The Effects of Ghost Fishing on Crab and Fish Populations

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ABSTRACT

Ghost fishing is when lost or discarded fishing gear is no longer under a fisherman's control and is also known as derelict fishing gear or DFG. The most common types of derelict fishing gear to ghost fish are gill-nets and crab pots/traps, along with long-lines and trawls. Ghost fishing is a major problem in many ecosystems around the world. Like all types of marine debris, ghost fishing has a wide range of impacts on the environment, conservation of species, human health, tourism and local economies. This experiment was conducted over the course of three months in different areas of Perrin Creek in Hayes, Virginia. I found how three types of ghost fishing gear affect crab and fish populations because ghost fishing is a huge problem in a lot of ecosystems and its effects are harmful. Ghost fishing is detrimental to the health of humans, economies, the environment, and many species. There are no advantages if the crab and fish populations die from the impact of ghost fishing. The fisheries economy decreases and humans are not able to benefit from the effect. The three types of gear are nets, hooks, and pots. I predict that pots will catch the largest amount of crab and fish populations because they capture organisms and are capable of self-baiting. I expected that hooks will catch the smallest amount because they cannot latch onto organisms easily. I've come to the conclusion that pots did catch the most, with nets coming in second, and hooks in last. In other words, my initial hypothesis was correct based on my data results.

INTRODUCTION

Ghost fishing is a major problem in many ecosystems around the world. Like all types of marine debris, ghost fishing has a wide range of impacts on the environment, conservation of species, human health, tourism and local economies. This marine debris interferes with fishing and damages fishing boats and gear, contaminates beaches and marinas, is a hazard for human health, interferes with ships, damages economies by contaminating fish catches, drives away tourists, and costs a lot of money to clean up. Ghost fishing also has diverse impacts like harm to wildlife through entanglement and ingestion, asphyxiation of sea beds and habitats, toxic chemical pollution, and transportation of invasive species (WSPA, 2014). It has detrimental impacts on fish stocks and potential impacts on endangered species and benthic environments (Macfadyen, Huntington, & Cappell, 2009).

Ghost fishing is when lost or discarded fishing gear is no longer under a fisherman's control and is also known as derelict fishing gear or DFG. The most common types of derelict fishing gear to ghost fish are gillnets and crab pots/traps, along with longlines and trawls. Fishermen initially have the intention to capture a particular species, whether for commercial or recreational use, however, derelict fishing gear can continue to fish for target species and non-target species as well (NOAA, 2015). The amount and type of ghost gear varies geographically and depends on a few factors. These factors include the type and extent of fishing activity, topography and currents in marine environments, and the gear handling (WSPA, 2014). Poor weather conditions, conflict with other vessels, gear overuse, and too much gear being used in one area can also cause gear to become derelict. Ghost fishing specifically implies that the organisms caught in the derelict fishing gear die as a result of predation, starvation, or cannibalism. This means that just because an organism is captured by abandoned derelict fishing gear, this gear is not "ghost fishing" unless mortality occurs. For example, a crab trap breaks loose from its buoy in a storm and continues to trap crabs. These crabs then act as bait and attract other fish or species that are not originally intended for capture. The time it takes for derelict fishing gear to continue ghost fish can vary, but can range from days to years (NOAA, 2015).

Anywhere fishing gear is used, there is a potential risk for ghost fishing and derelict fishing gear. Around the world, drifter experiments have shown five main areas where marine debris tends to accumulate. These areas are known as convergence zones. Ocean currents and winds concentrate water masses into these specific regions, where marine debris, like derelict fishing gear is found. Some of these regions include the Northwestern Hawaiian Islands, North Pacific Ocean, South Pacific Ocean, and the North Atlantic Ocean. Derelict fishing gear is also found on other coastal regions like the Chesapeake Bay, the Puget Sound, and the Gulf of Mexico (NOAA, 2015).

Ghost fishing gear may carry on fishing for decades, catching any animals of a variety of species in its path. All animals are affected differently by entanglement in ghost fishing gear. The animal's physiology, feeding and other behaviors, and the type of gear found in the animal's habitat all contribute to the ways that they are affected. Whales and turtles may swim through a section of fishing line or net where they can become snagged around the mouth or flippers, causing asphyxiation by drowning. Young seals may put their heads through rope or monofilament loops, which can become fixed around their necks or bodies, slowly cutting into their flesh and bone as they grow. Rope and line ligatures can cause amputations and infected wounds. Pieces of plastic net and line can sever arteries and limbs and cause strangulation. Birds that become compromised by entanglement by derelict fishing gear may not be able to dive, nest or fly. These animals mainly experience chronic suffering, which causes increasingly intense pain and distress for a long period of time. However, some animals endure acute suffering, when the pain and distress is quick and for a short period of time. There is a high degree of uncertainty in the overall number of animals affected by derelict fishing gear because many reports are often of animals that are seen alive. It is highly probable that the impacts are much greater than existing reports may conclude (WSPA, 2014).

There are a variety of fisheries, categorized based on what type of species they are trying to catch specifically and by the scale of their operation. Industrial and commercial industries operate on a broad scale that requires large boats and amounts of gear. Small-scale fisheries use smaller boats and less gear. No matter what type of fishery it is, all risk the potential of having derelict fishing gear. Gillnets get their name because fish tend to swim through the mesh and get their gills entangled. There are many types of gillnets that become derelict fishing gear and potentially ghost fish, but there are mainly two groups. One is considered active gear as they are towed from a boat and then retrieved with trammel nets. The other is considered passive gear as they are set in a particular location, then left unattended for a period of time, called "soak time," until retrieval. All gillnets are weighted at the bottom and have floats at the top edge so the net is positioned vertically in the water column. Passive gear can have soak times that last for hours or days depending on the fishery. This makes passive types of gillnets more susceptible to becoming derelict fishing gear and more likely to ghost fish, because there is no one actively monitoring the net. The most common ways that gillnets become derelict are: breaking free from floats, entanglement with the bottom surface, and interaction with the other fishing gear present (NOAA, 2015). Pots and traps are considered passive gear types that lure target species and entrap them. Trap gear have lines that are attached to buoys for retrieval and can be set either individually or in multiple sets linked together by groundlines. Like nets, traps also vary in what specific species is caught. One type of trap gear has escape panels that are shut by a cord of twine or another biodegradable material. Therefore, in the event that the trap gear does become derelict, the cord will eventually rot and allow the panel to open, releasing any trapped animals.

Another type of trap gear is made of metal and coated with a plastic resin. This makes the trap gear sturdier and longer lasting, which is beneficial to many fishermen. However, if this gear is lost, it has a higher risk of continuing to ghost fish for longer periods if not retrieved. As with gillnets, water depth can be a factor in how efficiently trap gear can ghost fish. Deep-water pots, which are less damaged by storms, may continue to ghost fish for longer time periods than in shallow-water pots (NOAA, 2015). Hooks and lines are also used by many recreational and subsistence fishers, and therefore, losses may be very high, especially within shallow and inshore waters. In the Florida Keys, the debris type causing the most damage was hook and line, mainly monofilament line, that is damaging reefs (Macfadyen et al., 2009).

According to a new NOAA study, the loss of derelict fishing gear is largely preventable. Integrated GPS tags are already being used in EU fisheries and have accounted for higher recovery rates. A new type of completely biodegradable escape panel for crab pots has been developed from polyhydroxyalkanoates, in which the entire escape panel degrades instead of just the cord. Cooperation between rope manufacturers and lobstermen led to new ground line improvements to reduce the breakage of lines on rocky bottoms, which reduces the likelihood of trap gear becoming derelict (NOAA, 2015). The World Animal Protection Sea Change launched a campaign in 2014 to save 1 million marine animals by 2018, by reducing the volume of ghost gear added to our seas, removing gear that is already there, and rescuing animals that are endangered (WSPA, 2014).

There are many preventive measures that reduce the possibility that fishermen will discard gear and make gear less likely to ghost fish. These measures include: improving gear design to reduce the chance of failure or snagging, spatial zoning of fisheries to avoid gear conflict and increase navigational awareness of gear in the water, reducing fishing effort, reducing ghost fishing efficiency of gear, gear marking, integrating GPS's, state or port monitoring and inspection of gear, and providing affordable port disposal facilities and incentives to discourage improper disposal at sea (NOAA, 2015).

Approximately 250,000 derelict traps are added in the Gulf of Mexico each year, resulting in the loss of more than 250,000 blue crabs per year in the state of Louisiana alone (Guillory, McMillen-Jackson, Hartman, Perry, Floyd, Wagner, and Graham, 2001). One crab pot in the Chesapeake Bay was estimated to have a potential ghost catch rate of 50 blue crabs per crab pot (Havens, Bilkovic, Stanhope, Angstadt, and Hershner, 2008). Trap gear has the probability to ghost fish for long periods of time, especially given the fact that trap gear can be "self-baiting." A Washington Department of Fish and Wildlife survey of derelict shrimp pots found that pots could potentially capture 3,796 to 7,580 endangered species of rockfish per year (Natural Resources Consultants, 2012). Endangered Hawaiian monk seals have been found entangled in masses of monofilament driftnet with seven confirmed deaths. Considering there are only 1,200 animals left in this critically endangered species, derelict fishing gear entanglement has been one of the four serious threats to the population (NOAA, 2015). Hooks cannot latch on to a lot of organisms unlike pots and nets. Pots and nets trap and capture organisms. We should care which gear captures the most because of how it affects a species population and each gear probably collects a different amount. Fishermen usually want to use the gear that has the less ability to ghost fish. Ultimately, pots will catch the largest amount of fish and crab populations, nets will catch the second largest amount, and hooks will catch the smallest amount of fish and crab populations.

Null and Alternative Hypothesis

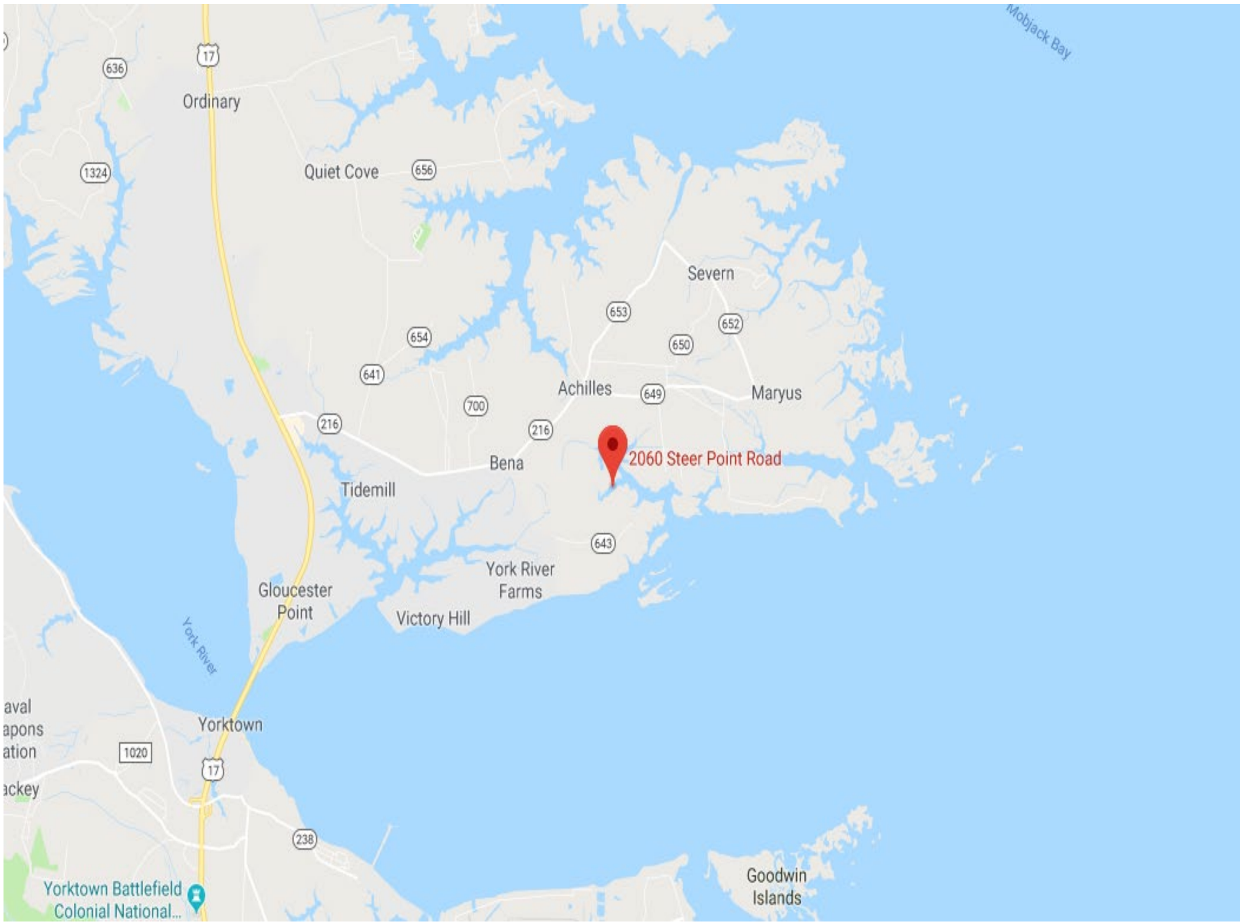
H_O: $C_H = C_N = C_P$

H_A: $C_H < C_N < C_P$

The C represents the amount of organisms caught by ghost fishing gear. Each subscript represents the different type of ghost fishing gear including: hooks, nets, and pots.

METHODS & MATERIALS

I conducted several research trips to Perrin Creek in Hayes, Virginia, which the location is shown in Figure 1. These trips occurred during the summer of 2018 with one-week time frames over a period of six weeks. Two crab pots, two nets, and two fishing hooks were placed into different areas of the creek, where they were not bothered by passing boats. The two crab pots were placed at the bottom of the creek with three Menhaden as bait in each. Each net was hung vertically into the creek with two sticks on each side as posts. The two fishing hooks were each attached to a piece of fishing line and thrown into the creek, then tied to the pier. I set out the gear one day during the week and exactly one week from that day, I went back to retrieve it. At the end of each one-week period, I counted the number of fish and crabs caught by the gear. I did not require both the fish and crabs to be dead in order to count it in the data. I did take into account any other species caught and if the gear was damaged, in which it had to be replaced. For example, the number of holes in the gear, if the gear was bent, or any snapped lines. I analyzed this data with a ANOVA single-factor statistical test.



Mobjack Bay
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2060 Steer Point Road
Tidemill
York River Farms
Gloucester Point
Victory Hill
York River
Yorktown
Goodwin Islands
Yorktown Battlefield Colonial National...

Figure 1a. & 1b. Study area: the red point shows the location where I placed the ghost fishing gear in Perrin Creek in Hayes, Virginia during the summer of 2018. The crab pots were placed at the bottom of the water. The nets were placed horizontally in the water with two posts on each ends, with one being near the shore and one away from the shore. The hooks were connected to fishing line and then tied off the edge of the pier.

RESULTS

The crab pots caught the most individuals as shown in Figure 2 and Figure 3. The nets came in second for catching individuals as shown in both Figures 2 and 3. Every week there was an average of two crabs in the nets and around seven crabs in the pots. The amount of fish caught in the three different types of ghost fishing gear was low, with hickory shad being the only fish captured. The amount of individuals caught by hooks came in last, catching no fish and only one crab hanging on the line, as shown in Figures 2 and 3. Both crab and fish averages were low for the hooks. Almost every week, one of the hook lines had been snapped and had to be replaced. After week four of testing, both gill-nets had completely disintegrated and were replaced. The p-value for the crabs was significant ($p << .01$). The p-value for the fish was highly significant ($p < .05$) as well. These p-values were found by using an ANOVA single-factor statistical test.

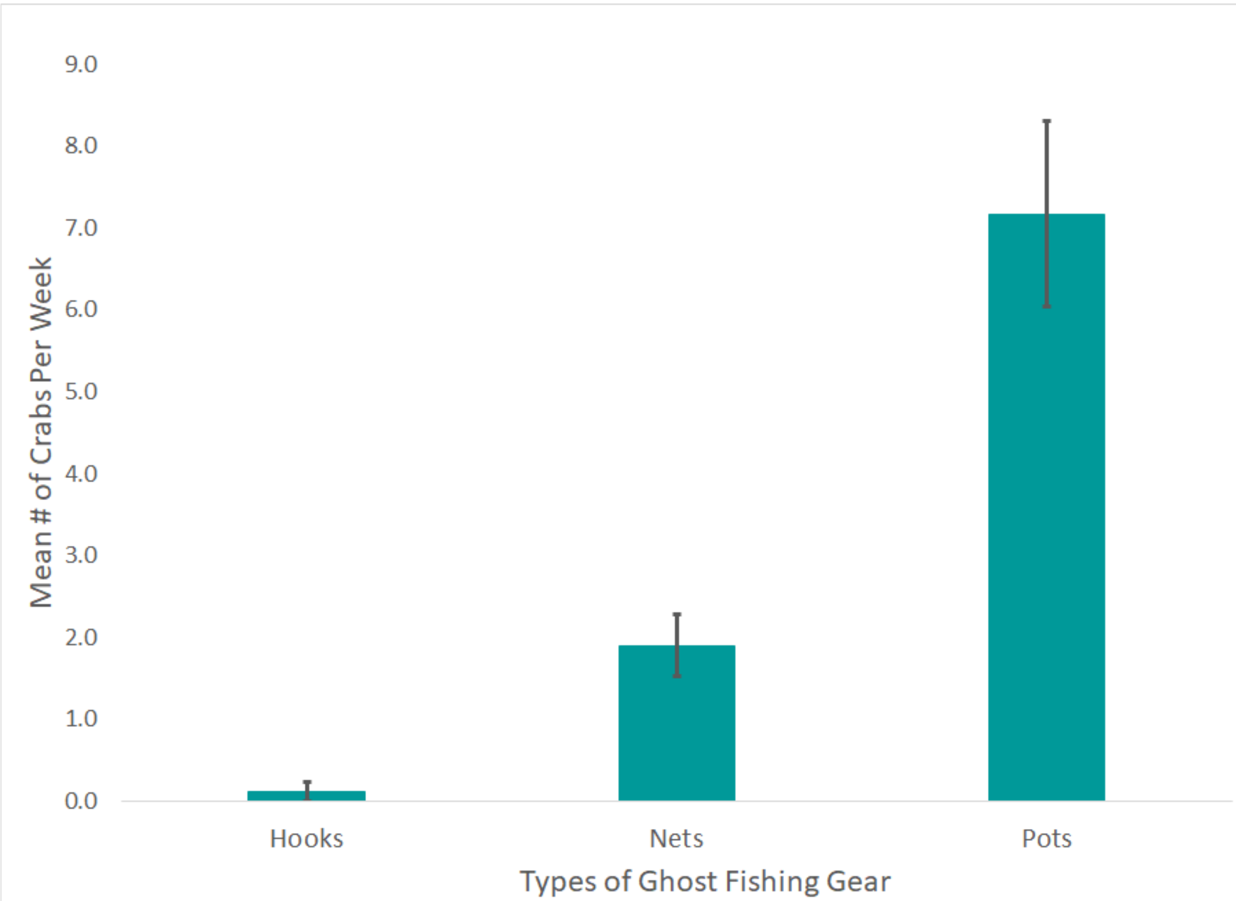

Figure 2. The mean number of crabs caught per week in hooks, nets, and pots, which are the different types of ghost fishing gear used in this study. Pots caught the most, followed by nets, with hooks catching the least. I ran an ANOVA single-factor statistical test ($p = .000002$) and it was highly significant.

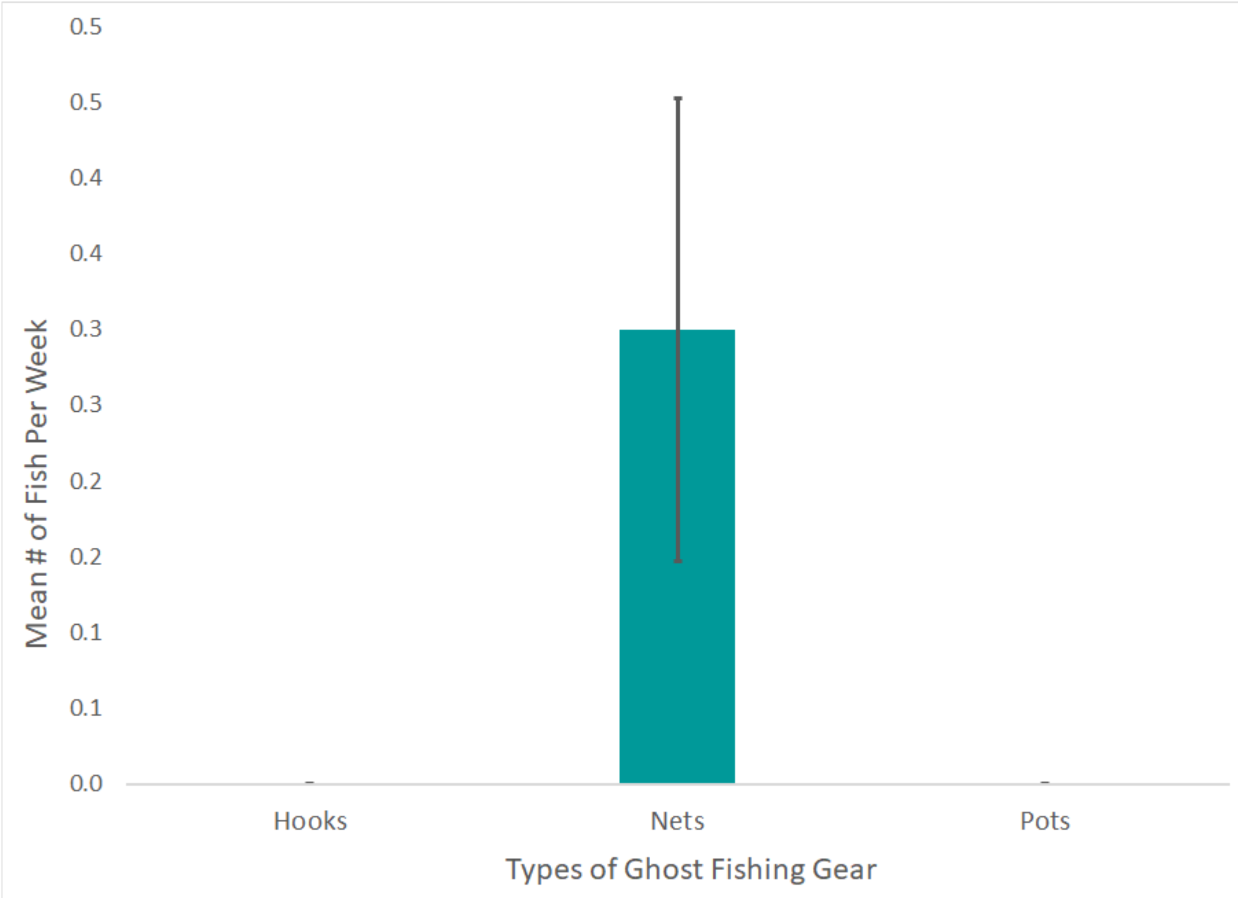

Figure 3. The mean number of fish caught per week in hooks, nets, and pots, which are the different types of ghost fishing gear. The nets caught the most, with the hooks and pots catching none. I ran an ANOVA single-factor statistical test ($p = .02$) and it was statistically significant. Hickory shad were the only fish captured.

DISCUSSION & CONCLUSIONS

The type of ghost fishing gear that affected crab and fish populations the most was the pots because they trap them in. In other words, when a pot is discarded or lost and left in a body of water, it will continue to ghost fish, which can be dangerous to some marine organisms and harm the environment. The pots also stayed intact the whole time. A possible solution to help limit ghost fishing is to use trap gear with a twine wire that shuts the trap, so that it would disintegrate faster than a trap with a metal caging. The nets came in second for catching crab and fish because they got tangled up. Gill-nets will also continue to ghost fish, but for a short period of time until they completely disintegrate. The lines of the hooks did get snapped or damaged almost every week. The hooks came in last for catching crab and fish because they didn't really have any way to hook organism unless they came directly onto the hook itself. Hooks left in the water on individual fishing lines will not cause any harm to marine organisms, but they do, in fact, damage the environment until the metal eventually rusts. In contrast, long-line hooks can cause entanglement of organisms (WSPA, 2014). The fishing line was able to let organisms go without harming them. Long-line hooks are also a lot more dangerous because they can extend up to 50 miles whereas a regular fishing line cannot. All of the p-values were either statistically significant or highly significant based on an ANOVA single-factor statistical test, which shows there are different effects depending on gear type and that derelict fishing gear does influence mainly crab populations and fish populations as well. However, only one species of fish was, hickory shad, a small freshwater creek. Whether the organism was alive or dead, it was accounted for in the data. The size of the body of water and whether or not it contains freshwater or saltwater may have had an effect on different fish species. Keeping track of fishing gear is extremely important because it can cause numerous long-lasting effects on the health of humans, the fishing industry, the economy, marine environments, and organisms. Some improvements to this study would definitely be to take in account for the temperature both outside and in the water. A longer time period of data collecting would be another improvement as well. A possible source of error would be waiting after a one-week time period to check the gear because the amount of time it takes to eat a fish is relatively quick.

LITERATURE CITED

Peer-Reviewed and Scholarly References

Guillory, V., McMillen-Jackson, A., Hartman, L., Perry, H., FLoyd, T., Wagner, T., and Graham, G. (2001). Blue crab derelict traps and trap removal programs.

Havens, K. J., Bilkovic, D. M., Stanhope, D., Angstadt, K., and Hershner, C. (2008). The effects of derelict blue crab traps on marine organisms in the lower York River, Virginia. North American Journal of Fisheries Management 28, 1194–1200.

Macfadyen, G., Huntington, T., & Cappell, R. (2009). Abandoned, lost or otherwise discarded fishing gear. United Nations Environment Programme Food and Agriculture Organization of the United Nations.

National Oceanic and Atmospheric Administration. NOAA. Marine Debris Program. (2015, March). Report on the impacts of “ghost fishing” via derelict fishing gear. Silver Spring, MD. 25 pp.

Non-Peer-Reviewed References

Natural Resources Consultants, Inc. (2012). Spatial Distribution and Magnitude of Derelict Shrimp Pots and their Potential Impacts to Rockfish in the Puget Sound.

World Society for the Protection of Animals. WSPA. (2014). Fishing’s phantom menace: How ghost fishing gear is endangering our sea life. World Animal Protection.