ENGLISH REPORT

SCUBA DIVING AND OCEAN ENVIRONMENTAL RESPECT

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1 WHAT IS SCUBA DIVING?

1.1 INTRODUCTION

Scuba diving is a mode of underwater diving where the diver uses a self-contained underwater breathing apparatus (called scuba), which is completely independent of surface supply to breathe underwater. Indeed, divers carry their own source of breathing gas, usually compressed air, allowing them independence and freedom underwater, but also longer underwater endurance than breath-hold divers. Scuba diving is considered as an extreme sport because it's an activity based on safety and if you don't respect the rules, you can die.

1.2 HISTORY

Modern scuba diving gear consists of one or more gas tanks strapped to the divers back, connected to an air hose and an invention called the regulator. The regulator controls the flow of air so that the air pressure within the diver's lungs equals the pressure of the water.

Around 1300, the first rudimentary snorkel used to enhance our abilities underwater was a cut hollow reed. Persian divers were making rudimentary eye goggles from the thinly sliced and polished shells of tortoises.

By the 16th century, wooden barrels were used as primitive diving bells, and for the first-time divers could travel underwater with more than one breath of air, but not much more than one.

In 1771, the air pump was invented by a British engineer, John Smeaton. A hose was connected between the air pump and the diving barrel, allowing air to be pumped to the diver.

In 1772, Frenchmen, Sieur Freminet invented a rebreathing device that recycled the exhaled air from inside of the barrel, this was the first self-contained air device. Freminet's invention was a poor one, the inventor died from lack of oxygen after being in his own device for twenty minutes.

In 1825, English inventor, William James designed another self-contained breather, a cylindrical iron "belt" attached to a copper helmet. The belt held about 30 bars of air, enough for a seven-minute dive.

In 1873, Benoît Rouquayrol and Auguste Denayrouze built a new piece of equipment a rigid diving suit with a safer air supply, however it weighed about 90 kg.

In 1876, Englishmen, Henry Fleuss invented a closed-circuit oxygen rebreather. Fleuss then decided to use his invention for a thirty-foot deep dive underwater. He died from the pure oxygen, which is toxic to humans under pressure.

Emile Gagnan and Jacques Cousteau co-invented the modern demand regulator and an improved autonomous diving suit. In 1942, the team redesigned a car regulator and invented a regulator that would automatically fresh air when a diver breathed. A year later in 1943, Cousteau and Gagnan began selling the Aqua-Lung (first regulator). Shortly

Figure 1 Aqua-Lung regulator

afterwards, this regulator was taken over in different forms for different uses. After that, the equipment has continued to develop to the present day where it is very safe and robust.

1.3 DANGER AND SAFETY

1.3.1 VOLUME AND WEIGHT

On Earth, there is one main force, weight. This force is closely related to gravity defined as follows, where P denotes object's weight, m denotes mass of the object and g denotes the gravitational constant equal to 9.8 on Earth:

$$\vec{P} = m * g$$

In the water, in addition to weight, an opposing force is applied to any object, Archimedes' thrust. It is defined as follows, where P_A denotes the buoyant force applied onto the submerged object, ρ denotes the density of the fluid, V represents the volume of the displaced fluid and g is the acceleration due to gravity:

$$\overrightarrow{P_A} = g * V * \rho$$

Underwater, these two forces oppose and cancel each other out. It is this balance of forces that allows the diver to have zero buoyancy and not sink or float.

$$\overrightarrow{P_A} = \vec{P}$$

On the figure 1, the first situation corresponds to a weight greater than Archimedes' thrust, the object sinks. On the third situation, Archimedes' thrust is greater than the object's

weight, the object floats. On the middle situation, the balance between the forces is respected so the object is stable in the liquid.

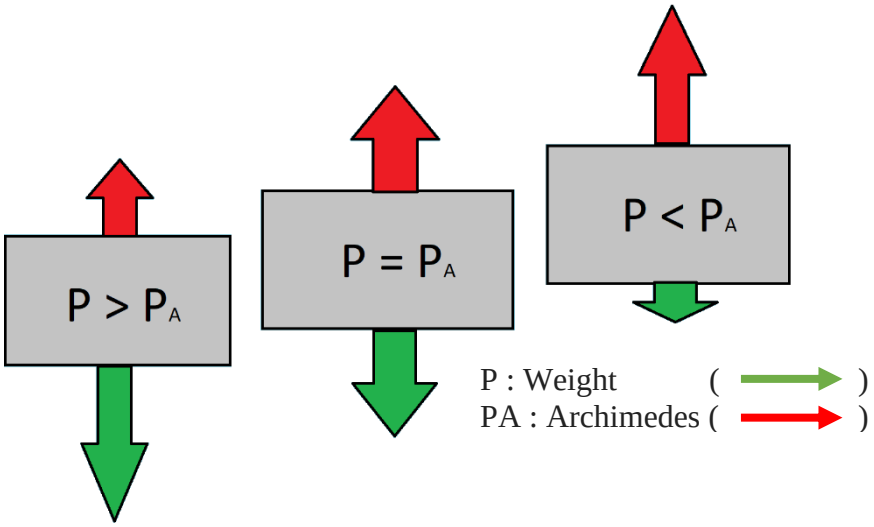

Figure 2 Archimedes's principles

Beyond 66 meters depth, compressed oxygen becomes toxic to the human body. Air is then replaced by gas mixtures which are not harmful at these pressures. For example, dry air contains 21% oxygen and 78% nitrogen and Oxygen is toxic beyond 66 meters depth. A mix named "trimix 10/70" consisting of 10% oxygen, 70% helium, 20% nitrogen is suitable for a 100-metre dive. For scientific research, scientists use a mix named "hydreliox" consisting of 49% hydrogen, 50% helium, 1% oxygen is suitable for a below 130-metre dive.

1.3.2 Pressure and Barotrauma (lungs)

These are not the only forces that apply to a diver in the water. Indeed, pressure is applied to the diver as soon as he submerges. This pressure increases as the diver goes deeper into the water (figure 3). At the surface, the pressure is 1 bar, which corresponds to a column of 1 kilogram per square centimetre. The pressure, expressed in bar, increases by 1 every 10

meters of depth. Therefore, from 0 to 10 metres, the pressure is doubled and from 10 metres to 20 metres, it is doubled again. This is a two-way relationship.

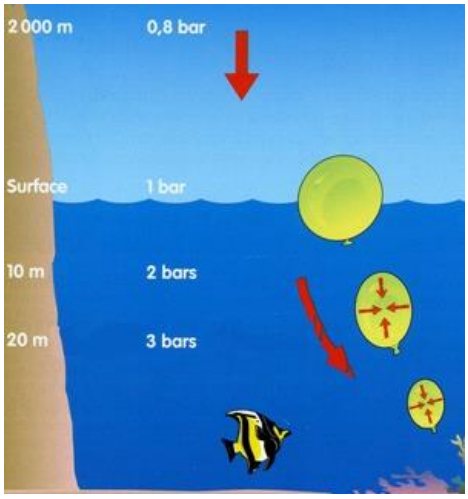

Figure 3 Evolution of the volume as a function of depth

If we assimilate the diver's lungs to the balloon in figure 4 which has a volume of 3 litres at the surface. This balloon will have its volume decreasing inversely in proportion to the pressure. But the lung volume must be constant in order to have a good nourishment of the organs. So, the diver breathes in air to make up the difference in volume and ends up with 3 litres at 20 metres.

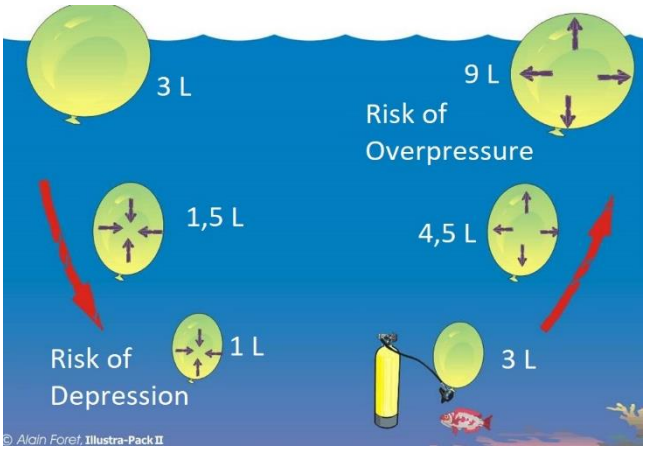

Figure 4 Evolution of the volume as a function of the pressure

This volume will increase (figure 4), always inversely proportional to the value of the pressure to reach a surface volume of 9 litres. However, the maximum lung volume is 5 litres. The diver must therefore exhale to avoid excess lung pressure.

1.3.3 PRESSURE AND BAROTRAUMA (EARS)

Ears are also subject to pressure changes. Indeed, pain may occur during descent. Simplifying an ear, we can say that it consists of an outer ear, an eardrum, a middle ear and an eustachian tube. The eardrum is a flexible membrane that separates the outer ear from the middle ear. The middle ear communicates with the nasal cavities through the eustachian tube. Usually closed, the eustachian tube opens naturally every 2 to 3 minutes or when we yawn or swallow.

During immersion, the pressure outside the ear increases, compressing the air trapped in the middle ear. As it compresses, this air decreases in volume. The middle ear is then depressed and "pulls" on all the surrounding walls. Since the eardrum is relatively flexible, it deforms first, causing a little discomfort when the deformity is small and severe pain if the deformity is large.

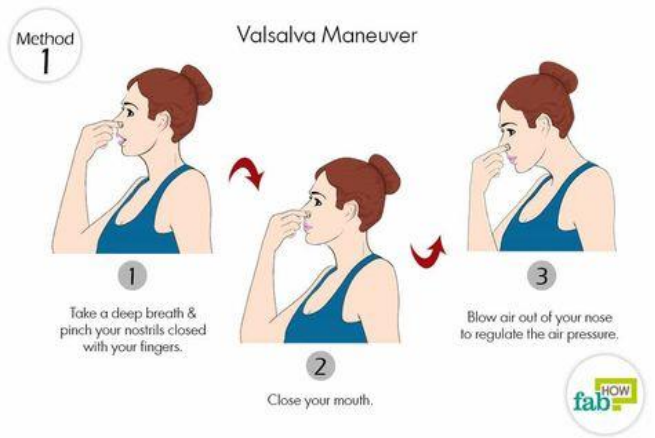

Figure 5 Valsalva Maneuverer

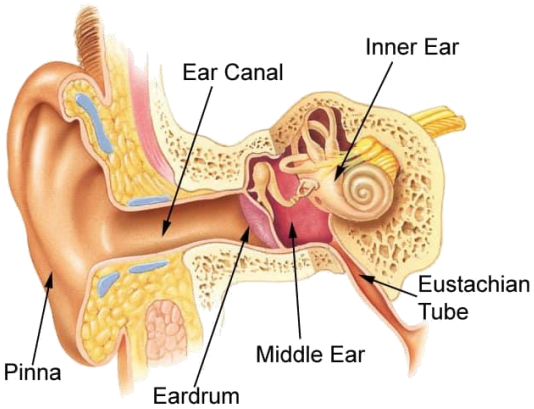

Figure 6 Ear anatomy

To restore correct pressure in the ear canal, the Valsalva maneuverer could be used (figure 5). Consists of pinching your nose and gradually blowing with your mouth closed, as if you were blowing your nose, without being abrupt. This should be done regularly and preventively on descent to avoid any discomfort in the ears.

1.4 LEGISLATION

The legislation is variable according to the regions and according to the organizations which offer diving as activity, but all agree on certain points, for example diving signals are international. Number one means that I'm fine, no problems, the second one means that something is wrong, it's followed by the designation of the place which poses a problem. Third and fourth are for going up or down, and the last to say I don't know. Diving signs are very intuitive for quick and effective understanding. These are just few examples.

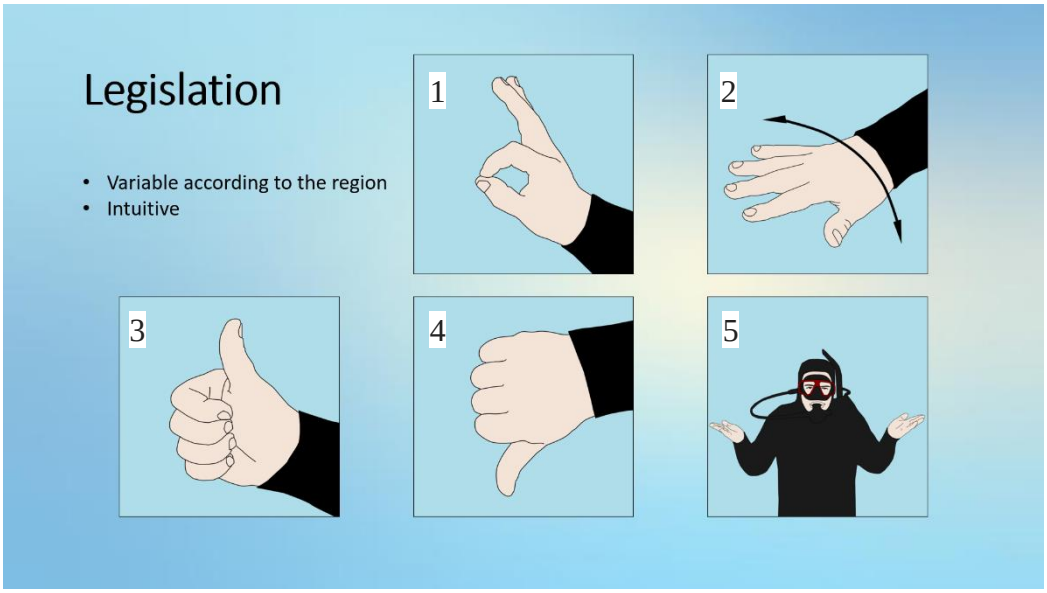

Figure 7 International diving signals

Diving alone is strongly discouraged for obvious safety reasons. Indeed, if anything happens to a diver underwater, there is no one to help him. In France, legally, you can't dive to the depth you want for the time you want. Everything is governed by laws. The CMAS (Confédération Mondiale des Activités Subaquatiques) also called World Underwater Federation, which deals with diving in France, offers levels for divers.

- A one-star diver must be supervised by an instructor and have the right to evolve in the range, 0-20m.

- A two-star diver can evolve independently up to 20m but must remain supervised up to 40m. To reach this level, physicals notions are essential to avoid health problems. They are assessed in writing.

- A three-star diver is fully trained and can dive up to 60m independently. Much more advanced physicals notions are required, always assessed in writing. The diver must be able to plan his dive, so he becomes completely autonomous.

There are also other organisms involved in scuba diving. For example, PADI (Professional Association of Diving Instructors), another international organisation, which offers much more restrictive levels on the depths.

	
1 Star (20m)	Open Water Diver (18m)
2 Star (40m)	Advanced Open Water Diver (30m)
	Rescue Diver
3 Star (60m)	Divemaster (40m)

Figure 8 Equivalences between CMAS and PADI

Scuba diving gear is safe and, in most cases, a technological digest. As a result, diving equipment is very expensive (figure 9). It is a long-term investment, the equipment is solid, and if used well, it can last fifteen years. The essential equipment for diving is as follows: a mask for eye comfort, fins for better ease, scuba tank containing air the way you breathe, diving regulator that allows you breathing underwater, buoyancy compensator to manage your buoyancy.

	full low-end equipment	Average equipment	Professional equipment
Mask	€ 5	€ 70	€ 800
Fins	€ 20	€ 50	€ 150
Diving regulator	€ 120	€ 300	€ 1,500
Buoyancy compensator	€ 140	€ 300	€ 900
Diving suit	€ 10	€ 600	€ 2,400
Others	€ 300	€ 1000	€ 5,900
TOTAL	€ 595	€ 2,420	€ 11,650

Figure 9 Comparative table of price according to the quality of equipment

The diver carries 25kg of equipment on his back. But in water, this weight is no longer a concern thanks to the forces exerted on the diver.

1.4.1 DIVING REGULATOR

A diving regulator is a pressure regulator that reduces pressurized breathing gas to ambient pressure and delivers it to the diver. The gas is supplied from a scuba cylinder carried by the diver. A gas pressure regulator has one or more valves in series which reduce pressure from the source and use the downstream pressure as feedback to control the rate of flow and thereby the delivered pressure, lowering the pressure at each stage. Most diving regulators are two-stage regulators. They consist of a first stage regulator and a second stage demand valve. An intermediate pressure hose connects these components to transfer air and allows relative movement within the limits of hose length and flexibility. Other intermediate pressure hoses provide additional optional components such as another second stage. A high-pressure hose is also connected to the first stage and has a pressure gauge.

1.4.2 BUOYANCY COMPENSATOR

A buoyancy compensator is a piece of diving equipment with an inflatable bladder which is worn by divers to establish neutral buoyancy underwater and positive buoyancy on the surface, when needed. The buoyancy is controlled by adjusting the volume of air in the bladder. It's used in support of lungs.

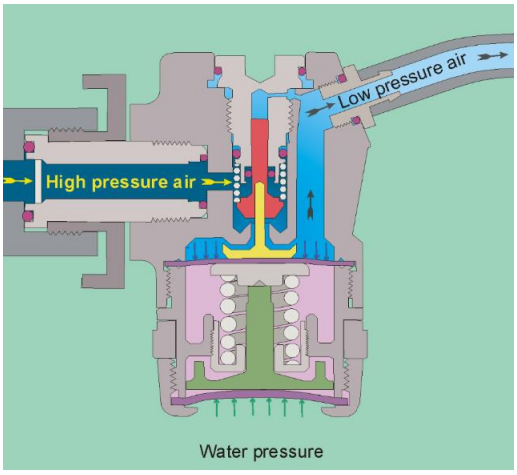

Figure 10 First stage of the diving regulator in a high-pressure environment

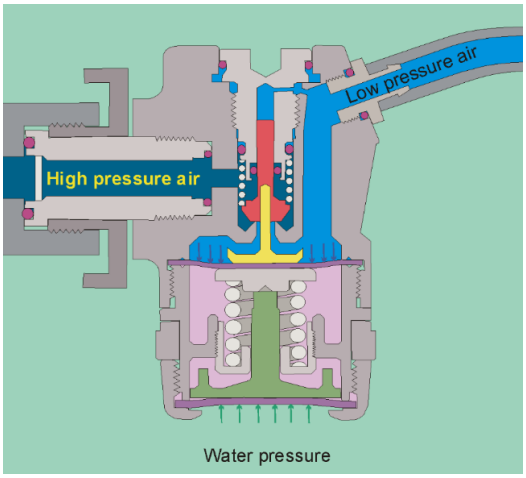

Figure 11 First stage of the diving regulator in a low-pressure environment

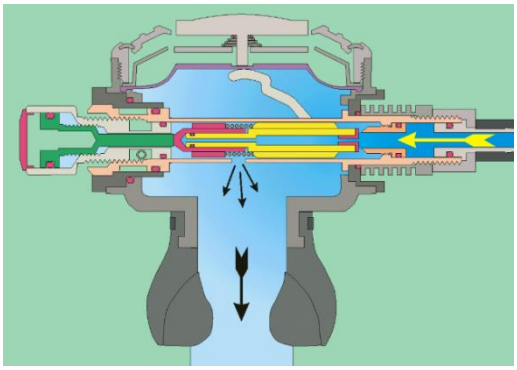

Figure 12 Second stage of the diving regulator in inspiration

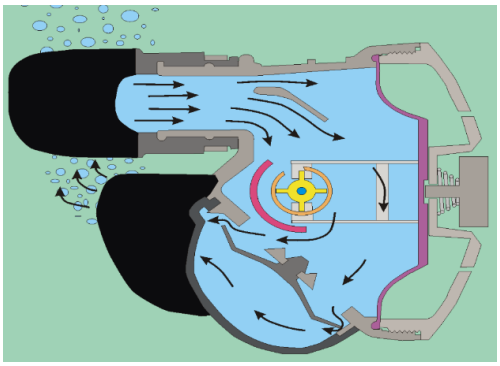

Figure 13 Second stage of the diving regulator in expiration

1.4.3 DIVING SUITS

There are 3 types of diving suits:

The so-called "wet suits" which are as their name indicates wet which means that the isothermal power is only effective because the suit is as close as possible to the body to the body and there is no water current along the diver's body. These suits can be used in so-called warm water or in swimming pools.

Wetsuits called "semi-waterproof" which are watertight thanks to the water. The different openings, at the feet, hands and head are made of a material that "sticks" to the skin when a film of water is present on its surface. These suits can be used in waters between 10 and 25°C or on long dives in warm water.

There are two types of "dry" suits. Neoprene suits are completely waterproof and are isothermal due to their thickness. Trilaminate suits are made of a thin and solid material, but they are not isothermal. A garment must be added to these buttocks.

1.5 TRAVELS

Diving can be practiced in several ways and in different environments and especially everywhere. Just in Limoges, there are 11 diving clubs. Indeed, we can dive in a swimming pool or in a natural environment, whether in a lake, the sea or the ocean. It's therefore one of the sports that is an excuse to travel, in fact, the sea and ocean environment are totally different depending on their location, whether for flora or fauna. For example in the Mediterranean sea, we can observe European pilchard, in Thailand, we can observe turtles, in the Pacific, Manta rays or then great white sharks, but to see a coral reef, you have to go to Australia, forests of Kelp, in California, or fields of Posidonia, in the Mediterranean. In Mexico, cenotes are also almost magical places to dive, they are pockets of underground water that are only accessible through soil erosion. These caves are filled with clear fresh water. Many wrecks lie at the bottom of the oceans, so many places to dive.

1.5.1 GREAT BARRIER REEF

Figure 14 Great Barrier Reef, space view

The Great Barrier Reef is the world's largest coral system composed of over 2,900 individual reefs for over 2,300 kilometres over an area of 350,000 square kilometres. It's located in the Coral Sea, off the North-East coast of Australia (Queensland) in the Coral Sea. As the Great Wall of China, this Great Reef is visible from space (figure 14).

A coral reef consists of coral polyps, which are animals in the jellyfish family, along with algae called "zooxanthellae". The Great Barrier Reef supports a vast array of life forms: Thirty species of whales, dolphins and porpoises have been recorded in the Great Barrier Reef. Large populations of dugongs, large marine mammals that are relatives of the manatees, make their home along the reef.

More than 1,500 fish species live on the reef, including the clownfish, red bass, red-throat emperor, and several species of snapper and coral trout. About 5,000 species of molluscs live on the reef. The Great Barrier Reef is home to 215 species of birds. Saltwater crocodiles live in mangrove and salt marshes on the coast near the reef. Six species of sea turtles come to the reef to breed. The 15 species of seagrass found along the reef attract the dugongs and turtles and provide habitats for the fish.

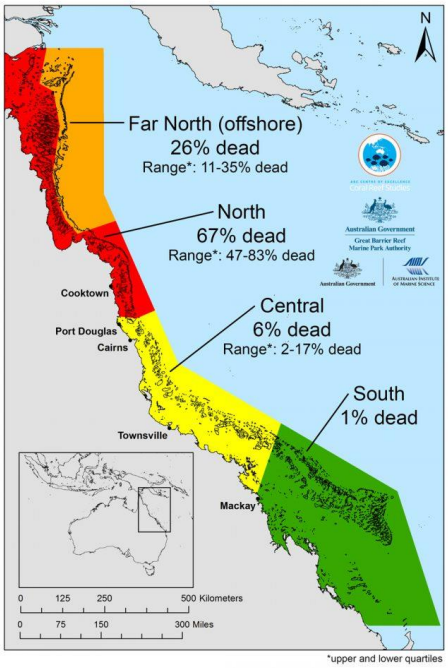

Figure 15 Average coral loss along each section of the Great Barrier Reef.

1.5.2 MEDITERRANEAN POSIDONIA

The Mediterranean Posidonia is a species of aquatic flowering plants endemic to the Mediterranean Sea. It forms vast meadows between the surface and 40 m deep. These meadows constitute the major ecosystem of the Mediterranean and play an important role in protecting the coasts against erosion. It is in these meadows that many organisms, animals and plants, find protection and food. It occupies between 25,000 and 50,000 square kilometers of the Mediterranean coastal areas, corresponding to 25% of the seabed.

It releases about 20 liters of oxygen per day for every square meter of grassland. Posidonia meadows would absorb 10% of the carbon captured by the oceans even though they represent only 0.2% of their surface area. A single square kilometer of this plant would currently store up to 83,000 tons of carbon. This would trap nearly 19.9 billion tons of carbon worldwide, twice as much as the amount of carbon dioxide released by fossil fuel exploitation in 2010. By comparison, a square kilometer of temperate or tropical forest would only contain 30,000 tons of carbon, almost three times less than an herbarium.

It produces and exports biomass either in neighboring ecosystems or at depth. It is home to many species of fish and other small marine animals. It consolidates the bottom of the coast, helping to slow down the transport of sediment due to currents. It acts as a barrier, limiting coastal erosion by limiting the strength of currents. It protects beaches from erosion with leaves washed up on the coast, especially in winter.

Figure 16 Posidonia oceanica

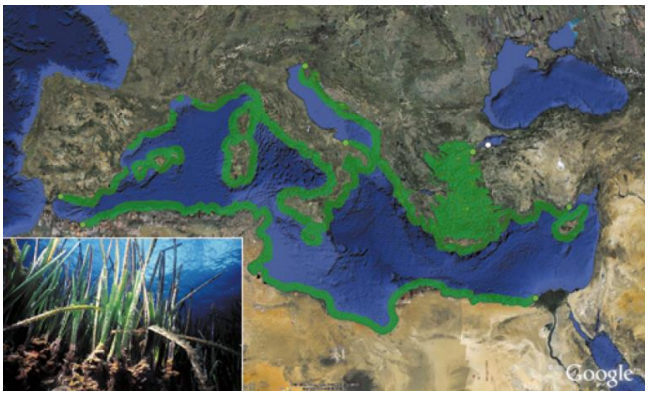

Figure 17 Posidonia oceanica disposition in Mediterranean Sea

1.5.3 KELP FORESTS

Kelp is a kind of seaweed. Some algae form dense patches on rocky reefs, resembling a forest of trees underwater, and are called kelp forests. One third of the kelp forests in southern California are in the Channel Islands National Park and National Marine Sanctuary. The Channel Islands kelp forests undergo a mixture of warm water currents from the south and cold-water currents from the north, creating a highly productive system that supports an abundance and diversity of marine life. Warm-water species include Garibaldi fish, California moray eels and California lobster. Colder water species include black redfish, red abalone and starfish.

More than 1,000 species of marine plants and animals are found in the kelp forests of the Channel Islands. The spikes, stipes (stems) and blades of kelp create a world of incredible biological diversity by providing many fish and invertebrates with food and protection. The thick kelp canopy provides shelter from predators and nursery habitat for juvenile fish.

Figure 18 Kelp forest

Figure 19 Channel Islands National Marine Sanctuary

2 OCEAN ENVIRONMENTAL RESPECT

2.1 THE PROBLEMS OF THE OCEAN

2.1.1 WATER POLLUTION

When scuba diving, several problems caused by humans can be observed in the ocean. First, there is aquatic pollution, which is mainly due to plastic waste. Every year, 8 million tons of plastic waste ends up in the oceans.

This waste is dumped there in different ways, for example, between 1 and 2.5 million tonnes of plastic are dumped into the ocean by rivers every year. There is also all the rubbish left by tourists on the beach. So, garbage carried by wind, rain and rivers eventually ends up in the oceans. After it arrives, most of the garbage sinks and settles to the bottom of the ocean but some of it floats and is carried by the currents, or it may end up on the beaches, but most of this garbage ends up on five points. These points are in the North Atlantic Ocean, the South Atlantic Ocean, the Indian Ocean, and the South Pacific Ocean.

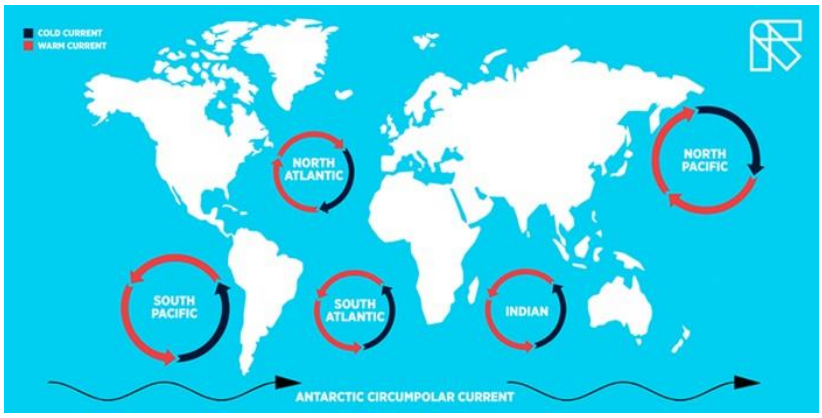

Figure 20 Ocean's Garbage Patch

The largest is in the North Pacific Ocean, it is called the seventh continent or Great Pacific Garbage Patch and was discovered by an oceanographer Charles Moore in 1997. The reason why this area had not been discovered before is that the plastic materials are transparent and on the surface of the water, so the satellites had not spotted it. It is believed that this continent contains between 50 miles and 150 thousand tons of garbage. This garbage

causes a huge problem for aquatic life because marine animals often confuse plastic garbage with their food. This is the case, for example, with turtles that mistake plastic bags for jellyfish and can choke on them. This is also the case for seabirds, according to an Australian study 90% of seabirds have plastic fragments in their stomachs.

2.1.2 OVERFISHING

The second very present problem is overfishing. First, I'll explain what it is called when too many fish are caught in the oceans and lakes to such an extent that there are not enough adults to maintain a stable population. This is largely due to illegal fishing, because according to experts, between 15% and 30% of the world's catches are illegal or unreported.

In addition to preventing fish from reproducing properly, overfishing poses problems for ocean management, as it causes the disappearance of key predators such as sharks and tuna, which are particularly affected by this phenomenon. When they are removed from the ocean, marine creatures along the food chain are negatively affected.

For this is detrimental to the proper functioning of the food chain. It is also important to know that 47% of the fish we eat come from aquatic culture, the problem is that most of these fish are carnivorous, for example, it takes 5 kg of wild fish to produce 1 kg of farmed salmon. Aquaculture is not a solution, because it's just a way of turning low-value commercial fish into high-value commercial fish. You probably think there are fishing quotas set by the European Union that are used to prevent extinction. But you must realize that it's far from helpful. Take the example of bluefin tuna in 2008, when experts determined that no more than 10,000 tonnes of bluefin tuna should be caught to allow the species to reproduce properly. But the EU ministers set the limit at almost 30 thousand tonnes, so that

in the end more than 61 thousand tonnes of bluefin tuna were caught. This example shows that the EU does not care enough about overfishing.

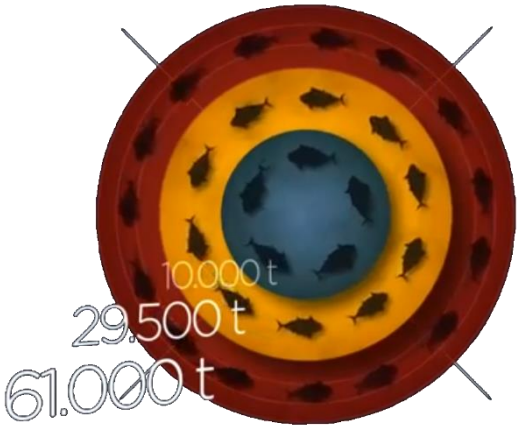

Figure 21 Bluefin tuna fishing limits

2.1.3 GREAT BARRIER REEF

The third problem is the survival of an endangered reef. Indeed, as we have seen before, one of the enormous resources of the ocean is the Great Barrier Reef. We can say without a doubt that it is a marvel of the world's ecological heritage. But this wonder is endangered because Greenpeace has written a report to find out what the biggest problems are that affect this place.

First, the coal industry, which is an ever-growing industry, it should also be known that coal is the most polluting source of energy, being responsible for 30% of the world's CO2 emissions. The biggest coal-exporting country is Australia, and that is not going to get any better because the Queensland government has launched a coal mega-mine project. This mine aims to be the largest in Australia but according to the calculations of scientists it will have a carbon footprint ten times greater than that of the city of Sydney.

Secondly, there is the problem of coral bleaching. According to a report made in 2016, 516 reefs out of 520 were bleached and may not recover (Figure 15). It must be said that the bleaching is caused by human activities, because due to global warming the temperature of the oceans is higher than normal, and this is when the corals expel the algae with which they

live in symbiosis. The loss of algae causes stress to the coral, which then becomes completely white.

Finally, there is the problem of ocean acidification, as more than a quarter of the CO2 linked to human activity is absorbed by the oceans, with the increase of CO2 concentrations in the atmosphere, more and more of this gas is dissolved in the oceans. By absorbing this carbon dioxide, the oceans undergo chemical transformations that make them more acidic. This slows down the development of coral and could eventually cause its loss.

2.2 How to Solve these Problems

2.2.1 Solutions to Reduce Water Pollution

There are many articles on the internet that can help you reduce the amount of plastic you consume and prevent it from ending up in the oceans. But on a large scale, the European Union is also looking for solutions, as it intends to ban single-use plastics before 2021, which is already the case for cotton buds. You have probably noticed that, for example, at McDonald's, there are no more plastic straws in drinks since 18 November 2019, in an interview with Delphine Smagghe, the president of McDonald's, who says that only 4% of plastic remains in their packaging. There are also major awareness campaigns aimed at getting people to react. These campaigns generally talk about what people should avoid doing in their daily lives. For example, anything that should not be thrown down the sink, bathtub or toilet. Among the rubbish that should not be thrown away are solid objects such as cotton buds, but also cooking oil, medicines and toxic products. But also, what should not be thrown out in the open because anything that falls through the floor grates ends up in lakes or rivers. So, besides that, you should not change an engine, wash your car, empty ashtrays and anything else you do not want to find in the oceans. To make people aware of the action, an association has been created in France, it is called "*Un océan de vie*" (An ocean of life). This association had the idea to clean the oceans on a large scale, it has set up a collaboration with several companies on the seaside. The concept is simple Each volunteer

can look for a bag made available in public or private places, clubs or shops participating in the operation. He will be able to slip it into his jacket, under his wetsuit, fix it on his kayak, or on his boat. During his trip at sea, he will thus have the possibility to collect the waste floating in the ocean. Once back home, he can throw this waste into recycling bins.

Figure 22 "Un ocean de vie" 's bag

As we've all told you, divers are concerned about the survival of the oceans, as you can see, because one of the associations that works with them is the ANMP, which is the national association of diving instructors. If you want to get involved, you can get involved, just go to one of their partner companies, which are represented by a button, and pick up garbage.

2.2.2 SOLUTIONS TO OVERFISHING

For the problem of overfishing, an organization called WWF, which represents the World Wildlife Fund, was founded in 1961 to help protect the environment. It conducts surveys to make sure vendors fish in a way that is safe for the oceans and publishes a buying guide to help consumers buy the right products, both for themselves and for the environment. At your level, the only thing you can do against overfishing is not to eat too many fish and to control where they come from. But on a large scale GreenPeace offers three main interesting solutions. The first is to set up a network of 30% marine reserves in which fishing would be banned. The second is to promote sustainable fishing in the remaining 70%, which would allow fish to return to a stable ecosystem. And finally, to step up controls to combat illegal fishing.

2.2.3 SOLUTIONS TO SAVE THE GREAT BARRIER REEF

Finally, I will talk to you about solutions to save the Great Barrier Reef. First, the Australian government must put in place a concrete protection plan. It should also ban the development of the coal industry near the reef and take better account of the threats of climate change, rather than censoring UN reports on the consequences of global warming for World Heritage sites, as it did recently. Then there is also the problem of all the other energies that pollute, so it is better to move towards renewable energies.

CONCLUSION

Divers are also very involved in the respect of the oceans. Indeed, the training of divers also involves knowledge of the different environments in which they evolve. By remaining stabilized in the water without touching the bottom, we protect the latter, underwater hunting is prohibited in scuba diving. The diver must protect nature if he does not want to dive in a sea of plastic without any fish. Diving federations therefore require divers to reduce their consumption of fresh water, to sort waste so that they do not wander around in the open sea among others.

To conclude, scuba diving is an activity that highlights the need to protect the planet against harmful human activity.

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