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Who’s eating who? -Sharks and People

Many human beings believe that sharks are blood thirsty and vicious creatures, mostly because of pop culture and movies like *Jaws*. In truth sharks are apex predators and occasional shark attacks do happen but humans are far more destructive to shark populations.

Sharks and Their Anatomy

Social media dictates that sharks are tooth-filled monsters. Instead they are a subclass of fish known as elasmobranchii. Elasmobranchii have no bones but instead have a more flexible tissue called cartilage. Sharks can have 5-7 gill slits on the side of their heads that allow them to breathe in the water. Sharks vary from size depending on the species. Dwarf lantern sharks are the smallest type of shark, when full grown they are only 8 inches or 20 centimeters long. The biggest species of shark, a whale shark, can grow up to 55 feet or around 17 meters. One thing almost all sharks have in common is multiple rows of teeth. These teeth can be long and sharp, or triangle shaped depending on the shark. The only exceptions to this is the whale shark and the basking shark who instead have filters they use for krill.

Hammerhead shark falling after being definned (BAWA)

Take a Bite Out of Shark Attacks

Sharks attack people for three known reasons: They might be curious and want to take a nibble of a human. They might mistake us for being prey such as confusing surfers and swimmers with seals. They may see the human victim as a threat. Although highly publicised and fictionalized shark attacks are extremely rare, only one in 11.5 million swimmers are victims of a shark bite. To prevent shark attacks avoid swimming in areas with shark sightings or areas with shark prey swimming nearby.
Human Attacks and Why

Most sharks are killed while humans are fishing; either as an unintended consequence of fishing or as the intended catch. Sharks are often killed on purpose because humans are worried that sharks may go after themselves, their fishing equipment or their catch. Sharks are fished directly to use their fins in a delicacy known as shark fin soup. Shark fin soup is an expensive and prized dish often served at Asian celebrations. Shark fin fishing damages the shark population due to a strategy of fishing called “shark finning”. During this type of fishing a fisherman would pull up a shark, cut off their fins and drop them back into the ocean. Without fins the shark is unable to swim, and drowns. For sharks, motion is essential to allow water to pass through the gills and allow them to breathe. By both indirect kills and direct shark fishing many sharks are destroyed. Sharks and other Elasmobranchii are now considered to be at an elevated risk of extinction.

Effects of Climate Change

Another way humans are affecting shark populations is through human driven climate change. Although unintentional, global warming is damaging shark populations through changing key ecosystems. Mangroves and coral reefs are necessary to most shark populations. Mangroves and coral reefs give protection to shark pups and allow fish populations to grow to sustain sharks later in life. Through global warming some corals are dying off or bleaching. Some mangroves are being killed off through rising ocean levels.

Why Sharks are Important

Sharks are necessary to underwater ecosystems by being an apex predator and controlling prey populations. If humans kill off sharks some ecosystems will be changed permanently. Although sharks have a bad reputation humans are much more dangerous to sharks than sharks are to humans. It is to our benefit to keep sharks alive as an important component of their ecosystems.
Sources – Emily Westerfall


The Stony Coral Disease

Coral reefs have been endangered for decades, but now a new and more deadly problem has taken front page news. This illness was first recorded in the United States off the coast of Florida in 2014. It next was observed in the Virgin Islands in 2019. This disease is extremely dangerous, and there is no known cure.

Stony Coral Tissue Loss Disease, or SCTLD is a coral disease that infects “reef-building, scleractinian corals”, or the stony corals, such as Brain coral, Mussidae, and porites. It results in the death of smaller coral reef colonies in one to two weeks, and larger colonies in one to two months. These hard corals are especially at risk as SCTLD spreads and kills rapidly. The progression of the illness has demonstrated that it moves quicker in the North than the South. This might be due to the influence of currents and the travel of sediment. It remains unclear if currents are the main means of transportation of the infection. It has also been found that climate change has aided in enhancing the severity of Stony Coral Tissue Loss Disease.

Though they appear similar to the eyes, there is a main difference between coral bleaching and the SCTLD. Bleaching occurs when water temperature rises and the coral goes into panic mode in response to these high temperatures. Bleaching can result in the death of the coral, but there is also the possibility of recovery. In contrast, if a coral is contaminated with SCTLD, it will most certainly die. There is no known possibility of recovery from this white plague for the corals. It is both quick and devastating, similar to the Black plague that humans faced during the middle ages.
Coral Reefs are important to the world, even though they make up less than one percent of the ocean floor. Many animals, from marine organisms to humans, depend on corals. Coral reefs provide a habitat for many fish, invertebrates and the polyps that make the corals. These reefs encourage tourism, including the activities of snorkeling, and scuba diving, for tropical Islands, such as the Virgin Islands, other Caribbean islands, and off the coast of Mexico. This disease decreases the population of coral reefs and will result in a decrease of biodiversity and ocean life. The coral disease, SCTLD, also negatively affects those who like to eat crab and lobsters as these delicious sea foods use the coral colonies as their homes.

Map by E. Otwell and C. Martin, sciencenews.org; Data from P.R. Kramer and J. Lang, 2019

In hopes of tracking the disease, citizen science has been employed, and tourists are asked to help report the occurrence of SCTLD. There has been a website created with a form where one can report the discovery of what appears to be Stony Coral Tissue Loss Disease (The link for the form: https://viepscor.org/sctld-outbreak). This disease is a danger that will not go away any time soon. This ailment is deadly and fast acting, it shows little to no sign of slowing down. A main fear is that this disease will spread to coral reefs in Australia, Asia, Madagascar and Africa. Scientists should be targeting a preventative or cure for this scourge before it is too late. The causal agent is unknown but is suspected to be a bacterium. We need research to determine if SCTLD is caused by a bacterium or a virus. Perhaps we can employ some molecular biology and obtain the genome of the bacteria or virus and determine how to kill it or prevent its spread. We are hoping that science can save the coral reefs of the world from SCTLD.
Sources – Arianna Poston


In-text citation


El Niño and Coral Bleaching

In 2002 and 2015 El Niño events occurred. El Niño events happen when winds across the Earth change, causing a band of warm water to develop in the Pacific Ocean. This leads to coral bleaching in coral reefs across the Pacific Ocean. Coral bleaching is when corals evict the algae in the skeletons that provide the corals with food because of the heat. The algae is the thing that makes the coral have color and so when it is evicted from the coral it becomes white giving it its name “coral bleaching.” Right before the algae is evicted it becomes a more vibrant color which gives coral the appeal that it does to the unknowing public. After the coral is bleached the coral is not dead yet. They still have a chance of recovering but they are stressed and have a higher chance of dying. El Niño events are normal events, but they are more exaggerated as a result of climate change and this is what harms corals long term. Climate change causes El Niños to be more frequent and they get longer and hotter. In the past, larger El Niños were followed by longer periods of recovery where fast growing branching corals can regrow but now El Niños are getting closer and closer together.

In 2002 the El Niño was shorter and the water was cooler than the 2015-16 El Niño. This would make someone think that the destruction would be larger and the recovery would be longer for the latter but this is not the case. The corals after the harsher heat in 2015-16 were in better shape than the corals after the 2002 El Niño and they recovered way faster than before. This is important because it raises questions like: are corals becoming more resistant to heat? Why did they recover better? Has there been a change in coral genetics since before 2002? Is there another factor that changed the coral reef’s response? And these questions are exactly what a lot of coral scientists are asking right now.

What Could This Mean?

The corals responding differently to the longer and warmer El Niño could mean that corals are becoming more resistant to heat which could help corals become more resistant to global warming and restoration of coral reefs could last longer. This still wouldn’t be a permanent fix though because factors other than heat are still killing corals, like disease.
**PIPA and What Might’ve Happened**

PIPA (Phoenix Island Protected Area) is an area in the Pacific Oceans that is protected fairly well from “fishing, coastal degradation, disease, destruction, sedimentation, tourism, sunscreen or other issues that plague coral reefs in more accessible locations,” according to Randi Rotjan, a scientist that was observing these islands during the 2015 El Niño event. It is also positioned so it only gets the edges of these warm waters moving in the Pacific. Randi Rotjan believes that the preventative measures that the local government made by removing the previously mentioned outside stressors might have given the Phoenix Islands a better chance at dealing with the stress from the El Niño. There is also the chance that the corals genetically evolved to deal with the heat in PIPA because of how often these corals must deal with the heat.

![A thriving reef in PIPA, 2018, courtesy Michael Fox](image)

**What Are Scientists Doing?**

Before the 2002 El Niño scientists didn’t get genetic samples of the coral and so now when researching to see if something changed between the 2002 corals genetics and the 2015 corals genetics instead of just checking the genetics directly scientists have to rule out every other option before coming to the conclusion that corals evolved. Scientists are working on this exact thing while other scientists are focusing on restoration and breeding these more heat resistant corals together and then using a method called microfragmentation to restore large areas of reefs.

**Microfragmentation and What’s Next For Coral Reefs**

Microfragmentation is when a larger coral that is either grown in a nursery or in the wild is broken into smaller parts and then they grow faster (about 25% faster growth rate, meaning a coral that would take years to grow normally now only take weeks or months) until they are deemed healthy enough to be reintroduced to a nearby coral reef. Part of these projects include microfragtation of more heat resistant corals to do more research with them but also just to use them to reintroduce into the wild because although we don’t know why they are more resistant from coral bleaching, but they can still be used for coral health restoration.
Sources – Claire Rohdy


The Chemistry of Saltwater

In the coral reef environment, there is one component that is arguably the most important: water chemistry. With poor water chemistry, whether a deficiency, or overload, or imbalance of a certain compound, very little can survive, especially stony corals, the foundation of the coral reef, which are known, at least in captivity, to be somewhat delicate. In the reef environment and for the purposes of this article, the most important elements and compounds include: Sodium chloride, magnesium, calcium, calcium carbonate, ammonia, nitrite, and nitrate. These essential substances are of utmost importance to life on the reef, from motile invertebrates to corals, algae to fish.

Each of those elements and compounds are important in different ways and their impacts vary from creature to creature. To start off but in no particular order, sodium chloride (NaCl). Sodium chloride, also called salt, is the main component of sea salt, which makes salt water salty. Salt in seawater helps in biotic functions for basically all reef creatures, and marine creatures in general. In corals, sodium chloride aids in calcification, which is how corals grow their skeletons. Additionally, without salt to make seawater saline, most creatures would die because their cells would pop as a result of osmotic pressure.

Next up and arguably the most important is calcium carbonate. Calcium carbonate is used by corals to grow their skeletons and form the base of the entire reef ecosystem. Calcium carbonate is also known as calcite or aragonite, and corals use it in forming their skeletons while shelled mollusks and invertebrates use it in the formation of their hard shells. Calcium carbonate is crucial to life on the reef. Calcium carbonate (if there is enough magnesium) is not present in the water, but corals and shelled mollusks make it using calcium ions and carbonate ions, both of which are readily available in the water. Ordinarily, corals would draw in calcium ions and carbonate ions to make calcium carbonate, but with ocean acidification, more bicarbonate ions are formed rather than carbonate ions. In order to create their skeletons, coral polyps, the tiny creatures that make up corals, first draw seawater that has these ions into the spaces between their cells, known as calcifying spaces. Then, they pump hydrogen ions out of this space, ensuring only carbonate and calcium remain, which they can then use to form calcium carbonate in their skeleton. Ocean acidification basically makes it so that bicarbonate forms instead of carbonate which means the corals have to use more energy to get rid of the extra hydrogen ions. This results in slower coral growth and a weaker ecosystem.
After calcium carbonate is magnesium. On the reef, Magnesium acts kind of like a placeholder. Usually, magnesium ions are found bonded to carbonate in the form of magnesium carbonate which is soluble in water. This is important as it keeps the alkalinity level of the water high which corals and other organisms prosper in, while also keeping calcium available to be used by corals and invertebrates. Basically, magnesium keeps the carbonate ion, which is found floating in the water, free to bond with calcium to then be used by corals in building their skeletons. Without Magnesium, calcium carbonate would precipitate out into the water, where it cannot be used by corals.

Another crucial element is calcium. In saltwater, calcium is found in the form of Ca2+. Chemically speaking, calcium is important because the oxygen atoms in water molecules orient around this positively charged ion because of ion/dipole interactions and this effect is important for many properties including solubility and osmotic pressure. The most important role that calcium ions have is the formation of calcium carbonate which corals use to grow their hard skeletons.

Now into the nitrogen compounds, ammonia, nitrite, and nitrate. Each of these is harmful to living things, with ammonia being the most toxic and nitrate being the least. All living things produce ammonia in the form of waste and decomposing matter (if they are no longer living), so luckily there are tiny bacteria known as nitrifying bacteria that consume ammonia and convert it into nitrite, which is in turn converted into nitrate. This process is known as the nitrogen cycle, and is very important in keeping ammonia levels low and living things alive. Nothing really consumes nitrate, other than non-calcareous algae, so the way it leaves the ecosystem is mostly by being carried away by the currents. However, more and more ‘dead zones’ (areas with little to no flow) are popping up, leading to algae outbreaks which crowd out and kill corals, potentially destroying entire reefs.
Sources – Zach Ben-Meir

Eighty percent of our oceans are unexplored, even though they cover over 70% of our planet. We know more about space than we do about our own oceans on our home planet. Underwater robots can be our eyes where even humans cannot venture, with more fine-tuned sensors than any human possesses. Ocean acidification and pollution adversely impact biodiversity, and underwater robots can help monitor and mitigate damage. Robots can not only provide more coverage, but also quickly gather large amounts of data. Underwater robots do a lot - they can be used to monitor characteristics such as currents, temperature, and salinity, create detailed maps of the sea floor, and explore wrecks and underwater ecosystems.

There are many examples of how underwater robots have helped us reach breakthroughs in marine and climate science. Scarlet Knight, developed by Rutgers University students, was the first underwater glider to successfully cross the Atlantic in 2009. This U.S. Integrated Ocean Observing System was an 8 foot autonomous vehicle which followed the path of Columbus’s ship from New Jersey to Spain. With no engine, water was pumped from nose to tail to change its pitch and propel it forward in a zig zag path. It spent over 200 days at sea, traveling over 7400 kilometers. Scarlet Knight measured temperature, salinity and depth to help model the density and currents of the Atlantic and better understand how the ocean interacts with global climate. Underwater robots can carry a variety of other sensors to measure chlorophyll, sediment, harmful algal blooms, track acoustic transmitters, and more.

Photo credit: https://spectrum.ieee.org/automaton/robotics/robotics-hardware/mit-soft-robotic-fish-explores-reefs-in-fiji
Biomimetic robots offer an opportunity to study marine life without disturbance. In 2018, MIT researchers developed SoFi, the Soft Robotic Fish. SoFi uses acoustic communication signals, a hydraulic actuator to wiggle its tail, and a swim bladder inspired by fish. In 2021, British scientists 3D-printed robotic jellyfish, nature’s most efficient swimmer, using similar technology. These jellyfish can replace human divers in restoring fragile corals without damaging them further. WasteShark is another autonomous robot inspired by the whale shark. It roams waterways “eating” debris, and can capture up to 130 lb of waste at a time.


Human divers can only do so much, spending up to three to four hours a day in the water. Conversely, fleets of underwater robots can be deployed simultaneously for cost-efficient automation. As more reefs continue to become bleached as climate change intensifies, we cannot continue to rely on human divers for coral restoration. Even if humans were to become ten times more efficient, we still would not be able to keep up with the collapse of coral reefs. Robots are the perfect way to automate restoration efforts and implement them on a wider scale. Terrestrial innovations have helped promote efficient environmental mitigation and sustainable economic growth, and it is time to optimize the blue economy and environment through oceanic innovations. It is time that we harness robotics and artificial intelligence to bolster our efforts in researching and conserving the ocean. With the assistance of engineering, the possibilities are limitless!
Sources – Tanya Das


Using Geoengineering to Reduce Ice Cap Melting

The Greenland ice sheet, a massive body of ice, stretching over 1,710,000 square kilometers, is losing mass at an alarming rate, and this rate will only increase as the 21st century progresses. This acceleration of the icecap melting is directly related to the amount of anthropogenic greenhouse emissions. These greenhouse gasses trap solar radiation that would have been reflected back into space, heating up the planet, and acting like a blanket. This “Greenhouse Effect” becomes more prominent when more greenhouse gasses are present.

So what can be done to reduce or fully get rid of these emissions? Well, that is hard to answer, and there is no single solution. What can be done is blocking the solar radiation from ever reaching the earth’s surface so it can’t be trapped in the first place. This would be done by a process known as solar geoengineering, a process to artificially reduce the amount of solar radiation above the ice caps, which would, in turn, limit the melting of the ice. This would be done by flying a plane up to from 8 km to 15 km in the stratosphere and releasing sulphur. As explained, in the article, “Brief communication: Reduction in the future Greenland ice sheet surface melt with the help of solar geoengineering,” Xavier Fettweis, a climatologist and the director of the Climatology Laboratory at the University of Liège, “The sulphur will then act as a sort of mirror that will reflect part of the solar radiation back into space.”

After witnessing the eruption of Pinatubo in 1991, which violently spewed millions upon millions of tonnes of sulphur dioxide up into the atmosphere, many scientists saw the potential for a new climate change intervention. The eruption caused a global drop in temperature by about 0.5°C. Although it would be done artificially, the effect would be the same for the area around Greenland’s icecap.
How safe and risk-free is this method of geoengineering, though? Is it reliable? Climatologists at the University of Liège are testing that.

Xavier Fettweis stated, "We used a plausible scenario of solar geoengineering (G6solar) that would reduce global warming by a factor of 2 on a global scale compared with the most pessimistic scenario in which nothing would be done about the climate." This suggests that this method of geoengineering would indeed be reliable and could slow down the melting long enough for other, more sustainable methods to be put in place. Climatologists used their MAR (Regional Atmospheric Model) they developed to use the geoengineering idea, and, "we show that the reduction in solar radiation associated with this scenario would make it possible to locally reduce the melting at the surface of the Greenland ice sheet by 6% in addition to the global reduction in global warming." This seems like a very sure way to fix the problem, but it isn't.

It is important to understand that solar geoengineering is a temporary fix so that new, better methods can be developed for combating global warming and for the world to become more eco-friendly. If the world doesn't turn around, geoengineering would only hold out until the end of the century. There are also side-effect climate risks to this intervention, including a hit to the ozone layer's health, as well as the water cycle and precipitation, making the difference between wet and dry regions more prominent.

Geoengineering is a drastic intervention that comes at the cost of polluting the earth and interrupting natural climates. However, we soon may have to swallow our fears for the sake of humanity. ‘Only solar geoengineering scenarios, which are much more ambitious but becoming unrealistic and dangerous, would make it possible to save the cap,” concludes Xavier Fettweis, “We are talking here about human and intentional intervention in the climate. A plan B that is not! It is therefore urgent to drastically reduce our greenhouse gas emissions by means that we know but are struggling to implement.”
Sources – Justin Feder


Choices: Cognitive Dissonance and The Omnivorous Human

I became vegetarian five years ago, when – just out of elementary school - I truly began to understand what meat was, the implications of how it got to my plate, and how those processes affected the world. I may have known these things previously, but there is a great difference between knowing something and really understanding it.

Since then, I've become increasingly agitated with the inaction of the people around me, especially when failing to convert meat-eating friends and family members to vegetarianism. My parents could likely recite my speeches on the subject while asleep, yet their behaviors do not shift.

According to the University of Michigan Center for Sustainable Systems, meats account for more than half of the average person’s food-related greenhouse gas emissions. Eliminating meat seemed like an excellent step to me, and I couldn’t understand why those around me wouldn’t take actions congruent to my own. I certainly know that my actions aren’t perfect, but seeing others make choices that seemed inconsistent with their goals always made me wonder where the disconnect was. These were selfless people, aware of their impacts and caring about the environment. I couldn’t understand what led them to make choices that seemed to conflict with their values. I wanted to help the environment, but with so many unwilling to make personal sacrifices I was at a loss for how.

Asking around in an informal survey indicated diversity in people’s reasoning as to why harmful behaviors were acceptable. Answers ranged from explanations of how vegetarianism would require too much effort, to excuses about tradition and how they were raised, to ideas about the impact. This latter variety of explanation was often pessimistic or optimistic to an extreme, with answers suggesting that people like me (referencing my vegetarianism) would save the planet (thus implying that their action was unnecessary) or telling me that the effects of climate change were irreversible (and therefore any change they would make would be insignificant).

The answers differed in speech and word but were the same in purpose. Not one person told me that they just liked the taste of meat and selfishly chose their own pleasure over the environment's health. All responses shifted blame or responsibility off the speaker. This internal justification is based on a psychological phenomenon called cognitive dissonance.
Cognitive dissonance is the idea that when conflict occurs between our values or beliefs, and cognitions about our actions, an internal discrepancy is created. This causes discomfort that we seek to rid ourselves of – often by changing our view of our actions rather than shifting inciting behavior. When avoiding what we consciously believe to be morally right, we end up creating reasons for why less moral behavior is acceptable. We want to believe that we are better than what comparing our actions with our morals would suggest, and we therefore change perception of the situation to give reasons for why those morals shouldn't apply to certain actions. Essentially, cognitive dissonance paves a path right past our morals, to make acceptable actions directly conflicting with our values.

A series of studies by researchers at the University of Melbourne indicate that cognitive dissonance influences how we perceive the sentience of animals (specifically livestock). People who ate meat were significantly more likely to consider an animal as more conscious when they weren't reminded of how it was farmed to be killed for human consumption. When reminded of how they contributed to its suffering and death, they repudiated the animal's sentience to accept its fate. The abstract of their report stated, “Many people like eating meat, but most are reluctant to harm things that have minds...this dissonance motivates people to deny minds to animals,” This is just one of the ways in which human brains uniformly attempt to nullify the conflict by changing personal truths regarding our action.

Cultural and societal factors also influence the way people view their actions. Because so many of us are raised to see meat-consumption as normal, we accept that as moral. More than half of the world’s population occupies urban areas, meaning that many are rarely reminded of where their food comes from. We have removed ourselves from reality so far that even the meats’ names have been dissociated from meaning to the point of euphemism. The word “beef” conjures ideas of the food, not of the dead animal flesh that the word would truly indicate. These factors can create great inconsistencies in our behavior. They create situations where even a person who would never imagine killing an animal can look at meat on their plate without blinking.

All of us are affected by cognitive dissonance, and will continue to be all our life. With each choice we make comes a possibility to put good into the world as we define it. But when we obscure that definition, we make our choices more and more blindly. I hope to instill in you a sense that understanding this phenomenon can help you be in control of how you react to it, hopefully using this knowledge to align your actions with your moral compass, and be truthful with yourself.
Sources — Maia Dock


The definition of navigation is to both ascertain one's location and one's destination. For centuries, humanity has scrounged for hints and tools in an attempt to explore the world; to navigate the far off corners of the globe. The history of human navigation is extensive and profound, with many tales of the conquests that humanity’s ancestors partook in. Their many journeys upon the high seas for a plethora of purposes can only lead one conclusion: Society has a need for navigation. A sense of urgency to find something new, a calling within everyone to explore. This necessity binds humanity all together in the voyage to find what is out in the wild.

Take for instance the Polynesians, an entire society of navigators. Around three thousand years ago, Polynesians began sailing the Pacific in search of new islands. When their resources ran low, they simply moved. Their ability to navigate and locate new homes with ease allowed them to survive. Here, the need to navigate was a calling to move forward, a drive to survive. They identified the wind belts in the Pacific, read the stars to know their direction, and built advanced canoes to achieve this goal. To this day, the Polynesians’ innovation leaves its mark on all sailing societies of the world, with the majority of their natural techniques still being used. The Polynesians’ drive to move between islands and find new ones has had such a major influence on society that even the social media of the modern day has captured these three thousand year old traditions. The popularity of movies like Moana demonstrate that in the 21st century, there is an intense interest for exploration and navigation on the seas.

How about the Age of Discovery? The hundreds of young, ambitious explorers who worked tirelessly for their countries. Inventions like the magnetic compass as well as more in-depth maps have left a lasting mark on society to this day. No reasonable ship will ever lack a working magnetic compass, and every ship will have dozens of maps dedicated to the ports and harbors that it visits. Even though they sailed the seas more than 500 years ago, these explorers’ dedication remains behind inside every boat worldwide.
Technology advances. In the 19th century, steamboats came into play. Although they were resource intensive, the speed at which they traveled was unrivaled. The countries who could afford this technology were propelled ahead of the competition. The 20th century saw the introduction of SONAR, which added a new dimension to exploration. The main focus of sailors was no longer on the sea surface, rather the thousands of meters of saltwater beneath them. Technology has advanced past the point where one must wonder, “how?” and instead must ponder, “why?” What is the purpose of exploring?

Why does humanity need to navigate? The answer is not simple, nor is it obvious. The Polynesians sailed for many reasons, but the principal among them was to survive. They needed the resources, thus they were going to obtain them in any means possible. They sailed endlessly to retrieve supplies that would never last them nearly long enough. The explorers of the Age of Discovery had many motives as well. Fame, money and safety were popular. The majority were chartered and paid to explore for the major nations at the time. It is in these human examples that we find the meaning to the aforementioned question.

Within all humans since the beginning of time, there has been uncertainty. As is the law of nature, everything trends towards chaos. Whether it is a lack of food and water, the concern of bankruptcy, or the dread of not knowing when which day could be the last day, there is insecurity in all. The motive of every explorer that has journeyed into the sunset can be boiled down to something plain and concrete. Find stability. Find steadiness in lives that seem predestined to collapse, fall apart, and fail. Thus, they explore. They navigate the waters of the world. Society innovates, pushes forward. They search for a new path.

The definition of navigation is to both ascertain one's location and one's destination. For centuries, humanity has known where they stand. Their location is on worn-out ground. A life path that has been tread by billions of humans before them. Their destination, however, is fluid.

Navigation is humanity’s way of finding a new path. One that differs from the norm. A drive inside everyone to be more than the sum of their ancestors. Humans will navigate until they are all wiped out, because within every human is the belief that the world could be better if they navigated just a little bit farther.
Sources – Ethan Wang

“College of Education.” Go to College of Education., coe.hawaii.edu/ethnomath/story/.