The continuous beeps, whirs and hums of the submarine relax you as light starts to fade from the water around the vessel. Your Captain skillfully steers the submarine as you plunge into the ocean’s depths. As a researcher, you are incredibly fascinated by the little switches, buttons and knobs of the ship and you feel you must ask how the controls work. However, you have a job to do, and you turn back to looking out the window. Hours pass in the blink of an eye, and after watching the surface disappear from view, your Captain tells you that you are almost there. Your heartbeat picks up in excitement. You are about to see one of the most bizarre places on earth and, possibly, in the universe. All of a sudden, a resounding, thudding squelch sounds as you land on the bottom. The lights flick on, and the delicate ecosystem revealed to you is astounding. Alien-like creatures scuttle, swim, and squirm as you
take in your surroundings. You feel like you’ve traveled to a different planet. You can hardly believe it. You are in the deep sea.

You just read what it might be like to experience the deep sea. Beautiful and mysterious life forms, interesting habitats and landscapes, all hidden in the deep. But these habitats are in danger. One might think: Why would that matter to us? Some habitats in the deep ocean are having problems. So? We won’t be affected. Now, we are becoming aware of this connection between us and our deep water habitats. Life on Earth is connected. To understand these connections, we need to understand these ecosystems. Let’s dive in!

**What are deep sea habitats?**

We can break this down into two definitions: (1) The deep sea, and (2) habitats. The *Google Dictionary* defines deep sea as “the deeper parts of the ocean, especially those beyond the edge of the continental shelf,” and habitat is “the natural home or environment of an animal, plant, or other organisms.” Therefore, deep sea habitats are the natural home or environment of an animal, plant, or other organism located in the deeper parts of the ocean, especially those beyond the edge of the continental shelf.
Where can we find the deep sea in the water column and around the globe?

Now that we know the definition of a deep sea habitat, where in the ocean are they found? Depending on where you are in the world, the deep sea is measured at different depths due to turbidity, the amount of suspended matter in the water. Essentially, you can find these important ecosystems where the ocean is deep. If you measure the deep sea based upon light levels, then the murkier the water, the shallower the deep sea would be defined. On average along the California coast, the deep sea is measured at 200 meters or around 650 feet.\(^1\) The chart to the right shows the ocean layers throughout the water column. Deep sea habitats are located from the Mesopelagic zone all the way past the Hadalpelagic zone.

What is the temperature of the “deep sea”?

Another factor to consider in learning about the deep is temperature. Deep sea temperatures can be extreme. Because of underwater volcanoes, nearby waters can have temperature differences of 230°F. The heat from high-temperature hydrothermal vents can reach up to 265°F. That is a huge difference compared to the typical 35-40°F waters that surround these deep ecosystems.\(^2\)

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\(^1\) Info from Pew Charitable Trusts Officer Tom Rudolph, March 15, 2019

What lives in the deep sea, and why is it important?

The deep sea has absorbed approximately 25 percent of all the carbon released up through present day (2016). Currently, these ecosystems are storing around 37 billion gigatons of carbon. That amounts to 37 trillion tons of carbon just in the deep sea. You can see now why the deep sea is really important, not only for all the life it supports, but also for how it affects our inland habitats. Deep sea ecosystems are fascinating and beautiful. They are all important, but together, they do one of the most needed things for our planet. Deep sea ecosystems regulate our climate!

Deep sea inhabitants range from microscopic bacteria to giant squid. Worms, fish, sharks, squid, octopus, sea slugs, and all sorts of extraordinary creatures can be found in these habitats. The deep sea is home to more than just rocks and mud, contrary to what many people think.

Habitats of the Deep Sea

Let’s learn what main types of habitat we’ll be looking at. In this paper we will explore: Deep sea coral, mud and silt ecosystems, hydrothermal vents, methane seeps, the threats that face them, and what we can do to keep these ecosystems healthy. Deep sea ecosystems are spread up and down seamounts. Seamounts are huge mountains rising from the deepest seafloor. Just like on land, the deep is littered with canyons and mountain

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3 Canadell et al., Sabine and Feely, 2007; [https://tos.org/oceanography/assets/docs/22-4_feely.pdf](https://tos.org/oceanography/assets/docs/22-4_feely.pdf)
ranges. Not only does the deep sea have mountains, it even has what could be considered volcanoes. The unseen biodiversity of deep ecosystems is crucial to the health of our planet.

- **Coral Forests:**

  ![Image Credit: NOAA](https://oceanservice.noaa.gov/education/kits/corals/media/supp_coral01a.html)

  Most corals have a limestone skeleton that builds reefs. However, deep water corals have a cartilage-like skeleton or no skeleton at all. The corals with skeletons — known as hard corals — build reefs while the corals with no skeletons — soft corals — provide habitat on a smaller scale. These skeletons, whether limestone or cartilage, are covered by the animal part of coral, the fleshy part. The animal component of coral is made up of hundreds of little polyps. The polyps have tentacles that catch small plankton for food.⁴ Deep water corals are found in our oceans around the globe including in the waters of over 41 countries such as Japan, Spain, the Seychelles, New Zealand, Mauritania, Canada, Australia, Colombia, Brazil, Norway, Angola, Russia, Sweden, the United Kingdom, Ireland, Palau, and the United States including right off the coast of California!⁵ That’s a lot of coral!

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Many different types of deep sea corals are octocorals. An octocoral is a coral that has a multiple of eight tentacles on each of its polyps. Hexacorals are another sub-class of corals. They are corals with tentacles that occur in multiples of six. Why do corals have tentacles? Well, corals are part of the cnidaria (pronounced nye-DAIR-ee-uh) phylum. Cnidarians include coral, anemones, and jellyfish! Deep water corals can live for hundreds of years, and some can reach heights of 33 feet. In fact, the oldest known coral is 1,800 years old!\(^6\)

We humans depend on coral habitats for food as they support seafood such as orange roughy, cod, redfish, rockfish, and rock shrimp. Some endangered species, such as monk and elephant seals, rely upon these fish as food as well. If we destroy their important deep ocean habitats, they won’t have enough food to sustain them. Deep sea coral don’t only support important species, they support cute and cool ones too! Many different animals have been discovered, including the *Opisthoteuthis* (pronounced oh-piss-to-TOO-this) *adorabilis* also known as the adorabilis octopus. This adorable orange species was discovered in 2015. Another adorable creature is the stubby squid, which is actually more closely related to cuttlefish. These brightly colored denizens of the deep are too cute!
Scientists are also doing research to explore material derived from deep corals as possible cures for cancer and other diseases. Imagine if the cure for cancer lies thousands of feet below the surface.\textsuperscript{7} If we don't properly protect our deep ecosystems, we may never know what potential lies in the deep.

- **Mud and Silt Ecosystems:**

Speaking of cnidarians, the amazing creature you see above lives in a mud and silt ecosystem. While seemingly unremarkable, the magic in these ecosystems is miniscule. Literally. These ecosystems are home to billions of microbes. Thousands of bacteria, viruses, and single-cell organisms thrive in this extreme environment, and some macro-fauna also exist in this ecosystem.

These ecosystems are very important to the surface food web. When whales or other large species die, they sink to the seafloor. Then, the many scavengers of the deep feed upon the carcass. The result? A nutrient rich ecosystem thriving with life. So how does

this help the surface? Well, when whales dive down the water column to forage, they bring these rich nutrients to the surface allowing the ecosystem to continue.\(^8\) This not only happens in mud and silt ecosystems but in other deep sea ecosystems as well. Mud and silt ecosystems not only have interesting species, they have interesting geography and topography as well. Many mud structures are formed into mud volcanoes or domes. When deep gases shift, the structures are formed. This diverse formation allows many types of fauna to reside in these ecosystems.

- **Hydrothermal Vents:**

![Image of Hydrothermal Vents](image.com)

Big, black and white plumes of what looks like smoke billow out of these small volcanoes. Welcome to a hydrothermal vent! Hydrothermal vents are miniature volcanoes that release hot, nutrient-filled water instead of lava. Also, instead of erupting every once in a while, the vents release a continuous stream of water. The color of the vents’ discharge depends upon what type of minerals are in the water. The white plumes are called “white

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smokers” and the black ones “black smokers.” The vents create a natural underwater hot spring. These important ecosystems support many organisms, and they support ecosystems on the surface.9

Around them, many different life forms dart about their daily business: tube worms, yeti crabs, small plankton and many others. Out of the deep sea habitats, these volcano-like vents seem to have the most life visible to the human eye. Many of the species living in hydrothermal vents are scavengers or prey upon the organisms that feast on the carcasses of surface life. Not unlike mud and silt ecosystems, these habitats provide many nutrients for the surface food webs.

- **Methane Seeps:**

![Image Credit: NOAA](image.png)

Methane seeps have vent-like openings and are generally found on hard surface substrate which is a base layer, like a foundation. These seeps host many life forms, including the pink cusk eel and the Patagonian toothfish. Both species are eaten by humans, however they are marketed under different names. The cusk eel is more commonly known

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9Woods Hole Oceanographic Institution, *Hydrothermal Vents*, 2019, [https://www.whoi.edu/know-your-ocean/ocean-topics/seafloor-below/hydrothermal-vents/](https://www.whoi.edu/know-your-ocean/ocean-topics/seafloor-below/hydrothermal-vents/)
as “rockling”, while Patagonian toothfish is known as “Chilean sea bass”. This renaming of these fish is meant to make them more appetizing, as neither species is much of a looker.

Methane seeps play an important role in absorbing greenhouse gases. Just like many other deep sea ecosystems, these seeps have methane eating bacteria. However, seeps have a higher concentration of methane than most deep ocean habitats. This makes them the prime location for a larger population of methane-eating bacteria. If we lose these habitats, not only would we lose the crucial bacteria, we would release hundreds of thousands of tons of methane into the ocean and our planet’s ecosystem. The result would be catastrophic, as methane is thirty times more potent as a greenhouse gas than carbon.10

What threatens the health of the deep sea?

Deep sea habitats are very important, yet also very fragile. These crucial ecosystems face many different threats, including plastics, deep sea mining, oil drilling, climate change, and bottom trawling.

10 Science Daily, *A more potent greenhouse gas than carbon dioxide, methane emissions will leap as Earth warms*, 2014, [https://www.sciencedaily.com/releases/2014/03/140327111724.html](https://www.sciencedaily.com/releases/2014/03/140327111724.html)
Bottom Trawling

Out of the threats listed above, bottom trawling is currently the most harmful and prevalent. Bottom trawls are huge nets that drag along the seafloor and demolish ecosystems in their path. To keep the nets on the bottom, the trawls have weights attached. These weights are the main cause of destruction as they crush anything in their way, destroying whole habitats. The image above shows the effect that bottom trawling has on deep water coral ecosystems. This destructive practice targets bottom and demersal species — species that live close to the seafloor— like flounder, sole, halibut and some crabs. It isn’t surprising to learn that much of the seafood we eat harms our deep water ecosystems.11

11NOAA, *Fishing Gear: Bottom Trawls*, 2018
Many scientific samples are collected by accident due to bottom trawling. However, this is no excuse, as the destructiveness of the practice is unforgivable. Our generation needs fewer coral samples and more ocean protection.\textsuperscript{12}

In 2018, the Pacific Fishery Management Council moved to protect a landmark 140,000 square miles of waters in the U.S. West Coast Exclusive Economic Zone (EEZ) from bottom trawling because it determined that the practice was too destructive to essential deep water fish habitats. We need more effective legislation to protect deep habitats.\textsuperscript{13}

**Deep Sea Mining**

Deep sea mining is the threat that is most concerning as we look into the future. It not only destroys ecosystems, it poisons them. Once the metals and minerals have been mined, processing these materials produces sediments that are dumped into the ocean as waste. This smothers sensitive species. The excess sediments can also poison fragile species. The noise emitted from this destructive practice also harms marine animals, especially whales and dolphins.\textsuperscript{14}

The metals obtained from this unfortunate practice are mainly used for new electronics. These metal include manganese, copper, and cobalt. Many deep sea mining operations have been located in the Pacific in Micronesia and in Papua New Guinea.\textsuperscript{15}

\textsuperscript{12}Oceana, *Bottom Trawling*, 2018, https://usa.oceana.org/bottom-trawling
few months, a new Apple or Samsung phone is released. Do we really need to update our technology this frequently? Our toxic consumerism is just feeding these issues.

To make things worse, this upcoming threat is a form of greenwashing. Greenwashing is putting an eco-label on a company that is, in fact, not eco-friendly. The claims of deep sea mining companies are that they do not promote deforestation or child labor. The problem though: They excavate and destroy our important deep sea habitats! We need better solutions to both humanitarian and environmental issues. We shouldn’t ruin one ecosystem and move onto another. The deep sea is literally “the last frontier” of our blue planet. What will happen once we exhaust the deep sea?

Even though this existential question lies ahead of us, CEOs of big companies and some governmental authorities see the deep sea as a way to make money, and won’t hear anything else. One of the largest issues that arise from this greed is oil drilling.
Oil Drilling

Similar to deep sea mining, this impact harms important deep water ecosystems through crushing and poisoning these habitats. Oil spills can affect deep water ecosystems far and wide due to the oil at the surface absorbing into plankton and bits of marine debris that sink to the bottom. This is called marine snow, and if it is oil saturated, then ecosystems throughout the water column will be affected. Aside from drilling, pipelines that service oil drilling sites can also harm these delicate ecosystems.  

Climate Change

Climate change comes from the burning of fossil fuels like oil. Our need to burn oil and coal is not only causing our world to heat up, it’s also destroying the very thing that is slowing the effects of this major issue. While global warming and warming waters don’t impact deep water habitats at a great scale, change in weather patterns do. A large storm can send avalanches of marine debris into the deep, crushing and smothering sensitive ecosystems. With these storms coming on stronger and more frequently than before, fragile ecosystems don’t have enough time to recover. They are bombarded with tons of rubble from the surface.”

Plastic Pollution

Many of us use plastics every day. What we don’t realize is that when these plastics get into the ocean, they cumulate and most end up where we can’t see them with our eyes - at the ocean’s floor. According to Eunomia’s Principal Consultant for Environmental

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17 Luiz Rocha and Pim Bongaerts et al., *CORAL REEFS, Mesophotic coral ecosystems are threatened and ecologically distinct from shallow water reefs*, 2018
Economics and Ecosystem Services Dr. Chris Sherrington; “94% of the plastic that enters the ocean ends up on the seafloor. There is now on average an estimated 70 kg of plastic in each square kilometer of sea bed.”18

Because plastic leaches chemicals, the millions of pieces of debris on the seafloor have the potential to create a bigger threat: the poisoning of deep water species. Large pieces of plastic can also harm delicate organisms by crushing or slicing them, and they can entangle or be eaten by larger sea animals.

How can we protect the important deep seas of our Blue Planet?

There are a few main actions that we can take to help protect our deep water habitats. The first thing we should do is change our lifestyle. One might believe that it’s difficult to turn your footprint around, but in reality, if everyone did a few small things a day, these issues would be much easier to solve.

We must reduce our carbon emissions. Instead of driving, walk or bike to work and school. If that’s not possible, carpool with coworkers or classmates. These actions save money and help save our deep sea habitats. Installing solar panels at home to reduce your carbon footprint is another solution. If you can’t get solar panels, you can ask your local energy provider to enroll you in a one-hundred percent renewable energy program. If they don’t have that kind of program, encourage them to develop such a program and base it upon programs already established in other towns or cities. Also, when your electronics are not in use, don’t charge them unless they have a low battery because it wastes electricity. Most electricity comes from burning fossil fuels, which releases CO2 into the atmosphere. These are easy ways to reduce carbon output and oil drilling and directly help our fragile yet crucial ecosystems.

Also, only buy a new phone if you really need one, not if there is a break that can be fixed or a new model coming out. It’s cheaper to have your phone fixed than to just buy a new one. It costs about a hundred U.S. dollars to fix an iPhone 6 or 7 screen. Buying a new model, let’s say the iPhone XR, costs seven hundred fifty U.S. dollars. By slowing down humanity’s out of control consumerism, we can help slow and hopefully stop deep sea mining.

Reduce your single-use plastic consumption! Help prevent plastics from getting into our deep water habitats. Don’t use plastic bags, styrofoam boxes, plastic utensils, and produce bags at the grocery store.
Do what you can in your everyday life to help our planet. If you live in a place where seafood is an important staple in your diet, ensure that the fish you eat is sustainably and locally caught. Fish for the seafood yourself, or, if you buy seafood, go directly to the fisherman, not the retailer, to confirm that they use sustainable fishing practices. Ask them directly how they catch the seafood they sell. If seafood isn't a main staple in your community’s, society’s, or culture’s diet, then try giving marine life a break and don't buy it.

The second action we should take is to talk to our congresspeople. They work for us, not the other way around. To many kids, and even some adults, talking to our policymakers is scary or nerve-wracking. But once you've finished the first meeting, it isn't all that difficult. Go to your local congressperson’s website and set up a meeting! Do what you can to protect our oceans and their vital habitats.

Last but not least, support and empower youth around the globe. If you are an adult, support your local youth in becoming empathetic and empowered environmental leaders. If you are a youth, start being a leader in your community! Start an organization or join us as an Heir and even start an Heirs To Our Oceans chapter!

We can all help protect our blue planet together.

Heirs To Our Oceans is inspiring the next generation of environmental leaders.

www.H2OO.org