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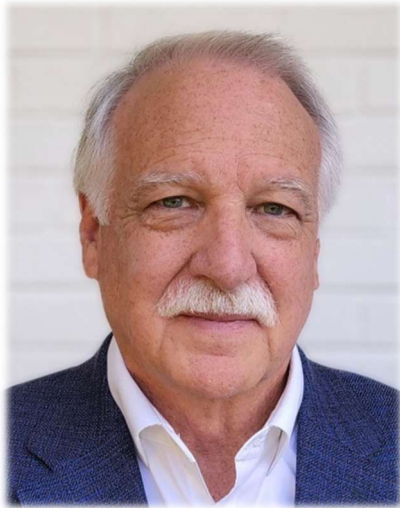
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A Message from the President:

Welcome to the inaugural issue of the Journal of the Biotechnology Institute. In this issue, we highlight the publications of our first Writing Intensive class. These research papers represent 36 weeks of instruction on how to pose a science question, conduct and organize the research, learn the fundamentals of scientific publication, and finally, produce a finished work.

We at the Institute are so proud of this year's class made up of 6th – 8th grade students. Before the writing series, they participated in our premier “bio” STEM online education program BioDiversity, an at home, after school 12-week course covering the fundamentals of science as it relates to biotechnology and its applications. Their dedication to learning over these many weeks in both programs was remarkable.

I must also recognize Mrs. Quinta Jackson, Executive Director of the Institute, who had the vision to create such a series. Her contribution to this effort was invaluable. Dr. Bijean Ford co-developed and oversaw the course content. And instructors from BioDiversity lent their expertise during the course and in the review of the manuscripts.

As those of you who are in a scientific field know, one's first attempt at authoring a paper is a daunting task and always conducted under the careful guidance of a mentor, thesis advisor or senior lab investigator. That these young individuals undertook the effort with focus and willingness to learn was an inspiration. They will be years ahead of their peers as they hopefully maintain a strong interest in science as a career.

We hope you enjoy their first publications. It is our goal that these become the foundation of a long and creative career in the sciences.

A handwritten signature in blue ink that reads "Larry Mahan". The signature is fluid and cursive, with a long horizontal stroke extending to the right.

Dr. Larry Mahan
President

TABLE OF CONTENTS

Saving Snow Leopards from Human Predators, p. 4 Over-Grazing Animals and Climate Change Chaeli Em Burns	
The Next Astronomical Frontier: The Possibility of Exploring Black Holes p.11 Quinton Burns	
A Review on Current Treatments for Group A Streptococcus pyogenes p. 19 Christian Downs	
Reducing Plastic Ocean Pollution and Its Downstream Impact p. 24 on Marine Fish and Human Consumers Brianna Givens-El	
The Preventable Extinction of Sea Turtles ! p. 33 Ivy A. Lewis	
How Did Humans and the Environment Impact the Population of Bison ? p.38 Ti-Maiah Marshall	

Saving Snow Leopards from Human Predators, Over-Grazing Animals and Climate Change

Chaeli Em Burns

June 7, 2022

ABSTRACT

Snow leopards were once listed as endangered and although they have elevated to vulnerable status, they are trending towards endangered again. Human beings are the primary cause of the decline in the snow leopard population. Humans are the only predators of snow leopards, hunting them for their fur and teeth. Human activity that causes climate change is warming their naturally snowy habitat and due to habitat loss, they must move to find new food sources.

Snow leopards often eat livestock when they cannot find their natural prey, and consequently this creates tension between snow leopards and farmers. As a result, farmers become predators of snow leopards to protect their livestock. Humans can help snow leopard numbers increase by stopping poachers and helping farmers learn to coexist with them. Humans also change their behaviors that are warming the planet.

INTRODUCTION

Snow leopards have a natural camouflage that renders them almost invisible in their snowy habitat, which is why they are often referred to as the “ghost of the mountains (WWF, 2022). The snow leopard’s habitat contains 12 countries, including Afghanistan, China, and India (McCarthy et al, 2017). On the extinction chart, snow leopards currently have vulnerable status (WWF, 2022). A species considered to be vulnerable faces a high risk of extinction in the wild. The definition of endangered is a species that faces a very high risk of extinction in the wild, and vulnerable status is one step away from endangered. Human beings are the primary culprit leading to the decline in the snow leopard population. Specifically, poaching practices and habitat loss are the largest contributing factors to their diminishing population.

The largest amount of snow leopards is in China – approximately 60% (Snow Leopard Facts, 2021). Chinese medicinal trade includes snow leopard skin and bones. Additionally, Chinese coal production is contributing to global warming in the region, which is melting the snow leopard habitat (WWF, 2022). The habitat loss is causing the snow leopard to migrate into areas that bring them into contact with farmers and poachers. Their camouflage is less effective, which makes them even more vulnerable. They eat available livestock due to the unavailability of their natural prey and get killed by farmers. They also fall victim to poachers because they are outside of their home environment.

In this paper, their current disposition is discussed, and insight is provided into how the steady decline of the snow leopard population can be reversed.

MATERIALS AND METHODS

The following graphs were either obtained from the internet or recreated by the author. Basic search terms about the decline in the snow leopard population were used. Data was obtained through genotyping according to the original sources.

RESULTS

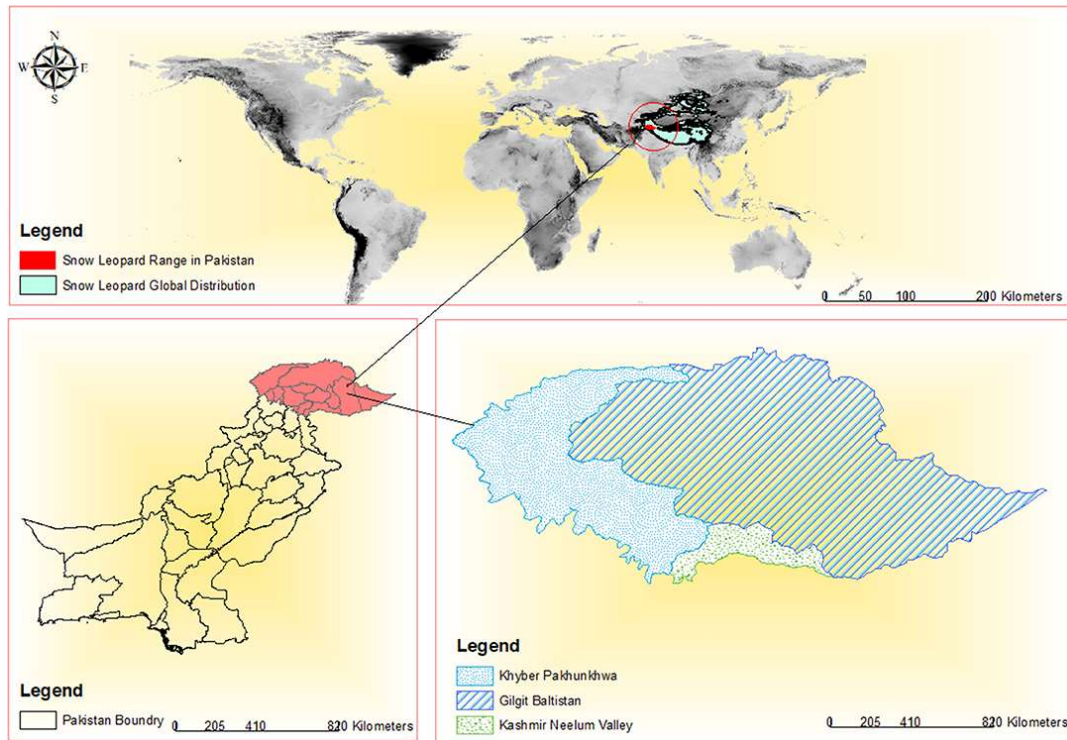
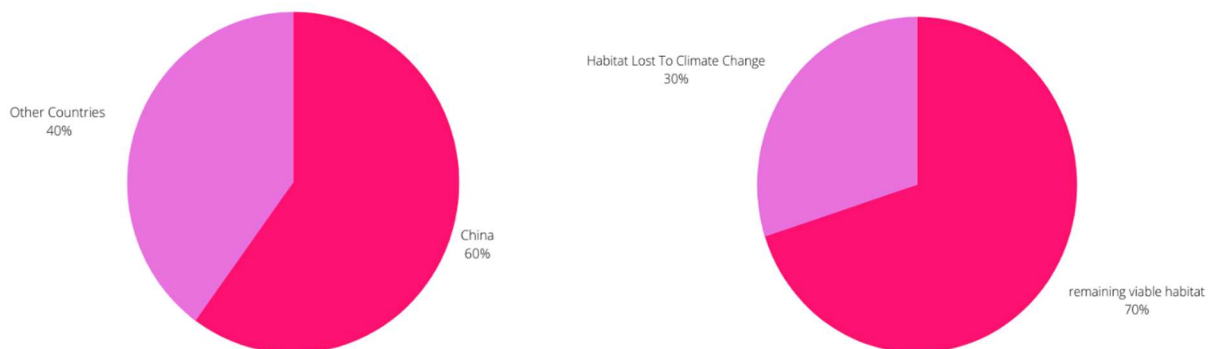


Figure 1: Distribution of the Snow Leopard Population

The global population of snow leopards is confined to the continent of Asia, with a concentration in 12 countries: Afghanistan, Bhutan, China, India, Kazakhstan, Kyrgyzstan, Mongolia, Nepal, Pakistan, Russian Federation, Tajikistan, and Uzbekistan (McCarthy et al, 2017). Approximately 60% of this global snow leopard population resides solely in China. Concurrently, 30% of the snow leopard habitat has been lost to the effects of climate change.



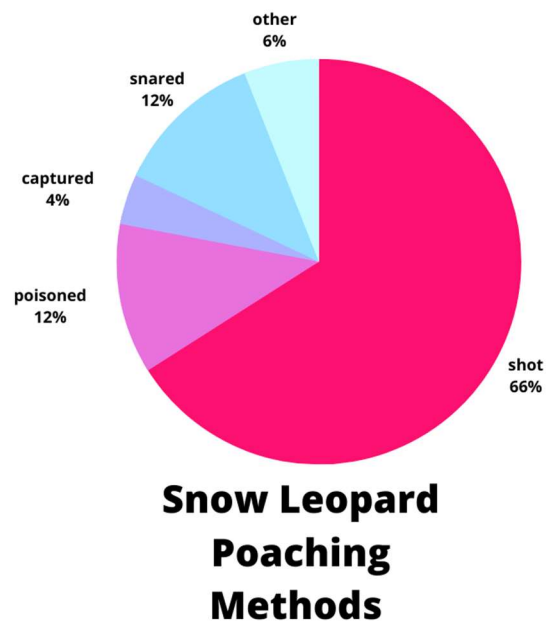


Figure 2: Disaggregation of Snow Leopard Poaching Techniques

Snow leopards are poached in a number of ways as displayed in Figure 2. Of the known ways of poaching, the majority of snow leopards are shot by poachers (66% of incidents), followed by poisoning (12%), snaring (12%), and capture (4%); there are 6% remaining that are currently uncategorized. Additionally, 89% of reported incidents against snow leopards were a result of poaching and trade.

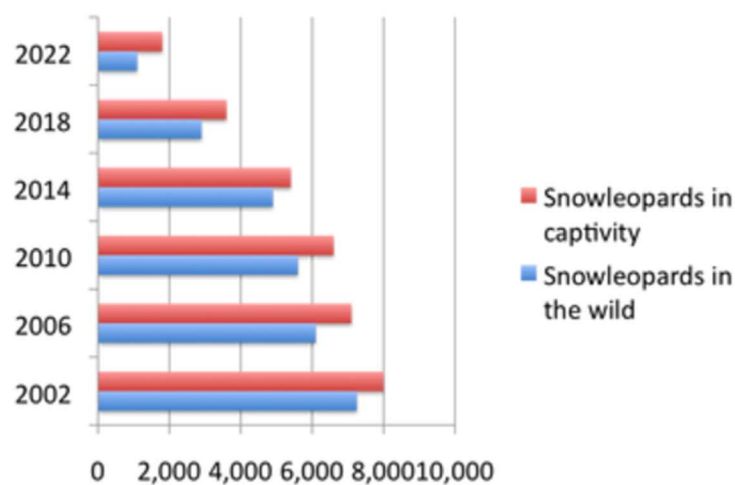


Figure 3: Population of Snow Leopards Declining over Time

Predominately, as an artifact of the extreme level of snow leopard poaching, the global population has steadily declined to vulnerable status (Panthera-Snowleopard, 2022). According to the World Wildlife Fund, 90% of the poaching incidents occur in 5 countries: China, India, Mongolia, Tajikistan, and Pakistan.

DISCUSSION

Taking into consideration all the factors that are working against the snow leopard, it is of little benefit to note a shift in their migratory pattern, which is making the already endangered cat even more vulnerable to extinction. At the age of 3, young male leopards leave the area where they were born and migrate to new territories. Scientists have found that an uptick in poaching and other threats are making male leopards stay closer to home. Loss of habitat and prey, as well as intense persecution as livestock killers, all pose a significant threat to the snow leopard (Bumstead, 2017).

They are heavily hunted in southern Asia for their skin and bones supplying the Chinese medicinal trade. To save snow leopards, humans must stop hunting them for their fur and control their livestock. The first step is to control hunting by passing prohibitive poaching laws. The next step is to teach farmers to control their livestock so that it will stop eating the leopard's prey. If snow leopards can hunt their natural prey, they are less likely to eat livestock. These steps are important because removing these issues will help the leopards to live by allowing them to keep their fur and preserving their prey for just them to eat. The largest problem to solve is climate change, as humanity must stop all earth-warming activity to save their cold, mountain habitat.

The largest snow leopard population is in China, and this country emits much of the world's carbon dioxide through coal refineries. To stop this, the Chinese government can start using different ways to power their cities, like nuclear. Researchers at Tsinghua University in Beijing say China will need to stop using coal entirely for generating electricity by 2050, to be replaced by nuclear and renewable energy production (Brown, 2021). This way, the snow leopard's habitat will not melt. In a move intended to improve Beijing's climate credentials, President Xi Jinping of China said in 2021 that his country would stop building coal-burning power plants overseas, ending its support for construction projects that rely on the world's dirtiest fossil fuel (Sengupta, 2021).

CONCLUSION

The extinction of the snow leopard will be an indication of the loss of freshwater reservoirs and other cold climate species that contribute to our ecosystem. There will be an excessive amount of the prey that they hunt, which will affect the food chain and the environment. Poachers must be stopped from killing them for their fur, while farmers and their livestock must be trained to live harmoniously with snow leopards.

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The Next Astronomical Frontier: The Possibility of Exploring Black Holes

Quinton Burns
June 7, 2022

ABSTRACT

Scientists are aware of black holes, but they have never been explored due to their destructive nature. Black holes compress and stretch any form of matter that enters. For this reason, astronauts cannot fly into them. What if spaceships of the future were designed to withstand the gravitational pull of black holes? That would open a new area of space exploration. Some scientists theorize that black holes could be used to power spaceships. If this is true, black holes are an untapped, potentially clean energy source. Unmanned ships that can withstand the initial gravitational pull of the black hole until it reaches the event horizon could be the key to exploring black holes.

INTRODUCTION

Black holes are points in space that are so dense, they create deep gravity sinks. Past a certain point in a black hole, nothing (not even light), can escape its gravitational grasp. The boundary of a black hole where nothing can escape is called the “event horizon.” There is zero visibility to see past this event horizon. And anything that gets too close — no matter if it is a person, a planet or even a star — will inevitably be stretched and compressed like clay by way of a process called spaghettification which means it stretches. The object then subsequently collapses into the black hole’s singularity. The singularity is a place where time and space are irrelevant; this is the true core of a black hole (Wei-Haas, 2021).

Various metals are used in the construction of modern space vehicles. Aluminum, a metal used in aircraft, migrated from aviation to rocket construction. However, it came to pass that its properties did not fully meet the needs of the SpaceX designers. Although it was light and malleable, it was not sturdy enough. Therefore, duralumin (or duraluminum), developed in Germany at the beginning of the 20th century, is used more often. This alloy or, to be more specific, this group of alloys, contains not just aluminum but also some copper and manganese, which make it stronger and harder. However, this material is very difficult to weld. Duraluminum parts are typically riveted or bolted, which ensures tightness. Hence, duralumin is used in so-called ‘dry’ rocket compartments.

In this paper, current technologies and capabilities for space travel and exploration of black holes are explored. Facilitating making this a reality based on our current knowledge and research is also discussed.

METHODS AND MATERIALS

I conducted a dry lab. The following graph was obtained on the internet. Search terms about black holes were used. Data was obtained through SCIRP according to the original graph. Author recreated the graph for use here (Md Shams et al., 2013).

RESULTS

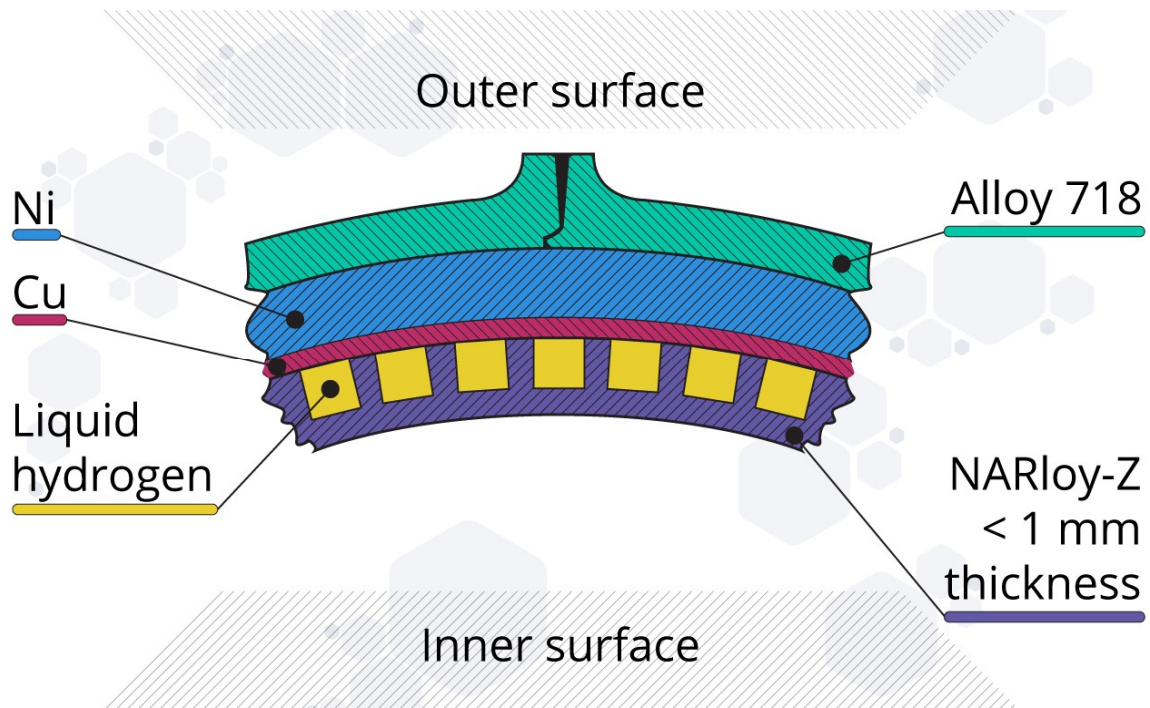


Figure 1: Material Composition of a Reinforced Fuel Combustion Chamber

Cross section of the main combustion chamber of the SSME. The innovative copper alloy NARloy-Z is deployed to withstand the tremendous heat fluxes from the propellant combustion by being actively cooled with liquid hydrogen. (Matmatch, Metals in Space: How Superalloys Changed the Rocket Landscape, 2019)

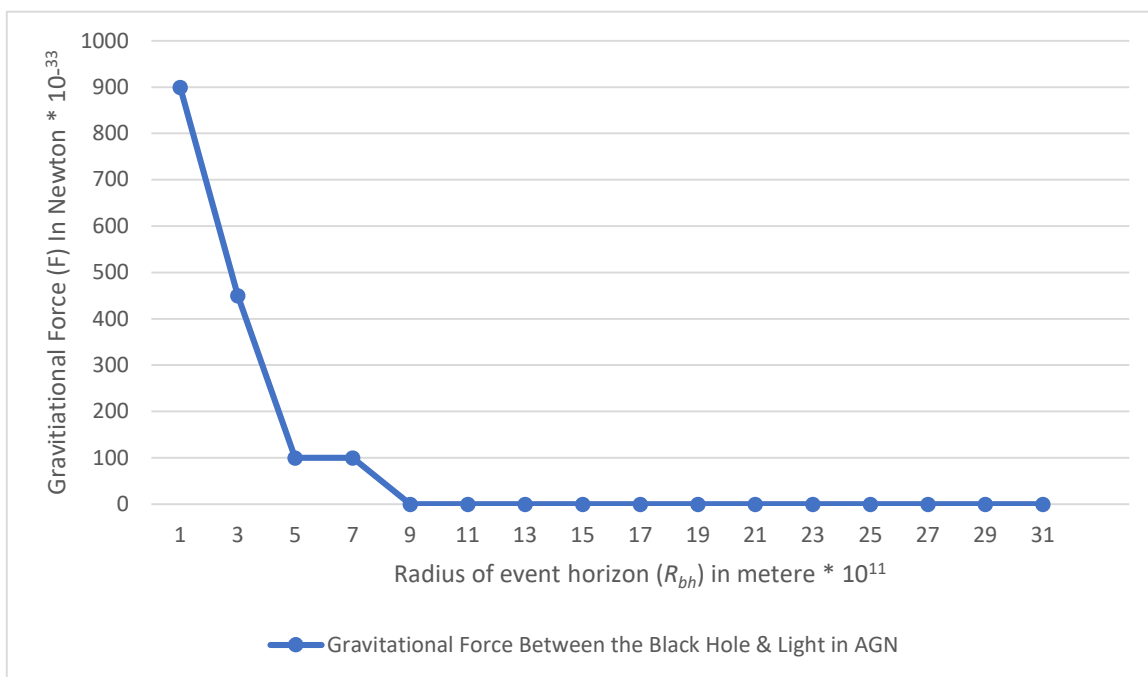


Figure 2: Relationship between Gravitational Force and the Radius of the Event Horizon

When the Gravitational force is 900 Newtons (F), the radius of the event horizon is 2 meters (R_{bh}). When the F is at around 450 newtons however, the R_{bh} is around 3.2 meters in length. You can see as the gravity drops, the event horizon widens. This trend keeps up for a while. When the F is at 100 newtons of gravity, the event horizon is five meters in length. When the gravitational force is zero, the radius of the event horizon seems to expand. (Md Shams et al., 2013)

Table 1: Metals used in conventional spaceships and prospective spaceships

Traditional Spaceship Metals/Alloys	Prospective Spaceship Metals/Alloys
Aluminum	Steel
Lithium	Duralumin (Copper and Manganese alloy)
Magnesium	Silver
Titanium	

Contemporary spaceships are made with materials that are strong, yet light, to allow for durability and the ability to be propelled into space. Not only does the exterior need to be sturdy, but also specific compartments such as the fuel reservoir need to endure extreme levels of pressure. If these spaceships are to withstand the additional pressures applied by black holes, these vessels need to be fortified as much as feasibly possible.

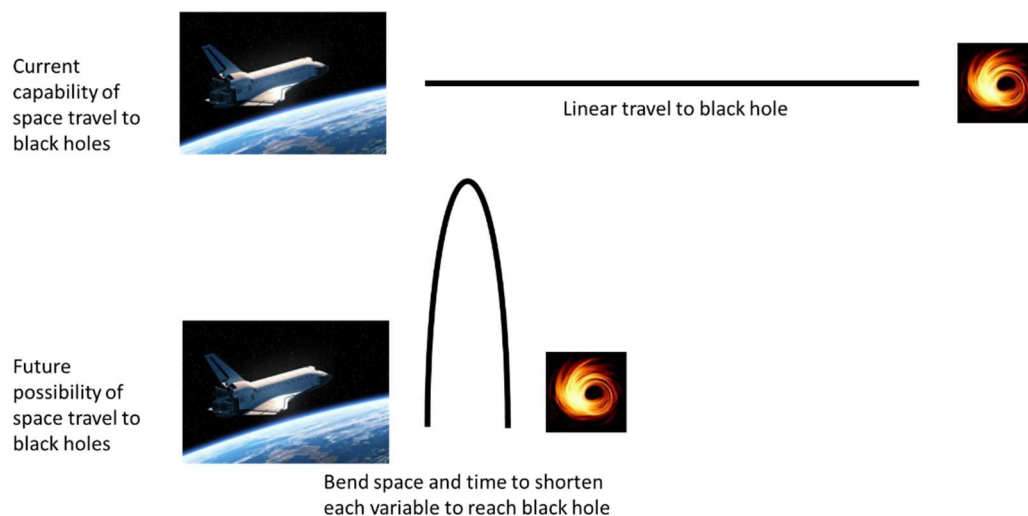


Figure 3: Future Ideas for Traveling Long Distances in Space

This is the theoretical proposition of how to work around the extensive distance from Earth to the nearest black hole. If traveling linearly from point A to point B is not feasible, then bending space and time can essentially pull the black hole closer to our point of origin.

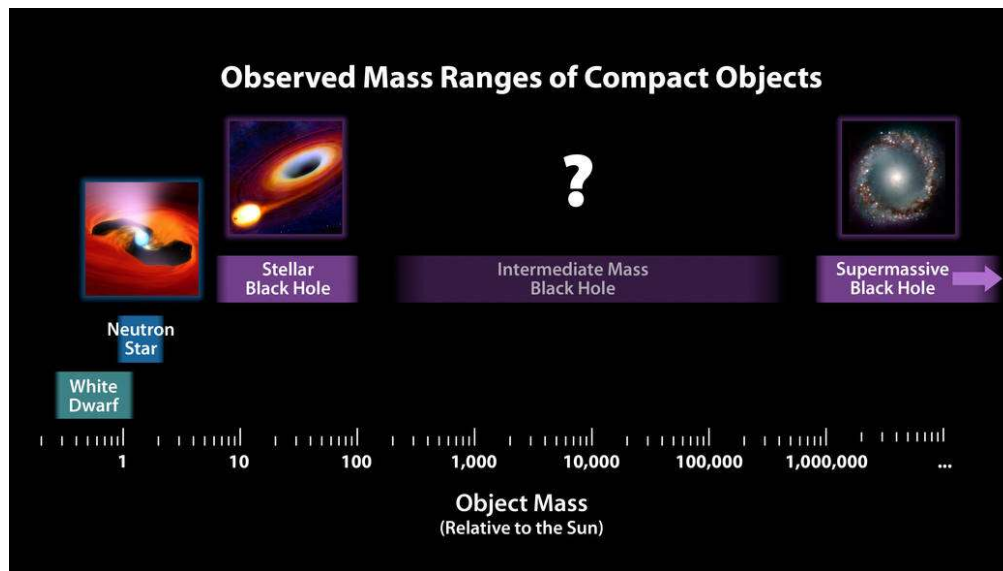


Figure 4: The Spectrum of Celestial Body Masses Compared to the Sun

This figure provides perspective of the size of different celestial bodies, with the inclusion of a variety of black holes. This shows the scale of how massive a supermassive black hole is in comparison to our solar system's sun.

DISCUSSION

For a spaceship to enter a black hole, it would have to have anti-compression capabilities to avert spaghettification. Because a black hole is invisible, the ship would also have to be equipped with a special x-ray telescope that allows it to see the black hole. There are three types of black holes, therefore, the spaceship must also be able to determine the size and mass of a black hole before entering it so that the spacecraft has adequate preparation if it is a supermassive black hole (Figure 4). The spacecraft would have to move faster than the speed of light – the fastest speed known to man – to the singularity, where the gravitational pull would not destroy it.

Currently, spacecrafts are made of aluminum. Space craft materials must be strong enough to escape earth's gravitational pull and endure the extreme fluctuations in pressure that the ship is exposed to (Table 1). The material must also be light enough to require less fuel (Smithsonian Institute, 2022). This may also require the ability for the ship to acquire and store energy from nearby stars. The closest black hole is 1,500 light years away. It takes 10 years to travel one light year (UCSB, 2022). Therefore, it would take 15,000 human years to reach it with our current technology. A craft that could reach Unicorn must be able to move faster than our current tech if will reach a black hole in our lifetime. Another alternative would be to bend space and time in order to shorten the distance (and time) to the black hole. At this point, this idea is not more than a theoretical exercise in mathematics and physics, but the most brilliant minds are hard at work to reach a solution.

The gravity acting between the black holes and light particle decreases rapidly with expanding the radius of the event horizon. The gravitational force acting between the black holes and light particle decreases slowly with increasing the radius of the event horizon (Md Shams et al., 2013). A reasonable hypothesis would be that a spaceship that could withstand a rapid trip to the event horizon could potentially explore the area once there. If black holes do in fact possess the energy to power space craft, a trapped exploratory ship could potentially provide data into eternity.

CONCLUSION

Man has accepted that black holes cannot be explored. If the laws of physics can get ships into space, it is arguable that physics can get them into black holes. Engineers should study decompression regulators for the exterior and interior of spacecraft, materials that can withstand compression and decompression, thrusters that can propel spacecraft at the speed of light, and the theoretical mathematics/physics that can manipulate space and time. These innovations could potentially get a ship to the event horizon where exploration could take place.

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A Review on Current Treatments for Group A Streptococcus pyogenes

Christian Downs

June 7, 2022

ABSTRACT

Streptococcus pyogenes is a bacterial pathogen that causes a wide array of life-threatening infections. There are a total of 517,000 deaths that happen each year worldwide just because of streptococcus (Gera 2005). *Streptococcus pyogenes* infections are relatively mild illnesses. More recently invasive and serious GAS infections have become concerning. There are 4 different types of streptococci. There is Group A Streptococcus, Group B Streptococcus, Group C Streptococcus, and Group G Streptococcus. Group A streptococcal (GAS) infection is caused by bacteria known as Group A (beta-haemolytic) Streptococcus, the most common type of which is *Streptococcus pyogenes*. GAS is a common infection that can cause sore throats (pharyngitis), scarlet fever or impetigo (school sores). Group B Streptococcus (GBS) infection is mostly found in newborn babies, most commonly causing [sepsis](#), [pneumonia](#), and [meningitis](#). Group C Streptococcus (GCS) and Group G Streptococcus (GGS) are commonly spread throughout raw milk, and are most likely in animals, such as cattle, and horses. When catching Group C or Group G Streptococcus, the bacteria can get into the bloodstream, the human skin, and the throat. Ineffective treatment of *S. pyogenes* infections can result in the post-infectious disease, this can cause dreadful fevers and post-streptococcal glomerulonephritis. Moreover, it causes invasive infections like toxic shock syndrome that is associated with high morbidity and mortality. Handwashing is one of the most important infection control practices for the prevention of spread of infection with *Streptococcus pyogenes*. To easily fix the rapid fire spread of gm streptococcus, and cure patients who suffer from streptococcus pyogenes, patients can use treatments to get rid of streptococcus pyogenes infections.

INTRODUCTION

Streptococcal disease is ordinarily spread by direct person-to-person contact. An excellent compilation of data and estimates of the global burden of GAS diseases from 2005 revealed 616 million cases of pharyngitis. In cases of pharyngitis and respiratory infections, droplet nuclei of saliva or nasal secretions are the mode of spread. Crowding such as occurs in schools or military barracks favors interpersonal spread of the organism in community outbreaks (Ostrowsky 2018). During the winter and spring in temperate climates, up to 20% of asymptomatic school-aged children may be group A streptococcus carriers. The topic “ Invasive Gas”, will be based on the Material and Methods on *Streptococcus pyogenes*. and many are [facultative anaerobes](#) (capable of growth both aerobically and anaerobically). Invasive Gas, which stands for a severe and sometimes life-threatening infection in which the bacteria have invaded parts of the body, Group A [S. pyogenes](#) is the causative agent in a wide range of [group A streptococcal infection](#) (GAS). These [infections](#) may be noninvasive or invasive. The Noninvasive infections tend to be more common and less severe. The most common of these infections include [streptococcal pharyngitis](#) (strep throat) and [impetigo](#). [Scarlet fever](#) is also a noninvasive infection but has not been as common in recent years.

Here we discuss GAS that causes scarlet fever while we explore the mechanism of the disease, and the possibility to make effective treatments. New research published in October 2020 in the journal that the bacterium appears to be getting more robust after being infected with viruses, specifically the North-East Asian serotype M12 (emm12) (group A Streptococcus, GAS). They found three new genes, acquired from viruses, leading to the development of "[superantigens](#)" target [white blood cells](#), leading to a more virulent strain of the bacterium. A vaccine that will protect against the 180 to 200 types of bacteria causing the disease has been worked on for over 20 years, but as of 2020 a safe one had not yet been developed. Current treatments used for Streptococcus contain inexpensive antibiotics, such as Penicillin.

METHODS

The data was retrieved from an internet source. This source was the National Library Of Medicine. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3920295/>. The article that was used was called “ Laboratory Growth and Maintenance of *Streptococcus pyogenes* (The Group A Streptococcus, GAS)”. Therapy for streptococcal pharyngitis is aimed primarily at preventing nonsuppurative and suppurative complications and decreasing infectivity. One accepted treatment method includes a 10-day course of penicillin V 250 mg twice daily in children and 500 mg twice daily or 250 mg 4 times daily in adults is very effective (Lange Pharmacology 2022). According to the articles, Medline Plus, Clindamycin, and Medline Plus, Vancomycin, from Natural Library of Medicine, there are some prophylaxes that can be used when infected by streptococcus pyogenes, these types are vancomycin, and clindamycin. Vancomycin is used to treat colitis (inflammation of the intestine caused by certain bacteria) that may occur after antibiotic treatment. Clindamycin is in a class of medications called lincomycin antibiotics. It works by slowing or stopping the growth of bacteria.

RESULTS

Table 1. Treatments For Streptococcus

Name of treatment	Treatment type
Penicillin	Antibiotic
Tylenol	Pain Reliever and Fever Suppressant
Advil	Anti-Inflammatory
Vaccine	Prophylactic

These are some of the many treatments for streptococcus.

Table 2. Streptococci Bacterium

Name of Bacterium	Abbreviation
Group A Streptococcus	GAS
Group B Streptococcus	GBS
Group C Streptococcus	GCS
Group G Streptococcus	GGS

These are the different types of streptococcus bacterium

Figure 1: Number of laboratory diagnoses of Group A Strep by week and season, from 2012/13 to 2018/19 week 20

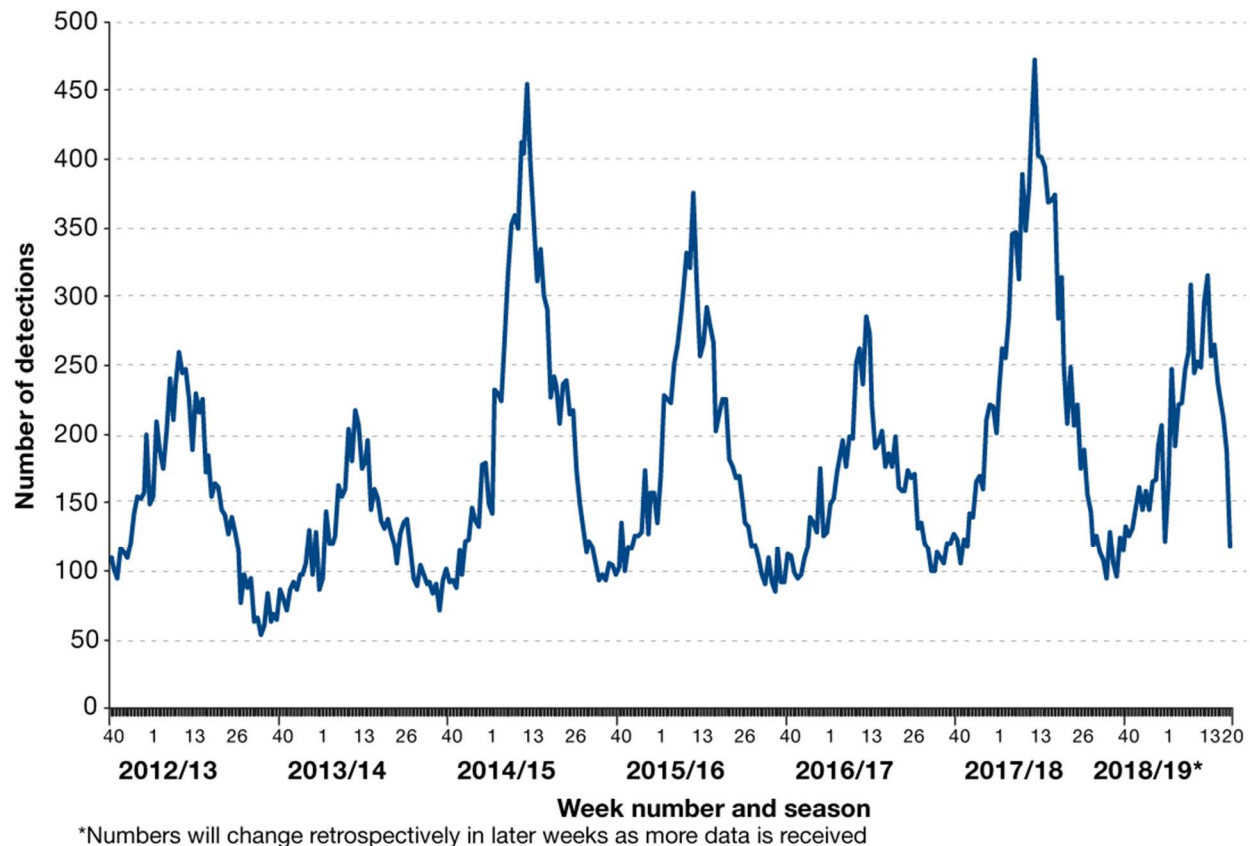


Figure 1 shows the results of strep throat from 2012-2019. In the year 2013/14, it has a low graph, only reaching 100, and having a spike at 250. As visible, in 2014/2015 this is where the spike begins to take its course. The spike is just 200 more from 2012/2013. After this spike takes its course, it slims down, going back to 100 in 2015. In 2016, It spiked to around 370-390. Yet again, it spikes down in 2016/2017, just only being around 290. In 2017/2018 we see the highest spike in this whole entire graph. The rate that it is at for 2017/2018 is 460-470. Now continuing into 2018/2019, this rate is at 300-310.

DISCUSSION

These data are significant because they show the diagnosis of Group A Strep. This is especially important because after skyrocketing to 450, in 2014/2015. After that fatal rise with diagnosis, they proceed to get into high numbers such as 300, being the starting point, which is now converted and seen as normal. These aren't just the reasons why it's significant. Treatments for streptococcus pyogenes are also important, such as penicillin. Penicillin contains a beta-lactam ring as part of their chemical structure, and they have strong antimicrobial activity against many different strains of bacteria. For people who are allergic to penicillin, they can take erythromycin. Erythromycin is known as a macrolide antibiotic. It works by stopping the growth of bacteria.

More reasons why it's significant is because one, these numbers are high extreme numbers and this is actually hurting people. Another final reason is that just because the number may look “ low”, does not mean that this is not a significant issue, due to the fact that these bacteria can develop antibiotic resistance and render these treatments futile.

CONCLUSION

With all the evidence I have provided, I can conclude that [streptococcus](#) pyogenes is a very serious life threatening disease that should be taken seriously. [Streptococcal](#) has caused a lot of people their lives, and uncomfortable fevers, and sicknesses. [Streptococcal also](#) is a disease that till this day is still trying to be unlocked, and having vaccines, etc. for it. Finally, [streptococcal is](#) one of the deadliest diseases that no one talks about. You can treat Streptococcus naturally, with items and food like Honey, Gargles with warm salt water, and use a humidifier, instead of taking antibiotics a lot. People need to try to stop and avoid antibiotics resistance. People need to stop because when bacteria become resistant, the original antibiotic can no longer kill them. These germs can grow and spread. So in conclusion, it would be the best thing to wash your hands before you eat, sleep, and cough.

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Reducing Plastic Ocean Pollution and Its Downstream Impact on Marine Fish and Human Consumers

Brianna Givens-El

June 7, 2022

ABSTRACT

The ocean covers two-thirds of the earth's surface and ends up serving as the trash receptacle for several million tons of debris each year. A contributing factor to ocean pollution is an explosion in the use and sheer magnitude of the amount of plastic that is produced worldwide. According to organizations like Condor Ferries, plastic pollution in the ocean negatively impacts marine life and causes irreparable damage to the ocean ecosystem. Fish in particular are negatively impacted because they absorb the toxins from the ocean into their tissues and breathe microplastic particles through their gills. They also mistakenly or intentionally ingest plastic debris as food because they are unable to differentiate real food from plastic garbage. These contaminated fish then become part of the food chain and many end up consumed by humans. Addressing ocean pollution caused by plastics and the damaging effect on fish is a global issue that will require global communities to commit to reduce the amount of plastic produced in the world. A first step would be to strengthen compliance of existing legislative initiatives such as the 1972 Convention on the Prevention of Marine Pollution. Another important step would require additional studies of the impact of the transfer of fish contaminated with plastic particles to humans to demonstrate the potential long-term impact on the human body.

INTRODUCTION

Ocean pollution, commonly referred to as marine pollution, involves mixtures of chemicals and unrecycled trash made from manufactured products that are discarded and end up in our oceans (National Geographic Society, 2019). Because the ocean covers two-thirds of the earth's surface, it ends up serving as the trash receptacle for several million tons of debris each year. A contributing factor to ocean pollution is an explosion in the use and availability of disposable and single-use plastics in our society today. Most marine trash - about 80 percent - originates from the land through littering, storm winds, and poor waste management (National Geographic Society, 2022). When consumed by marine animals, the toxic chemicals in these plastics become part of their tissues and ultimately become part of the food chain. Fish in particular are negatively impacted because they absorb the toxins from the ocean into their tissues and breathe debris in the form of microplastic and nano plastic particles through their gills. They also mistakenly or intentionally ingest plastic debris as food because they are unable to differentiate real food from plastic garbage. As a result, many of these fish starve to death because the plastics clog their stomachs and digestive system (Condor Ferries, 2021). For those that survive, the toxins transfer from the fish's gills or digestive system to its muscle tissue, which is most commonly eaten by humans (McInturf, 2021). In fact, about 100 species of fish that are frequently consumed by humans are impacted (Savoca, February 2021).

The primary reason plastics are so harmful is the amount of time it takes for them to decompose. According to an article published in 2022, plastics take 500-1000 years to degrade (Condor Ferries, 2022). Even then, however, plastics do not fully decompose but only convert into micro or macro particles. Another sobering fact is that each year approximately 100 million marine animals die due to plastic waste alone. In the last 10 years, manufacturers have created more plastic products for consumption than were created in the last century. In fact, by 2050 the amount of dumped plastic is projected to outnumber the population of fish. Reducing the amount of marine trash, especially plastics, is a global responsibility that must be addressed today. To begin, efforts must focus on strengthening existing international legislative efforts that address marine pollution. Finally, more research is necessary to determine the harmful effects of microplastics in fish on the human body.

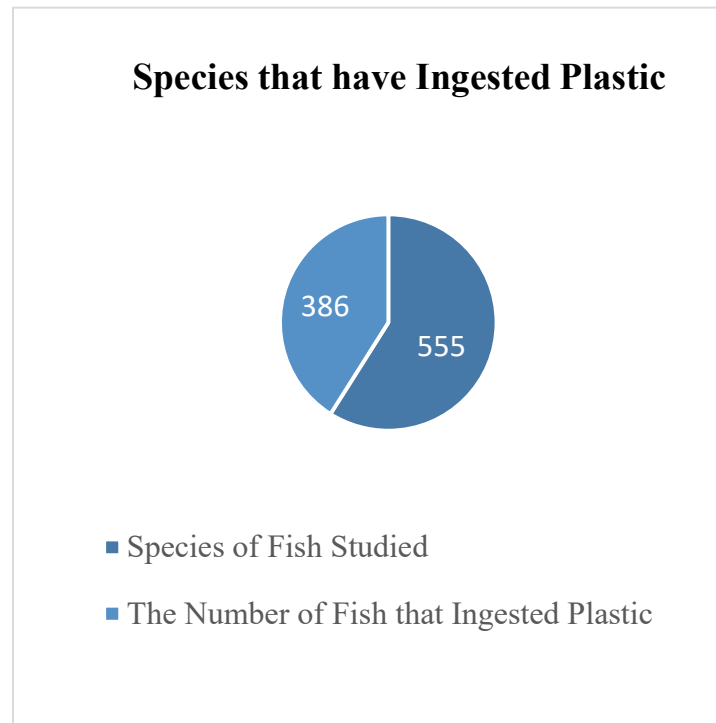
METHODS

The research focused research began with a review of several articles related to plastic ocean pollution, and the impact on marine life, particularly fish. Because billions of people around the world depend on fish as a source of food, additional efforts focused on scientific studies that addressed marine fish ingestion of plastics to understand the potential impact on humans. The studies covered the period 1972-2019 and focused on which species of fish were most impacted by this problem, the number of fish that had eaten plastic, and the regions where these fish were located. These efforts focused on the following key terms: plastic," "ocean pollution," "fish," "ingestion," and "marine life," "The research focused exclusively on articles related to plastic ocean pollution. Articles were excluded that focused on chemical ocean pollution and other marine animals.

RESULTS

Based on over 100 scientific papers that have studied 555 species of fish in the world, it was discovered that 386 have ingested plastic (Figure 1). That amounts to more than two-thirds of the studied fish worldwide that have consumed this harmful substance.

Figure 1: Fish that Ingested Plastic



Of particular concern is that 210 of these species are commercially important. To determine which fish species were more likely to ingest plastic, the studies examined each fish species' diet, habitat and feeding behaviors (Savoca, February 2021). Not surprisingly, fish such as sharks, grouper, and tuna that hunt other fish or marine organisms as food were found to ingest more plastic. There are thought to be more than 20,000 marine fish species so the current sampling of 555 represents only a drop in the bucket concerning how many marine fish may be affected by plastic pollution (McInturf, 2021).

Number of Fish that Have Ingested Plastics

A review of research covering the period from 1972 to 2019 reveals that fish consumption of plastic is only increasing. Additionally, since ocean pollution is increasing globally, one can only assume that the number of marine fish consuming plastics will increase as well. Figure 2 is an illustration of the impact of plastics on marine fish. As shown in figure 3, plastic production grew from 1.5 million metric tons per year in the 1950s to 275 million metric tons by 2010 and skyrocketed to 359 million metric tons by 2018. Of these amounts about 4.8 million metric tons are dumped into the ocean each year (Moore, 2022).



Figure 2: Illustration of a plastic contaminated fish:

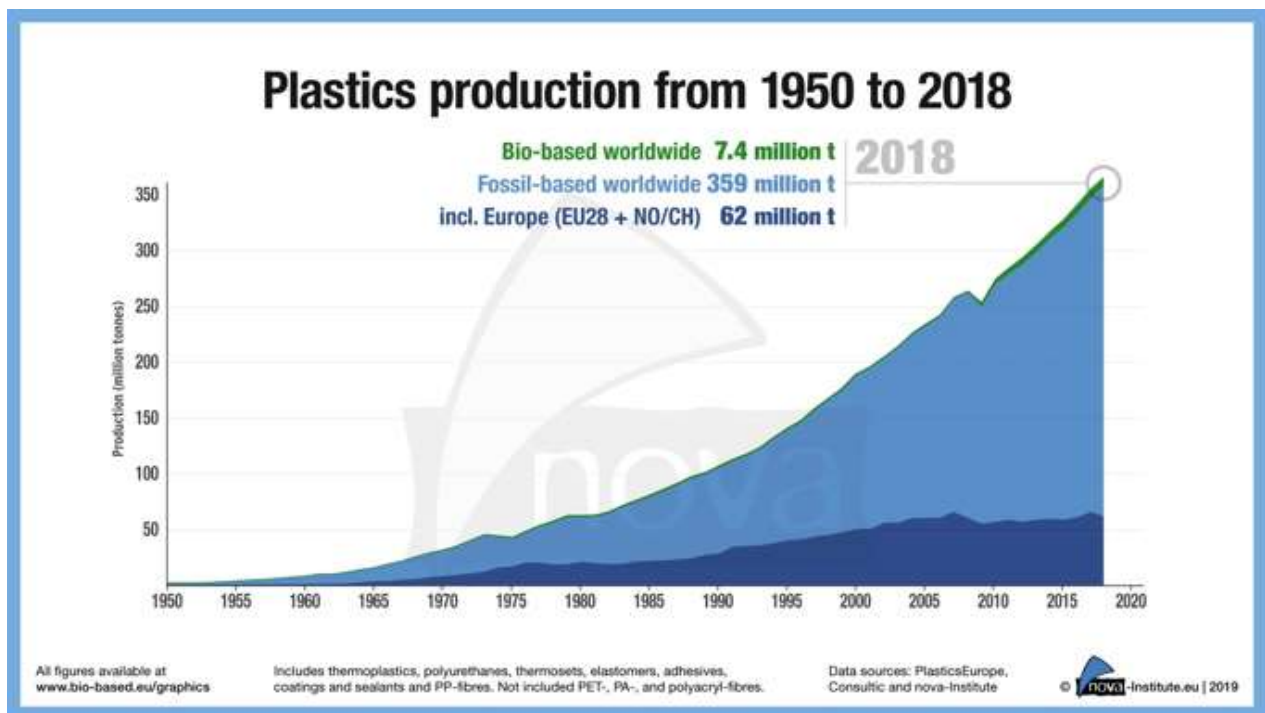


Figure 3: Plastic Production 1950 – 2018 (www.nova-institute.eu)

Since plastic is not easily biodegradable, it breaks down into small pieces called microplastics and nano plastics that are consumed by fish and other sea mammals (Andrews, 2012). In fact, an international assessment done by the United Nations in 2016 revealed that the number of fish species with plastic in their systems has quadrupled (McInturf, February 2021). Additionally, in the last decade alone, the sheer magnitude of fish consuming plastic has doubled across all species. Studies published covering the period 2010 - 2013 found that an average 15 percent of sampled fish had ingested plastic, and another study covering 2017 - 2019 found that the numbers had risen to a staggering 33 percent (Figure 4).

How Much Plastic was Discovered in Sampled Fish?

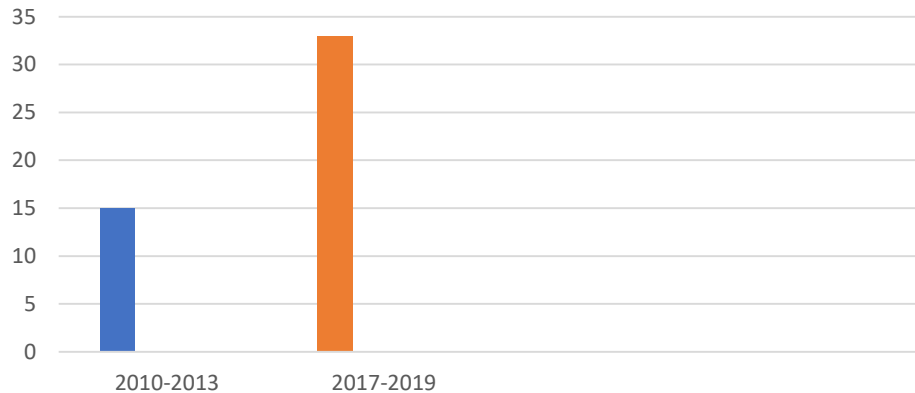


Figure 4

Table 1

Family	Species In Family	FO Plastic Ingestion	Mean Number of Particles Ind. -1	Total Number Sampled	Total Species Studied	Number of Studies
Soledae	Soles and Allies	0.8155	2.102	699	4	5
Mugillidae	Mulletts and Allies	0.4781	2.434	458	7	11
Myctophidae	Lanternfish	0.2374	0.788	1984	36	10
Carangidae	Jacks and Allies	0.2315	1.491	1002	20	19
Pleuronectidae	Righteye Flounders	0.2069	0.875	1609	7	10

Table 1 highlights five families or species of fish that were studied and found to be of special concern due to their extensive sampling and recorded plastic ingestion. It should be noted that four out of five families (all but Myctophidae) are intensively harvested and consumed by humans (Savoca, February 2021).

Regional Differences

The scientific studies of marine fish ingestion of plastic also reveal regional differences. Not surprisingly, the findings indicate the amount of plastic consumed by the various species of fish was dependent on how much plastic was found in their environment. For example, fish species that live in ocean regions known to have an abundance of plastic pollution were found to have more plastic in their stomachs. Two regions that are known for having significant levels of plastic pollution include the Mediterranean Sea and the coasts of East Asia. In fact, fish in East Asian waters had the highest levels of plastic ingestion of any large marine ecosystem (FO=0.46; n=22

studies; 3168 individual fish) (Savoca, February 2021). Figure 5 shows the global distribution of plastic ingestion by marine fish.

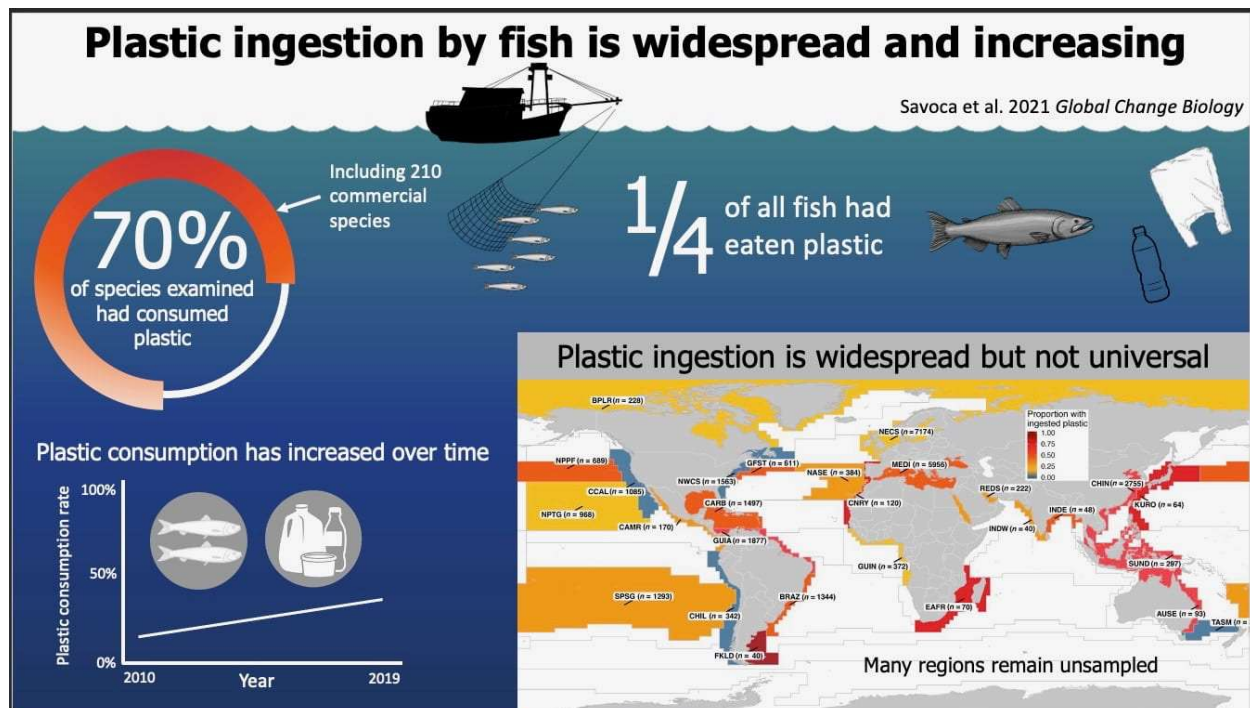


Figure 5: Global Plastic Ingestion by Marine Fish

Potential Health Risk to Humans Who Consume Plastic-Contaminated Fish

Plastic ocean pollution is a significant environmental problem that negatively impacts marine fish and there is increasing concern regarding the potentially dangerous effects on human health. In fact, there are known dangers of plastics to humans, including toxicity from lead, cadmium, and mercury (Andrews, 2012). Plastics, and especially microplastics in the ocean can travel up the food chain. The closer to the top of the food chain an animal is, the more likely it is to eat lots of microplastics. Because humans are at the top of the food chain, those who consume seafood are likely to also consume plastic-contaminated animals including fish. While toxins in plastics have been directly linked to various health problems in humans like cancers, birth defects, immune system issues, and childhood developmental problems, researchers do not fully know the effects of consuming plastic-contaminated seafood on human health (Villines, 2020). Figure 6 represents an illustration between known plastic toxins and various health problems that have been directly linked to those toxins.

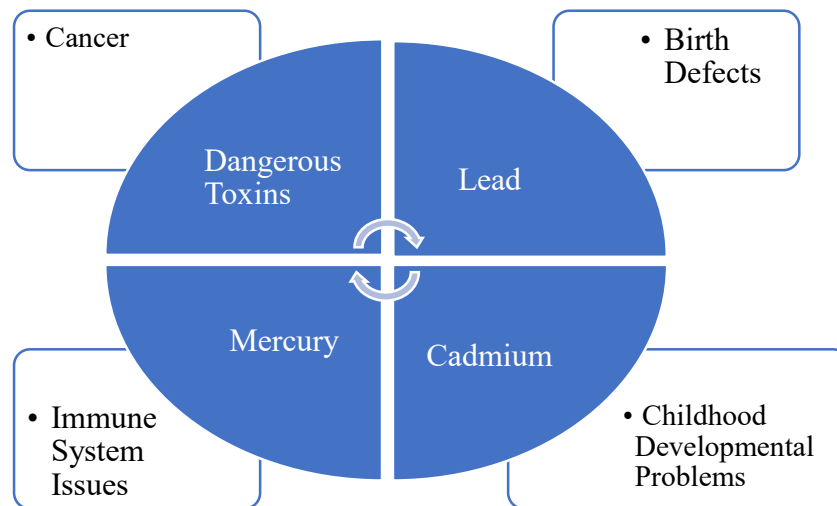


Figure 6: Toxins in Plastics and Associated Health Risk

The reason it is difficult to know the impact of consuming plastic-contaminated fish is it may take decades for the cumulative effects of this contamination to appear. Additionally, it is difficult to control studies concerning the impacts of fish ingesting microplastics on humans since people may have microplastic exposure from other sources beyond contaminated fish. Understanding the long-term impact on human health is important because the fish industry is a source of economic stability and nutritional security for billions of people around the world, which makes the urgency of reducing ocean plastic pollution a global issue (Savoca, February 2021).

DISCUSSION

While chemical toxins in the ocean is a real problem, pollution caused by plastics is increasing in significance because of the sheer magnitude of the amount of plastic that is produced worldwide. The first oceanographic study conducted in 2014 examined the amount of plastic debris on the surface of the ocean. It was estimated that 5.25 trillion individual plastic particles weighing roughly 244,000 metric tons were floating on or near the surface of the ocean in 2014. Current estimates for the period covering 2019 to the present estimate that more than 269,000 metric tons of plastic debris currently float on the ocean's surface. More alarming, 4 billion microfibers per KM^2 are estimated to dwell below the ocean's surface (Moore, 2022). The amount of plastics in the form of microplastics polluting our oceans is significant because marine fish ingest these harmful substances that eventually become part of the food chain that humans consume.

To understand the scale and magnitude of the problem of fish consumption of plastic, data was compiled from research documenting plastic ingestion by marine fish. Across all studies on the topic, the incidence rate of plastic ingested by fish was 26 percent (Savoca, February 2021). That amounts to 1 in 4 fish containing plastic. However, all these studies did not focus on microplastics because finding microplastics and nano plastics require specialized equipment, like microscopes, or more complex techniques. When studies did utilize more specialized equipment and techniques

the results were sobering. Researchers found five times more plastic per individual fish than when they only looked for larger pieces (McInturf, 2021). Studies that were able to detect this previously invisible threat revealed that plastic ingestion was higher than originally expected and the global threat of plastic pollution even greater. That is because many marine animals confuse plastic items with real food. The long-term challenge is what, if any, impact does ingestion of plastic microplastics have on the food chain and how will the transfer of these harmful substances impact humans who consume contaminated fish? Global efforts must refocus attention on strengthening compliance with existing international legislative frameworks that address marine plastic pollution such as the 1972 Convention on the Prevention of Marine Pollution by Dumping Waste and Other Matters (IUCN, 2021). Finally, since only 2 percent of fish have been studied for plastic consumption out of more than 20,000 species, more studies are needed to show the impact of contaminated fish that are consumed by humans. It is important to determine if the problem of plastic ocean pollution and its effect on marine fish has any additional long-term risk factors for increased cancer, birth effects, immune system disorders, or child development problems in humans.

CONCLUSION

It was once believed that dumping plastics and other trash into the ocean could be achieved with few if any long-term environmental issues. However, studies reveal that dumping plastics into the ocean has real consequences for marine fish that inhabit these vast waters. Of particular concern is the length of time it takes plastics to degrade and break down in the ocean's water - literally hundreds of years. Since fish are a staple in the diets of billions of people around the world, reducing the amount of plastic that is dumped in the ocean has taken on new urgency and a need to further study the implications of plastic-contaminated fish on the long-term health of humans.

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The Preventable Extinction of Sea Turtles!

Ivy A. Lewis

June 7, 2022

ABSTRACT

Did you know all species of Sea Turtles are listed and protected under the [Endangered Species Act](#)? According to *NOAA Fisheries's Law and Policies: Endangered Species Act*, the endangered species act was passed by congress in 1973, recognizing that the natural heritage of the United States was of "esthetic, ecological, educational, recreational, and scientific value to our nation and its people." In order for an act like this to be passed the sea turtles would have to be in danger..and that's exactly it. Over the years, sea turtles have become the hotspot of danger. Sea turtles all around the world are being affected by heavy amounts of marine pollution coming mainly from land. A proposed solution is to notify people that enter into territories where sea turtles live. This solution helps people be more aware of their surroundings.

INTRODUCTION



What is a sea turtle? Sea turtles are fun, loving puppies of the ocean! Sea turtles are marine reptiles with streamlined shells and big flippers to swim. They are fairly large, air-breathing reptiles that live in almost every tropical and subtropical body of water throughout the world. There are seven species of sea turtles which are: **Green, Hawksbill, Kemp's Ridley, Leatherback, Loggerhead, Flatback, and Olive Ridley.** Sea turtles are on the edge of danger with environmental issues constantly tipping the scales for their chances of survival.

A main contribution to their problems is plastic waste in the ocean. This issue has been going on for years and it's having a negative impact on sea turtles' existence. Sea turtles have a difficult time identifying plastic as something that can harm them. It does not end up good when they try to ingest it or swim through it. Plastic can easily end up in the ocean primarily from everyday littering and landfill dumping. The wind is usually responsible for picking up the trash and carrying it miles away ultimately landing in the waters where sea life resides. Toxins from plastic can harm the sea turtles as well. According to Lindsey Stanton's article, *100 Ocean Plastic Pollution Statistics & Facts (2022)*, there are approximately **593,043,485 pounds** of plastic pollution floating on the ocean's surface. All these disturbances are slowly resulting in the extinction of sea turtles. Extinction of animals, unfortunately, is a common incident on earth which refers to the dying out or extermination of a [species](#). However, sea turtles are a species humans can still save!

METHODS

Data was derived from numerous sources referenced in this paper.

RESULTS

Over 300 million tons of plastic are produced every year for use in a wide variety of applications. At least **14 million tons** of plastic end up in the ocean every year. Plastic makes up 80% of all marine debris found from surface waters to deep-sea sediments. Furthermore, the main way a piece of trash or harmful debris can get in the ocean is from land itself. Litter dropped on the street doesn't stay there. Rainwater and wind carry plastic waste through drains into streams, rivers, and eventually into the ocean. Rivers lead to the ocean! Careless and improper waste disposal is a big contributor. Illegal dumping of waste also adds greatly to the plastic surge in oceans. Based on statistics from the *U.S. Environmental Protection Agency, or EPA*, the average American produced 4.4 pounds of trash per day in 2013. It may not seem all that astonishing on the surface, but with 323.7 million people living in the United States, that is roughly 728,000 tons of daily waste.

The percentages of littering

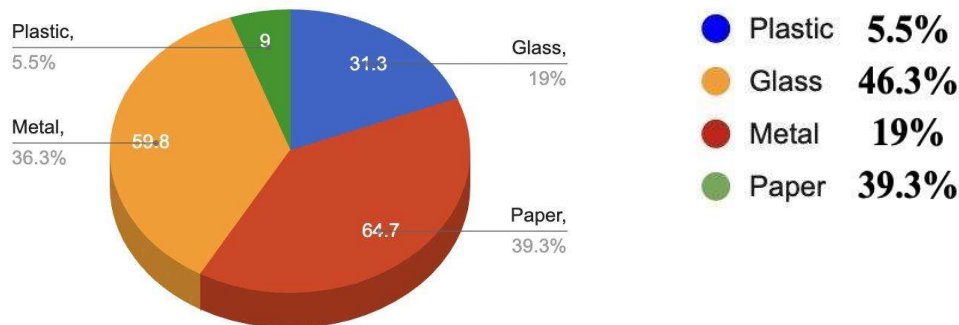
**Figure 1. Types of common litter**

Figure 1 shows the elements of litter and how much litter is being recycled. The vast majority of litter originates intentionally. A study done by *Keep America Beautiful*, a leading national nonprofit, which inspires and educates people to take action every day to improve and beautify their community environment, found that [76%](#) of litter on roadways comes from motorists and pedestrians. As you can see, plastic is not being recycled at rates similar to other types of litter. A whopping 380 million tons of plastic is produced a year and most of it ending up in places it shouldn't is why it has become the biggest factor leading to the extinction of sea turtles.

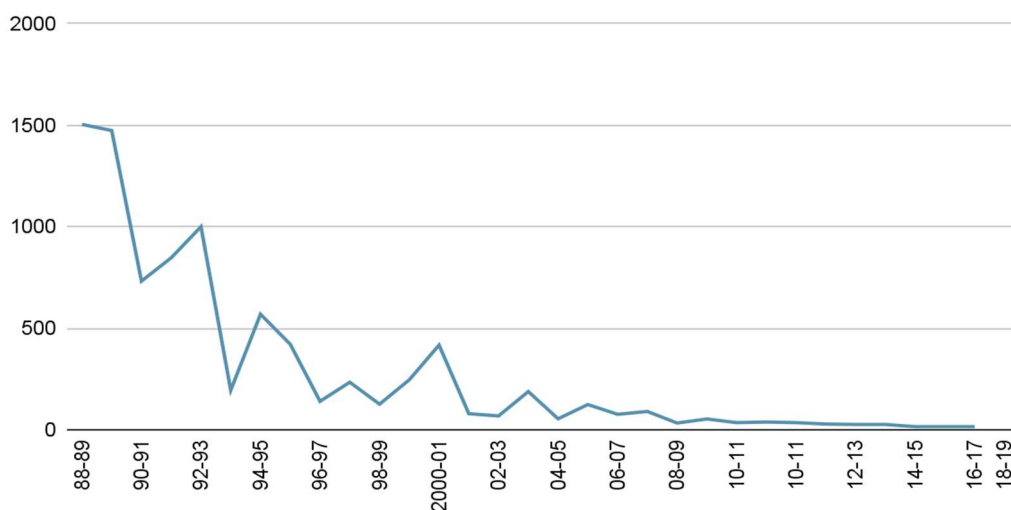
**Figure 2. Decline of nesting leatherback turtles**

Figure 2 above, shows the constant decline of nesting Leatherback sea turtles in Parque Nacional Marino Las Baulas. Reported by, “*EarthWatch Institute*” The data show that over the last 30 years, the number of nesting leatherback turtles has decreased by about 98%, or 20% per year. Their main job, as always, is to help recover from this problem. However, 46% of leather bags were recorded between 2018 and 2019, and 38% 2018-2019 was a newborn, that is, it was observed for the first time.

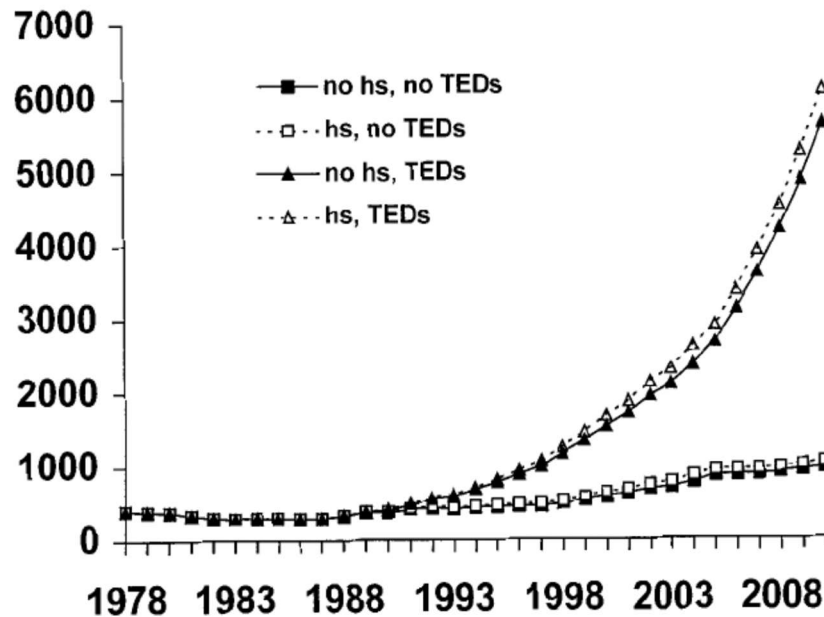


Figure 3. Nesting Females (model)

According to the chart derived from “*Prognostic Evaluation of Enhancement Programs Using Population Models and Life History Analysis*” by Selina S. Heppell and Larry B. Crowder, it helps to represent the likeness of survival for Sea turtles with the implantation of TEDS. TEDs are devices to promote sea turtle protection by addressing the interaction between sea turtles and trawl fishing gear. These devices consist of metal rods and meshes that fit the neck of the trawl net. In this age-based model simulation for nesting females, Kemp's ridley turtles comparing the effects of ledge (dashed line) and turtle remover device (TED) (solid line). The actual numbers of juveniles (50% females) and turtles (multiplied by estimated sex ratio, Table 1) released each year produced early populations. Life history parameters: age at first breeding = 10 years, annual mortality of puppies (0-1 years) = 0.44, annual survival of bottom puppies (2-10 years) = 0.66, annual survival of adults = 0.84, annual immediate mortality reduction of young and adult bottoms since 1990 = 30% (TED effect), number of eggs per nest = 100, number of nests per female = 2.5, relocation interval = 2 years.

DISCUSSION

It's been found that plastic is a problem for sea turtles. Unknowingly, the sea turtles may try to eat it as they mistaken it for food, however, they are unable to digest it. Sea turtles can also get trapped in the pieces of plastic. For instance, plastic rings that hold multi-packs of beverages. If they're trapped by these types of plastic, it can prevent them from finding food or escaping predators. Referring once more to Lindsey Stanton's article, *100 Ocean Plastic Pollution Statistics & Facts (2022)*, it claims that sea turtles also mistake plastic bags for jellyfish and end up getting tangled in the bag. One more example is plastic straws which could get lodged into their nostrils. This keeps them from breathing properly. One way to combat these dangerous materials is to reduce the amount of plastic waste that gets into the ocean. This can be done by people being more aware of how they dispose of their plastic waste and placing it in proper waste receptacles. As well as recycling the plastic that's already produced. Meaning, less plastic would be wasted rather than end up in the oceans. Which ultimately would result in effective protection against extinction of sea turtles. Along with this, TEDS can be implanted more for sea turtle's population. According to, *“Prognostic Evaluation of Enhancement Programs Using Population Models and Life History Analysis”* by Selina S. Heppell and Larry B. Crowder, TEDS will give a likelier life expansion for sea turtles.

CONCLUSION

The species of sea turtles are in danger of destruction and are in need of help. As humans being the pinpoint reason for this destruction, the least people can do is clean up the mess. This research proves that humans need to be more considerate when caring about the world around them. Many solutions such as reducing littering, production of plastic, and increasing the recycling rates of plastic is a step closer. It's all up to people to take that step!

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ABOUT THE AUTHOR

Hello readers! My name is Ivy A. Lewis and I am currently a freshman in high school. Growing up I have always dreamed of becoming a veterinarian. What better way to start than raising awareness for one of my favorite animals, Sea Turtles! So, I will be discussing why and how sea turtles are coming dangerously close to extinction as well as what people can do to help. Not only am I learning from writing this paper, I am also educating an audience. Enjoy!

How Did Humans and the Environment Impact the Population of Bison ?

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June 7, 2022

ABSTRACT

The Quaternary period consists of two epochs, the Pleistocene which ended 1.8 million years ago and the Holocene which started 11,000 years ago to present. During these two epochs there was and continues to be major climatic differences with much of the plant life experiencing little to no change. With the extinction of some large mammals during the Pleistocene period, the American Bison survived only to be hunted to near extinction by humans in the late 1900.

The Bison is one of the largest species that have survived the late Pleistocene- early Holocene megafauna extinction but experienced a population reduction later on due to climate change and human hunting. Bison typically live on plains, prairies and river valleys and were found in massive numbers in most parts of Canada, United States and parts of Mexico. The Bison is a keystone species that helps create a habitat for many different species including grassland birds and plants by aerating the soil with their hooves while searching for food which aids in plant growth and the maintenance of a balanced ecosystem. However, this animal's population has experienced extreme swings due to the impact of external factors, most notably, the Euro-American factor introduced by colonialism.

INTRODUCTION

In some ways, the American bison differs from domestic cattle or oxen. It's bigger, with a broad, hefty head that's carried low and can't be elevated to shoulder height. The bison also has a prominent hump at the shoulders, large forequarters, and 14 ribs as opposed to 13 in cattle. The dark brown shaggy fur is coarse and thick. It frequently develops a beard on the chin and grows particularly long on the head, neck, and shoulders. Bison are powerful, huge creatures. At the shoulder, a mature bull reaches around 2 meters (6.5 feet) tall and weighs more than 900 kilograms (1,980 pounds). The female is around 1.5 meters (5 feet) tall and weighs approximately 320 kilograms (700 pounds). This herbivore travels in large, organized groups and though their large frame can handle any physical confrontation, they never go looking for trouble.

After the influx of Euro-American settlers had arrived, bison were slaughtered in huge numbers for their hides and hunted to reduce railroad problems. The slaughter of these animals lasted until 1830, and herds were nearly gone in most places by 1880 (What Caused The Near Extinction Of Bison? – North American Nature, n.d.). The bison became a threat to the booming locomotive business as they caused collisions which led to delays and damage to the locomotive. The trains also saw an increase in hunters, who were sometimes hired by the company to kill the bison so that their workers could have meat. Many bison were killed on behalf of the U.S. military as a way to control the Native Americans as they relied heavily on the bison for their survival and wellbeing, using the bison for food, shelter, tools, jewelry and religious ceremonies, thus forcing them to live on reservations.

Bison, like many other animals, have progressed significantly since the beginning of time and have evolved alongside humans despite being brought to the point of near extinction. The near extinction of bison in the early 1800s is attributed to their slaughter by European settlers for their meat and hides which saw a population of 42 million drop to 325.

METHODS

Data regarding the American bison population from 1500 to 1884 were acquired from the US Fish and Wildlife Services.

RESULTS

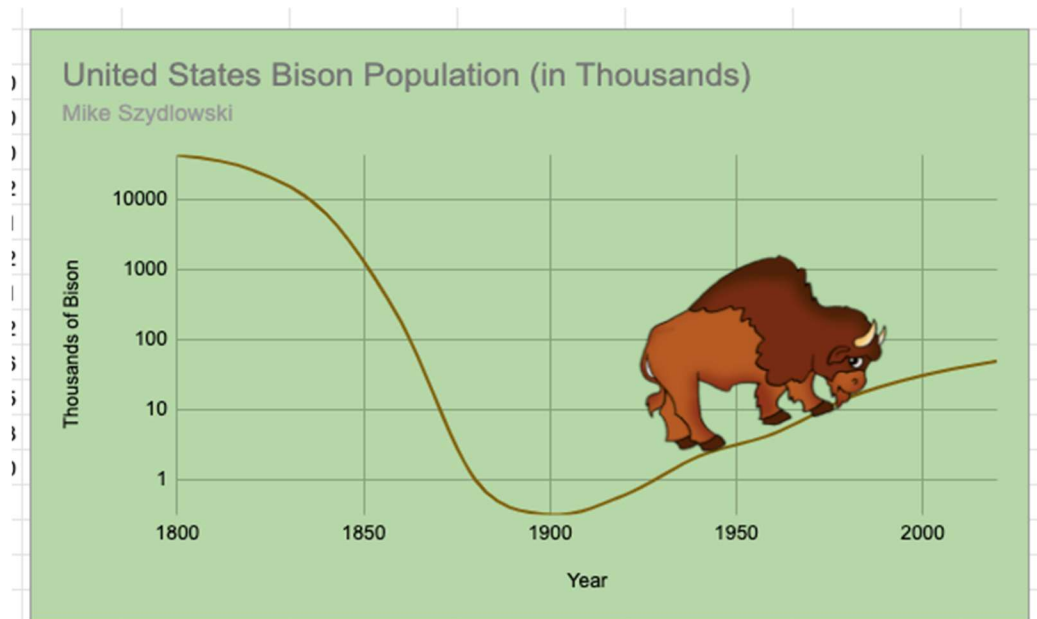


Figure 1: Trends in the American Bison population (Twitter, [Szydlowski](#) 2020.)

Research on the bison drop in population has shown that in spite of the ice age this mammal was able to survive because it was no longer hunted, and the habitat was bountiful which allowed it to flourish. Instead, its near extinction was due to human needs and greed, as shown in Figure 1.

Date	Population	Pressure
1500	60 million	No external pressure at this time.
1700-1800	30-60 million	Euro Americans arrive and changed the habitat with farming and plowing
1830	35 million	Market hunters focus on bison for trading. Bison are being killed for food, fur and sports
1860-1880	395,000	New Mexico passed law to protect bison.
1884	325	Congress passed law to protect bison from poachers and increase the population

Table 1: Key events that influenced the American Bison population

The American Bison were undisturbed prior to the arrival of European Americans. Because of them bison were killed for food, fur and sports causing New Mexico to pass a law to protect them. However, when that didn't work congress decided to pass a law to protect bison from poachers.

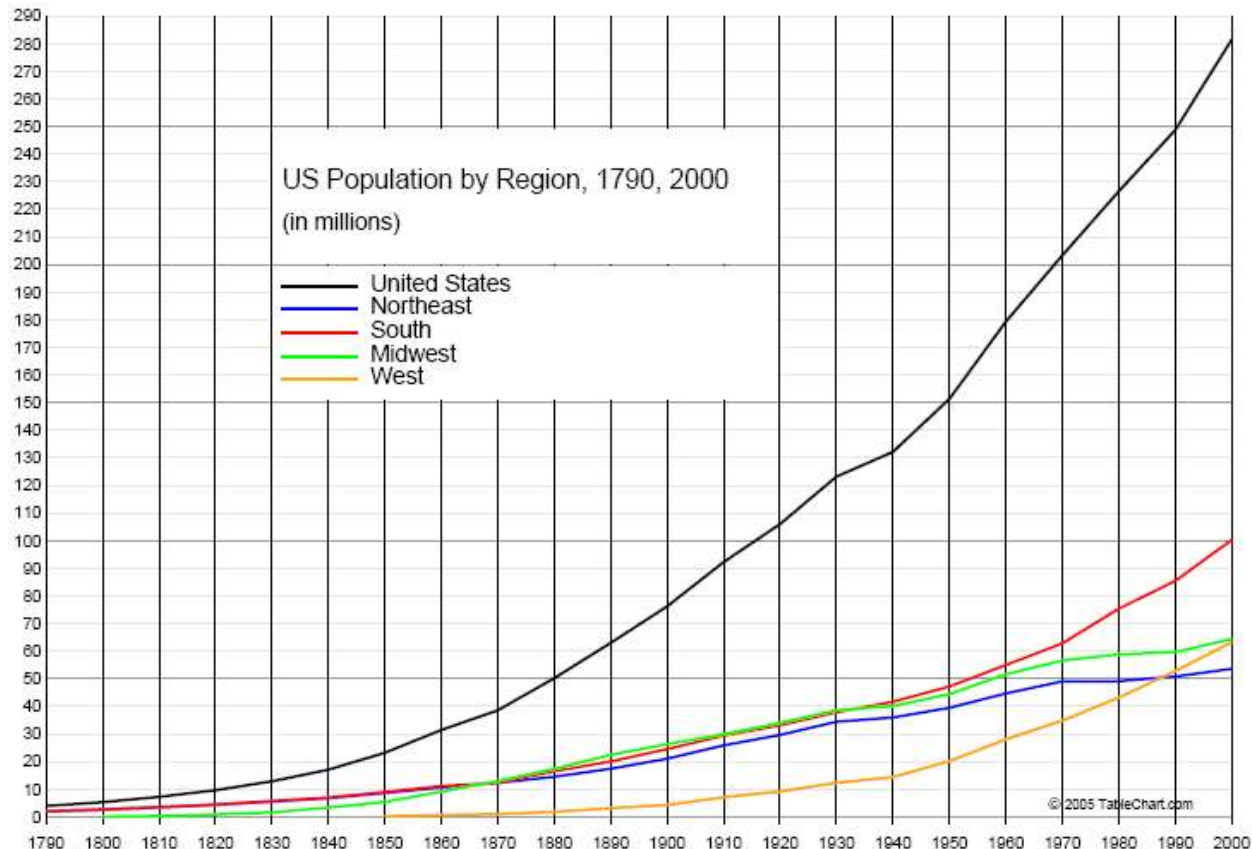


Figure 2: Increase of US population over time (*Chart of US Population, 1790-2000, n.d.*)

The black line shows the population of all regions combined increasing between 1790 and 2000. The other four colored lines denote the population increasing in their respective regions, over the same period of time.

DISCUSSION

Due to a variety of factors initiated by humans, the bison population dwindled to a point of near extinction with over-hunting. As shown in Figure 1 and figure 2, there is an inverse relationship between bison and humans. It also shows that while the bison population was decreasing the human population was increasing. Unless sufficient land is set aside, human population growth and use encroachment will stress the Bison population. Climate change has a direct impact on bison by raising temperature stress and lowering food and water availability. Luckily, they were identified as an endangered species and allowed to repopulate with the passage of state and federal laws, designed to protect them. As time progresses, we will be presented with another over-hunting of animals to satisfy our hunger for wealth and superiority.

With our world constantly changing ,the bison is threatened by genetic diversity , human intolerance and habitat loss, with climate change predicted to be responsible for one third of the earth's animal population extinction more definitely needs to be done to ensure the continuation of species and balance in our ecosystem (Bison | Defenders of Wildlife, 2022).

Although they only feed on grass ,their influence in the environment affects the wellbeing of many other species with the bison population today less than one percent of what it was in pre-colonial times {roughly 20,000} more needs to be done to ensure this animal continues to thrive and aid in our ecosystem.

CONCLUSION

The bison was able to endure through a stressful period of time in spite of human greed. More studies will likely reveal how much humans have contributed to changes in the Bison's home environment (Climate Change a Threat to Great Plains Bison Sustainability, 2021).

Future generations would regard some of what we call normal behavior today as terribly damaging to the environment and our bison population, which could lead to a significant extinction event. Continuing to apply pressure on our leaders and lawmakers to create and implement laws that protect our biodiversity, and the environment is greatly needed. (About Majestic Bison, 2022)

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