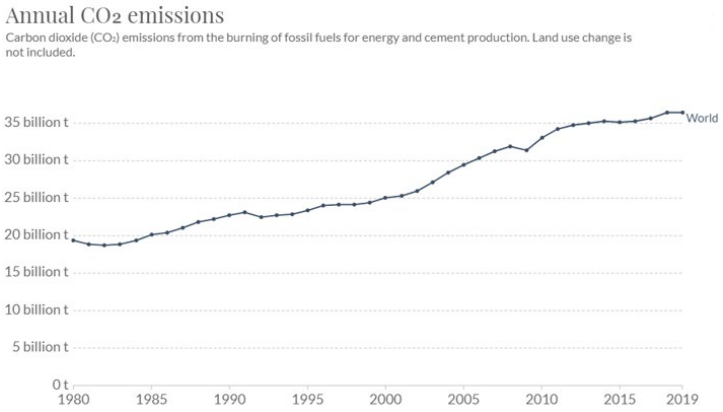
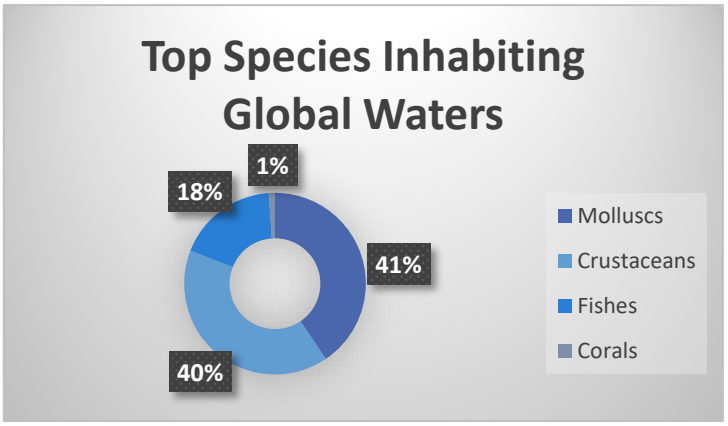
Saving The Depths

In the last 20 years (2000-2020), the annual global emission of carbon dioxide has increased by 10 billion tons (from 25 billion tons to 35 billion tons), double the increase of emissions between 1980-2000 (increased from 15 billion tons to 20 billion tons). The most concentrated areas of emissions are China and the USA. Both confine with the Pacific Ocean, home to more than 18.000 species of fishes in addition to other sea creatures, and to an estimate of 5.000 coral species which occupy around 1 percent of the seabed: That is exactly why we need to conserve them and avoid letting one of our main life support system fail.



This graph represents the annual Co2 emission in tons from the last 40 years
*-From **OurWorldInData***



*This pie chart represents the percentage of the top species that live in the oceans **(Notice the 1% of corals)***
*-From **OurWorldInData***

One of the reasons that we need to conserve these beautiful places and creatures is because they hold a very important foundation for the sea's ecosystem, protecting prey from predators and reducing the wave impact along the coastline disrupting the current's water flow.

Even if this is a valid reason to work as hard as possible to conserve these organisms, humans do not bring much attention to the problem, until the motive for reducing the risk of death of a big percentage of reefs is viewed from a selfish point of view. So, following this concept, we can come up with even more reasons why it is essential to save corals that are disappearing at an alarming rate:

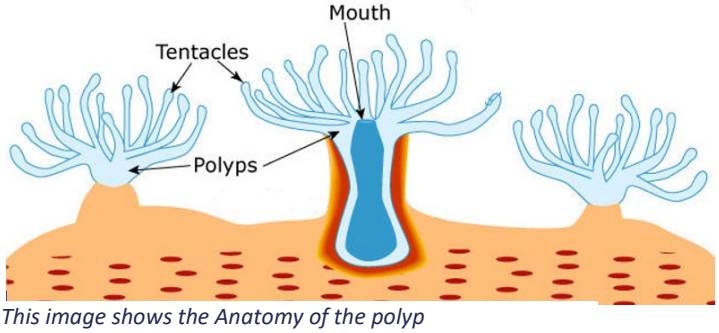
1. Corals, and reefs more in general, attract many fishes of various species, making the environment suitable for tourism such as scuba diving and snorkeling, which in turn provides a good income to local businesses like restaurants and shops.

2. Corals give protection to many different species of fishes which in turn make good sources of food and profits for fishers and fish farms making it easier to fish. Plus, reefs provide an important ecosystem for underwater life and if they are taken out of the equation, the entire food chain could collapse, ending many species and making the entirety of sea life unsustainable.

3. Corals, from a medical perspective, are applied in many different medicines and techniques; for example, these creatures are used as calcium supplements and can treat and prevent a vast array of diseases like cancer, multiple sclerosis heart diseases, and other chronic health problems. In addition, corals have an important role in a surgeon's arsenal, since they serve as a foundation for growing new bone in reconstructive surgery, cosmetic facial surgery, and in areas damaged by trauma.

Corals help us in many ways and make us prosper economically and medically, but in return, we release deadly gasses that are exterminating sea life at an alarming rate and if we keep this up, global warming will have irreversible consequences very soon; let me show you how:

Firstly, let's understand the process behind global warming from a coral's point of view. When we emit carbon dioxide into the air, it starts a process called the greenhouse effect which traps heat generated by the sun rays inside the atmosphere. This effect helps the Earth stay warm during night-time, but if there are too many greenhouse gasses in the air than there should be, the heat that remains in the atmosphere will gradually overheat the Earth, cooking it from the inside till reaching a point in which global temperature has increased by **1 C°,** which sounds like a very insignificant change, but if we consider that this alteration has taken place in every point of **4,200,000,000 cubic kilometers** of the atmosphere, that becomes a colossal increase. The only problem with this situation, apart from the possibility of an unsettling environment for the humans, is regarding water, or more precisely seas, that absorb roughly **90%** of heat present in the atmosphere, increasing its temperature by concerning rates, which disrupts water currents and makes sea life vulnerable since many sea creatures, corals, in particular,



This image shows the Anatomy of the polyp
*-From **USGS***

are very heat sensitive and just a little spike in temperature could destroy centuries (100 years) of work and evolution. This is because the micro-algae contained inside the walls of the coral is utilized as a main and important food source that is combined with other nutrients captured and eaten by the polyps, tiny animals which consist of many tentacles, a mouth, and a “stomach”.

A fun fact about polyps is that they come from the same family as jellyfish, which is called Cnidaria, therefore, destroying corals, would be like destroying 500 million years of evolution since jellyfishes started out as polyps which then became mobile and weren’t anymore stationary!

Now, going back to corals, the way that they die is due to starvation: micro-algae is actually the one to decease with a rising water temperature, and corals, like other organisms, don’t want to keep something dead inside their body so they expel the algae making the entire coral white (the algae provides the color for the coral): this process is called bleaching. Now the coral has no reliable food source and the one provided by the polyps is not enough, slowly starving it to death. After the organism has completely ceased living, the build-up brought by the current will start depositing on the coral’s corpse.

This image shows before and after the bleaching effect took place
*-From **Vox***

Many researchers and scientists are trying to come up with a solution to slow down global warming and unfortunately, we cannot reverse the damage done overnight, and stopping the increasing temperature would take several decades but we can slow it down.

The first idea that comes to mind on how to slow down global warming is to reduce the emissions of greenhouse gasses in the atmosphere so to directly stem the source of global warming, but this would mean changing the lifestyle of more than **7.5 billion** people which would take a lot more time, of which we do not have. So others have taken the lead and started building and developing a **Co2 capture**

system which takes in large quantities of air that are then passed through an ammonia solution which captures all the carbon particles. The solution is later flushed into another stage and gets separated from the carbon dioxide that is then stored and buried underground or pumped into the sea.

This image shows the fans of the Swiss Co2 Capture System
*-From **Climate Central***

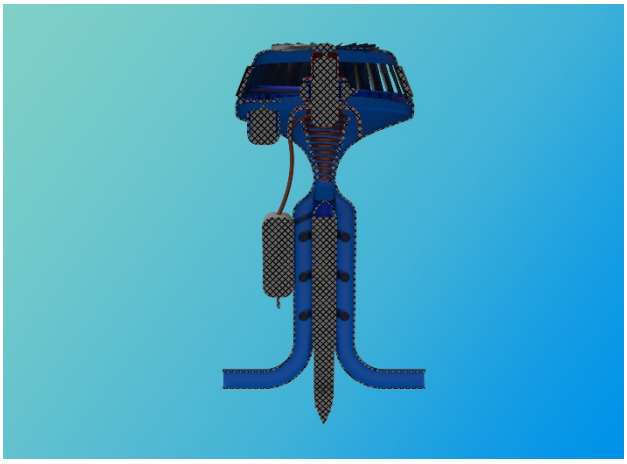
This system is already operational, but it does not provide the corals with a long-term solution and a high survival probability, so I came up with two main solutions/machines:

- There are many types of fishes, all have different colors and different abilities: but one, in particular, has a very peculiar upgrade which poses a threat to corals: **The Parrot Fish**. This species can eat practically anything, including corals, thanks to the **beak** on the fish's mouth (hence the name parrotfish). The Parrot Fish is an **extreme danger to corals** since it has no problem "sinking its teeth" into them, and the only other marine animal that hunts the parrotfish are **sharks**, which are fished from humans in always increasing quantities, resulting in an **over-population** of the parrotfishes. The solution that I came up with is very simple: it includes tinting fishing nets with **thermochromic paint**. This gives the net the ability to **change color** after a certain time while being exposed to a heat variation. The net will eventually turn from white to red (or into a color with good contrast against the blue of the ocean) making it **visible to fishes** which will then avoid it. In turn, this gives the necessity to bring the net back up on the fishing boat and wait for the **chromic effect to end**, turning the net white again. This technique **prevents** the **over-fishing of marine life** and disruption of the ecosystem, especially the fishing of sharks, while still giving **a good profit** for the fishermen.

This image shows a Parrot Fish eating a coral
*-Form **Color Green Science***

- The other idea/machine that I came up with is a “**Coral Cooler**”. The aim of this device has nothing to do with marine life, but rather with solving the problems that global warming is inflicting against corals. The machine’s purpose is to cool down a large volume of water around a reef so to save the corals and make them recover. The primary concept on which the device is based is the aspiration, thanks to fans, of large chunks of water that are then cooled down extremely fast while passing through a cooling coil (heat pipe) inside which a refrigerant in the gaseous state is constantly flowing to and from a pump and a compressor, imitating the same system used in fridges and freezers. However, all of these parts need to be coordinated and directed independently, presenting the necessity of a “controller” or “central computer”: this is why, all the cables and information run through a small waterproof briefcase in which are contained: a power switch, control knobs to control the desired temperature of the water and other parameters and a small LCD screen that displays valuable and primary information. The cooler has even another ability: to carbonate the water with Co2 using exterior canisters and tanks containing the gas which then is injected, near the coil, into the water. The reason why this process is necessary is that carbon dioxide is very useful for corals, which, just as terrestrial plants and trees, transforms it into breathable oxygen through photosynthesis to create the energy needed for the organisms.

This image shows the render of the Coral Cooler concept
*-Made with **Keyshot***

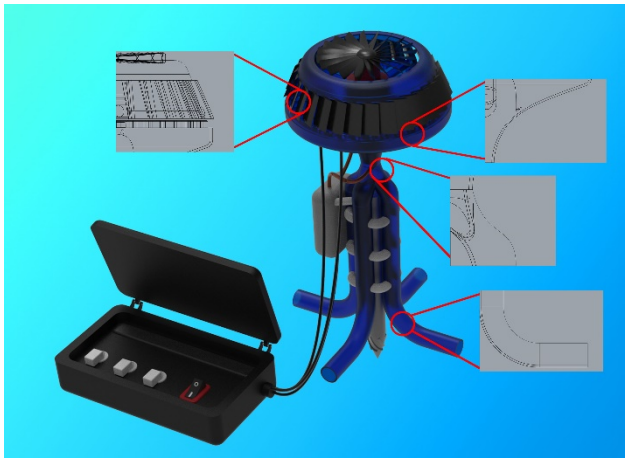


This image shows the cutaway of the Coral Cooler concept
*-Made with **Keyshot***

Before going into more detail about the machine, let's firstly see the materials used to make this project possible: the majority of the structure will be fabricated from bioplastics made from PLA, a Polylactic acid-based plastic, which will then be coated in a thin layer of resin to avoid the breakage and release into open waters of small pellets and pieces of plastic. The fans will be made out of Nylon or carbon fiber due to their light but resistant properties. Meanwhile, the drill tip will be constructed with steel, later coated with and hydrophobic solution to avoid corrosion over a long period.

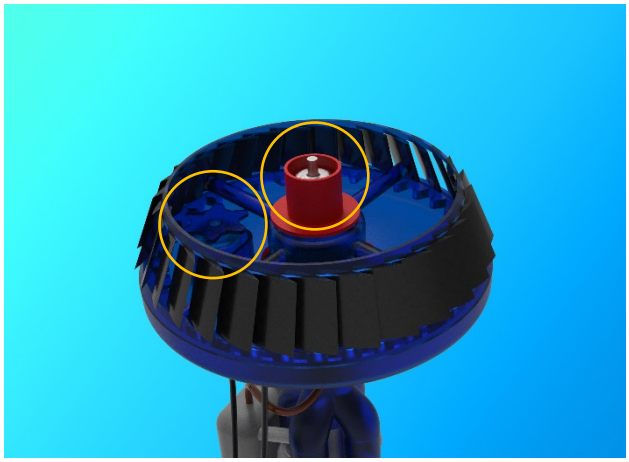
Now let's get into the more interesting part, analyzing the device from top to bottom:

- Already, taking a first glance at the cooler, you can notice that there aren't any sharp edges, inside and outside the device: this is to make the water flow inside smoother and with less drag to keep the flow as fast as possible, meanwhile, the round edges on the outside are to avoid that very strong current tip the structure over and possibly launch it onto reefs, ruining them.



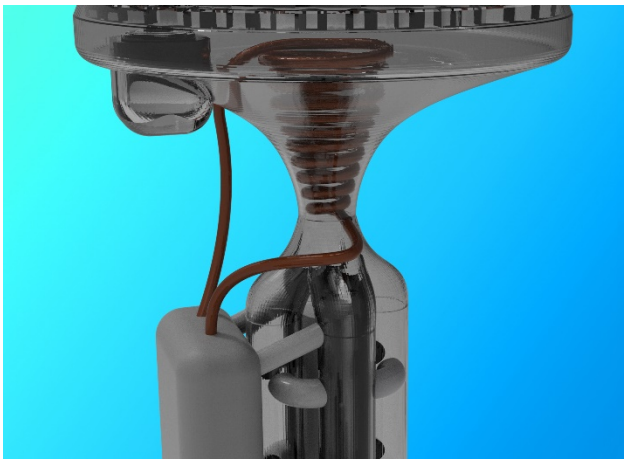
This image shows the complete Coral Cooler with profiles of the main parts
*-Made with **KeyShot** and **Rhinoceros3D***

- Secondly, let's take a look at the uppermost portion of the structure: this includes a big fan on the top which pushes air down into the funnel-shaped head and a centrifuge fan, composed of an array of fins, made to gather even more fluids that are all pushed down into the intersection. Both of these fans or turbines are rotating thanks to 2 independent motors: one fixed on a lateral part of the under-body of the funnel, and another one attached to a central resistant shaft, well-anchored down.



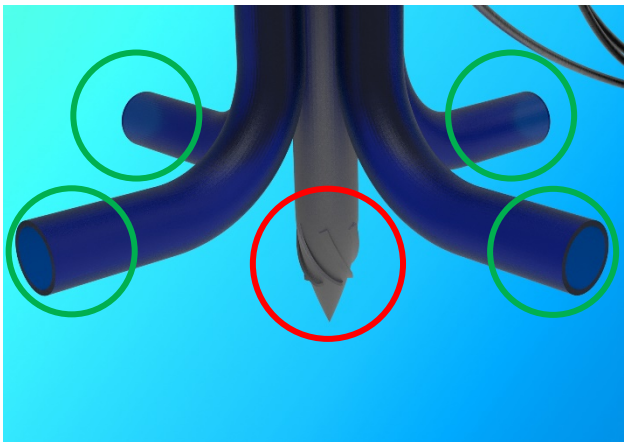
*This image shows the top part of the Cooler with the 2 motors **(Indicated by the Orange Circles)***
*-Made with **KeyShot***

- Next, while looking at the middle section, you can notice that here is where all the “magic” happens: here, valves linked to carbon dioxide tanks, pump the flow of water with the gas enriching it while at the same time a hollow heat pipe flows in a spiral shape along the intersection. The pipe is filled with a refrigerant in a gaseous state that is constantly flowing thanks to a compressor and an expansion valve that are continuously changing the state of the fluid inside the pipe so that the heat exchange can occur. Now though, another problem presents, because the heat that the pipe is carrying needs to as transferred and depleted without dumping it into the water, which would take away the entire point of the machine. But this troubling situation can be resolved thanks to a thermoelectric generator that will turn all of the heat into electricity making a secondary power source for the device. Instead, the main power source consists in the leaching of a nearby power grid, and an underwater turbine or floating solar panels depending on its location and the currents that are present there. In addition, located in this region of the device, there will be installed an array of sensors which purpose is to relay and store data so that it can be harvested and used in further researches.



This image shows the cooling coil found inside the funnel-shaped intersection with the box containing vital components
*-Made with **KeyShot***

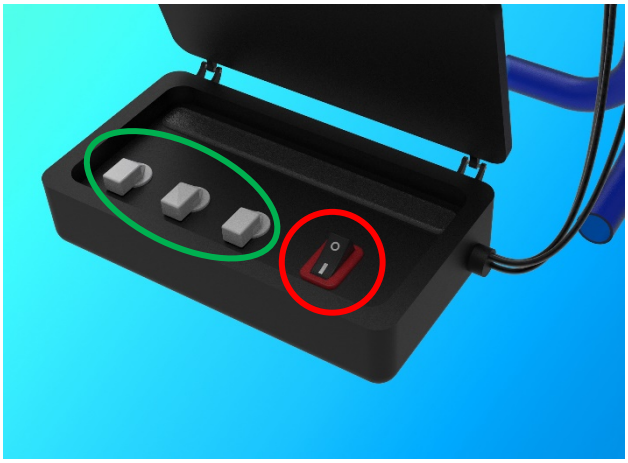
- Finally, observing the lower section, there are present four octopus-shaped pipes which serve as output pipe we’re the cooler and co2 enriched water escapes going back in the outside environment, and fortunately, since cold water is denser and “sinks” it is not sucked back in by the fans. There is also a box, attached to one of the output pipes, that contains a refrigerant



*This image shows the drill tip **(Red Circle)** and the 4 exhaust tube where water will exit **(Green Circle)***
*-Made with **KeyShot***

tank, a compressor, an expansion valve and a thermoelectric generator. All of this machinery is used to recreate a fridge, with the compressor that turns gas into liquid for the heat exchange with the generator, meanwhile, the expansion valve turns liquid into gas to then cool down the water. Lastly, just under the pipes, there is a large drill tip made to firmly perforate the ground to hold the structure properly since without it, there would be a high probability of the device tipping over due to the high center of mass.

- In the meantime, all of these very complex processes and instruction, that need to be executed with coordination, run all through a command box or console which manages the inputs from sensors and components to then form complete and organized commands. This console is composed of a power switch that could instantly turn on or off the machine and 3 rotatable knobs that could be regulated as wanted to determine: the desired temperature of the surrounding water, amount of refrigerant used, and at what speed to determine the velocity with which the cooler cools down water and a third to choose the speed of the turbines which constantly suck in water. Finally, on the top of the control panel, there is an LCD screen that can display the most valuable data and information used for later adjustments and research.



*This image shows the console with the on/off switch **(Red Circle)** and the 3 knobs **(Green Circle)***
*-Made with **KeyShot***