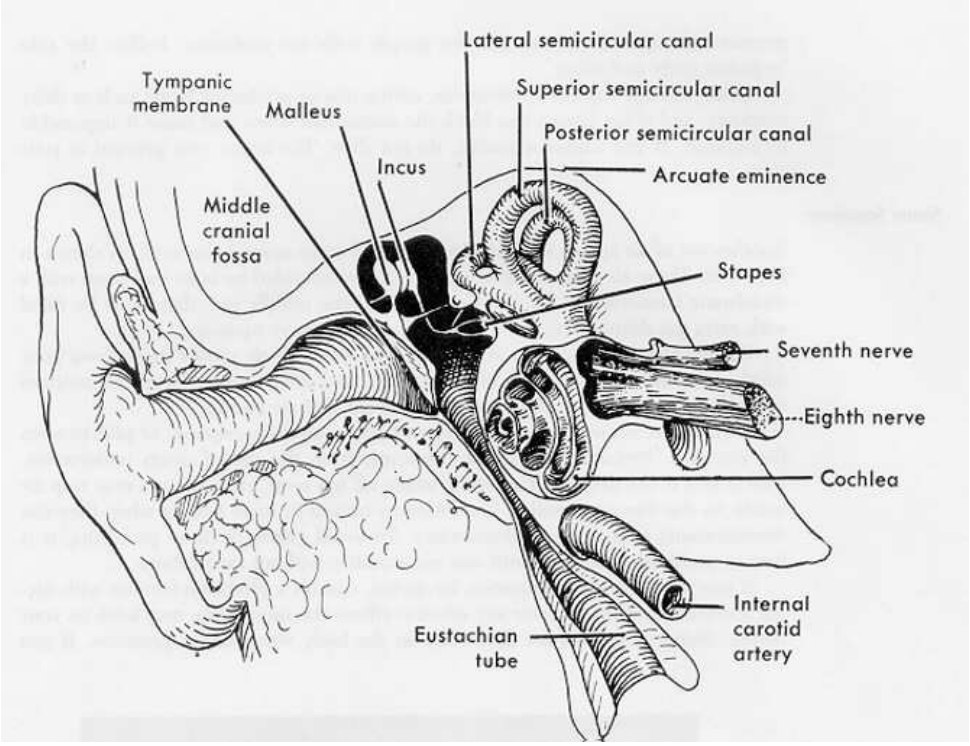
The effects of rapid breathing are progressive, since rapid, shallow breathing does not help to eliminate the high partial pressure of CO2, which started the condition. After a few minutes, the CO2 signal to breathe continues causing you to breathe even more rapidly and more shallow. The hyperpnoea can eventually lead to unconsciousness and collapse.

To avoid this problem, you should always swim slowly without making unnecessary effort. Know your own limitations and do not exceed them. If the problem appears in spite of your precautions, the only solution is to stop all physical activity and concentrate all your attention to your respiratory process. Take deep breaths slowly to eliminate the excess of CO2. Relax until your breathing comes back to normal.

5.2.4. - THE EARS

The human ear is split into three parts:

- The Outer Ear consists of the outer ear, the auditory canal and ends at the ear drum or tympanic membrane.
- The Middle Ear is a closed cavity with the eardrum at one end surrounded by a bony wall in which there are two openings called the oval and round windows. The Eustachian tube is in the lower part of the middle ear and communicates between it and the nasopharyngeal cavity (throat). Inside the middle ear there is a series of small bones in a chain that are called the hammer, anvil and stirrup.
- The Inner Ear begins at the narrowing of the middle ear and has three semicircular channels which contain the Corti, the real nerve centre of the ear. Sound vibrations originating externally arrive at the eardrum causing it to vibrate. That vibration is transmitted by the chain of fine bones in the middle ear to the internal ear and the acoustic nerve.

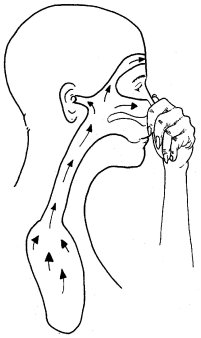


The ear (from Thibodeau CA and Anthony CP: The structure and work of the body, 8th edition, St Louis, CV Mosby)

5. Diving physiology: Medical aspects (continued)

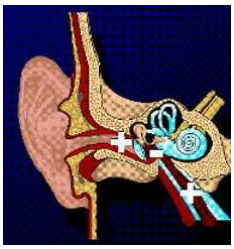
For divers, the importance of the ear is focused on the ear drum, where the external pressure must be equalized with the internal pressure. This is accomplished through the Eustachian tube. To open your Eustachian tube and keep it open, you need to begin clearing before you even enter the water. As you descend, you need to clear (equalize) every few feet (1 meter or less).

There are a number of ways to achieve this. An effective way is to try yawning with your mouth closed. This stretches the back of your mouth and the muscles that open the Eustachian tube. You can also move your jaw back and forth, or swallow saliva.



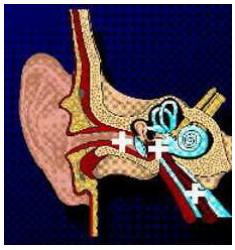
The Valsalva method

One other method that can do damage to your inner ears is called the "Valsalva Method". This consists of pinching your nostrils with your fingers and trying to exhale lightly through your nose. This will force air up your Eustachian tubes and clear your ears. The main danger in this method is that you could blow too hard and damage your ear drum or puncture the round or oval window in the ear. Also, you could push moisture from a sinus drain or saliva up the Eustachian tubes where it can cause an infection in your ears, putting you out of the diving scene for a number of weeks. If you are going to use the Valsalva method, be sure to blow gently and do not use any undue force.



Non compensated ear

As you descend, if your ears are not clearing and you are feeling any pain at all, STOP your descent. Ascend a few feet and try to clear. If you feel the pressure release, then you may continue down. If your ears will still not clear, ascend a few more feet and try again. If you are unable to equalize after a few tries, abort your dive. Should you continue to descend in spite of the pain, the consequence could be a perforated eardrum. This would cause you to become dizzy due to water entering the middle ear through the perforated drum.



Compensated ear

Never wear ear plugs while diving. The increased pressure with depth could force the ear plugs further into your ear. In addition, the air space between the plugs and the ear drum contains air which will compress and could cause your ear drum to break as it is pulled outwards by the compression of the air.

If, for some reason you should have an ear drum rupture, you may become dizzy or disoriented. It is important for your buddy to take charge and bring you to the surface immediately. Place a warm compress against your ear and seek medical help as soon as possible.

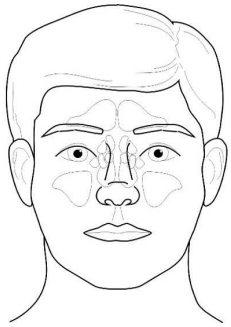
Normal eardrum

5.2.5. - THE SINUSES

In your head are a series of sinus cavities, located approximately above the eyes, called the Frontal sinuses, under the eyes, called the Ethmoidal and Sphenoidal sinuses and beside the nose, called the Maxillary sinuses. These sinuses are connected to the respiratory system through a series of fine tubes of mucous membranes. When you have a cold or are congested, these mucous membranes swell and become inflamed. When this happens, you may have difficultly clearing or equalizing your sinuses as pressure increases or decreases and you can suffer extreme pain, tears in the sinus walls or possibly a break in the bony wall of the sinus. Minor bleeding can occur if these membranes rupture. If you find that you are having difficulty clearing your sinuses, you can try the various methods you used for equalizing the pressure in your ears. Again, if you cannot equalize your sinuses after a few tries, you must abort the dive and wait for the swelling to go down.

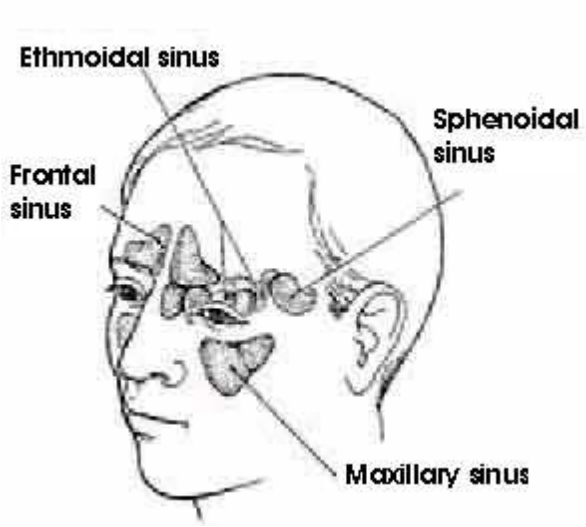
Perforated eardrum

5. Diving physiology: Medical aspects (continued)



The sinuses

The symptoms of sinus rupture are pain and bleeding from the nose. The best thing is to reduce movement, take a pain medication, and if it persists, seek medical attention.



The different sinuses

5.2.6. - DECONGESTANTS

Some divers take some form of decongestant in order to shrink their sinus membranes and Eustachian tubes and allow them to dive while they have a cold. There is a risk involved in this depending on the type of decongestant used. Some have codeine or other ingredients in them that can cause drowsiness. Becoming drowsy while underwater is not advisable for obvious reasons.

Another possible outcome can be a reverse squeeze. Should the decongestant wear off while you are underwater, the sinuses and Eustachian tubes could become inflamed and swell causing difficulty and possible injury, when the external pressure decreases and the internal pressure does not. For these reasons, it is recommended that you do not dive when you have a cold or are congested. There are other activities out of the water that you can engage in rather than run the risk of causing damage to your ears or sinuses

5.2.7. - TOOTH SQUEEZE

A cavity in your teeth can also be the cause of a barotrauma. If you have had a cavity filled by a dentist and there is a small hole beneath the filling, this air space can compress during descent and cause the soft tissue surrounding the tooth to be drawn into the small hole in order to equalize the pressure. This can cause a tooth ache. Should this pain disappear during your dive, the same thing can happen in reverse as the pressure decreases.

Tooth cavity

The air in the cavity expands as the pressure eases and pushes the soft tissue back out, again causing pain. The only treatment for this type of squeeze is to return to your dentist and explain the problem.

5. Diving physiology: Medical aspects (continued)

You may have to give the dentist a short lecture on the direct effects of pressure in order for him to understand what you are going through. As a good professional, the dentist will thank you and correct the problem by refilling your tooth.

5.2.8. - MASK SQUEEZE

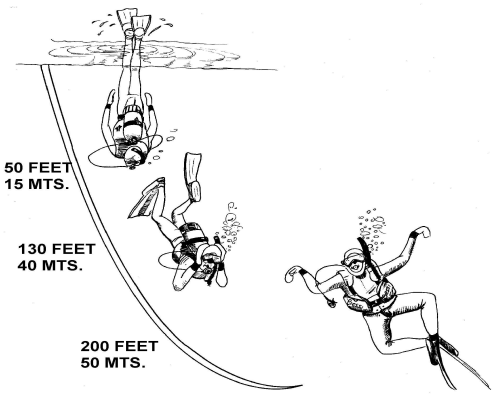
The largest air space of all is the space between the face of the mask and your face. On descent, the volume of air in the mask decreases due to the external pressure. To equalize, simply exhale a small amount of air through your nose into the mask. If you do not equalize, your soft facial tissue will be drawn into the mask cavity which could cause blood vessels near the surface of your skin to rupture in the shape of the mask. It may look unsightly but it is not serious and does not require medical treatment. It will clear up in a day or two. For this reason, it is important for the mask to cover your nose and eyes. Swimming goggles that only cover the eyes should never be used when diving.

5.3. - DESCENT PHYSIOLOGY

Following are the different physiological problems that can arise during descent with the consequent increase in pressure.

5.3.1. - NITROGEN NARCOSIS

According to Henry's Law, the amount of gas that dissolves in a liquid is directly proportional to the depth. As the pressure increases, more gas will dissolve. If you look at the percentage of Nitrogen (78.08%) in air, any increase in pressure will mean that more nitrogen will dissolve. This increase in Nitrogen in the system produces a narcotic effect. This narcotic or "narcosis" effect can reach a level which causes the diver to lose the ability to make decisions clearly and could lead to serious consequences underwater.



Narcosis effects

Not everyone is affected at the same level. In fact, two dives to the same depth at two different times can have different effects. Sometimes no symptoms will appear at all. Some divers experience disorientation, inability to concentrate, claustrophobia etc., while others manifest a euphoric feeling, all of which increase with the increase in depth. Any of these problems can be serious at depth. This narcosis can be affected by your physical condition at the time of the dive. If you are not experienced at diving to deeper depths, if you did not have a good nights sleep prior to the dive, or if you have consumed alcoholic beverages before the dive, any or all of these can make you more prone to suffer the effects of narcosis.

5. Diving physiology: Medical aspects (continued)

The mental state of the diver can also influence the onset of narcosis. If you are nervous or apprehensive about the dive, this could cause the onset of narcosis. This is one of the reasons we insist that you do not bow to peer pressure and dive when you do not feel up to it. A good buddy will understand your apprehension and not try to force you into diving.

The symptoms of narcosis have been compared to being drunk. Jacques Cousteau referred to narcosis in his book "The World of Silence" as "drunkenness of the depth". Over the years this has been expanded into "Martini's Law" which states "every 50 feet (15 metres) of depth is equal to drinking 1 dry martini on an empty stomach. The one advantage of suffering from narcosis is that it disappears as you ascend and you do not suffer a "hangover".

Due to the differences in each diver, it is logical that each diver will have a different depth where narcosis can appear. Recent studies have shown that narcosis appears at depths greater than 100 feet (30 metres). Narcosis always appears at depths greater than 200 feet (60.5 metres). Given the limits for sport diving, the risk of suffering from nitrogen narcosis is minimal.

5.3.2. - OXYGEN POISONING

In spite of the fact that Oxygen is needed to sustain life, breathing pure oxygen at a pressure greater than atmospheric can cause serious pulmonary problems depending on the length of exposure producing Hyperoxia. The limit for diving with compressed air is 198 feet (60 metres) where the partial pressure of oxygen would be 1.4 ATA. At that depth the absolute pressure would be 7 ATA. Beyond this depth, a diver runs the risk of oxygen poisoning. If diving with pure oxygen (as in commercial diving closed circuit) the maximum depth would be 20 feet (6 metres), where the pressure of oxygen would be 1.6 ATA. If diving in cold water, the depth limit drops to 16 feet (4.8 metres).

The symptoms of oxygen poisoning can vary between divers and may include nausea, dizziness, violent muscular contractions, cramps, shivering, depression, euphoria, hallucinations, panic, etc.

The treatment for oxygen poisoning is to breathe fresh air at atmospheric pressure.

Fortunately, as recreational divers, the risk of developing Oxygen Poisoning is remote, since the depth limit for recreational divers is well above the depth where oxygen poisoning could occur.

5.3.3. - CARBON DIOXIDE POISONING

Also called "Hypercapnea", Carbon Dioxide poisoning can be the result of not breathing properly and not achieving a good air exchange in the lungs while diving.

During a dive when you have had to use increased effort such as finning against a current, or if you suffer from anxiety, your rhythm of breathing could decrease to a point that you are only shallow breathing without a good exchange of air in your lungs. This can cause an increase in the carbon dioxide level, which in turn causes you to breathe more rapidly, increasing the amount of carbon dioxide again.

A result can be a headache or nausea after the dive. In order to avoid carbon dioxide poisoning, you must learn to breathe slowly and continuously, taking full inhalations and exhalations.

Some divers think that by "skip breathing", that is, take a breath and hold it for a number of seconds; they will increase the amount of time at depth on their tank of air. This saving air does not happen since when you do this, the carbon dioxide level goes up and you wind up breathing more rapidly after the exhalation, in order to decrease the carbon dioxide level.

5. Diving physiology: Medical aspects (continued)

Should you find yourself breathing rapidly, stop any physical activity and kneel on the bottom or hang onto something and relax. Take a series of deep breaths making sure you have a complete exhalation to reduce the excess CO2.

The following symptoms of CO2 poisoning depend on the concentration of CO2.

- 2% CO2: Rapid breathing
- 4% CO2: Headaches, gasping for air
- 7% CO2: Drunken sensation, nausea, intense headache, sweating and dizziness
- 8% CO2: Loss of consciousness

In all of the above the victim will be cyanotic with blue colour in lips and nails.

The treatment includes pure oxygen, if available, or fresh air. If the victim is found unconscious, immediate AR is required.

5.3.4. - CARBON MONOXIDE POISONING

Carbon monoxide (CO) is a colourless, odourless, tasteless gas produced in exhaust fumes by incomplete combustion in an internal combustion engine. Carbon monoxide poisoning can be lethal because carbon monoxide combines with the haemoglobin in the blood much more rapidly than oxygen. Once CO is combined with haemoglobin, the transfer of gas in the pulmonary alveoli is reduced and the CO remains in the haemoglobin.

Intoxication by CO

This decreases the function of the haemoglobin which is to transfer oxygen to the body. Carbon Monoxide poisoning in diving can only come from the air in your tank due to a bad fill from a compressor whose intake is too close to the exhaust from internal combustion engines (cars). 0.2% CO in breathing air produces serious effects, but 1% CO can be fatal.

The symptoms of CO poisoning are: headaches, dizziness, asphyxiation sensation, nausea, unconsciousness, collapse and even death after coma. Signs of CO poisoning are cherry red lips, red nails and red ear lobes.

The treatment for CO poisoning is pure oxygen delivered by demand valve, if available, or clean, fresh air.

To prevent CO poisoning, have your tanks filled at a reputable filling station whose compressor is well maintained and has air tested on a regular schedule. When filling from a portable gas compressor, be sure the fresh air intake is well upwind from the engine, and that there are not vehicles operating near the intake.

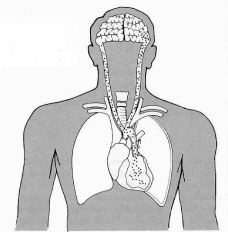
5.4. - ASCENT PHYSIOLOGY

5.4.1. - AIR EMBOLISM (AGE)

Boyle's Law states that gas volume decreases as pressure increases and the volume increases as pressure decreases. While diving, this Law is important to remember since your lungs are air containers whose volume increases as you are ascending. Should you hold your breath for any reason while ascending, the volume increase in your lungs could be very hazardous.

5. Diving physiology: Medical aspects (continued)

One of the most common causes of air embolism is an out of air situation with a rapid uncontrolled ascent caused by diver panic.



Trajectory of the bubbles in an air embolism

There is a valve in the pharynx called the glottis which closes the passage to the lungs when you swallow food and closes the passage to the stomach when you breathe. In a panic situation, the glottis closes the passage to the lungs and causes the lungs to become a sealed container. The air in the lungs then expands due to the external pressure decrease. Although the lungs have a lot of elasticity, if your lungs are full of air the decrease in pressure of only 4 feet (1.2 metres) can cause a rupture in the alveoli causing air bubbles to move into the blood stream where they can become lodged in any narrowing in the artery. Since the brain is one of the first places the arteries travel to, small bubbles would block the blood travelling to the brain with disastrous results. A lung rupture can have other effects which are described below.

To avoid an air embolism you must continue to try to breathe even when you are in an out of air situation. To begin to exhale and continue exhaling without trying to inhale can also cause problems. As air is expelled from the alveoli, the walls of the small passages leading to the alveoli can collapse and the only way to open them again is by an inhalation. If you exhale and the passages collapse, the small amount of air remaining in the alveoli expands and causes a rupture similar to the description above.

If you have an emergency situation and you must return to the surface, make yourself buoyant by dropping your weight belt, keep your regulator in your mouth and try to continue breathing as normal. There is a possibility that, because of pressure differences, air left in your tank may flow and you may get a breath of air from the tank as you ascend. In the worst case, you would become unconscious but at least you would be on the surface where a rescue is easier to achieve.

The symptoms of an air embolism would be an acute pain in the chest, bloody froth in the mouth, fatigue, blurred vision, or unconsciousness.

The immediate treatment for air embolism is to lay the victim in a supine (on their back) position, administer pure oxygen and transport to a hospital with a hyperbaric chamber if possible. Administer CPR and AR if required. Once again: Never hold your breath while ascending.

5.4.2. - MEDIASTINAL ANDSUBCUTANEOUS EMPHYSEMA

Another injury that can be caused by a lung rupture is for the air to enter the interior of the thoracic cavity which surrounds the heart called the mediastina. This injury is known as mediastinal emphysema. This causes pressure to be put on the heart making it more difficult to pump. Symptoms of this are chest pain, respiratory difficulty, etc. The treatment for mediastinal emphysema is the same as for an air embolism. Prevention is the same as for air embolism. Never hold your breath while ascending. A further injury caused by a lung rupture is for the air to gather under the skin usually in the area around the neck and shoulders. This injury is known as subcutaneous emphysema.

Symptoms of this is a swelling in the neck or shoulder area and when touched it feels and has a crackling sound like walking on snow or like a bowl of 'rice crispies'. In addition, there is difficulty with speech, and/or pain in the neck area.

5. Diving physiology: Medical aspects (continued)

The treatment for subcutaneous emphysema is the same as for air embolism. Prevention is the same as for air embolism. Never hold your breath while ascending.

5.4.3. - PNEUMOTHORAX

Another injury caused by a lung rupture is called Pneumothorax. When the rupture causes the alveoli to break, the air can enter the pleura area which encloses the lungs. This causes pressure on the lung and the lung can collapse.

Symptoms are chest pain, sometimes only on one side, respiratory difficulty, shallow breathing and cyanosis.

The treatment for Pneumothorax is the same as for air embolism. Prevention is the same as for air embolism. Never hold your breath while ascending.

5.4.4. - GAS EXPANSION IN THE STOMACH AND INTESTINES

Often called "Diver's Colic", eating gas producing foods before diving can cause discomfort while ascending. While under pressure during the dive the digestion process in the stomach and intestines is continuing.

As you ascend this gas in the stomach and intestines expands due to the pressure change and presses against the intestinal walls causing pain in that area.

This is not a serious problem and is relieved by a normal process when you relax. During a dive, you may swallow air which can cause a local pain in the stomach. Once again, this is not a serious problem and is relieved by a normal process when you relax.

5.4.5. - DIZZINESS

If, in the rare occasion you feel a little dizzy while ascending, it could be from a difference in pressure between your two ears due to a partially blocked Eustachian tube, or a difference in pressure or temperature due to a tight fitting wet suit hood.

Dizziness or vertigo

The symptoms will be dizziness and a loss of sense of direction. The solution is to try and retain the balance between the two ears. This is achieved by using your fingers to move your wet suit hood away from your ears allowing the pressure and temperature on both sides to equalize.

If the problem is a blocked Eustachian tube, you must stop your ascent and equalize similar to when you are descending so that the problem does not increase. To avoid the appearance of these problems, you should maintain a slow ascent rate so that your ears will get a chance to equalize naturally during the ascent.

5.4.6. - DECOMPRESSION SICKNESS (DCS)

Also known as the "Bends", from the style of walk called the "Grecian Bend" that females in ancient Greece used. Hull divers who developed pains in their joints from deep diving had difficulty bending their joints, causing them to walk in a stiff fashion. Another name for Decompression Sickness is "Caissons Disease".

5. Diving physiology: Medical aspects (continued)

Caissons or booths were used by workers digging tunnels under rivers in order to stay dry. Increased air pressure was pumped down to the workers in the caissons which caused more nitrogen to be dissolved in their blood. Not knowing any better, these workers were brought out to decreased pressure quickly causing them to have great joint pain and sometimes death.

These same physiological problems affect a diver after time at depth. This type of accident involves three Gas Laws. Dalton's Law is involved due to increased nitrogen dissolved in the blood due to the higher partial pressure of nitrogen; Henry's Law is involved due to the amount of gas that will dissolve in a liquid when pressure increases, and Boyle's Law is involved due to the volume expansion of gases from a decrease in pressure.

Decompression Sickness is caused by nitrogen being dissolved in the blood at depth. Staying a length of time at depth causes more and more Nitrogen to be dissolved and this excess Nitrogen must be allowed to off gas through the lungs during ascent. Failure to allow this slow off gassing, causes the Nitrogen to come out of suspension in the blood stream. There are a number of factors that play a part in causing Decompression Sickness. Age, the amount of fat the diver has (fat has an affinity for Nitrogen), cold (which causes the diver to breathe more quickly and increases the amount of Nitrogen dissolved), some diseases, and excessive exercise during the dive, causing the diver to consume more air.

The symptoms vary greatly, depending on the part of the body affected and the degree of severity. They can appear as tingling and itchiness of the skin, local pain in a joint, paralysis in an arm or leg, loss of hearing or vision, speech problems, general weakness, trouble breathing, light headedness, or even unconsciousness, giddiness, etc. These symptoms tend to appear upon arriving at the surface.

Statistics tell us that nearly all the accidents are detected within 6 hours, and 50% within 30 minutes. However, symptoms could appear as much as 48 hours later.

Hyperbaric chambers

The only true treatment for an injury of this type is to take the victim to the nearest Hyperbaric Chamber. The treatment consists of taking the victim down to a pressure where the symptoms are relieved and the bubbles are returned to solution. The victim is then returned to atmospheric pressure slowly, allowing the Nitrogen to off gas naturally through the lungs. It is important to take the victim to the nearest chamber as quickly as possible.

Having the victim breathe pure Oxygen during transport will increase the chances for a quick recovery. In some instances, breathing pure Oxygen has relieved the symptoms completely. Even if this should happen, the victim should still be taken to a chamber to be evaluated by medical experts. In addition, try to give the victim large quantities of liquids (non alcoholic) to ensure adequate hydration. Never take the victim back down to depth in order to relieve the symptoms. The injury could be worsened if there were not enough air to complete the treatment or not enough personnel to stay with the victim during treatment.

To prevent this type of accident, always pay attention to the No Decompression Tables and avoid any dives that require decompression stops. Always pay attention to your ascent rates and do a 3 to 5 minute Safety Stop at between 10 and 20 feet (3 to 6 metres) on every dive below 40 feet (12 metres).

5. Diving physiology: Medical aspects (continued)

Various tables have been developed with a specific number of minutes you can stay at various depths without having to make a decompression stop.

The most common tables in the past were based on those developed by the United States Navy. These tables were developed for use by fit, age 18 to 24 year old divers, who would go into the water and do a specific task at a specific depth. They were not designed for Recreational Divers of varying ages and physical fitness who dive at various depths during the same dive. The Tables you will learn on your course are based on the tables developed by DCIEM (Defence and Civil Institute of Environmental Medicine) as a joint project for the American, British and Canadian Navy. They are more conservative and have been developed from actual dives and the detection of the presence of bubbles in the blood, using Doppler Ultra Sound Equipment.

COMPARATIVE CHART BETWEEN US NAVY AND DCIEM TABLES		
DEPTH (metres and feet)	**US NAVY (in minutes)**	**DCIEM TABLES (in minutes)**
12 / 40	200	150
15 / 50	100	75
18 / 60	60	50
21 / 70	50	35
24 / 80	40	25
27 / 90	30	20
30 / 99	25	10

Regardless of which tables divers use, there is no guarantee that the user will not suffer a Decompression accident.

After any dive, if you should suffer any symptoms of Decompression Sickness even though you do not believe you could have DCS, it is better to err on the side of safety and contact DAN (Divers Alert Network). They will be able to assess whether in fact you have DCS or not. The symptoms can disappear momentarily only to recur at a later time with increased severity.

5.5. - RELATED PHYSIOLOGY

5.5.1. - LIPOID PNEUMONIA

This type of problem is due to improper compressor maintenance. A poorly maintained compressor can be pumping oil past the filters and into the tank. This oil contaminated air, when breathed by the diver gets into the alveoli and causes them to plug up thereby stopping the normal gaseous exchange (haematosis) between the lungs and the blood stream making it impossible to get oxygen into the system.

The symptoms are classic pneumonia, and in addition there will be the taste and smell of oil in the mouth. Coughing spasms usually occur with the symptoms.

Treatment requires immediate medical care to remove the oil deposited in the lungs, therefore the victim must be taken quickly to a medical centre.

5. Diving physiology: Medical aspects (continued)

To prevent this type of occurrence it is important that you get your air fills only from a reputable filling station that has the air tested on a regular basis and displays an approved air analysis certificate. In addition to this, it is important for you to smell the air in your cylinder before you attach your regulator to it. The air should have no odour, colour or flavour.

If you are operating your own compressor be sure to replace the filters and lubricating oil on a regular basis according to the manufacturer's specifications.

5.5.2. - HYPOTHERMIA

Your body temperature must be maintained close to 98.6 degrees Fahrenheit (37 degrees Celsius) for normal operation.

The skin gives up heat to the environment and as long as this heat loss is kept within certain limits, your body will generate the necessary heat to maintain this temperature. However, remember that the heat transfer in water is 25 times faster than in air, and, in the absence of wind, your body will relinquish 25 times more calories in water than in air.

When the speed of calorie loss reaches a point that your body is unable to compensate, the progressive cooling of the body will begin. This process, where your body will continue reducing temperature unless the heat loss is stopped by changing the environment, is called Hypothermia.

The symptoms of Hypothermia will begin with chills, shivering and drowsiness which demonstrates that your body cannot keep up with the rate of loss of calories. Continued cooling will manifest itself with disorientation and loss of muscular coordination.

If the loss of heat continues, the shivering will stop and speech and coordination will disappear as well as the ability to think clearly. In severe cases, pulse and respiratory rate will slow down until unconsciousness takes over.

Cover the victim

To avoid hypothermia, always wear adequate protective clothing when diving in cold water, and never continue to dive after you begin to shiver, since this is the first sign that your body cannot handle the heat loss. The areas of the body that lose heat most quickly are the head, the neck, the extremities and the groin, therefore it will be important to pay close attention to these areas before diving in cold water.

Do not give alcoholic beverages

In a case of suspected hypothermia, the first thing to check for is breathing and pulse, though on occasion, this can be difficult to detect. If none exists, cardio pulmonary resuscitation will have to be administered. Place the victim in a warm dry environment, remove wet clothing and dry the victim with a towel. Cover the torso with warm blankets or a coat if necessary, leaving the arms and legs uncovered since warming too rapidly can cause cardiac problems. If the victim is conscious, give him warm drinks but no alcohol.

If the hyperthermia state is serious and the victim has problems with memory or coordination, it will be important to seek immediate medical help.

5. Diving physiology: Medical aspects (continued)

5.5.3. - DRUGS AND ALCOHOL

Alcohol is dangerous in diving since it affects your capacity to react to unforeseen circumstances from its intoxicating effect. In addition, it is a potent diuretic which alters the water content in the circulatory system by causing an increase in the density of the blood which can aid in the onset of decompression sickness and also could mask the symptoms of DCS. Also it increases heat loss by producing a vasodilatation peripheral, increasing the risk of suffering hypothermia.

Certain drinks (coffee, tea) are also strong diuretics that decrease the quantity of liquid in your circulatory system; therefore they should be avoided before and after diving.

In reference to drugs, we are referring to any chemical product that alters the normal operation of your body. The consumption of any one of these products will have to be controlled carefully, and it is important to avoid any substance whose effects may not have been experienced previously under normal conditions. Consideration must also be given to the fact that the effect of a drug can be altered due to increased pressure while diving.

Press on this bar to go to the next chapter

ACUC

PRACTICES WITH SCUBA EQUIPMENT

LESSON OBJECTIVES

At the end of this chapter the student should be able to describe the theory regarding:

- How to do the exercises described in chapter 2, but this time with SCUBA equipment
- The Buddy System
- Equipment check
- How to ascend from the bottom
- Assembly and Disassembly of Equipment
- How to do different underwater skills


Pool practices

Next, the reader will find the description of some of the most important skills that will be done during the scuba course. Besides doing the exercises described in this chapter, students must also do, under the supervision of an ACUC Instructor, the exercises described in chapter 2 using full scuba equipment.

This ACUC Open Water Diver manual offers visual descriptions of these exercises. **All these exercises must only be done under direct supervision of an ACUC Scuba Instructor**.

6.1. - THE BUDDY SYSTEM

NEVER DIVE ALONE Even a minor incident could degenerate into a serious accident with serious consequences if you do not have a buddy with you that you can count on for help. Always dive in pairs. For instance, if four of you are diving, dive in buddy pairs of two. When discussing the dive plan be sure that each of the buddy pairs agrees with the dive plan and the parameters of the dive.

Help each other with the equipment so that you are familiar with your buddy's equipment and he is familiar with yours. Check to be sure your buddy's air is turned on. Review the hand signals for the dive so that you both understand their meaning and decide on the procedures to be used in case of an emergency. During the dive, stay within sight of each other and never separate more than 15 to 20 feet (5.5 to 6 metres) from each other.

Get closer, even within touching distance, if you are in limited visibility or there is a current. Glimpse at your buddy frequently to be sure that everything is OK and ascend together at the end of the dive. Whenever one member of the buddy team ascends, both must ascend. Never leave your buddy to go up or stay down alone. After the dive, help each other to remove your equipment and help each other to get back on the vessel or shore.

When dive planning, always plan dives within the limitations of the least experienced diver so that if a problem arises, both of you will be able to handle it simply and easily.

6. Practices with SCUBA equipment (continued)

6.2. - HANDLING THE EQUIPMENT

Make sure that the tank markings are up to date and check the valve

6.2.1. - INSPECTING THE TANK

Before using an unfamiliar tank, be sure that the hydrostatic test is within date for the area you are diving in, that it has a current visual inspection sticker and that the valve is in good condition complete with an "O" ring. If any of these items are missing, demand another tank. Once you fasten your regulator to the tank, be sure to check the air pressure in the tank to be sure that it is full, so that you will not get a surprise later on. To check the air pressure, make sure the pressure gauge is aiming towards the floor when you open the air valve.

Place the depth gauge facing down when opening the air

6.2.2 FASTENING THE BC TO THE TANK

Before fastening the backpack or jacket to the tank, wet the straps first. Some straps expand slightly when wet and if put on the tank dry, the strap could stretch underwater and your tank could fall out. The jacket or backpack must be mounted so that the jacket is on the same side of the tank as the regulator opening on the valve. When you put the jacket and tank on, your regulator should be between your body and the tank. Normally the jacket is mounted to the tank so that the top of the jacket is even with the top of the tank valve. This is done so that the regulator 1st stage will not hit the back of your head while diving, but as not all jackets have the same design, you will have to check out the proper mounting spot so that this does not happen. To be sure that the strap on the tank is tight enough, lift the tank by the top of the jacket and give it a jerk to be sure that the tank is not going to move afterwards.

Wet the compensator's back strap

6.2.3 CHECKING THE VALVE

Before fastening the regulator to the valve check the condition of the valve. Be sure that the connection port is round with no dents or gouges in it. Check the "O" ring to be sure that the seat of the 1st stage will fit against it, and that it is not nicked or broken. If in doubt, change it for a new one. You should always carry some spare "O" rings with you. In a situation where you do not have one, take the old "O" ring out and turn it so that the nicked edge is facing inwards and then fasten your regulator to it. Sometimes this will solve the problem.

Line up the top of the tank valve with the top of the jacket back pack

6.2.4 FASTENING THE REGULATOR TO THE TANK

Loosen the retaining screw and remove the dust cap from the 1st stage of the regulator. Place the yoke over the top of the tank valve and line it up so that the regulator connector is in line with the valve connection. Be sure that the hoses for the primary 2nd stage and the octopus will fall over your right shoulder and the hoses for your submersible pressure gauge and your BC will fall over your left shoulder. Tighten the retaining screw of the regulator to the tank valve. Be sure that it is only finger tight. If you tighten it too much, you could damage the "O" ring or be unable to undo the screw after the air pressure has been released.

Raise the tank by the jacket to ensure that the tank will not come loose

6.2.5 FASTENING THE BC HOSE TO THE BC

Pull back on the quick connector on the low pressure hose from the 1st stage and connect it to the male connector on the flexible hose from the jacket. Check that the connection has been made by giving a tug on the connection.

6.2.6 TURNING ON THE AIR

After all of the previous steps have been completed, you are now ready to turn on the air.

6. Practices with SCUBA equipment (continued)

While holding the submersible pressure gauge face against the tank or towards the ground, turn the tank valve on slowly (if the gauge is damaged, turning on the air could blow the face off of the gauge). As the air begins to flow you will hear a hiss as the air fills the hoses and stiffens them. When the noise stops, open the valve all the way open and then close the valve by one quarter (¼) turn. This is done to save wear on the tank valve. In addition, if you forget whether the tank valve is on or off, simply turn the valve on. If it only moves ¼ turn and then stops, your valve was turned on. If it turns more than that, your valve was closed and you are now opening it.

Remove the plastic dust cap from the regulator's 1st stage

Listen closely to be sure that there are no air leaks at the connections. Sometimes, if the regulator is put on wrong or the "O" ring is defective, you may hear a loud bang at the tank valve. If this happens, quickly close the tank valve and empty the hoses by pushing the purge button on the 2nd stage of the regulator.

Disconnect the 1st stage from the valve, change the "O" ring and then repeat the above process. If you are going into the water right away, leave the valve open and your equipment is ready to use.

Place the 1st stage of the regulator on the tank valve

If you are going to be moving your equipment a great distance (for instance, going on a boat to a dive site), close the tank valve, purge the hoses but leave the regulator connected to the tank. Do not leave your hoses under pressure for a long time, especially in warm climates.

6.2.7 CHECKING THE REGULATOR

Connect the regulator hose to the jacket inflator hose

To be sure that the primary 2nd stage and octopus regulators are working properly, press the purge button on each one briefly to ensure that air is flowing to them. Then, take a few short breaths from each one to be sure that they give you air on demand and shut off when you complete a breath. Watch the pressure gauge as you do this. If you see the gauge move erratically this means that the lever on the "J" valve (if you have one) is in the up position or that the air is not turned fully on. If moving the "J" valve to the down position, or turning your air fully on does not clear the needle fluctuation, then you have a problem with the 1st stage that must be corrected before you go diving. If, when you take a breath from the regulator, the air tastes or smells strange, do not use that tank. The air could be contaminated with oil or other impurities. Replace that tank with a fresh one and notify the filling station of the problem. Press the power inflator on the BC to be sure that it works properly. Leave the air in the BC so that you can use the buoyancy when you enter the water. Finally, make note of the tank pressure in your dive log.

6.2.8 PUTTING THE SCUBA EQUIPMENT ON

Once you have checked the equipment, have your buddy help you to put on the equipment. If you have to walk any distance in order to enter the water, such as on a boat, carry your fins in your hand and put them on at the edge of the water just before you enter.

6.2.9 REMOVING THE SCUBA EQUIPMENT

Once you have completed your dive and are back on the boat or the beach, remove your equipment in the reverse order to the above. Record the amount of air remaining in your tank as shown on your pressure gauge in your log book or on your slate for entry later.

Purging the air

- First, close the tank valve. Do not shut the valve tightly as this could damage its mechanism.
- Press the purge button on the 2nd stage to empty the hoses on the regulator. Hold the purge button until the pressure gauge reads zero pressure and the hoses go limp.
- Disconnect the power inflator hose from the BC.

6. Practices with SCUBA equipment (continued)

Carefully dry the dust cap

- Disconnect the 1st stage from the tank valve
- Blow the water from the face of the dust cap with air from the tank.
- Once dry, put the dust cap on the regulator and tighten it down to prevent water or dirt from getting into the 1st stage of the regulator.
- Unfasten the BC tank strap from the tank and remove the jacket from the tank.

As you are removing each piece of equipment, put it in your dive bag so that it will not get banged around on a boat or full of dirt from the sand at the dive. Now is the time to discuss the dive with your dive companions and relive your exciting experiences.

6.3. PRACTICES WITH SCUBA EQUIPMENT

6.3.1. - PURGING THE REGULATOR

Putting your regulator in your mouth, while underwater, causes the mouthpiece to flood and you must empty it before inhaling. You can use two systems: exhaling air from your lungs into the mouthpiece or pressing the purge button (block the mouthpiece with your tongue to avoid inhaling water). In either method, the air displaces the water.

6.3.2. - BREATHING FROM THE REGULATOR

Breathing from a regulator is very similar to breathing in air, the only difference being that at the surface you make an unconscious effort to inhale and exhale by flexing and relaxing a series of muscles, while underwater inhaling requires very little muscular effort but exhaling requires a bit more effort. However, the differences are not appreciable and breathing is done automatically. Another difference is that underwater you will inhale and exhale through your mouth. Exhaling through your nose underwater causes you to have problems with mask flooding. An important skill of all good divers is the ability to breathe through their mouths, even when their nose is uncovered underwater. For this reason, exercises are usually done during your course to practice controlling the reflex action of inhaling through your nose when it is not covered by the mask.

6.3.3. - BUDDY BREATHING

Normally, when in an emergency situation, the use of an octopus system simplifies the process because each diver has a second stage mouthpiece available. While mentioning the octopus system, it is important to practice this procedure frequently so that if you or your buddy are ever in a situation where you need to use the other’s octopus, you will go to the octopus regulator rather than the one that is in his or your mouth.

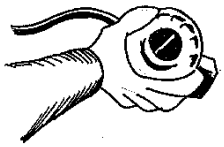
The natural tendency would be to concentrate on the one your buddy is using. This could prove dangerous especially in cold water where your mouth could go numb from the cold. Another system used in an emergency situation is one where one regulator is shared by two people. Although this exercise is optional, some Instructors teach this technique in a controlled environment such as a pool or in warm shallow open water.

When using only one second stage, the "donor" positions himself to the right of the diver with problems, and grasps his own regulator hose near the mouthpiece with his right hand so that it does not obstruct access to the purge button. He takes the mouthpiece out of his mouth and places it near his buddy’s mouth, while holding onto him by the vest with his left hand. The donor at no time gives up control of the regulator. The victim places the regulator in his mouth, using the purge button, if necessary, due to a lack of air in his lungs to empty it, and takes two breaths, retaining some air after the second breath in order to purge the regulator in the following cycle. The donor recovers the regulator and takes two breaths in turn, before repeating the procedure as many times as necessary.

6. Practices with SCUBA equipment (continued)

As soon as the the situation is under control, the buddy team must begin their ascent to the surface controlling the ascent rate and making the safety stop.

It is very important that the donor, as well as the victim, continuously exhale a small amount of air when the regulator is not in their mouth to avoid an overpressure in the lungs.



One of the correct methods of holding the 2nd stage when doing horizontal buddy breathing

When passing the regulator back and forth, keep the mouthpiece down to avoid a “free flow” from the regulator.

The position described above is called the *side by side*. During the ascent you would adopt the *front to front position*. The method is the same, with the only variation being that the donor positions himself at the front of the victim instead of to the left. This position offers an advantage in that it allows for better control of the state of the victim, while ascending, and also the victim, when able to see the donor in front, will be more relaxed, making the ascent comfortable.

If needed, you may use reasonable force to recover the mouthpiece

The reason for insisting that the donor always maintain control of the regulator is because in a panic situation the victim may refuse to return the mouthpiece to the donor. Should this happen, the donor must recover it by any means, even by placing a foot against the chest of the victim and giving a strong push. If this method is used, there is a chance that the mouthpiece will remain in the victim’s mouth, however, it is possible to still breathe from a regulator without a mouthpiece. Once the regulator is recovered, you can try to restart the ascent while trying to buddy breathe, providing the victim has calmed down.

When the regulator is not in your mouth, always exhale slightly

Another danger in buddy breathing by this method is that in cold water, the lips and face become numb. It will become very difficult to remove and replace the regulator in order to buddy breathe in this fashion for any length of time. This is very hazardous for both the donor and the victim.

You can see from the above that there are serious problems involved in buddy breathing using this method. This is the reason why ACUC recommends that all its divers use an alternative air source, so that each diver has his own breathing equipment to ascend to the surface.

6.3.4. - RECOVERY OF A LOST REGULATOR

If for any reason, you are diving and you lose your regulator from your mouth, stay calm and complete either of the two manoeuvres described next:

The first method consists of grasping the bottom of your tank with your left hand and lifting it up, while with your right hand, reach behind you to the tank valve and follow the regulator hose down until you reach the second stage.

The second method consists of positioning yourself horizontally on your right side, so that your regulator second stage will drop down. Then with your right arm extended, start a sweep outward beginning at your hip until your second stage is found. Any time you do not have your regulator in your mouth while underwater, remember to slowly exhale so that you do not run the risk of a lung overexpansion.

6.3.5. - DESCENDING USING A BUOYANCY COMPENSATOR

The best method of descending is *feet first,* which, as its name implies, means to drop vertically in an erect position. This is the easiest method because it is much simpler to control your descent than to descend *head first,* which can cause you to become disoriented at first. To begin your descent, decrease your buoyancy by dumping the air from your vest. In some vest models the only way to do this is by lifting the inflator hose above your head and pressing the deflate button.

6. Practices with SCUBA equipment (continued)

In other models the exhaust valve is located at the shoulder level. Grasp the cord hanging from the middle of the exhaust valve and pull it to deflate the vest.

Still other models incorporate the dump valve into the inflator hose at the position where the inflator hose enters the vest. The dump valve is activated by pulling on the inflator hose to open the dump valve.

Should you find that you do not have enough negative buoyancy after dumping the air from your vest, you should go back up and put more weights on, however you could opt to make a *head first* dive in order to descend the first 10 feet (3 metres) where, at that depth, the increased pressure will diminish the buoyancy of your protective suit, allowing you to continue the descent in a *feet first* position.

6.3.6. - CONTROLLED ASCENT USING A BUOYANCY COMPENSATOR

When returning to the surface you must keep in mind that when ascending, the volume of air contained in the vest will increase as the pressure decreases (Boyle's Law). You must control this expansion so that it does not increase your buoyancy excessively. Ascend with the inflator hose in your left hand, extended above your head and be prepared to press the deflate button to exhaust air if you feel that your ascent speed becomes too rapid. You should stay below your SMALLEST bubbles. If you are ascending faster than they are you are ascending too quickly.

6.3.7. - RESTING ON THE SURFACE USING A BUOYANCY COMPENSATOR

When you arrive at the surface and want to relax or are waiting for the dive boat to come and pick you up, inflate your vest and lean back slightly with your arms crossed over your chest. This will make you stationary without having to fin to stay afloat. Do not over inflate your vest because it can make it difficult to breathe if your vest is pressing against your chest.

6.3.8. - EMERGENCY ASCENTS

An emergency ascent, also called a *free ascent*, is a return to the surface as quickly as possible because you are out of air and it is impossible to contact your buddy for help. In other words, you should only need to make a free ascent when you have violated the safety rules of diving. If you practice the safety rules conscientiously, you will never be in this situation. Depending on the circumstances, you will need to decide between doing an emergency ascent or try to reach your buddy's octopus regulator.

If you are in deep water, it is preferable to attempt to reach your buddy in order to use his octopus. To attract his attention bang your knife on your tank. If the depth is fairly shallow, it may be more practical to ascend by your own means. The most important thing is to always remain calm and not allow yourself to panic. By staying in control of the situation, the problem will resolve itself with few problems. If you allow yourself to panic, the situation will degenerate into a serious accident.

If the cause of the problem was that you used up all your air, keep the regulator in your mouth and try to breathe while ascending. As the pressure decreases there is a possibility you will get a breath or two from the tank. Also, by trying to inhale and exhale while ascending, you will avoid the possibility of a reverse block in the alveoli.

If it is a regulator malfunction, there is no other alternative but to ascend. Even though you feel that your lungs are empty, they still hold a residual volume of air which will expand as you ascend. You must not hold your breath but exhale slowly by humming as you ascend. It is possible to ascend from depths of 90 to 100 feet (27 to 30 metres) with no problem using this method. All that is required is for you to remain calm.

6.3.9. - CONTROLLED EMERGENCY ASCENT

It is important to practice this exercise until you master it, because if on some occasion you are forced to use it, the self confidence of knowing you can do it will allow you to stay in full control of the situation. In the first place, you will need to decide whether or not to drop your weight belt, depending on the vest you are using and the quantity of weight you are wearing.

6. Practices with SCUBA equipment (continued)

Without weights, it will be very difficult to control your ascent, especially in the last few feet. If you dropped your weight belt, in order to avoid too rapid an ascent, as you approach the surface flare out into a horizontal position, facing the surface and with your arms extended toward the sides, in order to slow down your ascent with the friction against the water. As we mentioned previously, continue to try to inhale and exhale from the regulator as you ascend.

A position that will slow down the rate of ascent when doing an emergency ascent

6.3.10. - EMERGENCY BUOYANT ASCENT WITH FLOTATION

This ascent is extremely dangerous and has a high risk of accidents. It is the last resort and should be used only when the situation is desperate. It consists of dropping your weight belt and inflating your vest, which will catapult you to the surface in a completely uncontrolled fashion. You must always maintain your breathing cycle to maintain an open airway and avoid lung overpressure, and you should also try to control the ascent as much as possible, under these difficult circumstances. This ascent can cause a lung overpressure accident AND a decompression accident.

Press on this bar to go to the next chapter

ACUC

THE MARINE ENVIRONMENT

LESSON OBJECTIVES

At the end of this chapter the student will be able to:

- Differentiate between fresh and salt water
- Name several types of currents
- Define the characteristics of the different types of depth
- Define different types of marine life that the divers should know about
- Explain the reasons for marine conservation

7.1. - THE MARINE ENVIRONMENT

7.1.1. - SALT WATER

The main difference between fresh and sea water is the salinity of the sea water. This affects not only the flavour but, more important, due to the greater density of sea water the, diver's buoyancy. Remember Archimedes' Principle. A diver who is used to diving in fresh water lakes, rivers and quarries must adjust his weights before diving in seawater.

Seawater is 2.5% more dense than fresh water and you need to add that much more weight before diving in order to maintain your proper buoyancy. Even different seas can have different salinity. You also need to take into account the corrosive nature of seawater. Once your dive in salt water is finished, be sure to wash all of your equipment thoroughly with fresh water.

7.1.2. - SUN

Divers from cooler climate areas will have to be careful when diving in warm tropic water. Protection from the sun's rays will be needed to avoid sunburn. On a boat in tropical waters, sometimes you may not realize you are being burnt because of the wind. Also, when snorkelling on the surface, you won't realize you are getting burnt because the water keeps you cool.

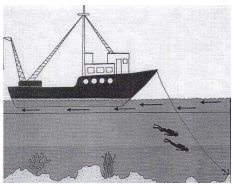
During the first days of your vacation, wear light clothing and a hat to protect your skin. Then, as you get acclimatized to the sun's rays, you can slowly have more exposure. This way, you can enjoy a pleasant tropical diving vacation.

7.1.3. - CURRENTS

Frequently you may find yourself diving in a current, sometimes called "rivers in the sea". Due to the different water temperatures, especially in polar zones and large water bodies, the colder water sinks due to its greater density and is replaced by warmer, less dense, surface water. These are the large general ocean currents that travel in a clockwise rotation north of the equator and counter clockwise south of the equator.

You should pay attention to these general currents when planning a dive because in some areas this current is strong enough that it makes for unpleasant diving. On occasion, local winds cause currents with whitecaps on the water. In fresh water, due to the warm surface water and cooler depths, you will find a thermocline (water layers).

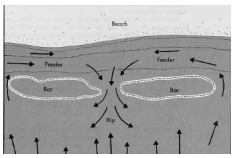
7. The marine environment (continued)



Dive against the current at the beginning of the dive

When diving where currents exist, always begin the dive against the current. The reason for this is that at the beginning of the dive you are more rested and have more air available when a greater effort is needed. At the end of the dive, when you are tired and low on air, the current assists you on your return to the vessel.

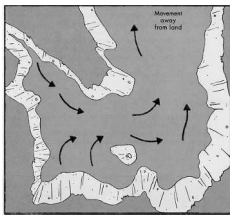
In strong currents, allow a line to trail out the back of the vessel so that you can grab it as you drift by. To find the direction and force of the current, let a rope trail from the back of the vessel weighted with a sea anchor or a pail. This will also show the strength of the current by how taut the line is.



Reef Rip current, due to submerged reef or sand bars

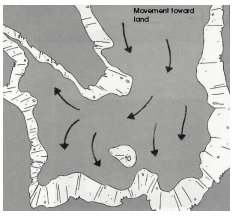
Where the vessel is positioned in relation to the anchor does not necessarily indicate the current direction since the boat position is affected by the direction of the wind. As well, the surface current direction is not the same as the current direction underwater.

ACUC offers a specialty course on “Drift Diving”. This course teaches you how to have fun, allowing yourself to be moved along by the current without swimming and letting you look at the underwater scenery passing by. This training also teaches you how to dive where tidal currents are a factor.



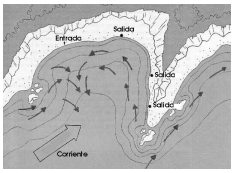
Ebb current

The great quantity of water mobilized by the rise and fall of the level of the sea produces a tidal current at certain hours, which is different in each area. Before diving in unknown areas, find out about the tides and general currents in the area. Consulting the local tide tables or talking with local fisherman can give you valuable information. Once informed, you can abstain from diving in strong current hours and avoid being carried along by the strong currents.



Flood current

One form of current that is especially dangerous is an offshore or rip current. The effect of this current is that it moves you away from the shore when you are trying to swim towards it. If this type of current is present, try to locate an area where the current is less strong and leave the water from that location rather than the area you entered.



Point Rip current

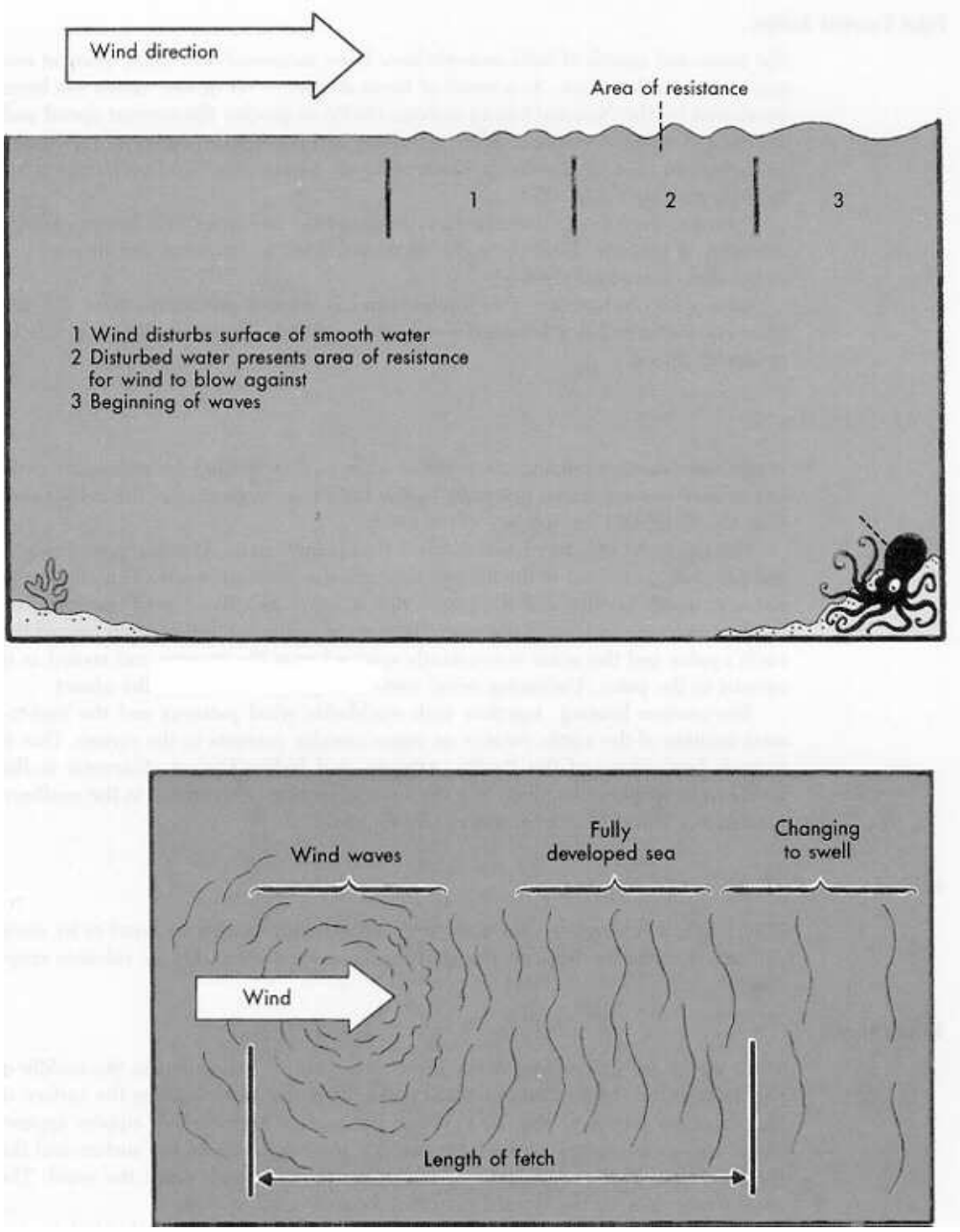
Another common type of current is the one that travels parallel to the shore. Should you find yourself in this situation, do not try to return to your entry point since this will only tire you out from swimming against the current. Go with the current and swim on a diagonal path to the shore, leaving the water down current from where you entered. You may leave the water far from your entry point but you can walk back to your entry point with your gear easier than trying to swim.

7.1.4. - WAVES

Waves are on the surface of the water and are caused by winds. There are basically two parts of a wave: the crest, the part that reaches the greatest height and the trough, the lowest part. The height of the wave is measured from the crest to the trough, and the length is measured from crest to crest.

The classification and study of waves is beyond the scope required for this manual. Further information on waves is available in other courses offered by ACUC International. In this course, we will concentrate on how to handle wave action.

7. The marine environment (continued)



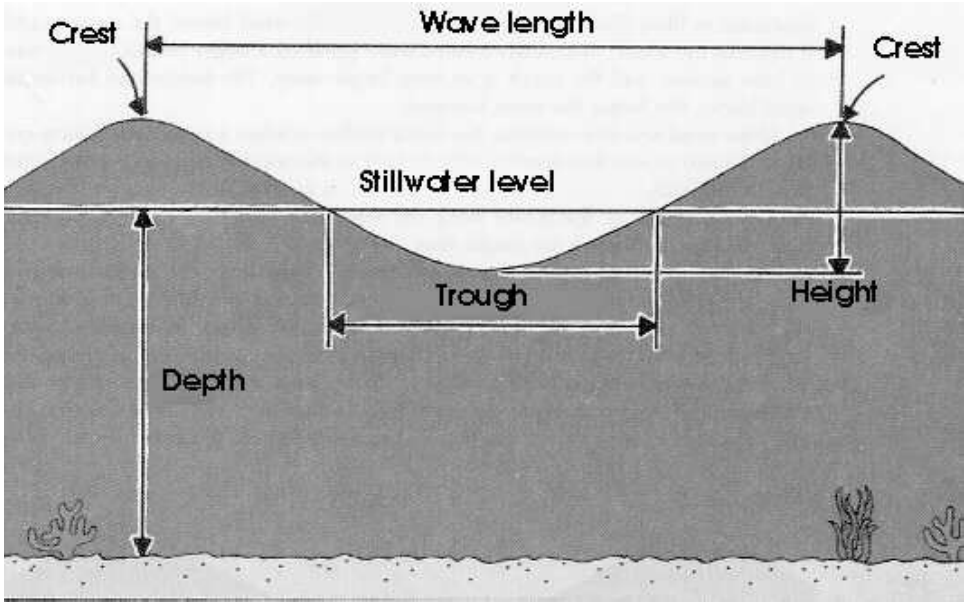
Wave formation

Should you find yourself in the situation where you are beginning your dive from a beach with surge, there are techniques you can use to get yourself under the surge without losing some of your equipment from the action of the waves.

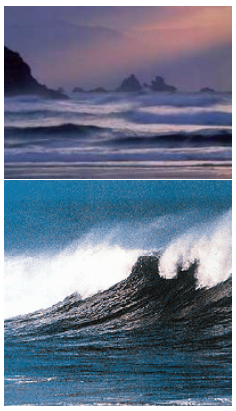
Begin by studying the movement of the waves since they tend to produce a series of strong waves, followed by another series of softer ones. When you see that a series of strong waves has ended, walk with your mask pulled down on your neck and your fins carried in your hand, into the water until it is up to your knees.

7. The marine environment (continued)

At this point, if a wave breaks, turn your back to the wave and walk backwards until the water is up to your waist.



How waves are measured



Waves

At this point put your mask and fins on, turn around, and begin to swim out into deeper water.

When returning to land, surface a short distance from the shore to evaluate the situation and to check the wave action. When the series of strong waves ends and the series of light waves begin, swim in until the water is waist deep, stand up and remove your fins. Hold on to your fins tightly in case a sudden wave knocks you off your feet. Once you are out of the water, walk a short distance away from the shore before removing your equipment.

When diving from a vessel in waves, enter and exit the water on the side of the boat that is out of the wind so that the boat acts as a buffer from the waves.

Occasionally, the wave action causes the weeds and corals to move back and forth and makes you feel disoriented and sometimes nauseous. If this should happen, concentrate on the bottom or non moving rocks or coral until the feeling passes.

The following procedure may help in situations where strong wave action moves you towards and then away from your exit point, making it difficult to reach it: Swim with the current as it is heading for your exit point. Then, when it begins to move away from where you want to go, grab onto a rock or coral and hold yourself in that position until the motion begins to move towards shore again.

7.1.5. - SHORE TOPOGRAPHY

Normally, the selected dive site is one that has good visibility and one that you have previous knowledge of. When the site is not what you expected it could be frustrating.

7. The marine environment (continued)

However, diving in an area that is not what you expected could be enjoyable just by the discovery of new types of topography than what you are used to. Pay attention to all details of your surroundings so that it is easy for you to return to your starting place.

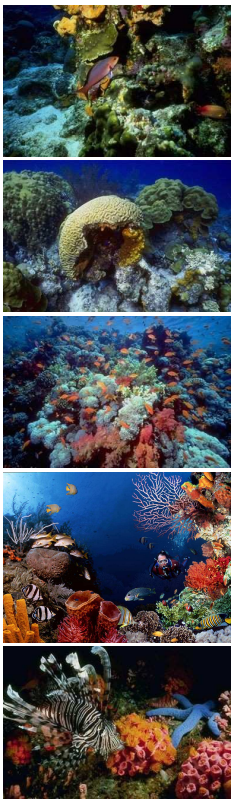
Some areas have a sand and silt bottom that is stirred up by the water movement. When in this situation, care must be taken that you do not bump into something due to the low visibility. The first thing to do is to become neutrally buoyant and stay a minimum of 3 feet (1 meter) off the bottom. This serves a double purpose. It keeps you from bumping into things and also stops you from stirring the sediment up from the bottom.

Remember that coral will die if it is covered with sand. An innocent fin kick in the sand can be the cause of the death of thousands of microbes that make up the coral.

When diving in this type of environment you need to protect yourself by wearing a suit made of neoprene or lycra (depending on the temperature of the water), for warmth and also, in order to protect yourself from rubbing against the coral. Wear gloves and booties for warmth and also because your skin, softened by time underwater, is very sensitive to any abrasion.

Entry of a dive site that has a sandy bottom tends to have less visibility than a rocky bottom unless the sea has been perfectly calm for a number of days previously, due to the light sand grains being stirred up with the slightest disturbance.

To dive in this type of bottom, enter the water completely equipped except for your fins and drag your feet as you walk to protect yourself from certain kinds of sea life that live in the sand and defend themselves by stinging when stepped on. When the water is waist high, put on your fins and begin to swim. This is one of the most uncomfortable types of diving, due to the fact that the slightest disturbance lifts a silt cloud and decreases visibility dramatically. In addition, it is important to maintain perfect buoyancy control to keep yourself off the bottom and not cause sediment to be kicked up by the movement of your fins.



Different coral bottoms

Sandy bottom

7.1.6. - NAVIGATION

The use of a compass in navigation is taught more in-depth in the ACUC Advanced Diver Program. As well, the specialty program on Underwater Navigation will take you into great detail on how to use a compass. The objective of this section is to introduce you to methods of using your surroundings for navigating underwater.

Obviously, if you are diving from shore, the slope will indicate to you which direction to travel in order to bring you back to the surface. In addition, your exhausted bubbles always give the surface direction. In shallower waters, wave action will cause a sandy bottom to develop contours running parallel to the shore. You can follow these to get back to your entry point.

When diving from a boat, pay attention to which way the currents are travelling in relation to where you entered. Always swim into the current at the beginning of your dive when you are fresh and have lots of air so that the return will be easy. In addition, always take a look at your surroundings.

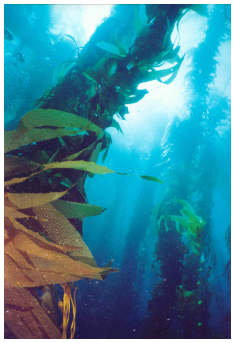
7. The marine environment (continued)

A familiar rock, piece of coral, or other object will help you to locate your entry point or the direction to travel underwater. Look behind you every once in a while so that you will be familiar with the topography on your return trip.

Before you enter the water, pay attention to the prevailing winds so that when you surface later on, you will know which direction to look in order to find the vessel or land point.

Closer to the surface the plant life will sway back and forth with the surface wave action. Pay attention to their motion to give you a guide to the direction you want to go.

7.1.7. - MARINE LIFE



Kelp

Due to the extent of the topic, which also changes depending on the geographical location, the intent of this handbook is to cover only the basics of marine life. Divers are encouraged to increase their knowledge of the marine life in the area or zone they will be diving in. Check with your Instructor regarding an ACUC Biology course for your area.

Kelp: An example of the different styles of diving in certain areas is diving in kelp. These are marine forests whose foliage come up from the bottom to the surface and can entangle your equipment making it more difficult to return to the surface. In this type of water, always submerge feet first taking care that you do not allow your hoses (octopus, pressure gauge etc.) to hang free and get entangled in the kelp.

Coral

Coral: In tropical waters you will find an abundance of coral, which are living growths. Coral are very delicate and it is very easy to ruin its development. They are animals and live by capturing the nutritional particles from the water. These particles (phytoplankton) tend to be found near the surface where the sun's rays permit their growth.

Phytoplankton

There are a vast number of types grouped under the "coral" denomination, but they all get their nourishment by the same methods. The most common are the Fan Corals, which look like a fan; the various colours of the Stag and Elkhorn Corals, which look exactly like a deer or elk colours and Brain Corals, called so because they look exactly like a human brain.

A type of soft coral

Some types possess cells on their outer surface that are transferred on contact to the unwise diver producing inflammation, swelling and strong burning sensations which can last for many days. The most common is Fire Coral that form large fans, generally found close to the surface and appear clear brown in colour with whitish extremities. Contact with a branch of fire coral can be extremely dangerous, depending on the location of the affected area and you should be extremely careful when diving in locations where this coral is common. The use of protective suits, including gloves and booties is very advisable.

Elkhorn coral

In some areas, usually in tropical waters, live certain types of Jellyfish that look like small plants but are really living animal colonies. Some of these kinds can be strongly poisonous, producing small size blisters whose healing can take weeks.

The treatment for contact with fire coral is to wash the affected area with seawater and soap followed by covering with a bandage to prevent infection.

7. The marine environment (continued)

An antihistamine taken internally or put directly on the wound is advised.

Sea Urchins: Are found in all salt-water areas of the earth, some of them are visible during the day while others hide in hollows on the bottom. These animals travel on the bottom in search of algae to feed on. They are covered with spines for protection from other animals. These spines are very fragile and break when they come in contact with the diver's skin. Depending on the type of Urchin, these spines can produce a simple splinter or a burning inflammation and have been known to cause a cardiac arrhythmia.

A type of hard coral known as Brain coral

To be protected from sea urchins you must be aware of their presence and wear protective clothing. Most of the sea urchin spines can pass right through a wet suit so it is very important to control your buoyancy in order to stay off the bottom where sea urchins live.

Fire coral

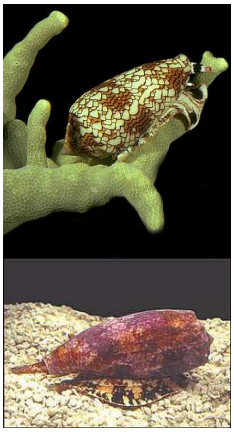
Treatment includes extraction of the prongs, normally a long and painful procedure, to control the infection. In cases where there is a great quantity of prongs it is advisable to consult with a physician.

Sea urchins

Cone Shells: There are many kinds of Cone Shells in all salt-water areas of the world. Some of these Cone Shells produce very strong toxins that, in extreme cases, can cause death. If you must really pick up a cone (we recommend that you do not), always grab it at its widest part, never along its length. The opening is usually sharp and the animal that lives inside moves in and out through the opening to kill the small prey that it feeds on.

The effects of a sting can be from a mild burning sensation, through to numbing of the affected area, paralysis or comma. To avoid the risks, it is best not to touch live cones at all. If it is necessary to touch them, use the method described above. Warning! There are cones that can fire a sting a great a distance.

The treatment for cone stings is to apply hot compresses, analgesics and even, in severe cases, the application of a tourniquet. In this event, immediately transfer the victim to a hospital.



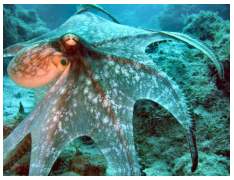
Cone shells: in the top image the "conus textile" and in the lower image the "conus geographus"

Jellyfish: They navigate by being carried along with the movements of the water. They have the appearance of umbrellas but they trail tentacles that can reach astonishing lengths. The body carries the toxins whose strength depends on the kind of Jellyfish. Those found in tropical waters are usually the most dangerous. Contact with the tentacles will produce symptoms from a mild irritation to sores and swelling in more severe cases. Should you come into contact with a jellyfish, the first thing to do is to try to remove all the remains of the tentacles that are sticking to your skin. Use salt water and sand applied using a towel so that the poison from the tentacles does not get on your bare hands. Apply ammonia, diluted in water, and antihistamine ointments. If strong analgesics are required take the victim to the nearest physician. To avoid this problem, always wear protective suits and pay attention to your surroundings especially while ascending.

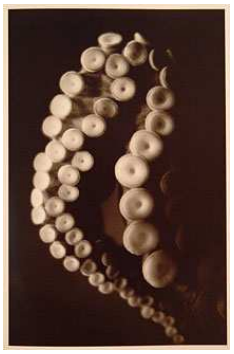
Jellyfish

Octopi: Are of the same family as squid. These creatures are very shy and will quickly hide if they see or feel the presence of a diver. They have the ability to change colour to match their surroundings. Octopus also come in various sizes and can grow to be quite large.

7. The marine environment (continued)



Octopus



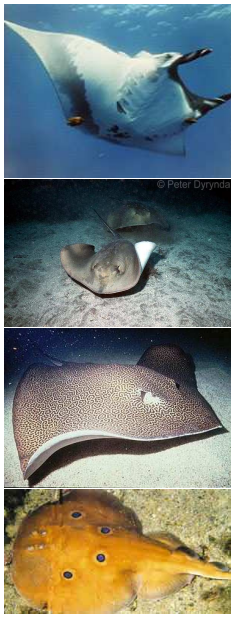
Octopus' tentacles

Except for the tropical octopus with blue rings that is found in waters off the coast of Australia, these creatures are completely harmless. However, their mouths, which are in the shape of a parrot's beak and found on the underbelly, in the middle of the tentacles, can give the diver a nasty bite. This normally would only happen if you annoy him unnecessarily. Should you suffer from a bite, it would usually be small in nature and non-life threatening. However, due to the octopus' feeding habits, it is important that you disinfect the bite thoroughly to avoid infections.

The best way to avoid a bite is not to annoy them by attempting to separate them from the rock or piece of coral they are hanging on to. It is not normal for an Octopus to abandon its hiding place and attack a diver. Squids tend to be more aggressive than the octopus.

Rays: Are a group of fish that normally live near the bottom and feed on algae found there. The manta rays are harmless while the Leopard and Sting Rays have a stinger (sometimes two) found on their tail, which is used as a whip to hit an aggressor when stepped on. Others can give small electric shocks.

To avoid this type of injury, it is best to drag your fins along the bottom when walking in the sand in the ocean in order to warn the fish of your presence. These fish lay buried in the sand and by dragging your feet, you give them a chance to move away, which they will normally do.



Different types of rays. From top to bottom: Manta; Sting; Leopard and Electric

The main problem with injuries produced by the sting of rays is that the stinger tends to break and stay in the wound. These stingers contain a toxic mucous membrane and injuries require a great deal of cleaning by qualified personnel. Sometimes, stitches are required after the stinger has been extracted and the area has been cleaned and disinfected. It is wise to also get a tetanus shot.

Electric Eels: Produce an electrical shock to stun their victims. The intensity of the shock depends on the size of the eel and also the length of time that has elapsed since the eel sent out its previous shock. In other words, it takes time for the eel to build up a strong charge. Once again it is recommended that you refrain from annoying these fish. If you leave them alone, they will leave you alone. They are not normally aggressive in nature.

Snakes: Some snakes have adapted to aquatic life and are usually found in tropical waters. They are almost unheard of in temperate or cold water. Their bite is dangerous since their fangs hold a toxic poison similar to snakes that live on land. The danger to a diver is reduced since their mouths are generally small with short fangs, which do not allow them to bite over a wide area or through a protective suit. However, some water snake bites are very toxic and sometimes fatal. Therefore, extreme caution should be used when diving where snakes are known to be.

Sea snake

The effects begin with general discomfort, followed by anxiety or states of euphoria, muscular spasms, respiratory problems, convulsions and shock.

Treatment includes the use of a tourniquet above the injury to stop the spread of the poison, anti snakebite serum, anticonvulsives and immediate transfer to medical attention.

Remember that they are in their habitat and we are the intruders. Avoid contact with or annoying them so that you do not have problems with them.

7. The marine environment (continued)

Scorpionfish: These are very common and are found in just about every salt-water area of the world. Their main characteristic is their dorsal fin, which is made up of hollow spines that inject poison into the victims they come in contact with. The strength of their poison depends on the temperature of the surrounding water. Those who live in tropical waters are more poisonous than those who live in cooler water.

Scorpion fish

The most poisonous of the scorpion fish family is the stone fish that lives in tropical waters. These fish live on the bottom and look like a stone. They are very difficult to see since they do not move and blend in with their surrounding. Their method of hunting is to stay very still until their prey pass by, at which point they dart out, grab and eat their victims.

Lion fish

To avoid stings from these fish, it is important that you maintain neutral buoyancy to stay off the bottom. When you touch rocks on the bottom pay very close attention where you place your hands.

The treatment for a diver who has been stung by a Scorpion Fish is to put a tourniquet above the sting to stop the spread of the poison and allow the area to bleed to wash out any poisons. Apply hot water compresses (as hot as the person can stand) to the injury. These poisons are protein in nature and are destroyed by heat. Seek medical attention as soon as possible.

Stone fish

Eels: These fish have a serpent like appearance and stay in crevices and holes in the rocks and coral by day and come out at night to hunt. When diving, they are normally found looking out from the mouth of the cave or crevice they live in. Since their method of breathing is through their mouths, they look very menacing but the truth is that they are not aggressive unless they are annoyed.

Morey eel

Naturally, if you stick your hand in their mouth or into their living quarters it is very probable that they will bite you as a defensive move. The obvious advice is not to put your hand in his house or make any moves that the eel would consider a threat and he will leave you alone. Although Morey eels are most abundant in tropical waters, they are found in almost all waters.

Conger eel

Lamprey Eels are found in fresh water and many other types such as the striped eel, wolf eel and the green eel are found in the oceans and seas. Their bite tends to be rather large in nature. Their teeth are angled towards the back of their mouths and this causes the skin to be torn as the injury is pulled away from the eel. This leads to lots of bleeding and the victim can go into shock. The injury is easily infected if not tended to quickly due to the amount of food residue found in between the teeth of the eel. Conger Eels can be more dangerous due to the fact that when they bite, they wrap themselves around their prey to hold on to it.

The treatment is to try to contain the bleeding, suture if necessary, treat for shock, and treat for infection.

Barracudas: There are several kinds of barracuda that live in the seas, ranging in size from the small barracuda found in the Mediterranean, to the Great Barracuda that live in tropical waters. Certain kinds travel in large groups but the great barracuda live and hunt alone. These animals are very curious and will come close to you to look you over but when attacking they will come from a further distance and at a very fast speed.

Barracuda

7. The marine environment (continued)

Detail of a barracuda's mouth

Most known attacks have occurred in murky water where the diver has been spear fishing and is trailing fish or wearing brilliant objects which attract the barracuda.

Barracuda bites tend to be serious because they are usually large and can cause massive bleeding. The treatment is to try to stop the bleeding and get the victim to a hospital. The victims usually require sutures, tetanus shots and antibiotics.

Group of Barracudas

To avoid attacks from barracuda, it is important not to annoy them, drag speared fish behind you or wear shiny objects (bracelets, neck chains, etc.) that could attract their attention. The great barracuda shows that it is agitated when its grey spots along the sides turn darker, almost black. If you should see this happening, you are best to move away from the barracuda but keep your eyes on it until the spots return to their normal colour.

Orcas

Orcas: These mammals live in herds and prefer cold water. Although many of them have been captured and trained by Aquariums for people's enjoyment, they are feared in the sea, even by great white sharks. Their exaggerated name is "Killer Whales" but they are usually quite harmless. However, some assaults have been recorded. Due to their great size and power, bites from orcas tend to be very serious. The size and diameter of the bite is large and the strength of their jaw causes massive crushing to the bitten area producing extensive bleeding, shock and death. Should you find yourself in the water with these animals it is best to slowly get out of the water and not make any moves that the orca could interpret as a threat.

White shark

Sharks: Much has been written and spoken about these large predators of the sea, most of it being the fruit of a vivid imagination rather than experience. More than 250 kinds of shark are in existence, but assaults have been documented from only seven kinds: the great white, mako, hammerhead, tiger, bull; white tip, and the blue tip. In some areas, it has been reported that lemon sharks have attacked but this data has not been confirmed.

Hammerhead shark

Sharks are large predators who scavenge food from wherever they find it. Often garbage bags with empty cans and bottles are found in the stomachs of tiger sharks, which causes them to be known as the great sanitation workers of the deep. They tend to follow large ships knowing that garbage is thrown off the stern of these ships. Sharks are unpredictable and you can never be guaranteed that a shark that is listed as harmless will not attack. The animal can become excited for any number of reasons and this will change their behaviour. The grey reef shark, for example is basically harmless, but, if there is food or blood in the water, this can produce a 'feeding frenzy' that would make it very dangerous to be in the water near them.

Blue shark

Normally a shark will pass by a diver a few times out of curiosity. If, however, the shark makes a few more passes, this demonstrates that his interest has gone beyond curiosity and the diver is at greater risk of being attacked. At this point the diver is best to get out of the area.

Sharks have very keen senses of smell and vibration. They are capable of detecting small quantities of blood in the water and can feel the vibrations of wounded fish from a great distance. They are very territorial in nature and when they see or sense a diver they consider him to be a potential competitor for food in their territory. Due to the size of the diver, the shark may make menacing moves to warn the diver that he is annoyed.

7. The marine environment (continued)

At this point, it is best for the diver to vacate the area slowly while keeping an eye on the shark. Probably the shark will see that you are leaving and be satisfied. The usual standards of conduct if you find yourself in the presence of a shark are:

- Avoid contact
- Do not carry dead or wounded fish
- Don't throw garbage on the surface
- Never turn your back on a shark
- Slowly and quietly get out of the water.

Never attack or annoy a shark and above all never be guaranteed that a shark, even though it is considered harmless, will never attack. Remember: "sharks can't read", so they don't know they are considered harmless.

Shark bites are usually large with a great loss of flesh which will produce shock and in many cases death. The treatment for a shark bite is to try and control the bleeding and get the victim to medical attention as quickly as possible.

7.1.8. - INTERESTING CONSIDERATIONS

Although this topic is beyond the objective of this manual, we will mention some of the dangers from eating certain kinds of marine life.

Ciguatera: This is a poison produced by larger carnivores such as barracuda and red snappers eating poisonous smaller fish (puffers, porcupine, some rays, eels, etc). These small vegetarian fish eat toxic algae, which on their own are not particularly hazardous to humans, but when eaten in large quantities by the larger fish, their cumulative effect can be harmful. Given the cumulative character of the ciguatoxins, these toxins build up in the stomach of these fish and, if not cleaned immediately after catching, these poisons can filter through the meat of the fish especially if the fish is allowed to stay in the sun more than two hours. Should this poisoning occur, induce vomiting and get the victim to medical attention as soon as possible.

Red Tide Organism: In the summer months (May to September), in some areas there are often "invasions" of plankton that is reddish in colour and contains "dinoflagellates", which are hazardous to man. Since this plankton is the principle food for many bivalve molluscs (mussels, clams, oysters etc.), these animals become poisonous and should not be eaten. Normally the authorities communicate the appearance of the red tide, so that fishermen abstain from collecting these kinds that have accumulated the plankton toxin. Therefore it is rare for this type of poisoning to occur. Should it occur, however, induce vomiting and seek medical attention as soon as possible.

7.1.9. - INTERACTION WITH MARINE LIFE

The best way to enjoy marine life that you know nothing about is not to touch it. If you must touch it, you should take maximum care to avoid injuring any of the animal life. Defence mechanisms in the marine environment include speed, camouflage, spines, thorns, teeth and poison. Most of the ones that appear touchable have some form of defence mechanisms. As a general rule, look at them, photograph them, but do not touch them. We represent more of a danger to marine life than they are to us. By complying with the do not touch rule, we are protecting and preserving the marine environment for all.

The greatest injury risk is usually from accidentally bumping into something, or stepping on something with thorns, spines or sharpened extremities. Most diving accidents are the fault of the divers and not the environment.

7. The marine environment (continued)

7.2. - MARINE CONSERVATION

7.2.1. - WRECKS

Plane wreck

Every sunken wreck found has its own personality and has historic value that should be preserved. If it is an old wreck it may be the only way for archaeologists to study past forms and habits of life. Newer wrecks should be preserved, if not for historic value, then for the enjoyment of other divers. Isn't it better to travel across a deck or in a hold full of equipment, boxes, tools, cars etc. than to look at empty spaces where something once was?

Ship wreck

Let's look at the practical aspects of taking objects from wrecks. Any object removed from the water environment is going to deteriorate quickly when it comes in contact with air. Wood, metals, etc. decompose very quickly unless they are properly cleaned and treated. As responsible divers, it is important that we promote and encourage our diving partners to preserve wrecks in the condition we found them. It is better **to take only pictures and memories and leave only bubbles** so that those who dive on the wreck after you can enjoy it as much as you did. It can be a laudable objective to attempt to repair wrecks, though normally this is very difficult. The additional damage caused by unconcerned divers taking artefacts from wrecks makes it very difficult to return the wreck to its original state.

7.2.2. - FISH AND CONSERVATION

Usually there are government regulations that control fishing and seafood harvesting. It is important that you respect these regulations so that the fish populations will remain with us.

Remember, anything you take from the sea is no longer going to be there. Once the fish life is all gone, so is the pleasure of watching these animals in their habitat. A lot of the fish taken from the sea winds up in the garbage because it smells wrong or you don't know what to do with it. Therefore it is important to remember the phrase: "Take only pictures - Leave only bubbles" and apply this to your dives so that our children will be able to enjoy what you have seen when they begin diving.
If you don't, they will have to find another enjoyable activity since there will be nothing left to see underwater.

It is a must for all divers, not just the ACUC divers, to report to the appropriate authorities any illegal action on the part of wreck strippers or underwater fishermen hunting illegally (for example, in most countries, spear fishing with scuba cylinders is illegal). The usual excuse used by these hunters is "commercial fishing ships make much more damage than I do". That may be true but each one of us must do what we can to protect our marine environment because, if we don't, who will???

Press on this bar to go to the next chapter

THE FRESHWATER ENVIRONMENT

8

LESSON OBJECTIVES

At the end of this chapter the student will be able to:

- Name five different types of diving in freshwater
- Describe two frequent differences a diver will encounter when diving in freshwater.
- Explain why a diver needs to weight himself differently in freshwater than in saltwater.
- Name one of the things that can attract a diver to dive in rivers.
- Name the two ACUC specialties that serve as references to a diver interested in cave diving.
- Name the fish frequently called “freshwater barracuda”.
- Name four types of fish that are found in freshwater.
- Name the group of lakes that contain 18% of the world’s freshwater.
- Name three types of reptiles that are found while diving in freshwater.
- Name two mammals seen while diving in freshwater.

8.1. - FRESHWATER

Quite often, diving is only associated with diving in saltwater. However, there are a large number of divers who, either by circumstance or preference, dive regularly in freshwater. Ocean divers can handle diving in lakes, quarries or rivers with little adaptation. However, diving in rapids, exploring wrecks that are almost intact or diving in whole villages that have been submerged in a quarry requires different skills. Each type of diving environment has its own challenges and excitement, and with the proper equipment, training and adequate preparation, a qualified diver can enjoy diving anywhere.

8.2. - LOCATIONS

Freshwater offers a great variety of places to dive. There are lakes, rivers, quarries, caves, springs and even swamps. In reality, any place where there is water and a little depth is a potential dive site for avid divers. These locations offer the lucky diver exciting opportunities to explore, collect and photograph. Although the training is basically the same, freshwater divers must usually adapt to colder water, limited visibility and other potential dangers that are not found as often in oceans.

Diving in caves, caverns, under the ice and on wrecks (called confined space diving), requires an additional quantity of training hours and a degree of aptitude that is not required when diving in oceans.

While diving in freshwater lacks the variety of coral, fish life and great visibility, there are many types of fish and marine life growing and living in freshwater. Any place to dive, whether it is an ocean, lake, river, or quarry, deserves your attention and appraisal.

8.2.1. - LAKES

Lakes are the main places to dive in inland waters, with sizes ranging from a few acres to the Great Lakes in Canada and the United States. In fact, the Great Lakes contain 18% of the freshwater in the world. In addition to natural lakes, there are many artificial lakes of various sizes already existing or are being created the world over. Changing the natural flow of rivers generally creates these lakes or dams.

8. The freshwater environment (continued)

A lake

When these artificial lakes are formed, totally new ecosystems are created. The diver who explores these dammed lakes can be witness to the differences in bottom culture versus natural lakes. The diving activities in new artificial lakes are generally limited to exploration and photography. Newer artificial lakes do not contain many man-made objects and also they have not established populations of aquatic life. They can, however, contain newer things such as lost boats, motors and fishing tackle. Diving to recover these "treasures" is not only thrilling, but can also be fun.

Natural lakes, on the other hand, offer the greater potential for diving. They are generally clean and depending on the location, they can be filled with old artefacts. With the constant interest in collecting old objects, it is difficult to find a better place for the search than natural lakes. The first inhabitants used these, and practically all water surfaces, as the method of travel. These areas can be explored by recreational divers who seek a combination of their love for the diving activity with an interest in the historical value of artefacts.

Since freshwater does not affect metals like salt water does, most of the recovered articles are in very good condition. It is recommended, however, that you understand any local, provincial or state laws regarding the recovery of sunken objects so that you can enjoy this activity without fear of breaking the law.

In some countries, most of the lakes are geographically located at sea level so they would not qualify as altitude diving. It is important that you not attempt a dive at altitude if you have not been properly trained, especially in the use of altitude tables.

In the case of wrecks, it is the moral duty (and in all probability, law) of each diver not to damage the wrecks, remove artefacts or damage them in any way. Leave them as you found them so that other divers can enjoy them. In areas where railway tracks pass over or run beside lakes, treasures abound. Conductors used these lakes to hide their garbage as the trains were passing by. You will find all kinds of things like old bottles, plates, silverware, etc. In addition, there will be objects left behind by the construction crews while they were building the bridges or laying the tracks. There may even be the odd train from a collapsed bridge in years past hiding there.

The Great Lakes are the burial ground for some of the largest steam ships ever built. Ocean freighters have been travelling on the Great Lakes since the end of the nineteenth century. Storms, collisions with other ships, and groundings have caused countless wrecks, both wood and steel, which are lying on the bottom waiting for divers to explore them.

8.2.2. - RIVERS

Diving in rivers can be a thrill. Similar to lakes, rivers were the mode of transportation during the days of exploration.

A river

Trading goods were moved inland by way of the river systems. These rivers contain vast amounts of archaeological treasure just waiting to be found. While most rivers are not sufficiently deep or clear enough to justify a dive, many offer to the qualified diver a potential thrill. Underwater photography, the recovery of objects and searching for gold are only some of the many possibilities. For the enthusiastic, adventurous diver, searching for gold is a thrilling activity and potentially rewarding.

8. The freshwater environment (continued)

This activity is often found in the remote areas of Alaska, the Rocky Mountains and in California. This requires a physical and economic commitment level that is not found in other areas of diving.

8.2.3. - QUARRIES

Quarries are small bodies of water formed artificially by industries extracting minerals. At some point a lot of these operations hit an underground stream, which caused the quarry to rapidly fill with water. These quarries now contain some of the equipment used for mining when the quarry was abandoned, such as cranes, crushing machines, conveyors, trucks, and even there is one that contains the track and a complete train. Many quarries contain objects that have been put there on purpose for the interest of the diver. Anything from buses, planes, cars, and boats can be found in quarries.

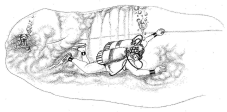
A lot of water in quarries arrived there from underground streams and is usually quite clear offering good visibility most of the year. As the quarry ages and vegetation begins to grow, at certain times of the year the algae cause the visibility to decrease by varying degrees. The less plant life there is, the more visibility you have.

Some quarries contain sand and fine sediment that lies on the bottom and is easily stirred up by fin kicks. Many quarries have an abundance of marine life, which is exciting for photographers. Some rock quarries contain fossils imbedded in the rocks.

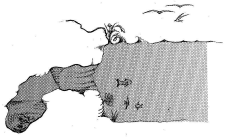
One of the things to remember about freshwater lakes and rivers is that land animals depend on these waters for drinking purposes. Some of these land animals also depend on the fish and other marine animals for food. The observant diver may catch a glimpse of these wild animals while diving particularly in dry regions where water is not in great supply.

8.2.4. - NATURAL CAVES

Natural caves are normally found above water, and Spelunkers are the persons who explore them. Sometimes caves penetrate into the water and depending on the headroom available, this may block further exploration of the cave. It would seem appropriate that the spelunker consider training in cave diving in order to continue exploration of the cave. The great majority of diving activity in caves is done in systems that do not have tunnels that wander any great distance away from the entrance. Cave diving requires additional training and equipment than that required for normal diving. No level of open water diver training - including instructor training - is sufficient to prepare divers to safely enter water filled caves and caverns. For those who are interested in cave and cavern diving, ACUC has two specialty programs specifically designed to educate the diver. These are Cavern Diving and Cave Diving.



Cave diving



Example of an inundated cave

8.2.5. - SIPHONS AND SPRINGS

Siphons and springs can be very deep and can be attached to cave systems. As all potentially confined environments, siphons and springs can be quite dangerous and require a great amount of training and special equipment.

Example of a siphon

8. The freshwater environment (continued)

Due to exceptional water clarity and relatively warm temperature, (about 23º C), these areas are frequently visited by divers and offer excellent opportunities for photography.

Numerous siphons and springs in Florida contain bones of prehistoric animals and other artefacts that are now gone from the region, such as shark teeth. Any objects that could have a regional or national historical importance must be registered with the local authorities. Some places require permits to search for these objects within the limits of the spring. In some areas, there are hot water springs with a high percentage of minerals. Some have waters with a temperature of more than 38ºC.

8.2.6. - MINES

Abandoned mines can offer exciting dives and the water is often very clear. Many contain relics from when the mine was being operated. Due to high mineral content, there may not be any vegetation or fish. Mines are generally deep and the main shaft, at the beginning of the mine, is usually straight vertical. As with diving in other confined spaces, it is not considered a normal open water dive. It can, however, be a thrilling dive for those divers trained and equipped for confined environments.

8.3. - COMMON FRESHWATER ANIMALS

Freshwater bodies do not have the immense variety of fish that are found in the seas. However, depending on the location and on the temperature of the water, a considerable variety of aquatic freshwater life can be found. In the freshwater environment many rare animals exist that are seldom, if ever, seen. This section is an introduction to some of the freshwater inhabitants that a diver can find.

A muskellunge

8.3.1. - FISH

Small members of the sunfish family are found virtually in all freshwater bodies. In some instances they represent most of the kinds of fish in shallow lakes, reservoirs, rivers and creeks. Similar to their ocean relatives - the damselfish - they are territorial in nature and can bite. Fortunately their small size eliminates any real danger. Due to their inquisitive nature, they make ideal subjects for underwater photographers. Large muskellunge in northern waters, especially in the United States and Canada are one of the more common fish of the world. Due to their canine teeth and their voracious appetite they are sometimes called freshwater barracuda. Shy by nature, muskellunge, similar to other large freshwater fish, are seldom seen underwater.

A frog

A triton

8.3.2. - AMPHIBIANS

Amphibians include frogs, tritons, and salamanders. Frogs and toads spend the majority of their lives in or near water. They often offer night song arrangements but are rarely seen. The enthusiastic photographer has to look very closely in shallow waters to see these amphibians, though there are approximately 70 different kinds. Salamanders, approximately 85 kinds, are also very hard to find.

A salamander

8. The freshwater environment (continued)

8.3.3. - REPTILES

Three of the four more important groups of reptiles are common in rivers, lakes and freshwater reservoirs - turtles, snakes and crocodilians. Crocodiles are the least common. Reptiles are the most dangerous creatures in the nutritional freshwater chain. All these can inflict serious injuries, even though most attacks are defensive rather than aggressive reactions to the presence of a diver.

A turtle

8.3.4. - MAMMALS

Freshwater mammals are few but the list includes manatees, otters and beavers. Encounters with any one of these three creatures underwater will be worth writing about in your log book. Of them, the manatee is the only non-human mammal that can be seen regularly by freshwater divers. Manatees are quite common in the freshwaters of Florida, especially in the winter months. These mammals and their habitats, are strictly protected. They are seen better while snorkelling because the noise of the regulator tends to scare them. Continuous efforts are being made to save to the manatee from extinction. These animals, like all of the inhabitants of the underwater world, deserve our understanding, appreciation and protection.

A beaver

A manatee

Press on this bar to go to the next chapter

ACUC

ECOLOGY

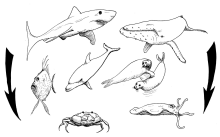
LESSON OBJECTIVES

At the end of this chapter the student will be able to:

- Explain the meaning of the life chain.
- Describe the meaning of the symbiotic relationship.
- Indicate the cause of some mutations of the marine life.
- Explain the environmental dangers caused by dredging and land filling.
- Indicate the two greatest causes of fuel spills.
- Describe the impact on the ecosystem of the current commercial fishing practices.
- Indicate the most important attitude of diving that will limit accidental damage to the environment by recreational divers.
- Describe the environmental risk that continues by dumping.
- Explain the consequences and ecological damage caused by acid rain.
- Recognize the “Red Tide” and know what to do if these algae are found.

9.1. - SOURCES OF PROBLEMS

The balance of nature is, in reality, a magnificent simple thing. In nature a life chain exists where plants and animals supply either food or protection to each other in order to live. Each creature, to live, must eat. If we in some way eliminate its source of food, the creature will die.



Life’s chain

Sometimes, the balance of nature alters itself. Where optimum growth conditions exist, the population of most kinds can increase in huge proportions, beyond what is considered normal. When that occurs, nature tends to balance itself. When the population grows, the need for food is greater. When the availability of food reaches its limit, the population decreases until a balance is achieved once again.

Symbiotic relationship between a shark and a remora

If it is not disturbed, nature establishes a system in which the strongest and better adapted to the environment survive. The weak are consumed and the survivors produce increasingly expert successive generations. This system improves constantly.

In all seas large and small creatures can be seen being helped by others. The small crabs help to maintain healthy coral by eliminating all the organic residues and consumables. The relationship between sharks and the remora is a good example of a fish, which in other circumstances would serve as food to the other, living peacefully with its potential predator. The remora cleans parasites and small organisms from the skin of the shark. Accomplishing this, it enjoys a source food for itself and it helps to look after the welfare of the shark.

Symbiotic Relationship between a crab and the coral

Some small cleaning fish, other fish, and some shrimps operate cleaning stations in the seas where large fish come to be cleaned of parasites from their skin. The large fish even let the small creatures enter their mouths to clean food from their teeth. The cleaners are remunerated by a constant source of food that they get from their "clients". These associations, where the two groups benefit from the relationship, are called symbiosis.

9. Ecology (continued)

Symbiotic Relationship between a shrimp and the anemone

Man, the great hunter, in an effort to provide a better life for himself, constantly alters the balance of nature. The harvesting of natural resources (animal, vegetable and mineral), the construction process, in and out of the water, and the dumping of waste, all alter the natural chain of life in some way. Nature has an incredible capacity to recover from the alterations and adapt to the changes. However, the magnitude and gravity of the pressures on the environment, in modern times, threatens to exceed the capacity of nature to adapt. The changes in air quality of the earth affect everyone in the chain of life on the entire planet.

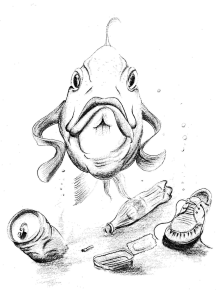
9.2. - COASTAL PROBLEMS

Liquid waste

9.2.1. - LIQUID WASTE AND GARBAGE

The dumping of liquids and garbage illegally into rivers or the seas kills much of the local marine life. The survivors develop a variety of diseases, and eventually develop a high degree of mutations. These affected creatures are not fit for human consumption and are no good either, for food for the other members of the nutritional chain.

Healthy fish that eat sick fish also are affected. The marine life reduced by pollution affects some, but not all, of the total biomass, so that some species increase enormously, free from competitors in the struggle for existence.



Pollution endangers and causes mutations in several types of marine life

Pollution, in all its forms, affects not only the fish that live in the water, but also those who live around water and those who live from the water. The high levels of nutrients provided by pollution have been associated with the “red tide”, a high algae growth that damages molluscs, which feed by filtering their food, such as oysters, and become toxic.

Solid waste dumped into the sea by municipalities or by ships that sail on the waters along the coasts, contaminates the beaches, in spite of being far from where they dumped it. Solid waste also affects potential recreational activities (swimming, diving, fishing and sailing) on beautiful beaches, coasts and otherwise crystalline waters for everyone. Many countries have very liberal laws with respect to the treatment of wastewaters.

In some areas, raw sewage is allowed to be poured without treatment into rivers or on beaches. Bathers who come in contact with this type of pollution run a great risk of contracting many diseases, including dysentery, hepatitis, salmonella, typhoid fever, etc, especially among elders and children.

9.2.2. - CONSTRUCTION

Dredging, filling in water with land, and construction along the coast as a rule, increases property values, but usually lowers the quality of life for animals who live in the water and tends to disturb or destroy the normal nutritional cycle.

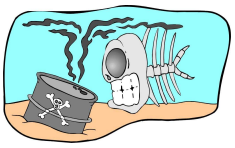
Especially vulnerable are the fragile coral reefs and river mouths, since the two act as the breeding-grounds of the sea. The sediments, caused by dredging and construction, are deposited on the reefs and in the river mouths, killing the coral and many kinds of small plant life.

The deaths of coral and of the creatures associated with shallow waters, can irreparably disturb the chain of life. The ramifications can negatively affect not only the animals of the area, but the whole marine community.

9. Ecology (continued)

9.3. - INDUSTRY

9.3.1. - WASTE CHEMICALS



Chemical waste dumping effects

Industrial chemical dumping causes, more or less, the same results as wastewater. It kills the marine life and causes deformations and diseases.

In freshwater, industrial waste can contaminate underground streams and cause a decrease in the quality of our drinking water. In the southeast of the United States, huge underground natural rivers transport hundreds of million of litres of freshwater each day.

Pollution of those underground streams by dumping pits, or the torrents of uncontrolled storm water, can seriously reduce the quality of drinking water for a large part of the population of the area.

Consequences of oil dumping

Concerned groups are currently helping to develop ways to control the legal dumping of industrial wastes and pollution, caused from agricultural waste containing pesticides and herbicides, running into storm drains. Fortunately, the Ministries for the Protection of the Environment in many countries have strict laws and make industries comply with regulations by giving out heavy fines to those who break the law. A constant alertness has to be maintained to avoid uncontrolled and illegal dumping in order to protect the quality of one of our most valuable resources: freshwater.

9.3.2. - CONTAMINATION BY BLACK TIDE

Oil has caused much damage to some coastal areas affecting its beauty, recreational activities and marine life. Land animals, which depend on the sea to live, have also suffered.

Natural filtration of oil over millions of years has integrated effectively with the sea. However, with the depletion of our natural reserves of oil on land, man has gone into the seas to draw from its wealth and resources. If you consider the amount of oil beneath the sea and the quantity of oil transported by sea, the potential to spill more oil than the sea can handle is meaningful.

Contamination by black tide

Due to the thirst of the world for oil, there are three principal sources of oil pollution. The main source comes from the accidental spills by oil super tankers that navigate on the seas of the entire world. The others occur while unloading the oil and by collision or grounding at sea. Another source of oil pollution is intentional. Oil tankers transport roughly two billion tons of oil each year; this oil is transported in large compartments. Seawater is then used as ballast on the return trip to clean the tanks. At the end of the trip, the seawater, together with its oil residues, is dumped back into the sea, while mineral oil, relatively clean, stays in the tank and is used over again.

The oil industry has guessed that 5 million tons of oil is poured into the sea in this way each year, and scientists believe that this ballast pumping causes the black tides we hear about so often. This dumping is legal, though tragic from an ecological point of view.

Oil dumping directly into the sea

The other source of oil pollution is from fuel lying abandoned in sunken ships. An estimate is that over 800 million litres of oil lies in 60 sunken ships off the coast of Europe alone!!

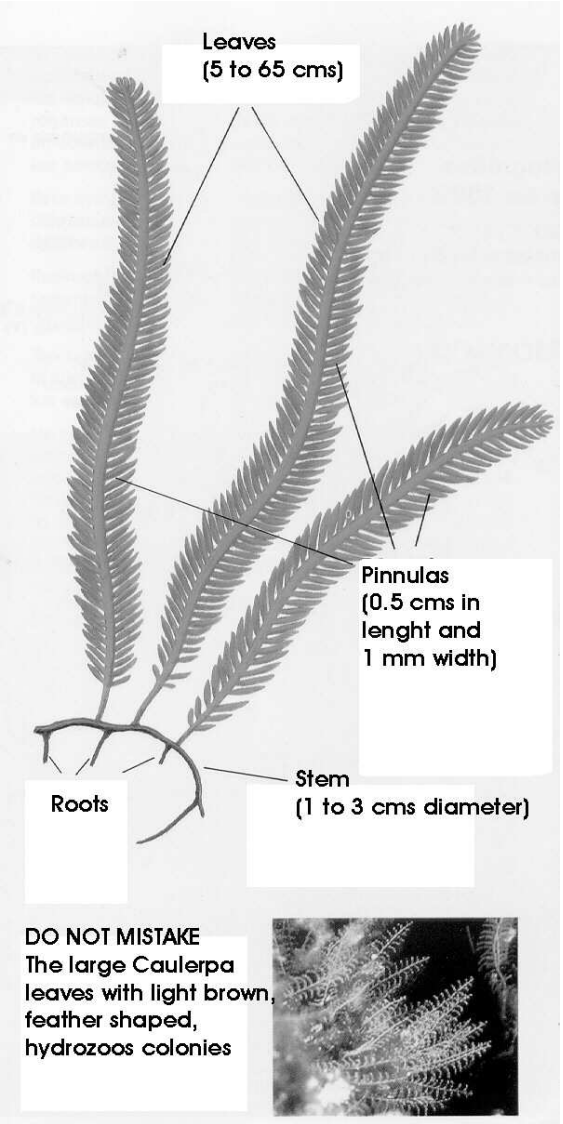
9. Ecology (continued)

9.3.3. - CAULERPA TAXIFOLIA

Caulerpa Taxifolia

The Caulerpa Taxifolia is a tropical alga that was introduced accidentally in 1984 in the waters of Monaco. This alga has spread to most Mediterranean coasts. In the Mediterranean, this alga lives between the surface and 350 feet (106 metres) depth, in any type of marine bottom and lives off port pollution. It rejuvenates itself naturally, by normal growth, by breaking up or by seeds, or by the actions of man (algae pieces fixed to anchors, fishermen nets, etc). No place is out of danger.

Fish and marine invertebrates living in the waters do not consume this alga and therefore, if it continues at its current pace, will affect coastal food chains. To evaluate the impact of this alga and to plan its eradication, it is necessary to know the amount of the invasion and the speed of its spread. For this reason, it is very important that we, as divers, know what to do, and what not to do, if we see these algae.



The Caulerpa Taxifolia

9. Ecology (continued)

The algae is a brilliant green colour, has a shaft that can measure more than three feet (one metre) long and have a diameter of 1/5 to 1 ¼ inch (1 to 3 centimetres). On this shaft are found some leaves, similar to the leaves of some coniferous trees. The leaves tend to measure between 2 to 26 inches (5 to 65 cm) in height and they can be branching.

If found, make an accurate note of the place where it was observed and get in touch with a local Club, Dive Centre, Marine Authorities or contact your local ACUC Instructor, who will contact the local authorities. You can also contact an ACUC Office near you.

Do not throw the fragments back in the water. This would only help the algae to expand. Do not attempt to destroy it, since this is a delicate operation and it must be done under controlled conditions.

Also, it is important to watch for signs of algae when the anchor is being removed from the water. If it is found, be careful that you do not allow any of the pieces to fall back in the water. Put the pieces in a plastic bag and contact any of the places mentioned before.

9.3.4. - COMMERCIAL FISHING

Pollution, accidental or intentional, is not the only factor contributing to the reduction of some populations of fish. Commercial fishing is the cause of as much, if not more, shortage of fish life. In the last few years, sophisticated electronic equipment and satellite photographs, have improved the techniques for finding fish for ships with gill nets or drag nets. New larger ships can process the fish as soon as they are caught, and they can fish and store much more fish than the fishermen might even have dreamed of, only a few years ago. Even with the current improved fishing techniques, during 1972 fishing ships in some areas only caught about 10% of the quantity collected in 1965. This trend continues at present, and if left unrestricted, many areas of the oceans are being emptied of their available resources.

Turtles and dolphins trapped by industrial fishing nets

The modern techniques that commercial fishing currently uses, has also caused the accidental death of some kinds of fish not destined for human consumption. Dolphins, marine tortoises and other creatures of this type, are sometimes sacrificed in attempts at more effective ways of fishing.

Currently, concerned groups are helping to develope technical and sophisticated equipment to help reduce the number of losses of these creatures, while maintaining, in spite of it all, an optimum productivity level.

Some types of aquiculture are practical, but not all kinds can be controlled. As a consequence, fishermen should be careful to not exhaust the fish supply beyond its natural recovery capacity. The seas currently provide only a small percentage of animal protein used in the world. As the demand increases, conservation methods will have to be used by fishermen of the entire world. Remember that, because of depth, only a tenth of the ocean is actually fertile. The rest is virtually sterile.

9.4. - RECREATIONAL DIVING

The threat to the oceans by recreational divers is minimal. But as the activity of recreational divers is usually done in the most productive zones of the world's oceans, the potential impact could be positive or negative. Recreational divers have the responsibility of observing and appreciating all aquatic life, and should not take anything just for the sake of taking it.

9. Ecology (continued)

The recreational diver should observe the underwater environment and avoid damaging it. Unfortunately some divers do damage it in a number of ways. Probably the most evident intentional damage, is the one constantly being done by collectors who take beautiful coral, dry it and sell it to others. Accidental damage is equally important. It usually results from divers who do not control their buoyancy and break and damage coral, when they swim over reefs.

Diver training needs to be strengthened in order to minimize its impact on the underwater environment. Try your utmost not to disturb the marine life. Do not take anything unless there is a very good reason. Remember that the coral reef takes millions of years to develop and only a few careless moments to destroy it.

Through the eyes of the diver, the underwater world is a place of magnificent beauty - very fragile in nature - full of exciting creatures. The world under the waves belongs to the marine life and we, humans, are only visitors. We should not leave any trace of our short time there. As said earlier: "**take only memories or photos/videos and leave only bubbles**".

9.5. - INLAND WATERS PROBLEMS

Industrial pollution

The problems in freshwater are very similar to those of the seas and include wastewaters, garbage and dumped industrial chemicals and, in addition, problems of water quality created by the wide use of pesticides. Chemical fertilizers from crops and waste from cattle farms, eventually find their way into reservoirs and lakes.

This drainage is creating a problem known as putrification. This is a process by which a great an amount of nutrients enter the water, and sometimes cause an explosive growth of vegetation. When these plants die, the rotting process absorbs the oxygen from the water and produces a lethal methane gas that kills animal life. If we do not stop the intentional or accidental runoff of these nutrients, the time will come when putrification will reach larger water surfaces and cause a larger decrease of life in freshwater than there is now.

Acid rain effects

Another problem that afflicts fresh waters in many countries is acid rain. Industrial smoke stacks emit substances that mix with water vapour in the atmosphere to form acid. The result of this is rain and snow with high acid levels that cause the creeks and lakes to turn acidic. The impact of acid rain is recognized by the decrease in life forms, which were common a short while ago in these same creeks and lakes. The most notable disappearance of life forms, which many biologists consider as the ecological barometers, are frogs and salamanders.

9.6. - SOLUTIONS

It would be fantastic if it were possible to make a list of the causes of pollution, and then, in the same way, to solve the problems. Unfortunately, it is not that easy. The solutions to the pollution problems are at least as complex as the problems. Ecologists are tragically conscious of the fact that a drastic action to eliminate what is evident would create, in reality, new problems that would be equally damaging, if not worse.

9. Ecology (continued)

9.7. - SUMMARY

A point to clearly emphasize between the confusing search for answers: Pollution is everyone's problem, and we all must participate to maintain pollution levels at a minimum to permit nature to absorb it. Until the day arrives in which solutions are found, a program of public awareness and active prevention must be maintained. We, the divers, are in a position to see the differences.

Our knowledge and direct experiences can be vital so that others, less lucky, may understand the nature of the problem. We must contribute to protect and improve the environment that means so much to all of us. We must continue to take an active part in the protection of the environment so that everyone can enjoy the lakes and oceans now and in the future.

Press on this bar to go to the next chapter

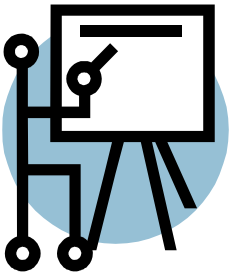
ACUC

FIRST AID

LESSON OBJECTIVES

At the end of this chapter the student will be able to:

- Develop methods of preventing accidents or incidents
- Define the difference between an incident and an accident
- List the basic first aid steps
- Know the symptoms of several physiological problems related to diving



Note: This chapter does not constitute a complete first aid program. Its only function is to give neophytes a basic knowledge to attend minor accidents. ACUC recommends that all its divers take first aid and rescue courses for scuba and to improve their knowledge. Also, some procedures mentioned here might be different in your country. Please check your country standards.

10.1. - ACCIDENT PREVENTION

A good adage says "its better to prevent that to cure" and this is a great truth, especially when talking about diving. It is much better to make plans to avoid circumstances that can provoke an accident, than to try to solve its effects when it happens.

10.1.1. - EATING AND DRINKING BEFORE DIVING

There are certain foods and drinks that you should avoid before diving: fatty foods, since decompression accidents are related to excess fats, gas producing foods, to avoid the appearance of stomach cramps, etc. A good pre-dive diet would include high calorie foods, such as sugars, which allow you to better handle water temperature decreases. Carbonated drinks should be avoided before and after the dive. It is preferable to drink fruit juices or simply water, but be sure to drink lots of fluids to keep good hydration to avoid decompression problems. Coffee, tea and other drinks of this type, should be avoided, since they are diuretics that tend to eliminate liquid from our circulatory system, increasing the risk of nitrogen build-up. Although we have spoken about this previously, it is very important to insist that you avoid alcohol and any type of drugs before and after diving, because there is a relation between alcohol and decompression sickness, and also, alcohol is a diuretic. When speaking of drugs, we include all medicines as a rule, unless their effects underwater are known.

10.1.2. - PRE-DIVE REVIEW

Another good way to avoid accidents is a complete and meticulous review of your own and your buddy's equipment, before going underwater. You should be sure that, in the event of an emergency, you know how your buddy's equipment operates, as well as your own. It can be very frustrating, for example, to attempt to inflate your buddy's jacket and not be able to find the inflator button. Planning: First plan the dive completely to avoid decompression, allowing a good safety margin. Check your buddy's equipment, paying special attention to where the weight belt is attached and how to open it, how to power and oral inflate your buddy's BC, location of his octopus regulator and how it functions, how to unfasten the different parts of his equipment, in case you have to remove some of it quickly. Just before the dive, review the hand signals that will be used on the dive. Even if this is your customary dive buddy, it is wise to review them occasionally.

10. First aid (continued)

Agree on emergency procedures, especially in the case of a lost buddy. In such a case, both have to attempt to locate their buddy, allowing for this attempt about 30 seconds. If unsuccessful, ascend a few yards (metres), attempting to locate his bubbles, staying there about 30 seconds more. If this fails, ascend directly to the surface. If both divers act the same pre-agreed way, there is no doubt that the problem will be solved in less than 2 minutes from the time the absence occurred. In a worst case, a proper search can be started quickly. The buddy team should decide what to do in the event of an out of air situation. They should have a plan laid out and, if possible, practice the procedure.

The Divemaster should have emergency procedures set out, with the numbers for the local Emergency Response Team and coins available for a telephone, if needed. The use of the dive plan by the divemaster will save time getting emergency help, thereby increasing the chances of a successful resolution. This information can be found in your ACUC Log Book.

You should also know the difference between an "accident" and an "incident". As a general rule an Accident is any situation that results in a physical injury, no matter how small, to a person. Depending on the nature on the injury, it is classed as minor or serious. An Incident is any situation that, though it is considered dangerous, there is no personal injury. Depending on the nature of the situation, it is classed as minor or serious. Next, the reader will find a handy table that can be used to increase safety and be prepared in case of emergencies

INFORMATION TABLE IN CASE OF EMERGENCY	
Name:	
Address:	
City / Province or State:	
Phone:	
Emergency contact:	
Address:	
Phone:	
City / Province or State:	
Doctor	Address: Phone:
Ambulance	Address: Phone:
Police	Address: Phone:
Hospital	Address: Phone:
Hyperbaric Chamber	Address: Phone:
Medical problems:	
Allergies:	
Special medication:	

10. First aid (continued)

10.2. - FIRST AID

10.2.1. - BASIC STEPS OF FIRST AID

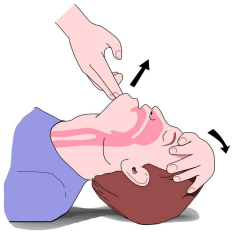
1. Maintain breathing
2. Control bleeding
3. Treat for shock
4. Prevent possible complications
5. Obtain medical assistance

10.2.2. - NON-BREATHING VICTIM

The causes of a respiratory arrest can be varied: drowning, obstructed airway, suffocation, drug reaction, electrocution or inhalation of toxic gases. The physiological affect will depend on the elapsed time since breathing stopped, since brain damage can be irreversible, if starved of oxygen for any length of time. The best method of artificial respiration is still mouth-to-mouth, through the mouth directly, or mouth to snorkel, depending on the circumstances. The principal advantage of this system is that it does not require special equipment. Resuscitation can begin immediately, even in the water, victim response is controlled at all times and finally, it is simple to do.

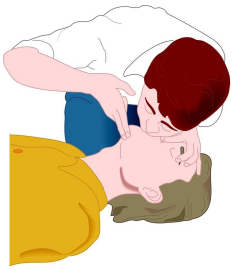
Checking for breathing

First ask someone to call for professional help (ambulance, etc). Then, determine that the victim is not breathing by holding your ear near the victim's nose and mouth and listen for sounds and or observe any rise or fall in the chest. If the victim is not breathing, begin by making sure that there are no obstructions in the airway, blocking the passage of air to the lungs. Gently grasp the chin of the victim and lift it upwards to hyperextend the neck, which guarantees that the tongue will not obstruct the air passage. Pinch the nose and hold it while opening the mouth wide. Take a deep breath, press your mouth firmly against the victim's mouth and exhale slowly into the victim's mouth. If you have a concern about disease transmission, use if available, a CPR mask or face shield. Repeat this quickly two to four times to be sure that oxygen has reached the alveoli before checking for an exhalation from the victim.



Avoiding obstructions

You can check that the air is getting into the lungs and they are deflating automatically, by feeling the exhalation against your cheek. If no breath is felt, it is a sign that the air is not getting into the lungs and is going either to the stomach, or being lost through the victim's nose (incorrect pinching of the nose). Check again for foreign objects in the air passage that is preventing the air from getting in. You can do a finger sweep of the mouth.

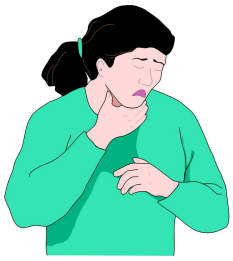


Mouth to mouth respiration

After the first slow breaths into the victim, blow into the victim every five seconds, or twelve to fifteen times per minute. A good method is to count one thousand, two thousand, three thousand, etc. After each set of breaths, remove your mouth from the victim to permit the air to exhale, making sure that the chest is deflating and listen for the sound of the air leaving the mouth. If the victim has swallowed water, he may vomit, in which case, turn the victims head to allow the mouth to clear, so that it will not be inhaled and cause serious consequences. You will not have this problem if you are using a CPR mask with a one-way valve. Continue with mouth-to-mouth until additional help arrives to take charge of the victim. Do not stop unless you are exhausted, someone has taken over, or a Doctor has pronounced the victim dead.

If the victim revives, do not leave the victim until he has been taken to a hospital, or passed over to qualified Emergency Response Personnel.

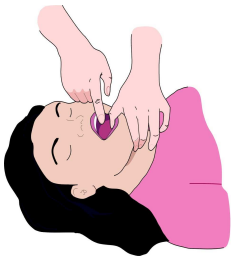
10. First aid (continued)



A sign of an airway obstruction

10.2.3. - AIRWAY OBSTRUCTION

An airway obstruction is detected immediately when the affected person cannot speak or cough, appears nervous and, above all, grasps their neck with their hands. When these symptoms occur, slightly bend the victim over, stand behind him, reach your arms around him and grasp your hands land marking at the victim's navel. Pull your hands quickly and sharply into the abdomen so that the diaphragm is lifted. This will cause the object to be forced from the airway. In order to achieve this in the water, it will be necessary to remove the victim's tank if he is wearing one.



Extracting obstructions

10.2.4. - BLEEDING

Bleeding can be internal or it may be from an open cut. Internal bleeding can show up with several symptoms: pale complexion, froth at the mouth, weakness, nausea, thirst, shallow breathing, yawning or rapid breathing. The pulse can weaken quickly. The body defends itself from bleeding by any internal means possible: coagulation, restriction of the blood vessels, decreasing blood pressure, etc. There are several ways to control and, hopefully, stop the bleeding. These methods should be applied in the same order as they are stated next:

1. Apply, through gauze, towels or any other type of available fabric, pressure directly on the injury, adding more gauze when the previous becomes blood soaked. NEVER remove the old dressing.
2. Elevate the bleeding part to try and decrease the blood pressure.
3. Apply pressure to the pressure points, pressing the artery against the bone.
4. Apply ice if possible

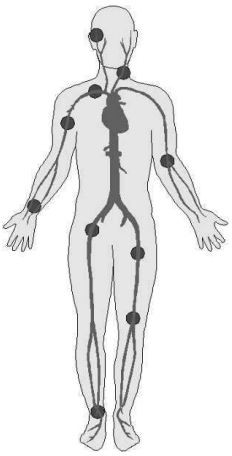
Heimlich manoeuvre

10.2.5. - SHOCK

Shock is characterized by a possible loss of consciousness, due to the lack of blood circulation and consequently, oxygen to the body. Shock can be the consequence of many circumstances, among them: intensive bleeding, large burns, dehydration, heart attack, pulmonary embolism, allergic reactions to foods or medicines, etc. The symptoms of shock will be: distress, disorientation, pale cold skin, cold sweats, loss of energy, bluish lips, dilated pupils, weak and rapid pulse, rapid and shallow breathing, etc.

The treatment for shock, without specific medical aid, consists of closely monitoring the victim. Have the person lay down, with the feet slightly elevated, loosen clothing around the neck, thorax and abdomen, cover the victim with a blanket, and if possible, administer oxygen.

If the victim is conscious give water to avoid dehydration, but only if the victim is not going to be operated on later. Under no circumstances give the victim alcoholic beverages. Alcohol is a depressant and that is exactly what you are trying to cure.



Points where to apply pressure to slow bleeding

10.2.6. - PREVENTION OF COMPLICATIONS

Do not move the victim any more than is absolutely necessary. If there is a fracture, immobilize the wound with splints. Keep the victim calm and do not leave him unattended if at all possible. If he goes into convulsions, try to immobilize him.

10. First aid (continued)

10.2.7. - WAYS TO OBTAIN HELP

In an accident it is important to get the victim quickly to proper medical attention, so that a physician can take charge of the situation and treat him. Even though you may think the injury is not serious, if it continues bleeding or if there is a chance of infection, a physician should treat it. It is very important, for the comfort of the victim, that he not be left alone, unless absolutely necessary, and do so only if you are absolutely sure that he is not in danger.

10.3. - BAROTRAUMA

10.3.1. - EAR SQUEEZE

Signs of a squeeze on the eardrum include: pain, blood from the ear, nausea and disorientation. The treatment consists in covering with a warm sterile dressing and getting the victim to medical attention as quickly as possible.

10.3.2. - CHEST PAIN

An intense pain in the area of the chest would indicate that there has been some kind of serious injury and it is important to seek medical attention as quickly as possible.

10.3.3. - ARTERIAL GAS EMBOLISM

The symptoms of an Arterial Gas Embolism include: unconsciousness, chest pains, blurred vision, bloody froth from the mouth and paralysis. These symptoms can onset quickly and lead to the death of the victim. The only effective treatment is to administer pure oxygen and immediate recompression in a hyperbaric chamber.

If possible, give oxygen

10.3.4. - MEDIASTINAL EMPHYSEMA

Just as in the preceding case, the only effective treatment consists of administering oxygen and obtaining medical assistance as quickly as possible. The symptoms are: severe pain in the centre of the chest, respiratory difficulties and cyanosis. Though the air contained in the mediastinum cannot be reduced by recompression, treatment in a chamber is recommended, to assist breathing when difficulties exist.

10.3.5. - SUBCUTANEOUS EMPHYSEMA

The symptoms that present themselves are: respiratory or speech difficulties due to swelling in the neck in the area of the windpipe. You can also hear a crackling sound (similar to that produced when walking on crisp snow), when you compress the affected area. The treatment will be the same as for the other cases of pulmonary obstruction, and that is immediate medical help. Though, in some cases the air can be extracted with a syringe, it should not be attempted by anyone who has not been properly trained.

10.3.6. - PNEUMOTHORAX

Once again the treatment is to administer oxygen and get the victim to medical assistance as quickly as possible. The symptoms of a Pneumothorax are: rapid, shallow breathing, pains in the chest and cyanosis.

10.3.7. - DECOMPRESSION SICKNESS

Decompression Sickness usually presents itself shortly after leaving the water. The estimated percentages of time lapse before symptoms appear are 50% within one half hour, 85% within one hour, 95% within three hours and 99% within six hours. The symptoms that appear vary greatly, depending on the affected area and the seriousness of the accident. The following are the most frequent:

- Skin itch
- Pain in the joints, arms, legs or body that gets progressively worse
- Unusual fatigue
- Dizziness
- Shortness of breath
- Numbness, tingling and paralysis
- Problems with hearing, vision or speech
- Loss of bladder control

The only treatment consists of administering pure oxygen and getting the injured diver to a recompression chamber as quickly as possible.

Obtain as much information regarding the injured diver as possible (dive profile/plan, dive computer for example), so that the medical personnel at the chamber can use the treatment required for that specific profile. The dive companion should, if possible, accompany the victim as he probably did dive the same profile.

In some occasions, the symptoms disappear after a little while, but may return later. It is still prudent to take the victim to a chamber, even if there are no symptoms at the time and explain to the chamber technicians the situation. Oxygen administration is known to ease symptoms or even make them disappear. To be on the safe side, move the victim to a chamber to be checked out and monitored.

Never attempt recompression in the water. This will tend to only aggravate the situation and delay proper attention. You can call DAN for assistance.

10.4. - OTHER PROBLEMS RELATED TO DIVING

10.4.1. - CRAMPS

Cramps are sharp and painful contractions of a muscle, caused by the muscle being overworked. The legs are usually the area that gets cramped because they are used most while diving. The pain can be reduced by massaging the affected muscle, or by straightening out your leg, grasping the tip of your fin and pulling it towards you. Remember, the reason for the cramp is that the muscle was having a strain put on it. One method of ensuring that the cramp does not return is to change your kick style every once in a while to rest the affected muscles.

10.4.2. - SWIMMERS EAR

Is caused by fungus or bacteria in the external ear due to exposure to contaminated water. It is very annoying and can prevent you from diving for several days. It is manifested by pain, especially when moving your jaws or running sores in the auditory canal. To prevent contracting swimmers ear, be sure to dry your ear thoroughly after the dive and clean out your ears with alcohol, or a vinegar and water solution (50% in water). Tropical waters are especially noted for this growth, due to the normal warm temperatures and the marine life living there.

10. First aid (continued)

10.4.3. - SUNBURN


Careful with the Sun

Since diving takes place on water, it is only natural that the suns rays, both direct and reflected off the water, can easily produce sunburn. It appears with a reddening of the skin, accompanied by a burning sensation, making you very uncomfortable. There are a number of specific products designed for sunburn relief but the best treatment is prevention. When you begin your exposure to the warm sun, stay in direct sunlight only for short periods of time. Be sure to cover your back, chest, arms and legs with light clothing. When blisters appear, they should not be punctured. Clean the affected area and cover with sterile gauze.

10.4.4. - SUNSTROKE

Another consequence of long exposure to the sun is sunstroke, manifested by headaches, weakness and nausea. It is important to wear some form of head protection when out in the sun for long periods of time in order to prevent sunstroke. Treatment for sunstroke includes giving plenty of liquids and getting the victim out of the sun. If the victim is unconscious, call an ambulance or take him to the nearest physician (if close by).

10.4.5. - HYPOTHERMIA


Careful with the cold

A consequence of long exposure to cold temperature can be hypothermia. It begins with uncontrolled shivering, mental confusion, difficulty with muscle coordination, difficulty with concentration, hallucinations, etc. Prevention includes wearing a protective suit, designed for cold water, and abandoning the dive when shivering begins. If the victim is not breathing, begin artificial respiration. Administer pure oxygen to a breathing victim. Remove wet clothing; cover the torso with blankets, to heat up the core first, before warming the extremities. Administer non alcoholic warm drinks. A physician should attend to serious cases.

10.4.6. - FROSTBITE

The symptoms of frostbite are: greyish or white colour skin and pain in the affected area. Sometimes there is no feeling at all until the affected area begins to thaw. To treat, cover the affected area with warm cloths. Do not rub the affected area. Attendance by a physician is recommended.

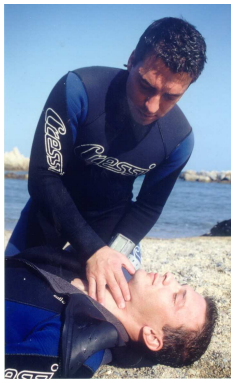
10.4.7. - AIR IMPURITY PROBLEMS

Caused by an excess of carbon monoxide or carbon dioxide from an oil-lubricated compressor. Treatment includes removing the victim from the source of the poison and take to a medical centre as quickly as possible. If possible, administer pure oxygen while in transit. If the victim is not breathing, apply artificial respiration. Treat for shock.

10.4.8. - CARDIAC ARREST

The clearest symptom a cardiac arrest is the absence of a pulse. The victim will be cyanotic (blue lips and finger nails) and the pupils will be dilated. The treatment, obviously, will be to administer cardio pulmonary resuscitation, administer oxygen if possible, and get the victim to medical attention as soon as possible. The application of cardio-pulmonary resuscitation by untrained people can be dangerous and also, in some countries, it can be illegal.

10. First aid (continued)



Searching for the pulse

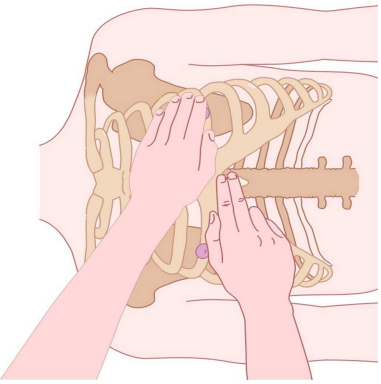
Consult the standards and regulations in your country with regards to this topic. The complete concept of the application of CPR is a very wide topic that is beyond the scope of this manual. Next, we reproduce part of the ACUC First Aid Manual, which deals with the External Heart Massage, related with this topic. We only do it with the intention of giving the reader a basic idea. Those that are interested in treating the topic in a wider manner, may take the ACUC First Aid course, or other similar ones, or request from their ACUC Instructor a copy of the ACUC First Aid Manual (where available).

10.4.9. - EXTERNAL HEART MASSAGE

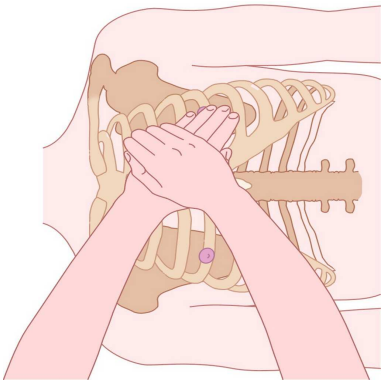
One rescuer CPR

An intermittent increase of chest pressure that helps to provide a blood flow to the heart takes place. This flow is enough to cover the minimum necessities of blood contribution to the main organs. When pressing the victim's chest, their heart is compressed, between the breastbone and the spine. You should act the following way:

- Place the victim in CPR position, rising if possible, the victim's feet.
- The rescuer must be placed at one of the patient's sides, to the height of the victim's shoulders. If the patient is on the floor, the rescuer will get on his knees.
- Place the heel of a hand on the lower third of the breastbone (centre of the chest or sternum).
- Place the heel of the other hand on top. Intertwine the fingers and elevate them without touching the thorax.
- Discharge the weight of the body vertically on the rigid arms, without bending the elbows to make force.
- Compress the breastbone firmly down, vertically, 3 to 5 cm (1.5 to 2 inches). Follow a rhythm in two times, compressing and releasing (without lifting the heel of the hand, so as not to lose the pressure area)
- Do these compressions at an approximate rhythm of 80 compressions per minute in an adult and 100 compressions per minute in children. (Count: 1000, 2000, 3000, etc...)



Finding the right spot



Starting compressions

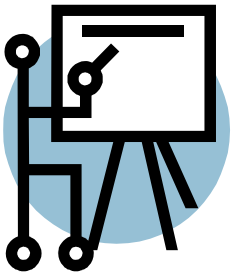
EMS services have noticed that often, after an accident, the victims carry a cell phone. However, they do not know who to contact from the very long list of phone numbers. They are suggesting that people should add to their cell phone listings, the phone number of the person that should be contacted in case of an emergency, using always the same initials. This international initials used should be ICE (In Case of Emergency). Under these initials we can put the phone number of the person that EMS people should contact.

Press on this bar to go to the next chapter

UNDERWATER RESCUE

11

LESSON OBJECTIVES



At the end of this chapter the pupil will be able to:

- Recognize personal signs that can cause a problem
- Recognize buddy signs that can cause a problem
- Identify the main differences between Help and Rescue
- Know what "STAR" means
- Name the ACUC specialty course related to the topics in this chapter

Note: It is not the scope of this manual to give complete knowledge about Underwater Rescue, but only to give some basic knowledge that will enable the diver to assist in emergency situations involving diving companions. ACUC has an Underwater Rescue Program which teaches the theoretical as well as practical knowledge to enable those who hold the certification to act in situations of this nature.

11.1. - UNDERWATER RESCUE

11.1.1. - CAUSES OF DIVING PROBLEMS

There are a number of causes of diving problems. Among them, the most frequent are: poor physical condition, weariness, environmental conditions, ascent problems, buoyancy problems, difficulties with equipment, etc.

11.1.2. - PROBLEM RECOGNITION

Be prepared to recognize symptoms in yourself, as well as your buddy. Personal symptoms include cramps, tiredness, cold, trouble breathing, rapid and shallow breathing. Buddy symptoms include signs of tiredness; cold; cramps; wide open eyes; erratic movements; discarding the mask or the regulator; gasping for breath and heavy, panting breathing.

11.1.3. - RESCUE TECHNIQUES

The most important objective in any rescue situation, is to obtain positive buoyancy. This is obtained by inflating the buoyancy compensator, dropping the weight belt, or both. These actions tend to relax you, so that you can better evaluate the situation quietly. It is wise to know the technique for relieving cramps and to be able to apply it, in the event this problem arises. You should also know other finning methods to avoid being affected by a cramp.

Your buddy is not only there to share an enjoyable diving experience. He should also be able to lend a hand in the event of an emergency situation. Do not hesitate to request help - the next time it may be him that requires help. Indicate to those on board the dive vessel, by hand signals or using a whistle, that you are having problems and need assistance. The best rescue method to use from the boat is to throw a buoyed line, with one end attached to the boat, to the divers in need.

11.1.4. - BUDDY HELP

The following advice is for assisting on the surface. When you observe problem signs with your buddy, you should not wait until he asks for help. You should act quickly to assist. In many instances it will be sufficient just to establish contact.

11. Underwater rescue (continued)

For example grasping him by the arm, using caution due to being so close. Also, you can advise him how to react (inflate your jacket, drop your weight belt, etc.).

If this fails, you should approach, with caution from behind, inflate his jacket and drop his weight belt to make him buoyant. Once positive buoyancy has been established, you can tow him toward the vessel or shore, by one of the methods explained later on in this chapter. Signal to the vessel or shore that you require help. Once in the vessel or on land, you can evaluate the situation and decide what type of additional help is needed.

11.1.5. - DIVER RESCUE

Panic effects

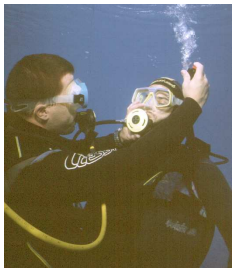
There is a clear difference between the rescue of a diver, and help to a buddy who is in need of assistance. Assistance of a buddy supposes that it is not an uncontrollable panic situation and that the buddy himself is going to help you to assist him. The rescue of a diver supposes that the victim is panicking and suffering serious problems, or is submerged and in difficulty.

Panic can manifest itself in two ways, active or passive. An active panic victim will continuously move without any real effort to assist you. A passive panic victim will not respond to any commands, and will do nothing to assist in his rescue. A passive panic can turn into an active panic at any time. So both should be approached with caution. The first step is to evaluate the situation and then decide if you can assist. Take into consideration whether you are tired, have the necessary skills to attempt a rescue, and also how much risk is involved. Attempting a rescue unprepared can wind up having two victims, instead of only one.

Victim in trouble

To assist a panicky victim <u>underwater</u>, you should approach him from behind, to avoid being grabbed by the victim and seriously complicating the situation. You can try touching his arm, but again, be careful that he does not attempt to grab you.

If he calms down, you can grasp his jacket from the rear, and inflate your own jacket, to make you both buoyant and begin a slow ascent to the surface. During the ascent, be sure the victim is exhaling by checking his bubbles. Encourage the victim to exhale.



Ascending with a victim

Stop the ascent if the victim is not exhaling. If the victim attempts a rapid ascent, try to slow him down by grasping him and dumping air from your jacket. Once on the surface, you can inflate his jacket and, if necessary, drop his weight belt. Put the victim on his back, be sure he is breathing easily and begin towing him to safety.

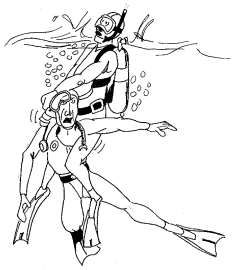
Another situation is when the victim is found panicking on the surface. Signs of panic include rapid movement of the arms, no mask (panic victims are claustrophobic) and wide eyes. In this situation, stay a safe distance away and talk to the victim. Tell him to drop his weight belt, inflate his vest, turn around, that you will assist him, etc. If he listens to your directions and calms down, minimize his ability of grabbing you by approaching from the rear. Grasp his jacket or tank valve and begin towing him to safety.

A towing method

With an unconscious victim, on the bottom, again you must approach with extreme caution. After making sure that the victim is, in fact, unconscious (not breathing), drop his weight belt and use his buoyancy compensator to make him buoyant. Hold on to him on the way up, and attempt to control the rate of ascent. If his regulator is still in his mouth, leave it there. If the regulator is out of his mouth, do not worry about it. Begin the ascent as soon as possible. An unconscious victim cannot embolize during ascent.

11. Underwater rescue (continued)

The muscles that control the glottis are relaxed and therefore, expanded air in the lungs will escape during ascent. You may want to tilt his head back to assist, just in case the victim is not unconscious, but in a passive panic state.



We must pay attention to the reactions of a panic victim, so that there are not two victims instead

Once on the surface, if the victim is not breathing, start artificial respiration using the snorkel to mouth method. Hold the mouthpiece of the snorkel in the victim's mouth and hold his nostrils closed with the same hand, while at the same time pulling the chin up to cause a hyper-extension, to open the airways. Through the snorkel we will start the process of AR as in the mouth to mouth method already commented. If it is a great distance to the boat or shore, you would be best to save your energy and not try towing. Instead, spend your energy doing AR, as discussed previously.

In the event of a lost buddy underwater, it is extremely important not to panic. Use the "STAR" (Stop, Think, Act and Recover) technique to avoid this.

The process used to locate a lost buddy, is to look around, especially towards the last direction you saw him, for a maximum of 30 seconds. If you cannot locate him, ascend about 10 feet (3 metres) and look around for your buddy's exhaust bubbles, for another 30 seconds. If you still cannot locate him, ascend to the surface and wait another 30 seconds, for your buddy to appear.

Since you are a buddy pair, your buddy should be going through the same procedure and you will meet on the surface. If you fail to locate him after the last 30 seconds, signal the safety divers that there is a problem.

11.1.6. - PANIC AND FATIGUE

Panic is defined as an "unreasonable action, generally caused by blind dread or fear of the unknown". You lose control, you cannot think and therefore, you take the wrong actions! When you encounter a situation that you are not familiar with and your brain believes there is danger involved, you will react by trying to remove yourself from the situation as quickly as possible. Blind reaction to a perceived situation, can lead to compounding the problem, especially while diving. No one is exempt from panic, no matter how much training and experience you have had.

Typical reaction of a panic victim

The best way of preventing panic is to understand the cause and stop it quickly. Fear is a common and healthy reaction, when facing danger. If the fear of falling causes you to move away from the edge of a cliff, that is a healthy reaction. If that same fear causes you to freeze at the edge of the cliff, then panic has taken over, you have lost control, and the problem is compounded.

Panic signs

Panic is not a healthy reaction. Avoiding panic is simply a matter of controlling ordinary fear. If something out of the ordinary happens during a dive, you should recognize it for what it is and take the steps necessary to fix the situation. Situations, such as being out of air, difficulty with strong currents, overweighting (due to items that you may be carrying), cold water, entanglement with kelp or fishing line, getting lost in a wreck, etc., are situations that have a logical and sensible solution. However, to solve any type of problem, you will have to be sufficiently calm to think about the solution. Panic is never a solution.

Recognizable panic signs, either in yourself or in your buddy, are wide eyes, rapid breathing and actions that are not normal. The rapid breathing may seem to be hyperventilating, but in reality, the shallow breathing of panic causes an increase in carbon dioxide and a decrease in oxygen in the blood. This depletion increases panic, which begins a panic cycle that can have disastrous results.

11. Underwater rescue (continued)

Tank valve tow

Head tow

Shoulder to fins tow. A very comfortable position to tow a buddy when the victim and the sea are calmed

Panic, in reality, is probably the main cause of drowning and of near drowning in recreational diving. Drowning has been responsible for half of the fatal recreational diving accidents in the United States, from the 1970s.

If, at any time while diving, you feel anxiety or you have any type of difficulty, you should stop all activity, breathe slowly and deeply, think about the solution to the problem and act to control the situation. Remember “STAR” (Stop, Think, Act and Recover).

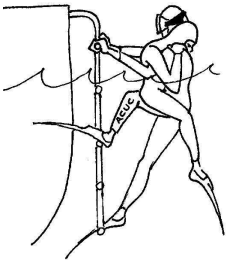
Prevention is generally the best way of avoiding problems that lead to anxiety during the dive. Know your physical limitations and do not surpass them during the dive. Do not carry uncomfortable or poorly fitting equipment, because this only adds stress to the dive. Your equipment must be maintained in perfect working condition.

The ACUC Rescue Course goes more into signs and causes of panic and stress in the diver.

11.1.7. - RESCUE EXERCISES

There are a number of towing methods that can be used depending on the circumstances. Several are listed below.

1. Tow from behind the victim, holding on to his tank valve and supporting his head with your chest.
2. Tow the victim by his chin and support his head
3. Push the victim, by placing his feet on your shoulders and grasping his knees.
4. Use his inflated jacket to support the victim’s head.

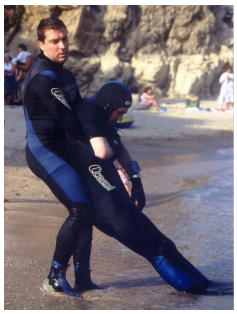


A method to bring a victim on board

When you reach the point of exit from the water, there are several possibilities:

1. The victim leaves by himself when the exit point is reached
2. To climb onto a boat, with an unconscious victim or one who is unable to help, you will need to remove all of his equipment as a first step. Place your leg between his legs and move up the ladder, one step at a time, carrying him with you.
3. If the boat has low enough sides, you can climb out first and then pull the victim up, by grasping him under the arms and lifting. Lean the victim over the side, take another grip lower down, and lift again. Continue to do this until the victim is completely inside the boat
4. Removal of the victim is much easier If there is help on board. People on board can lift from above, while you push up from below.
5. When exiting from shore, stand up when you reach shallow water, grasp the victim under the arms, and drag him to safety on dry land.
6. If you are strong enough, another way to carry the victim to shore is on our back, across your shoulders.

Bringing a victim to



Moving a victim, once on shore

From this point on, first aid techniques will be used, that have been previously described.

The minimal training that you have received on this course, will not make you a specialist in Rescue or First Aid. ACUC has an specific course dealing with Rescue for divers, and also courses on First Aid, Artificial Respiration, Cardio Pulmonary Resuscitation and Oxygen Administration. ACUC also recognizes numerous societies and associations who give training and greater knowledge of these topics.

Press on this bar to go to the next chapter

DIVE PLANNING

LESSON OBJECTIVES

At the end of this chapter the pupil will be able to:

- Name the step-by-step process for preparing for an open water dive.
- Describe a quick way of evaluating your state of hydration.
- Indicate recommendations, regarding women and diving.
- Define the objective of the dive.
- Plan a dive that is far from home.
- Indicate an important safety element, when dive planning.
- Name, in addition to the normal equipment, two pieces of equipment, related to safety
- Explain why you should examine your diving equipment before the day of the dive
- Describe when and why, you begin to calculate your bottom time.
- Complete the phrase "Plan your dive and ....."

12.1. - CONDITIONING

A reasonable physical condition is needed for diving

Physical conditioning should be part of your daily activities, whether you are an active diver or not. If you are in shape, only a slight modification to your routine exercises will be necessary to prepare you to dive. Swimming, snorkelling, practising with the equipment in a pool, or any activity that reinforces and exercises the muscles used in diving, are excellent methods of preparing you to dive. A clear evaluation of your current physical condition and your capacity to accomplish the physical efforts of a dive, are vitally important for your safety and welfare. Your aerobic capacity, age, weight, drug consumption, alcohol intake, smoking habits, all have a substantial effect on the capacity of your body to function correctly underwater.

If you are over 40 years old, have problems with weight or any physical factor that could hamper your safety or that of your buddy, a medical examination must form part of your preparation to dive.

It is strongly recommended (and mandatory in some countries), that you have a complete medical evaluation, before beginning the course.

Nourishment is also an important factor in dive preparation. Foods, with a high level of fat and oil, reduce the capacity of the blood to transport oxygen to the muscles and brain, which can result in muscular cramps, sluggish reaction underwater and heart attacks. On the other hand, eating foods rich in hydrocarbons, such as cereals, rice, fruit, etc., increases energy level. On the night before the dive, avoid eating gas-producing foods.

Hydration before the dive, must be considered for your safety and health. Drinking plenty of water, beginning the night before the dive, will help avoid dehydration and reduce the risk of decompression sickness. You will know that you are correctly hydrated if your urine is clear, not coloured, before the dive.

Between dives, drink plenty of liquids, but do not drink liquids that are diuretic in nature (coffee, tea and alcohol, for example). Consume liquids that hydrate the body adequately, without stimulating an increase in urine production. Cold water is probably the best liquid.

12. Dive planning (continued)

12.1.1. - WOMEN IN DIVING

The only additional health consideration for women has to do with pregnancy. It is generally recommended that a pregnant woman, (or a woman who thinks she may be pregnant), not dive due to the possibility (though not proven) that the high pressure environment underwater could injure the fetus. Since the fetus does not have the same mechanism (lungs) of filtering microscopic bubbles (silent bubbles), normally produced when diving, these bubbles may be very dangerous for the fetus. Numerous doctors do have a concern for females diving during pregnancy. Although the jury is still out, in regard to gas dissolving in the fetus and its ability to be off gassed, the concern is that, should the pregnant female require treatment in a chamber for decompression sickness, the high concentrations of oxygen used in the treatment **IS** harmful to the fetus.

For females who are not pregnant, but use birth control pills, it is thought that the pill provokes physical changes that cause the body to be more susceptible to decompression sickness, and therefore should dive more conservatively. While there is no definitive evidence, no table no matter how conservative or conservatively used will eliminate the possibility of DCS.

Another concern that has many theories, is related to diving during the menstrual period. A female diving expert answered this question immediately, by saying that there is no concern, if the female uses normal sanitary protection. If, however, the woman flows heavily during her period, there is a concern about hydration during the dive. Be sure to drink plenty of liquids before diving and more liquids between dives. Other than that, there is no obstacle to diving. The female reproductive system is not designed to trap air, even with the use of tampons. So there is no concern regarding air expansion, as in the lungs. Physically, there is no need for more than the normal precautions to protect menstrual fluids from the environment, especially since it has been demonstrated that menstrual fluids do not attract sharks and other marine life. There are no effects from menstruation underwater. Women can dive freely, the same as they can swim, play tennis or do exercise, during their period. Always consult with a physician for an evaluation before diving.

12.2. PLANNING

12.2.1 - PRE-DIVE PLANNING

Proper dive planning starts days before, and on land, with the selection of:

1. The diving buddy
2. The objective of the dive
3. Dive site information
4. Alternative sites, in case the primary site is unavailable for some reason
5. Time of dive, with regard to visibility, water conditions, tide tables, current, etc.
6. Related logistics: - transportation, necessary equipment, emergency procedures, (nearest telephone, numbers to call; police, ambulance, hyperbaric chamber, etc.)
7. ACUC Dive Centres: After deciding to take a diving trip, it is a good idea to request information from your Instructor, or call an ACUC office directly, about dive Centres affiliated with ACUC in the selected area. The fact that a centre has been recommended by ACUC means an ACUC Instructor is available to help you and that the level of quality will satisfy your needs.

12.2.2. - PRE-DIVE PREPARATION

Before going to the dive site, there are a series of steps that you should take to guarantee the success of the dive:

1. Inspection of your equipment, - it is always easier to repair any problems "locally"
2. Check your list, to be sure you have all the necessary equipment
3. Obtain a weather forecast for the dive site
4. Leave information with a responsible person that includes the location of the dive site and the anticipated hour of return, in addition to action steps to take and who to contact in the event of failure to return, after an adequate time lapse.
5. Packing the dive bag.

12. Dive planning (continued)

12.2.3. - PREPARATION ON SITE

An evaluation will have to be made on site whether to dive there, change locations, or cancel the dive. Weather and water conditions need to be taken into consideration, when making your decision. If the conditions are favourable, decide on where to enter the water to begin the dive and exit the water at the end of the dive.

12.2.4. - DIVE PLAN

Before the dive, review with your buddy the hand signals to be used during the dive, as well as the emergency procedures to adopt, if necessary. These have already been discussed in a previous chapter. Also you must plan the dive according to the dive tables, with the objective of:

1. Avoiding dives requiring decompression
2. Decide on maximum depth and time in regards to available air.
3. Minimize the number of stops required.
4. The depth and stop time, for the dive
5. Calculate the maximum bottom time on a second dive, to avoid decompression
6. Calculate the minimum surface interval between the two dives

It is very important to "Plan your dive and dive your Plan" underwater, as it relates to the Dive Tables, which you will learn to use in this course.

12.3 DIVE TABLES TERMINOLOGY

Bottom Time: begins at the time you leave the surface at the beginning of the dive and start your descend, until the time you begin your final direct ascent to the surface.

Single Dive: Any single dive conducted within the minimum hours specified on the decompression tables, as needed to free your body of nitrogen.

Repetitive Dives: more than one dive conducted within the minimum hours specified on the decompression tables, as needed to free your body of nitrogen

Dive Depth: Taken as the deepest depth achieved during the dive.

No Decompression Dive: Any dive within the no decompression limits, for time at depth. .

Ascent Rate: The rate at which a diver ascends. The ACUC tables are designed on a rate of 50 ft (15.2 m) per minute, plus or minus 10 ft (3 m) per minute

Safety Stop (SS): A safety off gassing stop, designed for safety on any dive, having a dive depth greater than 40 ft. (12 m). ACUC uses a 3 to 5 minute stop at between 10 and 20 ft. (3 and 6 m)

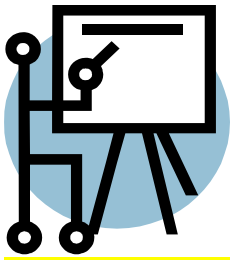
Decompression Stop: A mandatory off gassing stop, as required by the tables.

Residual Nitrogen Group (RNG): A letter designation, assumed to be the amount of nitrogen in the diver's system, at the completion of the dive.

Surface Interval (SI): The amount of time spent on the surface between Repetitive Dives. Surface times of less than the first hour/minutes, appearing in the Surface Interval Row on the Surface Interval table, is considered to be part of the previous dive. The time of the two dives must be added together to arrive at the Bottom Time. In these cases, we will take the depth of the deepest dive, for calculation purposes.

Nitrogen Penalty Time (NPT): The calculation of the number of depth minutes of Nitrogen, remaining in the diver's system, after a surface interval.

12. Dive planning (continued)



Total Bottom Time (TBT): The NPT must be added to the Actual Bottom Time (ABT) of the Repetitive Dive, in order to arrive at a Total Bottom Time. This number is used to compensate for the Nitrogen build-up in the diver's system. Any Decompression requirements are based on the TBT.

12.3.1. - DECOMPRESSION TABLES

It must be stated that no matter which tables are used, there is no guarantee the diver will not develop DCS.

Because tables used can vary depending on where you take the course, there is no explanation on any specific tables in this manual. If you obtained a student kit when you registered for your ACUC course, a set of plastic tables, along with written instructions, is included in the kit. If you did not obtain a kit, you can obtain the plastic tables from your ACUC Instructor, or from the ACUC office or ACUC authorized distributor nearest you. **In any case, your ACUC Instructor will show you during the course, how to work with at least one model of decompression tables.**

ACUC strongly recommends that you DO NOT participate in dives that require decompression. Nevertheless, ACUC believes that it is morally and ethically correct to teach all of our divers how to use the decompression tables in case they accidentally get themselves in a situation requiring decompression. In addition, legislation in some countries makes the teaching of decompression tables mandatory.

ACUC has its own set of decompression tables, which are based on the Canadian DCIEM (Defence and Civil Institute of Environmental Medicine) tables. There are several decompression table models in existence that are based on documented studies. ACUC uses the DCIEM based tables, because they have proven to be the most conservative tables that offer the least risk of developing Decompression Sickness.

General Rules for using any Dive Tables:

1. Ascend at a rate of 50 feet (15 metres) per minute, plus or minus 10 feet (3 metres), per minute.
2. Do the deepest dive first.
3. Follow the same flying after diving rules, if driving over mountains higher than 1,000 feet (300 metres).
4. Dive conservatively: consider your age, the underwater environmental conditions and the amount of physical exercise that will be required during the dive.

12.4. - AIR CONSUMPTION DURING DIVES

This topic is discussed in great detail in the ACUC Advanced Diver course. We will, however, give you a quick way of getting a rough idea of your air consumption.

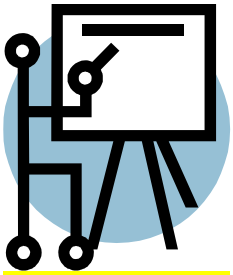
On any dive greater than 40 feet (12 metres), ACUC requires that divers do a SAFETY STOP of a minimum of 3 to 5 minutes at between 10 and 20 ft. (3 and 6 m) even though the tables do not require a stop. For decompression dives requiring a mandatory stop, use the depth and time specified on the tables that you are taught.

As an example, the figure of 1 cu. ft. per minute, on the surface, is used. Therefore, for example, an 80 cu. ft. tank, that contains 3,000 psi of air, would last 80 minutes on the surface. Remembering Boyles Law, as pressure increases, volume decreases and density increases. Under pressure, it will take more air to fill the same volume in our lungs. Continuing with this, at a depth of 33 ft. (10 metres) your 80 cu. ft. of air will now only last you ½ the time, or 40 minutes (2X the pressure = ½ the volume). At 60 ft (18 metres), the tank would only last you 1/3 of the time, or 26 ½ minutes. This number will vary depending on how often you ascend and descend, but it is a rough rule of thumb to use, until you gain more experience and your air consumption decreases, due to your getting more comfortable underwater. If you plan your dive correctly and monitor your submersible pressure gauge, you should never run out of air. If, however, this should happen, there are a number of things you can do:

1. Use an alternate air source such as a pony bottle, or your buddy's octopus regulator to surface.
2. Do an Emergency Ascent: make yourself buoyant by inflating your BC or dropping your weight belt. Keep your regulator in your mouth and, with your head tilted back, continue to try to breathe in and out, while swimming toward the surface. As the pressure decreases, there may be enough air in your tank to get a breath. In addition to the chance of getting air from your tank, by trying to breathe in and out, you will avoid a reverse block in the alveoli.

12. Dive planning (continued)

3. If you find yourself ascending too fast, flare out by spreading your arms and legs and assume a horizontal position, in order to slow yourself down (see chapter 6 - Point 6.3.9).



Knowing how to calculate air consumption does not take the place of using a submersible pressure gauge.

12.5 THE DIVE

12.5.1. - DESCENDING

Before going underwater, proceed to do one last equipment check of yourself and your buddy. Check the time on your watch if you do not have a Bottom Timer. Let the air out of your jacket and allow yourself to descend feet first for better control. Begin clearing your ears as soon as your head is below the surface. During the descent, maintain a rate of 60 feet (18 metres) per minute by controlling your buoyancy. When it is possible, descend using the anchor rope or a descent line, especially if there is a current or poor visibility.

12.5.1. - ON THE BOTTOM

Once you arrive on the bottom, get with your buddy, check that everything is okay and then begin your dive. The first thing to do is establish neutral buoyancy. The method to do this has been described earlier. This will make your dive more comfortable. Adjust your buoyancy at various times during the dive. Always keep your buddy within your field of vision and, in order to find your way back, frequently turn around and look behind you. Take note of your surroundings. Always maintain a normal respiratory pace without holding your breath, which would only cause you to lose your breathing rhythm and use more air.

12.5.2. - ASCENDING

When you have completed your planned dive time, or when your pressure gauge shows the agreed upon amount of pressure remaining, signal your buddy to go up. Begin an ascent rate of 50 feet (15 metres) per minute (plus or minus 10 feet - 3 metres - per minute), and make your safety stop for 3 to 5 minutes between 10 and 20 ft. (3 and 6 m). As you ascend, any air in your jacket will expand (Boyles law) and this will increase your buoyancy, causing you to ascend faster. The reason why you must ascend with your jacket power inflator/deflator in your left hand is so that you can dump air from your jacket as your ascent rate increases. During the ascent to the surface be sure to maintain contact with your buddy to ensure that there are no problems. After the safety stop, extend your arm over your head as you ascend to the surface, making sure that you have scanned full circle to watch for overhead objects. It is better to hit an object with your hand rather than your head. Upon reaching the surface touch your hand to the top of your head to give the OK signal to the Divemaster on the boat or shore, that everything is fine.

12.5.4. - DECOMPRESSION PROCEDURES

Decompression stops should be made at the depth indicated on the tables, being as exact as possible. This is difficult to do if you have not obtained perfect neutral buoyancy. For this reason, it is best to have a decompression station fixed at that depth to avoid trying to maintain the level by yourself. The best system is to have a decompression bar hung from the boat at the correct depth of the decompression stop required. Decompression bottles, in case you run out of air on your primary tank, can be hung from the bar. There is a possibility that you will not be able to find the bar on your way up so you need to look at other methods of making safe decompression stops. One method, already mentioned before, is to carry a float and flag on your dive. Use the float line as part of your ascent method and when you get to a pre-marked depth on the line, hang on to the line at that depth and do your required decompression stop. The flag on surface also indicates your position so that the boat can come over and pick you up. It is also an indication to other boats in the area to stay away from your flag.

12. Dive planning (continued)

Another method is to use a compass so that you know your exact return position and you can come up under the decompression bar on the boat. The main drawback of this system is that any distraction can cause you to drift off the sight line, and you can wind up away from your intended position.

One of the better solutions is to plan your dive so that you wind up in shallow water and you can use up your decompression stop time exploring the area around you. If, for some reason, you miss a decompression stop and surface, you can correct this problem.

Let us say, for example, that you missed a 5 minute decompression stop at 10 feet (3 metres). Providing you are showing **no signs** of decompression sickness and the surface interval is less than 5 minutes, you can take a fresh tank and descend 10 feet (3 metres) below the missed decompression stop. You stay at this depth for the amount of time designated for the stop you missed. From then on, conduct the original decompression profile before surfacing.

As an example, on a planned dive with a 5 minute stop at 20 ft (6m) and a 10-minute stop at 10 ft. (3m), you came directly to the surface without doing any decompression at all. The solution is to re-enter the water and descend to 30 ft (9m) (10 ft - 3m - deeper than the missed stop) and stay there for 5 minutes. Then ascend to 20 ft. (6m) for 5 minutes and then 10 ft (3m) for 10 minutes before surfacing.

As another example, on the same planned dive with a 5-minute stop at 20 ft. (6m) and a 10-minute stop at 10 ft. (3m), you completed the 5 minutes at 20 ft. (6m) stop, but came to the surface without stopping for 10 minutes at 10 ft. (3m). The solution is to re-enter the water and descend to 20 ft. (6m) (10 ft. - 3m - deeper than the missed stop) and stay there for 10 minutes. Then ascend to 10 ft. (3m) for 10 minutes before surfacing.

Another method is sometimes also used. Again, providing you are showing **no signs** of decompression sickness, you can take a fresh tank and descend to 40 ft. (12m) where you spend ¼ of the missed decompression time. You then ascend to 30 ft. (9m) and spend 1/3 of the missed decompression time there. Now ascend to 20 ft. (6m) and spend ½ the missed decompression time at this depth. Finally, ascend to 10 ft (3m) and spend 1 ½ times the missed decompression stop time there. Then, you can surface.

If when you divide the time of the decompression stop by ½, 1/3, ¼ or 1½ it gives you a decimal number, then you go to the nearest full number. For example: ¼ of 5 is 1.25, then you take 2.

For example, for a missed decompression stop of 5 minutes at 10 ft. (3m), you would descend to 40 ft (12m) and spend ¼ of 5 minutes, in other words, when you round up, is 2 minutes. Then go to 30 ft. (9m) and spend 1/3 of 5 minutes, in other words, when you round up, is another 2 minutes. Then ascend to 20 ft. (6m) where you spend ½ of 5 minutes, in other words, when you round up, is another 3 minutes. Now, go to 10 ft (3m) where you spend 1 ½ times the missed decompression stop, in other words, 8 minutes.

12.6. - ALTITUDE DIVING

The problem that arises when diving at altitude is the different atmospheric pressure on the surface. Decompression tables are based on an atmospheric pressure of 14.7 psi, (1 ATM), the pressure that exists at sea level. When the atmospheric pressure changes, the dive tables must change. One system, called the ***Rule of 4%***, consists of adding 4% to the real depth for each 1,000 feet (300 metres) of altitude above sea level. Using this method, a dive to 50 feet (15 metres) at an altitude of 6,000 feet (1,800 metres), would tell you to enter tables as if it were a dive in the ocean at 62 feet (19 metres)

50 + ((50 * 6 * 4) / 100) = 62

Another system consists of finding the barometric pressure on the surface of the lake. Multiply the pressure at sea level (760 mm.) by the anticipated dive depth, and then divide the result by the barometric pressure at the surface of the lake. As an example, the lake in which we want to dive has a barometric pressure of 640 mm., and we wish to dive to a depth of 66 feet (20 metres). After the relevant calculations, you will see that you should be using the tables as if the depth of the dive is 78.3 feet (80 feet) or 24 metres.

(66 * 760) / 640 = 78.3

12. Dive planning (continued)

Also the depth at which decompression stops will have to be made will have to be changed when diving at this altitude. For this calculation, you need to do it backwards - multiply the decompression stop depth times the barometric pressure at the lake, and divide by the barometric pressure at sea level.

(10 * 640) / 760 = 8.4 feet (2.55 metres)

12.7 - DIVING IN TIDES

When diving in areas affected by tides, you should plan the dive in order to avoid the hours before high tide and low tide, when the tide currents are strongest. Tide tables for specific areas are available that will give you all the information required for diving. Talking and listening to local divers can save you a lot of problems.

12.8. - FLYING AFTER DIVING

Commercial aeroplanes fly with a cabin pressure equivalent to being at 4,000 to 6,000 feet (1,200 to 1,800 metres), and because of this, a diver who has residual nitrogen in his system, after one or more dives, can suffer decompression sickness when being subjected to lower than atmospheric pressure. Many procedures have been tried to minimize the risks, but it has been demonstrated that none can guarantee 100% that an accident would not happen. The more conservative organizations, including ACUC, recommend not to fly for at least 12 hours following a single no decompression dive, or 24 hours following two successive dives, or one that requires decompression.

12.9. - DIVE LOG

It is important to register all your dives in an appropriate record book (ACUC has logbooks designed for divers. See chapter 1 - Point 1.1.10). A logbook fulfils several objectives:

1. Keeps a record of the types of dives and the certification level you have obtained.
2. Records information on dive sites visited in case you want to return to dive again.
3. Contains first aid and safety information.
4. Lists information and procedures in case of emergencies.
5. It is a record of your personal diving experience and more and more often, Dive Centres are demanding presentation of a logbook before allowing you to dive.

ACUC Log book

Press on this bar to go to the next chapter

ACUC

LABOUR OPPORTUNITIES

LESSON OBJECTIVES

At the end of this chapter the student will know:

- An aspect of journalism that could interest recreational diving instructors.
- Two markets for underwater adventure writing.
- The first step in learning underwater photography.
- The names of two potential buyers of underwater photos.
- Two attributes of light commercial divers.
- The great advantage and the great inconvenience, of heavy commercial diving.
- The science applied to marine environment.
- The scientific application to fresh water.
- The science that involves underground waters.

13.1. - LABOUR OPPORTUNITIES

Diving is considered by millions of people to be the most fascinating and exciting of all recreational activities, due to its flexibility and diversity. It requires complete training and common sense to be done safely. It is a great source of recreational activity and it allows a diver to take many land sports and hobbies and adapt them to the water.

For many, diving is a way to earn a living doing an activity that they really enjoy. The employment opportunities in diving are broken into four categories: recreational diving, which includes teaching and services, as well as activities such as writing and photography/video; light commercial work that can be done with Scuba; heavy commercial work that requires gas mixtures and/or hard hat diving; and the scientific investigation associated with salt and fresh water.

Whichever underwater work you choose, you are in continuous contact with nature, on the threshold of earth's last frontier. You are a true pioneer and a part of the future of the world.

13.2. - RECREATIONAL DIVING

There are several ways of earning a living with recreational diving. Teaching, services, writing and photography are among them.

13.2.1. - TEACHING

The first step in becoming a diving instructor is, of course, to be certified as a diver. After having gained experience taking more courses and specialties, diving and teaching as a Divemaster, Assistant Instructor or Entry Level Instructor, you can attend a course/evaluation for Instructor certification. These courses are offered by several national and international organizations. In a later chapter you will see the route for continuing as a member of ACUC. The Instructor certification course/ evaluation can last from several days to several weeks.

Teaching

13. Labour opportunities (continued)

It includes intensive learning experiences in the classroom, pool and open water and very high standards and very rigorous exam procedures are applied. Some instructor training centres offer the students a course not only in teaching diving but also selling, equipment repair and all the operations involved in operating a store or diving centre. Many instructors start their own business in the form of a diving school, tourist centre or dive shop, or a combination of all the above mentioned.

13.2.2. - SERVICES

It is not necessary to wait until reaching the Instructor level to begin earning a living with recreational diving. Once you obtain the level of Divemaster, Assistant or Entry Level Instructor you can begin working in this exciting field. Tourist centres throughout the world need well-trained instructors and divemasters to assist their facilities and clients. As in other fields, it is highly recommended that the candidates for these jobs speak several languages. The specialties most looked for among these candidates are: First Aid, Rescue and Equipment Maintenance. The candidates that possess some type of powerboat certification will have better labour opportunities.

13.2.3. - JOURNALISM

As the interest in diving increases, the demand for information also increases. Journalism and photography offer fields where the diver can transform their discoveries, adventures and knowledge, into money making revenue, while enjoying the activity. The journalistic areas open to the potential writer are education, adventure and travel.

13.2.3.1. - EDUCATION

Instructors everywhere are continually searching for technical information. They constantly look for information regarding new techniques and the problems that arise with other instructors, when teaching divers. Also, they need information regarding modifications and evaluations of equipment, since few can buy and evaluate each piece of available equipment on the market themselves. Information written on those topics and others of interest to instructors is not only published by the teaching organizations, but also by popular magazines.

13.2.3.2. - ADVENTURE

Every activity has its fictional heroes, and diving is no exception. There is a demand for real and fictitious stories for magazines and books, since every dive is an adventure. Maybe your personal adventure can be polished to become excellent reading.

13.2.3.3. - TRAVEL

Information on trips to diverse diving areas is included in almost all diving publications, even in some equipment catalogues. Even if material has already been published about a diving centre, the appearance of something new can make it worthwhile to visit it again and to publish a new article. Divers like to read about where to go and what to look for, including any problems that can arise and how to treat them.

Underwater Photography

13.2.4. - PHOTOGRAPHY

Pictures are probably the best way, apart from diving, to introduce the underwater world to other people. Photographers are very often used to illustrate articles and stories. The training in underwater photography begins with basic land-based, picture taking courses, that are offered by some photography schools.

13. Labour opportunities (continued)

Once you have obtained the basic knowledge of photography, you can move to the underwater techniques taught at many diving schools or by independent instructors, experts on the topic. After gaining experience shooting several rolls of film underwater (easier now with the use of digital cameras), you can obtain specialized training in schools that specialize in teaching underwater photography. In photography, especially underwater, there is no substitute for experience. For more information, contact your instructor or the ACUC office nearest you. There are several ACUC courses in underwater photography.

Almost every editorial company and television chain is a potential buyer of underwater photos. A career in journalism and photography can begin with the basic training received in your store, centre, school or diving club.

13.3. - LIGHT COMMERCIAL

Light Commercial work is usually defined as work underwater that is done in a short period of time, or in sufficiently shallow waters so that decompression is unnecessary. It is a quickly growing occupation in the seafood harvesting field, with specialists in sea urchin, scallop and kelp harvesting, as well as fish cage and weir maintenance. It also includes inspection of dams, pipelines, cables and even wastewater outlets. It can also be involved in tasks such as re-floating small craft, small repairs underwater, cleaning of ships and even some forms of underwater construction.

For divers with imagination, there are infinite possibilities of work that can be done with basic diving equipment. However, all certified divers can be potential competitors and unless there is a great demand in the area in which you reside, it may not be a source of enough revenue.

A competent light commercial diver requires advanced training and good technical ability. He must be skilled in all types of work. A background in the techniques of construction and a good knowledge of physics and photography are strong assets. Light Commercial Diver courses are available in commercial diving schools. In Canada, ACUC has Light Commercial Courses for Seafood Harvesters. After certification, there is no substitute for experience.

13.4. - HEAVY COMMERCIAL

Heavy commercial diving

Heavy Commercial work is the best paid and the most dangerous of all professional diving work. Most of the work is done under adverse conditions where visibility is zero and the temperature of the water is cold. The work includes search and recovery, repair, maintenance and construction and it can include saturation diving.

Recovery work is usually done for ships or other articles that are worthwhile to recover. Repair, maintenance and construction include structures such as oil platforms, pipelines, bridges, dams and ports.

Commercial diving equipment is very sophisticated, including closed circuit rebreathers and helmets that use both compressed air and gas mixtures. Before attending a commercial diving school, you must have a good background in recreational diving in order to have a good idea of what you can expect in heavy commercial work with all its inherent conditions. Commercial instruction generally includes underwater welding, the use of equipment with helmets, units with gas mixtures and also, techniques of heavy construction, amounting to a lot of hard work. In most countries, Light and Heavy Commercial Diving is regulated by some government agency.

13. Labour opportunities (continued)

13.5. - SCIENCES

It has already been said that the waters of the earth are our last frontier. Diving is one of the instruments used by scientists to personally examine what happens in the world underwater. More scientists now recognize the potential of the oceans and fresh waters. It is clear that we must do more investigation so that we can use that great potential.

13.5.1. - OCEANOGRAPHY

When science is applied to the marine environment, it is called oceanography; and the scientists are oceanographers. Oceanography specialization includes biology, botany, zoology, geology, geography and archaeology, to name a few. Universities and Colleges in many countries have investigation ships in operation. They use sophisticated equipment in the form of submarines, one atmosphere diving systems and remote control vehicles, in their efforts to discover the mysteries of the deep.

13.5.2. - LIMNOLOGY

Limnology is the application of scientific methodology to fresh water instead of the ocean environment; and as in oceanography, more and more limnologists are needed. Fresh water, as well as the oceans, is one of the keys to the future.

Other areas of interest in underwater investigation include hydrology (the study of underground water resources) and marine archaeology (the study of underwater history). A great part of current investigation concerns contamination and the threat that it presents for the waters of the world. Enormous measures are being taken to locate and stop the causes of contamination.

If you are interested in a scientific career, you should begin with a good scientific base of your choice. It is never too early or too late to begin. Science courses, for young and adults, at high schools can give you the necessary preparation for study at a university. A University education and a scientific certification are absolutely necessary in order to look for scientific work. For more information, contact your local college or university to obtain more specific information on how to begin a career in oceanography or limnology.

Press on this bar to go to the next chapter

ACUC

LESSON OBJECTIVES

At the end of this chapter the student will be able to:

- Explain what the initials of ACUC stand for.
- Explain what the initials of RSTC stand for.
- Identify where the head office of ACUC is located.
- Tell what the highest ACUC Instructor rating is.
- Identify the location of the ACUC European Head Office.
- Explain the quality control system used in ACUC.
- How many dives are required to become an ACUC Divemaster.
- Describe what the minimum time underwater that is required to be considered a dive by ACUC.

14.1. - WHAT IS ACUC INTERNATIONAL?

14.1.1. - BRIEF HISTORY OF ACUC

ACUC originally stood for the “Association of Canadian Underwater Councils”. In 1986, the meaning of the initials was changed to “American and Canadian Underwater Certification”. This occurred when our organization changed from a National organization to an International organization. The fundamental pillars of ACUC are diving safety and respect for the environment, through continuing education.

During the 1950’s in Canada, each territory and province had different practices and standards for dive Training. What was perfectly acceptable in one province was not acceptable in another, etc. Due to this, the diving situation was quite chaotic. For example, a diver from the province of Quebec could not dive in British Colombia, or vice versa, because the certification was not recognized or accepted by the different clubs or "councils ".

In 1962 the different provincial councils decided to unite and A.C.U.C., the Association of Canadian Underwater Councils, was born. A.C.U.C. incorporated as a registered, non-profit organization in 1968. The next step was the creation of standardized dive training practices across Canada.

The highest standards from other training agencies operating at that time were selected and adapted to the needs of the rigorous Canadian environment. The result was the creation of a set of the highest Standards for the practice and teaching of Recreational Diving in the world.

As time passed and equipment and teaching methods improved, these standards and norms have been adapted to reflect these improvements. The flexibility demonstrated by ACUC to meet these changes and to adapt to new methods and equipment, has allowed our Organization to stay in the forefront of high quality of all Diver Training Organizations.

The objective of ACUC has never been to produce the highest in numbers, but the best in quality. To improve our services and teaching capacity it was decided to make ACUC INTERNATIONAL a Commercial Organization. Thanks to the commercialization of our Organization we have been able to establish such programs as: Air Quality Inspection, conferences and periodic seminars, active communication among instructors, creation of materials and effective and professional teaching methods, etc, and to help tremendously in the development of the industry of recreational diving. This commercialization has also opened doors of the rest of the world, as it has allowed us enough resources to create an ACUC INTERNATIONAL infrastructure in several countries. This, in turn, has created work for many people in these countries, who at this moment, are working in the industry of recreational diving.

14. ACUC (continued)

14.1.2. - ACUC TODAY

ACUC INTERNATIONAL at this moment enjoys an excellent reputation among diving professionals. Our divers and instructors are among the most respected in the world.

At the time of the printing of this edition of this manual, our Organization has almost 54 years of experience in the teaching of recreational diving. In 2011, we had already trained and issued in the entire world more than 1,000,000 certifications. Our Instructors, approximately 2,500 around the world, are active in countries such as the U.S.A., Mexico, Germany, Italy, Israel, England, Spain, Argentina, Ecuador, Cuba, Holland, Belgium, Canada, Korea, India and in most of the Caribbean Nations.

ACUC has two main offices: ACUC's HQ located in **Canada** and ACUC Europe located in **Spain**. Currently, ACUC also has national offices, which we call "International Delegations" in Argentina, Benelux (Belgium, Holland and Luxembourg), Cuba, India, Italy and Korea.

ACUC is a founding member of the European and Canadian RSTC (Recreational Scuba Training Councils).

14.1.3. - EXPERIENCE

With almost 55 years of experience in the teaching of diving (almost 25 years at the international level), ACUC knows how to adapt its education systems and its courses to new technologies, as much in training methods as in equipment.

The result is a flexible and young Organization, willing to listen to all its members, instructors or divers and to support them from inside their own country where they operate, not from a foreign location. ACUC knows how to adapt to the specific needs of the countries where they have national representation, allowing these countries complete autonomy in national matters related to diving.

14.1.4. - CONTINUING EDUCATION AND EQUAL OPPORTUNITIES

ACUC promotes continuing education of our divers, offering many advanced and specialty courses and gives constant opportunities to those who wish to make scuba diving a profession.

ACUC has no limits in the quantity of instructors, the only limit is the quality and professionalism that those who wish to become ACUC Instructors need to have.

14.1.5. - ACUC: A COMPLETELY INTERNATIONAL CERTIFICATION

ACUC has most of its teaching material available in most main languages.

Due to our modern system of certification procedures, a student can have his card in less than three weeks after successfully completing his course.

We keep all our professional members constantly informed, through periodic email based communications and yearly bulletins, as well as a private web just for them.

Our multilingual web sites on the Internet, keeps not only ACUC divers, but divers of any organization informed. By keeping them informed we also keep their interest and we all know that an interested diver is an active diver. The addresses of our webs are www.acuc.es and www.acuc.ca.

14. ACUC (continued)

Those certified by ACUC enjoy, in addition to being recognized for quality training, the biggest and best possible international coverage. ACUC, by being members of the R.S.T.C. (see www.wrstc.com), is recognized by all the other international organizations, and is also recognized in any cooperating dive centre with these organizations and of course, in our own associated centres around the world. ACUC also holds a mutual recognition agreement with CMAS (World Underwater Federation), for diver levels.

14.2. - LIST OF SPECIALTIES AVAILABLE TO OPEN WATER DIVERS

14.2.1. FIRST AID

A program that includes first aid in the event of an accident, artificial respiration and basic cardiopulmonary resuscitation. The knowledge gained in this program can be applied to accidents or incidents with divers and non-divers. In areas where the ACUC First Aid program is not available, recognized first aid programs available from other organisations such as St. Johns, Red Cross, etc., are acceptable. It is a requirement for several other courses, such as: Divemaster, Oxygen Administration, etc. Non– divers can also take this course

14.2.2. UNDERWATER ECOLOGY/BIOLOGY

A basic program designed so that the diver better understands the surrounding environment while diving. It puts special emphasis on explaining the symbiotic relationships of the ecosystem, and how actions that at first sight seem inoffensive, can unchain harmful consequences for the underwater environment. The emphasis of this program is to protect the underwater environment through the diver's increased knowledge.

14.2.3. UNDERWATER DIGITAL PHOTOGRAPHY

A basic program designed so that the diver can enjoy activities underwater that don't damage the environment and, at the same time, offer an additional incentive to the diver to maintain his interest in diving, offering him a purpose for each dive, other that simply one of going to observe the underwater surroundings. While introducing the novice diver to underwater photography, a medium is also created (by the diver) that will act to attract other people to the activity of recreational diving. This course is a requirement for those who, having found that they enjoy underwater photography, decide to improve their techniques and knowledge through Advanced Photography programs.

14.2.4. EMERGENCY OXYGEN PROVIDER

This is another of ACUC's key programs. It has been demonstrated in most accidents related to diving, that correct oxygen administration to the victim gives excellent results and it vastly increases the recovery possibilities. To increase safety in diving, ACUC is trying to ensure that most of its divers and all of its instructors have this specialty. A prerequisite for this certification is that the candidate has previously completed (or taken at the same time) a course in First Aid, including CPR. In areas where the ACUC Oxygen Provider program is not available, recognized similar programs such as DAN's (Divers Alert Network) or USP's (Underwater Safety Programs), etc. are acceptable. It is a requirement for all of ACUC's leadership certifications (Divemaster or higher).

14.2.5 SURFACE CONTROLLER

It is not necessary to be a diver to participate in this course but a requirement is to have completed a Specialty program in First Aid and Oxygen Administration. This is a course designed to involve those people who are not able, or do not wish to dive, but they want to participate in the world of diving.

14. ACUC (continued)

The surface controller is a perfect “dry” assistant for Divemasters and Instructors when organizing diving trips and dives, as well as in case of emergencies.

14.2.6 RESCUE SPECIALTY

This is a theoretical and practical course teaching a diver how to recognize the symptoms of dangerous situations, and how to act on these occasions. The candidates should be OWD certified divers or equivalent and should have a minimum of 5 hours of bottom time (10 dives). It can be offered and certified by any ACUC Open Water Instructor or higher. It is highly recommended, but not mandatory, that the candidates complete specialty courses in First Aid and Oxygen Provider to compliment this program.

14.2.7 NIGHT DIVING SPECIALTY

This is a theoretical and practical course teaching a diver how to dive in limited visibility conditions. The candidates should be OWD certified divers or equivalent and should have a minimum of 5 hours of bottom time (10 dives). It can be offered and certified by any ACUC Open Water Instructor or higher, with the Night Diving Instructor specialty. It is highly recommended, but not mandatory, that this course be taken after completing the Advanced Diver course.

14.2.8 DRIFT DIVING SPECIALTY

This is a theoretical and practical course teaching a diver how to dive in strong current situations. The candidates should be OWD certified divers or equivalent and should have a minimum of 5 hours of bottom time (10 dives). It can be offered and certified by any ACUC Open Water Instructor or higher, with the Drift Diving Instructor specialty. It is highly recommended, but not mandatory, that this course be taken after completing the Advanced Diver course.

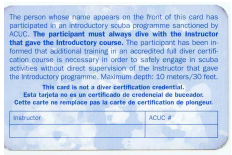
14.3. - DETAILED INFORMATION ON ACUC COURSES

14.3.1. - NON CERTIFICATION COURSES

Snorkelling

This program can be run anywhere. The objective is to teach the simple basic skills of using a mask, fins, and snorkel. The culmination of the course is a dive, with snorkelling equipment, in a pool or in protected waters. The course duration is approximately 2 hours. It can be offered by any person with a certification of Divemaster or greater (Important: Divemasters certified prior to 1996 must have completed an updating course to be able to teach this course). The purpose of this type of course is a simple introduction to the underwater world.

Introduction to Diving



This short course can be offered in places where there is no access to open water, landlocked cities, for example. The culmination of the course is a dive in a pool. The course duration is approximately 3 hours. It can be taught by a Divemaster overseen by an Entry Level Instructor or higher level (Important: Divemasters certified prior to 1996 must have completed an updating course to be able to teach this course). The purpose of this type of course is a simple, safe and basic introduction to diving with scuba equipment, and allows people to experience the sensation of breathing underwater.

14. ACUC (continued)

Diver Introductory Program

This course is offered in places where there is easy access to open water. The culmination of the course is one dive in open water to a maximum depth of 30 feet (9 metres), supervised by the person who taught the course. The course duration is approximately 6 hours. It can be taught by a Divemaster overseen by an Entry Level Instructor or higher level. The purpose of this course is to introduce people to the underwater world using scuba diving equipment. This course must NEVER be considered as a certification course.

14.3.2. - CERTIFICATION PROGRAMS

Open Water Diver

This is the course this manual was written for. This course can be offered and certified by an Entry Level Instructor or higher.

Advanced Diver

This course includes a basic introduction to certain specialties. The candidate should be an OWD or equivalent. Candidates should have a minimum of 10 hours of bottom time before becoming certified, although you can begin the course as soon as you have completed the OWD. It can be offered and certified by any Open Water Instructor or higher.

Rescue Diver

A theoretical and practical course designed to teach a diver how to recognize the symptoms of dangerous situations and how to act on these occasions. The candidates should be ACUC Advanced divers or equivalent and should have a minimum of 20 hours of bottom time. It can be offered and certified by any ACUC Open Water Instructor or higher. It is highly recommended, but not mandatory, that the candidates complete specialty courses in First Aid and Oxygen Provider to compliment this program.

Divemaster

This is a highly technical course involving the theoretical and practical methods of running diving operations. The course content includes teaching techniques. The candidate should be a Rescue Diver and have the following ACUC specialties: First Aid Provider and Oxygen Provider. The candidate should also have a minimum of 40 hours of bottom time logged. It can be offered by any Open Water Instructor or higher. The Divemaster can teach basic snorkel techniques, and under the supervision of an Open Water Instructor, teach the Introduction to Diving and Diver Introductory Programs. A Divemaster can also work under the **direct** supervision of an Open Water Instructor (or higher level) teaching Open Water Diver programs.

Open Water Instructor

A theoretical and practical program which includes a high content of teaching techniques. The candidate should be a Divemaster as a minimum with a minimum of 70 hours logged bottom time. It can be offered by an Instructor Trainer, but must be evaluated by an Instructor Trainer Evaluator. Successful candidates can teach and certify courses up to the Divemaster level and teach (but not certify) the Assistant Instructor level. The Open Water Instructor can also teach any programs for which he holds the Specialty Instructor Rating for. Some Specialty Instructor ratings are as simple to achieve as showing proof of Diver Certification in that specialty. This does not include ratings in “restricted” specialties such as First Aid, Oxygen Provider, Wreck Penetration, Nitrox, etc.

14. ACUC (continued)

For a complete list of both, “restricted” and “non-restricted” specialties, contact your nearest ACUC Office.

Advanced Instructor

This is an experience based certification. The Advanced Instructor can teach and certify up to the Assistant Instructor as well as train those preparing to present themselves for evaluation on an Entry Level program. The Advanced Instructor can also teach and certify those specialty programs that he holds qualification in.

14.3.3. - OTHER (OPTIONAL) CERTIFICATION PROGRAMS

Scuba Diver

This is a theory and practical course. The limitations of this certification are that holders will only be able to dive to a maximum depth of 50 feet / 15 metres and they must always dive while directly supervised by an ACUC Divemaster (or similar level from other organisations).

Assistant Instructor

Candidates should be Divemasters. This course has a high content of the theoretical and practical skills in teaching techniques and how to teach the Open Water Diver program, with emphasis on the theory lessons. Candidates should have a minimum of 40 hours of bottom time.

It can be offered by an Open Water Instructor or higher rating, but the evaluation is done by an Advanced Instructor or higher rating. The Assistant Instructor can teach and certify the first four levels of the snorkel program and under the supervision of an Open Water Instructor, teach, but not certify, the Open Water Diver program.

This program is designed for those who desire a slower and more economic progression to the Open Water Instructor's level.

Entry Level Instructor

Candidates should be Divemasters. This course has a high content of the theoretical and practical skills in teaching techniques and how to teach the Open Water Diver program. Candidates should have a minimum of 50 hours of bottom time. It can be offered by an Advanced Instructor or higher rating, but the evaluation is done by an Instructor Trainer or higher rating. The Entry Level Instructor can teach and certify up to and including the Level V Snorkel Instructor and the Open Water Diver. This program is designed for those who desire to be able to earn an income while training to become full Open Water Instructors.

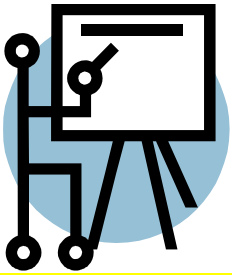
Instructor Trainer

Candidates should be an Advanced Instructor. This course concentrates on how to evaluate the Entry Level Instructor program. It can be offered by an Instructor Trainer Evaluator. The Instructor Trainer can teach and certify all levels up to and including Entry Level Instructor. They can also train and certify as ACUC Instructors those candidates that are already instructors in other ACUC’s recognised organizations. This certification is designed for instructors wishing to teach and evaluate other instructors but do not wish to be dedicated to ACUC exclusively.

14. ACUC (continued)

14.3.4. - INSTRUCTOR TRAINER EVALUATOR CERTIFICATION

The Instructor Trainer Evaluator is the highest rating within ACUC. This is an honorary certification that can only be granted by the Central Office in each country, with the final authorization of our Canadian Headquarters and based on each candidate's individual merits regarding their dedication and collaboration with ACUC. The Instructor Trainer Evaluator can certify all certification levels and he has as a major responsibility, the certification of instructors. The Instructor Trainer Evaluator will be dedicated EXCLUSIVELY to ACUC.



ACUC is continually developing continuing education and specialty courses. For an up to date list of specialties and diving courses, consult with your ACUC Instructor. For information about recreational-technical courses with NITROX, please contact with your nearest ACUC Office.

These standards can change periodically. Check with your ACUC Instructor when you take your course to ensure that the standards shown in this manual are still the same, or check the "Course standards" section of the ACUC Web www.acuc.es

Press on this bar to go to the end of the manual

ACUC

THANK YOU FOR TRUSTING ACUC WITH YOUR DIVING EDUCATION

Please help us to improve our training programs by answering the online course quality control questionnaire that you will find in our web at www.acuc.es

PLEASE RECORD SOMEWHERE FOR YOUR OWN RECORDS

Your Instructor's name:

Your Instructor's Club, School or Dive Centre:

Your Instructor's ACUC #:

Your Instructor's Address:

Your Instructor's phone and fax #:

Your Instructor's email:

ACUC's office in your country (if there is one)

Please note if you wish to contact any of ACUC's HQ:

If you took your ACUC course in Canada or the USA, contact our North American HQ office in Canada (acuchq@acuc.ca). If you took your course anywhere else in the world, contact our European HQ office in Spain (acuc@acuc.es)

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ACUC