# A Novel Way to Solve Coral Bleaching

By Preethi Vijay & Trisha Prabhu

## Abstract

### Background

The objective of our experiment and prototype was to take preventative measures against the  growing number of coral bleachings. Out of 1036 reefs surveyed during the 2020 mass bleaching, around 60% of the corals had moderate to severe bleaching. Bleaching being the largest cause of death for these corals. Which lead us to our hypothesis of if we were to use a thermoelectric chip combined with a CPU fan and heatsink, and connected it to a 12 volt power bank, it would enable us to create a water coolant technique that runs on hydro energy, therefore cooling down the reefs more efficiently than methods that are being pondered.

### Investigation

The concept behind our prototype was inspired by the process of thermal equilibrium. In addition a key part of our project resides within a peltier module. The chip is an implementation of the peltier effect which is the cooling of one junction and the heating of another when a current is passed. This allowed for our prototype to cool below ambient temperature and meet goals of cooling down the water.

### Experimenting & Results

In order to find out how to accurately compare our prototype to other methods, the experiment was conducted in a 1 gallon tank. Water heated to 85°F. We compared both water cooling techniques and after 10 minutes, took the temperature of the water during trials to see which cooled down more. Due to the idea of thermal equilibrium, our prototype proved much more effective by the even distribution of cooler water.

## Introduction

The objective of this experiment was to create a prototype that reduced the water temperature below ambient temperature of the water so that it makes a liveable environment for the coral to sustain life in, that being said the main cause for coral death is coral bleaching caused by the warming ocean temperatures. Coral bleaching occurs when a coral loses its vibrant color and turns into a bleached white. Although many know that the bleaching is being caused by ocean temperatures rising, many are unaware of the overall bleaching process which occurs. Corals are known for their bright and vibrant colors however this color doesn't come from the coral itself but from an algae called zooxanthellae. That being said when the coral is put into stress it releases the zooxanthellae because the two have a symbiotic relationship meaning that both organisms provide and help each other out. This therefore causes the coral to lose its color and become bleached, however the color isn’t the only thing being affected, but the livelihood of the coral itself. Zooxanthellae also provides food for the coral so without it the coral cannot survive therefore causing it to die unless the coral de-stresses. Corals need a water temperature of 74°F and 83°F. Even the slightest temperature change or offset can kill a whole reef of corals.

## Other Methods

Cool water dumping and coral nurseries are current methods of helping save the world’s coral reefs. Cool water dumping is estimated to cost about $3.9 million dollars for one summer. Coral nurseries cost $150,000 just to grow one reef. These methods aren’t effective for the amount of money they are costing. Cool water dumping doesn't cool down the ocean at all. The quote, "you can't boil the ocean," means an impossible task, but the same is true for cooling down the ocean. Coral nurseries are to grow corals but just so that they can go back into the ocean and possibly go through the same bleaching process again. These two methods being used are being used as a bandaid on a bullet wound. They do not address the actual problem of coral bleaching and how we can cool down the water near a coral to make the temperature so they don't expel their zooxanthellae and be very vulnerable to death and disease.

## Thermal Equilibrium

Thermal equilibrium means that when two surfaces or substances are brought into contact together, the hotter surface will transfer its heat to the colder substance by conduction. For example if there is a surface that is 100°F and another that is 0°F then when the two are brought together the temperature of both will be 50°F because the hotter surface transfers its heat onto the colder surface therefore being in equilibrium or balance. This relates to our project because the peltier effect carries out thermal equilibrium by a current making cooling and heating when it goes through the contact area between the two solids that are close together and transferring heat by conduction.

## How Materials Are Affected by Thermal Equilibrium

The materials used to create this prototype correlates to one or more parts of thermal equilibrium. The first material used to create the prototype was an APC fan. This distributes the coolness in the combination of hotter and cooler in thermal equilibrium. The coolness of the fan works with the heat sink and thermoelectric chip to employ the peltier effect by the heating of that junction and the cooling of the water. The power bank that is used to power our prototype replicates the harnessing of the tidal energy used in the ocean if large-scaled. The heat sink compound is used to fill gaps between the CPU (central processing unit) or other heat generating components and the mechanical heat sink. The mechanical heat sink, a passive component made of a conductive metal, is placed over the CPU. We used this to glue the APC fan to the thermoelectric chip. The thermoelectric Chip is a mechanism that employs the Peltier effect for thermal transfer. Heat is created on one side of the junction and absorbed on the other as current travels through the junction between two ceramic substrates. It acts as the barrier between the heat transfer and is the barrier in thermal equilibrium. The APC fan is a commonly found object that is used in computers to cool down their central processing unit (CPU). This part was not extremely hard to find as you may find it in most computer hardware stores or repair shops. The thermoelectric chip is designed for cooling down temperatures below ambient temperature. This is one of the main parts to cooling down the water.

## Peltier Effect

The Peltier effect is the cooling of one junction and the heating of the other when an electric current is maintained in a circuit of material consisting of two dissimilar conductors; the effect is even stronger in circuits containing dissimilar semiconductors. A temperature drop occurs at the junction where the current passes from bismuth to copper. Peltier modules can be an optimum solution when there is a need to cool an object to below the ambient temperature or to maintain an object at a specific temperature. The heat exchanger is typically either the electronic package itself or an extruded or stamped heat sink attached to the package. The Peltier effect is the reverse phenomenon of the Seebeck effect; the electrical current flowing through the junction connecting two materials will emit or absorb heat per unit time at the junction to balance the difference in the chemical potential of the two materials. The APC fan spreads the coolness around the mechanism, cooling down the heated water which leads to the water temperature going below ambient temperature resulting in the water becoming a livable temperature for the corals.

## Creating Prototype and Testing

The creation of the prototype was fairly easy and didn’t require immense amounts of work. We first cut out a plastic tupperware container according to the size of the thermoelectric chip. Then we put our simple heat sink into the inside of the container and used our heat compound to ensure that it wouldn't fall apart. We stuck the thermoelectric chip onto the back of our heatsink and from there added more heat compound and attached the APC fan with heat sink to the chip. Finally we connected all of the wires together and connected them to our power supply. After the prototype was created we then needed to test it out. The prototype reduced the water temperature by an average of 6.03°F. Cool water dumping was also tested but only reduced the water temperature by an average of 1°F.

## Results

The prototype that had been created actually reduced the temperature of the water the most and did not change the pH of the water unlike the cool water dumping. Timers were stopped at the same time for about 10 minutes. The prototype and cool water dumping were given the same amount of time to cool down the water. The cool water dumping only lowered the temperature of the water by 1.5°F the first trial, 0.5°F the second trial, and 1.1°F the third trial. The prototype lowered the temperature of 6°F the first trial, 5.5°F the second trial, and 6.6°F the third trial. Clearly our prototype lowered the temperature a lot more than the methods being used today. Also the cool water dumping changed the pH of the water. That is another reason why corals are bleaching. Our prototype just lowered the water temperature and didn’t add anything else into the water.

## Conclusion

Overall the prototype created opens up new venues and ideas for future coral bleaching solutions. Helping fix coral bleaching has proven to be more effective when trying to address the problem of thermal stress on corals itself and cooling down the water near corals. Despite all the advancements and success, there is always room for refinement. In addition we also think we could’ve improved upon the overall build and structure of our prototype due to the fact that it was not very stable. Also the effectiveness and efficiency of the prototype could be improved upon as it is not extremely fast but is slower paced. Furthermore we would like to improve the look of the prototype and make it so that if it is scaled to the ocean, it would not be an eye sore or anything that disrupts the viewing and look of the ocean and coral reefs.

## References


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