



## Coral, a Habitat to be Protected

Heir Charley Peebler, 13 years old

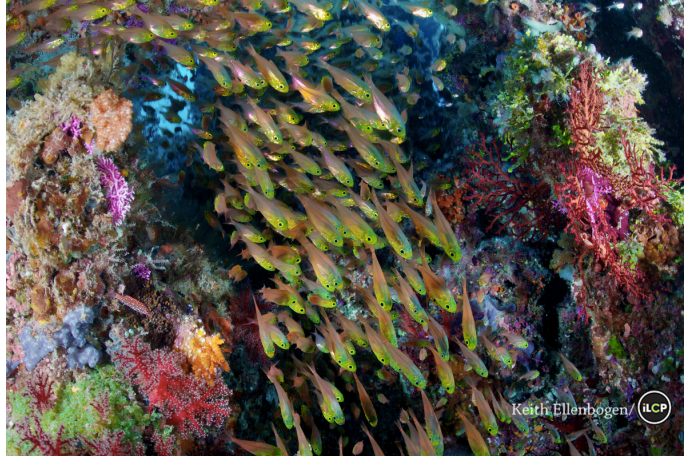
June 2017

What is coral? Is it **animal**, **vegetable**, or **mineral**? Well, in a way, it's all of them at the same time. Coral is a marine **animal** that builds a **limestone** structure to support their small, fleshy bodies. It contains an **algae** called zooxanthellae (zoh-uh-zan-THEL-ee) that supplies the coral with sugars to ingest as food, and the coral provides the zooxanthellae a home; it is a symbiotic relationship. The coral also hunts for itself, using tiny tentacle-like arms that sprout out of its anemone-like body to catch ocean drifters like plankton.<sup>1</sup>

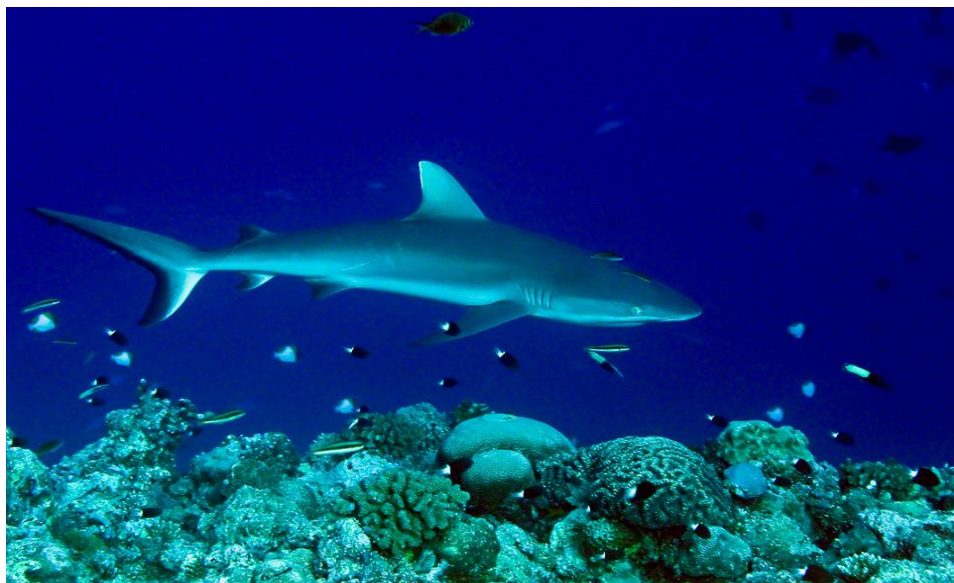
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<sup>1</sup> Teach Ocean Science, "Coral Reefs and Climate Change - What is a coral?", [http://www.teachoceanscience.net/teaching\\_resources/education\\_modules/coral\\_reefs\\_and\\_climate\\_change/what\\_is\\_a\\_coral/](http://www.teachoceanscience.net/teaching_resources/education_modules/coral_reefs_and_climate_change/what_is_a_coral/), 2016

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Corals are very important to our planet. They support 25% of all known marine fish, and yet they cover just 0.2% of the ocean floor.<sup>2</sup> That's like having 1.85 billion people living in the state of Oregon (the current population of Oregon is about 3.9 million people<sup>3</sup>). Even though they can be microscopic, corals create a habitat enriched with life supporting the entire ocean ecosystem.



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<sup>2</sup> Defenders of Wildlife, “Basic Facts About Coral Reefs”, <http://www.defenders.org/coral-reef/basic-facts>, 2016

<sup>3</sup> Suburban Stats, “Oregon Population Demographics 2017, 2016”, <https://suburbanstats.org/population/how-many-people-live-in-oregon>, 2016

<sup>4</sup> Fink’s Photos, “Palau - Finks Photos - Atlanta, GA, USA”, <http://finkspotos.com/galleries/palau/>, 2007

Corals also protect coastlines, create fisheries and are the base for reefs. These reefs are HUGE tourist attractions! This means that the community living near the coral is supported economically by this tourism. For example, a Caribbean island, Bonaire, annually earned 23 million dollars from coral tourism in 2001 and spent 1 million dollars to keep their reefs healthy that same year. If these rates stayed the same, Bonaire would make 32 million dollars today and only spend 1.4 million to maintain their reefs.<sup>5</sup>

Unfortunately, many tourists touch and break coral for souvenirs because they don't realize that it is alive. This causes stress and can be fatal to the polyp -- which is an individual coral organism -- because the stress causes coral bleaching. Coral bleaching occurs when the coral expels the zooxanthellae algae causing the coral to lose its color. This leads to starvation and vulnerability to viruses in the coral. It also is bad for the zooxanthellae because the algae is expelled into the water column where it is eaten by smaller forage fish. The coral loses the sugars the zooxanthellae provides, and the zooxanthellae loses its home.<sup>6</sup>

Ocean acidification and warming sea waters also cause coral bleaching. As they have a bigger impact on coral than other issues affecting reefs, we will focus on these two problems and their relation to coral health. Corals are a crucial part of the marine ecosystem because they support so much life. In order to save our planet, we need to create solutions to save our corals!

### **Coral Bleaching**

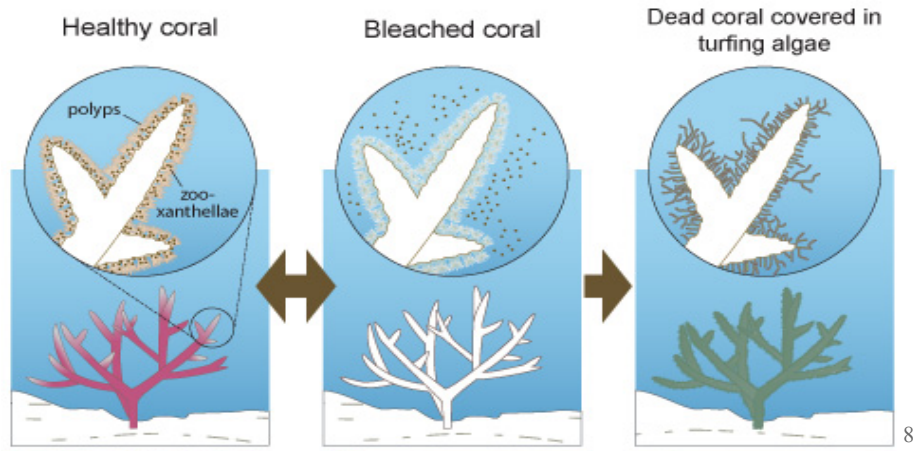
Bleaching occurs when the coral expels its zooxanthellae, the algae that lives inside the coral. Zooxanthellae gives the coral polyp its color, which is what coined the term “bleaching”. As the coral depends on the zooxanthellae for sugars derived by photosynthesis, it eventually starves, killing the coral. The limestone structure is then covered in turfing algae, preventing new coral polyps from growing there. Coral

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<sup>5</sup> Frank Talbot's and Clive Wilson's Book on Managing Reefs and Seagrass Beds, <https://portals.iucn.org/library/sites/library/files/documents/2001-055.pdf>, pg. 15, 2001

<sup>6</sup> Smithsonian Ocean Portal, “Corals and Coral Reefs”, <http://ocean.si.edu/corals-and-coral-reefs>, 2016

bleaching can be caused by: ocean acidification, warming sea waters, cyanide fishing, toxic runoff, erosion, and by chemicals in certain sunscreens!<sup>7</sup>



## Ocean Acidification

Ocean acidification is extremely problematic for most corals. The more acidic the water, the lower it measures on the pH scale. Historically, the ocean is slightly basic, at 8.16<sup>9</sup> on the pH scale. This means the ocean is normally an alkaline body of water. Therefore, sea life is not accustomed to an acidic ocean. Current human activities are creating huge amounts of CO<sub>2</sub>, causing the pH balance to be disrupted.<sup>10</sup>

“Every year, we as humans, release massive amounts of carbon dioxide into the atmosphere by burning fossil fuels, and about 30% of what we release into the atmosphere winds up getting absorbed by the oceans, causing measurable shifts in the chemistry of the seawater.<sup>11</sup>”- Dr. Rebecca Albright, 2014

When this CO<sub>2</sub> produced by carbon emissions from exhaust pipes on cars, factories, and the burning of fossil fuels, dissolves into the ocean’s waters, it reacts with H<sub>2</sub>O

<sup>7</sup> Ocean First Education, “Natural History of Indo-Pacific Coral”, [www.oceanfirsteducation.com](http://www.oceanfirsteducation.com), 2016

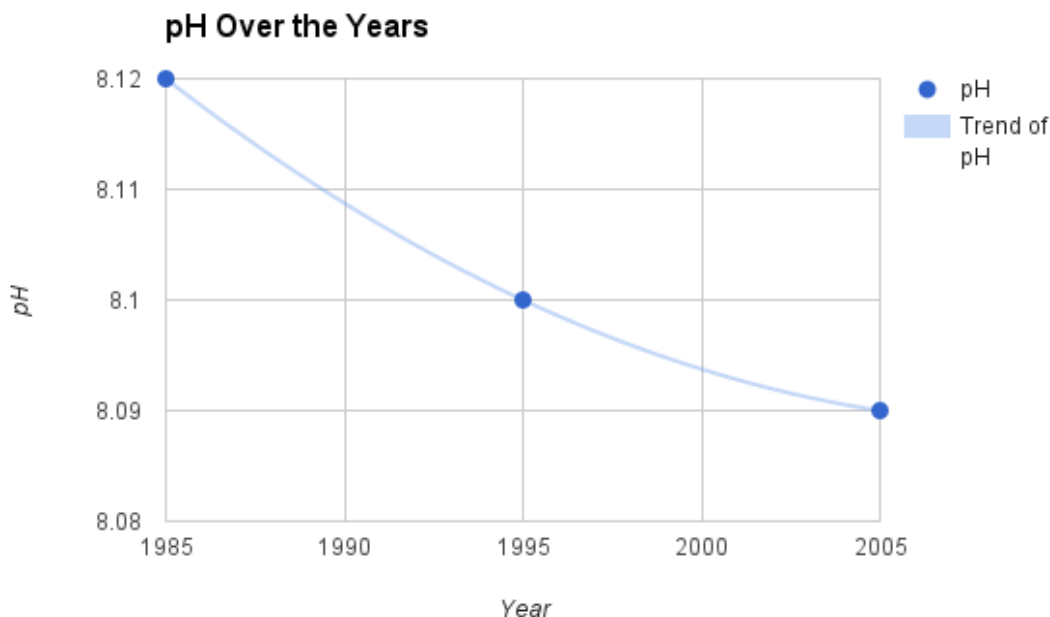
<sup>8</sup> Extreme Marine, “Coral Bleaching: can coral reefs recover?” <http://extrememarine.org.uk/2016/12/coral-bleaching-can-coral-reefs-recover/>, 2016

<sup>9</sup> Integrated Ocean Observing System citing Richard et al., “Carbon Dioxide and Our Ocean Legacy”, 2006.

<sup>10</sup> Integrated Ocean Observing Systems, “Introduction 1 CeNCOOS”, <http://www.cencoos.org/learn/oa/intro>, 2014

<sup>11</sup> Rebecca Albright’s website, “rebecca | MEDIA & OUTREACH - My research in 3 minutes.” <https://www.rebecca-albright.com/media---outreach>, 2014

molecules to form a weak acid called carbonic acid. This carbonic acid almost immediately breaks apart, creating hydrogen ions, which is hydrogen with an extra electron. These ions cause ocean acidification.<sup>12</sup> Ocean acidification prevents corals from settling on a surface upon which to grow in the larval stage because the increased acidity makes the larvae restless. This prevents the corals from reaching adulthood.<sup>13</sup> Also, the adult corals are unable to grow because, as the coral is building its structure, it's being dissolved at the same time by the acidity of the water. Ocean acidification also causes coral bleaching because the pH drop stresses the coral resulting in bleaching and, ultimately, coral death. Here is a chart showing the trend of ocean pH over the last twenty years. Ocean pH has changed dramatically due to an increase in carbon emissions, which is the leading cause of ocean acidification.



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## Warming Waters

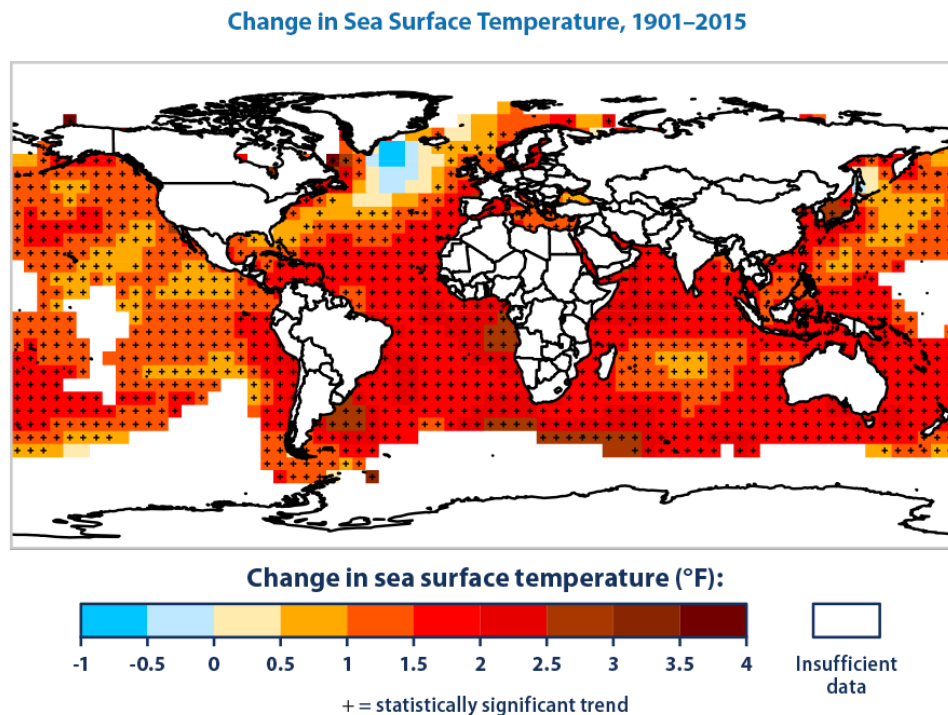
<sup>12</sup> PBS, "Palau's Improbably Healthy Coral Reefs - NOVA Next", <http://www.pbs.org/wgbh/nova/next/nature/acidic-coral-refugia/>, 2015

<sup>13</sup> PLOS, "Coral Larvae under Ocean Acidification: Survival, Metabolism, and Metamorphosis", <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0014521>, 2011

<sup>14</sup> Earth Habitat, "Global Ocean Acidification Graph", <http://earthhabitat.files.wordpress.com/2010/02/global-ocean-acidification.jpg>, 2007

Warming waters are also a big problem for corals mainly because of temperature rise, which, in turn, causes stress. But the rise in temperature also creates algal blooms at the surface which block out the sunlight, and, therefore, the zooxanthellae can't create the sugars the coral needs to survive. Since the algae relies on photosynthesis to create the sugars, without sunlight the zooxanthellae cannot produce the necessary nutrients leading to starvation of both coral and algae.<sup>15</sup> This is hugely problematic because corals are not likely to survive a deprivation of nutrients.

Here is a chart of the change in global sea surface temperatures in Fahrenheit, tracked over the last 116 years:



Data sources:

- IPCC (Intergovernmental Panel on Climate Change). 2013. Climate change 2013: The physical science basis. Working Group I contribution to the IPCC Fifth Assessment Report. Cambridge, United Kingdom: Cambridge University Press. [www.ipcc.ch/report/ar5/wg1](http://www.ipcc.ch/report/ar5/wg1).
- NOAA (National Oceanic and Atmospheric Administration). 2016. NOAA Merged Land Ocean Global Surface Temperature Analysis (NOAAGlobalTemp): Global gridded 5° x 5° data. National Centers for Environmental Information. Accessed June 2016. [www.ncdc.noaa.gov/data-access/marineocean-data/noaa-global-surface-temperature-noaaglobaltemp](http://www.ncdc.noaa.gov/data-access/marineocean-data/noaa-global-surface-temperature-noaaglobaltemp).

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at [www.epa.gov/climate-indicators](http://www.epa.gov/climate-indicators).

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<sup>15</sup> Teach Ocean Science, "Coral Reefs and Climate Change - How does climate change affect coral reefs?", [http://www.teachoceanscience.net/teaching\\_resources/education\\_modules/coral\\_reefs\\_and\\_climate\\_change/how\\_does\\_climate\\_change\\_affect\\_coral\\_reefs/](http://www.teachoceanscience.net/teaching_resources/education_modules/coral_reefs_and_climate_change/how_does_climate_change_affect_coral_reefs/), 2016



In this chart, the deeper the red color, the larger the temperature increase. The areas in blue show a decrease in temperature. We can see that our oceans are warming quickly. The main source of this warming trend is climate change caused by carbon emissions.

“The heat-trapping nature of carbon dioxide and other gases was demonstrated in the mid-19th century. Their ability to affect the transfer of infrared energy through the atmosphere is the scientific basis of many instruments flown by NASA. There is no question that increased levels of greenhouse gases must cause the Earth to warm in response.<sup>16</sup>” - NASA

Scientists have been studying how carbon emissions relate to climate change for decades. It has been proven that CO<sub>2</sub> from emissions is directly contributing to the warming waters of our oceans.<sup>17</sup> This alarming temperature increase has put corals in danger of disappearing. Action is needed now!

## **Solutions**

What must we do to stop coral bleaching and coral death and, therefore, prevent the elimination of a huge amount of ocean life? What must we do to stop the demise of these important creatures? What do we need to change on a global level, and as individuals, to help coral reefs survive? There are solutions, and each person needs to act now to save our oceans' reefs.

Scientists around the world are currently working on the prevention of coral bleaching. Dr. Ruth Gates, a research scientist at the University of Hawaii in the Gates Coral Lab, is breeding corals that are resistant to ocean acidification and warming sea waters. These ‘Super Corals’ - as they have been deemed - are transplanted into reefs that are severely

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<sup>16</sup> Nasa, “*Climate Change: How Do We Know?*”, <https://climate.nasa.gov/evidence/>, 2017

<sup>17</sup> Teach Ocean Science, “*Coral Reefs and Climate Change - How does climate change affect coral reefs?*”, [http://www.teachoceanscience.net/teaching\\_resources/education\\_modules/coral\\_reefs\\_and\\_climate\\_change/how\\_do\\_es\\_climate\\_change\\_affect\\_coral\\_reefs/](http://www.teachoceanscience.net/teaching_resources/education_modules/coral_reefs_and_climate_change/how_do_es_climate_change_affect_coral_reefs/), 2016

damaged or need help. When the time comes, Super Corals breed with normal corals in the reef creating a reef that is stronger and healthier.<sup>18</sup> Currently, Dr. Gates has been training corals to recognize bleaching situations, and then the coral can learn how to react in a different way. The coral survives and is able to pass on the genetics that prevented bleaching to future corals.<sup>19</sup>

Dr. Rebecca Albright is a marine biologist in the department of invertebrate zoology of the California Academy of Sciences. She has been studying coral reproduction for the last ten years and is now looking at the ability corals have to adapt to the increasing temperatures and acidity of the ocean. Dr. Albright has found that coral's reproductive success in the early-life stages is affected by ocean acidification and warming waters. This inspired her to create a coral culturing facility in the Steinhart Aquarium. She is the first coral scientist to use the aquarium as a source of study.<sup>20</sup> Her goal is to breed corals in a controlled environment and then to use that process to restore our coral reefs in their natural environment.<sup>21</sup> Dr. Albright's important research provides us with a tool we can use to return coral reefs to a healthy state.

Another cutting edge marine physiologist, Dr. Mary Hagedorn, is working on cryopreservation of coral species. Cryopreservation is the freezing of tissues in the body of an animal susceptible to damage in an attempt to conserve the tissue. This technology of freezing coral egg and sperm has been developed by scientists for the past several years. Dr. Hagedorn has created the first bank of endangered coral species to preserve their genome. These banks could help reseed our oceans as coral species are wiped out.<sup>22</sup>

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<sup>18</sup> Gates Coral Lab "Home", <http://gatescorallab.com>, 2017

<sup>19</sup> See footnote 17, above.

<sup>20</sup> Rebecca Albright's website, "rebecca | About", <http://www.rebecca-albright.com/about>, 2016

<sup>21</sup> California Academy of Sciences, "Rebecca Albright | California Academy of Sciences", <https://www.calacademy.org/explore-science/rebecca-albright>, 2017

<sup>22</sup> Smithsonian's National Zoo, "Mary Hagedorn | Smithsonian's National Zoo", <https://nationalzoo.si.edu/conservation/mary-hagedorn>, 2016



We've seen that scientists are developing cutting edge solutions to save coral, and now it's time to turn to what the individual can do to support the health of our ocean ecosystem.

What can we do to change our everyday actions for the benefit of corals? Here are three simple steps that everyone can take:

(1) Use coral-safe sunscreen.

Some sunscreens harm coral because some of the chemicals used, such as oxybenzone, smother and coat the colonies. When a sunscreen enters the reef, it is absorbed by the coral and awakens dormant viruses in the zooxanthellae which multiply until the algae explodes. The coral is deprived of important nutrients and starves.<sup>23</sup> “The algae that live in the coral tissue and feed these animals explode or are just released by the tissue, thus leaving naked the skeleton of the coral,” said study leader Roberto Danovaro of the Polytechnic University of Marche in Italy.<sup>24</sup>

Many companies use these unsafe chemicals, including Alba Botanica, Aveeno, Banana Boat and Johnson & Johnson. To do your part to save coral, buy only coral safe sunscreen by checking the active ingredients section on the back. Here is a list to show which chemicals in sunscreen are coral safe and which chemicals are not<sup>25</sup>:

1. Safe
  - a. Titanium Dioxide
  - b. Zinc Oxide
2. Unsafe
  - a. Oxybenzone
  - b. Octisalate

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<sup>23</sup> National Geographic, “*Swimmers’ sunscreen Killing Off Coral*”, <http://news.nationalgeographic.com/news/2008/01/080129-sunscreen-coral.html>, 2008

<sup>24</sup> National Geographic, “*Swimmers’ sunscreen Killing Off Coral*”, <http://news.nationalgeographic.com/news/2008/01/080129-sunscreen-coral.html>, 2008

<sup>25</sup> Info provided by Goddess Garden Sunscreen, more info at: [www.goddessgarden.com](http://www.goddessgarden.com)

- c. Avobenzone
- d. Homosalate
- e. Octocrylene
- f. Octinoxate

(2) Reduce our individual carbon footprint.

We each must reduce our generation of carbon emissions. Warming sea waters and ocean acidification are extremely dangerous to coral. Instead of driving, walk or bike to work and school. If that's not possible, carpool with others. These actions save money and save coral. Installing solar panels onto your house is another solution to reduce your carbon footprint. Also, when your electronics are not in use, don't charge them because it wastes electricity. Most electricity comes from burning fossil fuels, which releases CO<sub>2</sub> into the atmosphere. These are easy ways to reduce carbon output and directly help our coral reefs.

(3) Use eco-conscious tour companies when traveling.

Give your business to tour companies and dive shops that seek to prevent the touching of coral and other marine life. For example, when I went diving in Palau, our dive tour company, Sam's Tours, did not allow dive gloves because the distribution of gloves encourages tourists to touch and break the coral. I appreciated this as touching coral can also cause bleaching, therefore we need to raise awareness about this issue. We all need to choose what is best for coral when we travel. It is crucial for the health of our planet that we understand that our purchases and actions affect the ocean ecosystem.

### **Final Thoughts**

We've seen that corals are greatly affected by our choices, and we've also seen that we as everyday citizens can make decisions to save corals. We know that corals are in danger,

and we can choose to help or harm the reefs. Purchase only products that are safe for corals. Don't touch them.

There is so much that we can do to help our oceans. Educate yourself on environmental issues. Reduce your carbon emissions. Stop eating seafood or choose to eat only seafood that you know, with certainty, is sustainably caught and which isn't threatened or endangered. Support eco-conscious companies.

If we all do our part to stop the many problems facing our reefs, we will save corals, and the ocean. Corals are essential to our survival because we depend upon them to support a large portion of our marine environment, to protect many communities' food sources, to maintain our coastlines, and, ultimately, to preserve our diverse global home – Earth.



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