Hammerhead Sharks in Florida: Marine Protected Areas

By
Debbie Nalesnik
Department of Environmental Science
Allegheny College
Meadville, Pennsylvania

May 2024

Submitted in fulfillment of the senior thesis requirements of the Department of Environmental Science and Sustainability at Allegheny College and approved by the senior thesis committee.

Dr. Bradshaw-Wilson	**Dr. Whitenack**

Pledge

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Acknowledgement

I would like to thank my parents for being my biggest supporters from the beginning and always pushing me to be the best student I could be. Thank you for always supporting my career aspirations and always listening to my shark tangents even if you had no idea what I was talking about. Thank you guys for being my rock and believing in me when I did not believe in myself. I could not have done this without you guys!

I would also like to thank my comp advisor Casey Bradshaw-Wilson for all the help throughout this process. You were extremely helpful and encouraging. Thank you to my second reader Dr. Whitenack for all the help as well. I am so grateful for you and your passion for sharks. You steered me into the marine route for environmental science and I could not be happier!

I would like to thank all my family and friends for all the support as well. Each and everyone of you are so incredibly helpful and the best support system I could ever ask for!

Lastly, thank you hammerhead sharks!

Abstract

The worldwide shark population is drastically declining due to human activity that impacts the environment. Since 1970, shark population has decreased by 71% which is leading one-third of the world's shark population to extinction (Clemson 2023). In the state of Florida, there is an increased rate of shark species becoming endangered. The four species of hammerhead sharks that reside in the state of Florida are declining. The state of Florida, has implemented Marine Protected Areas for species that are susceptible to being vulnerable to extinction. This project focused on identifying the Marine Protected Areas (MPAs) in the state of Florida and where there should be MPAs. A second objective of this project is understanding and identifying Florida's laws with commercial and recreational fishing, the political hurdles, what makes an MPA and the process to implement one, and the ecological requirements for the four species of hammerhead sharks.

Introduction

Sharks worldwide are in decline due to environmental changes from human activities. Due to the high demand of the market for shark fins around 100 million sharks are killed annually for their fins (WWF 2023). Without proper laws and management, there will be a continuation of overfishing and shark fin trading causing extinction in most apex sharks. If a shark becomes subject to catch and release they might have long-term health effects or if they are hammerheads who are susceptible to having a high mortality rate would be unable to survive and most likely will die before they make it back to the ocean. Another issue that human activities are causing that is harming sharks is the damaging of habitats such as reefs, mangrove forests, and seagrass meadows (Pierce 2023). Not only is this causing them to lose their habitats and for some a nursery area for juvenile fish but in most cases, they are also losing their sources of food. There are ten species of hammerhead sharks, four of which reside in the state of Florida. The three most known species of hammerheads in Florida are the scalloped hammerhead (*Sphyrna lewini*), great hammerhead (*Sphyrna mokarran*), and smooth hammerhead (*Sphyrna zygaena*)

shark. These three species share similar characteristics when it comes to their ecological requirements. The fourth species of hammerhead shark that can be found in Florida is the bonnethead shark (*Sphyrna tiburo*). Unlike the other hammerhead sharks, they are found in sandy or muddy areas that contain seagrass as they are omnivorous (Enric et al., 1996). Hammerheads are extremely delicate and fragile. Due to the decline of these four species, they are under conservation protection and in need of further information regarding protection policy. According to the IUCN Redlist, the scalloped hammerhead shark as well as the great hammerhead shark are listed as critically endangered. While the bonnethead sharks are listed as endangered. Lastly, the smooth hammerhead shark is vulnerable which makes this species the only hammerhead in Florida that is not classified as endangered (IUCN Redlist n.d.). Although smooth hammerhead sharks are vulnerable, their population continues to decline.

One of the main reasons that these four species are listed as endangered as well as vulnerable is because of commercial fishing and fin trading. Hammerhead fins are widely desirable in fin trading due to size, meat, oil, and display throughout the world (Abercombie et al., 2005). These sharks are commercially targeted for their fins in fishing gear such as longline, bottom trawl, gillnet, and hook-and-line fisheries (Oceana 2023). Of all the species, smooth hammerhead shark fins are the most valuable in the fin trade (Defenders of Wildlife n.d.). In some cases, these species of hammerhead sharks are accidentally caught during fishing, and due to their high mortality rate, these sharks usually do not survive their catch and release.

Another issue impacting the hammerhead sharks is habitat degradation as it reduces the areas that hammerheads can reside in and for some allows juveniles to survive (Defenders n.d.). For around 20 years now there has been an increase in habitat degradation. With this impact, seagrass meadows are being chopped down due to human activities which is negatively impacting juvenile bonnethead sharks as 62% of their diet consists of seagrass while adult bonnetheads diet consists of 40% (Pierce 2023). Along with juveniles being threatened the ecosystem as a whole becomes harmed. If there are no apex predators such as the different species of hammerheads there might be an unbalanced ecosystem. There would not be any predators to keep the ecosystem balanced. Due to activities such as bottom trawl fishing, we can see destruction to key habitats for sharks and other vulnerable species. This causes a change and in some cases new adaptations if possible.

Climate change is also affecting these sharks and the way they migrate. Warmer water causes sharks to either migrate earlier or later depending on the temperatures of the water. This affects their eating patterns as well as reproduction (Bouyoucos 2020). Climate change can also impact a shark's breeding and habitat. Scalloped hammerhead sharks are more vulnerable to climate change actions as they use bays and mangroves for their breeding habitats. Due to climate change, there is an increase in storms and flooding which will increase runoff. Impacts of climate change will also cause their coastal nursery areas to decrease which will cause issues with the juvenile shark's life stage (NOAA 2023).

Protection for hammerhead sharks includes implementing trade regulations to protect vulnerable shark species such as the hammerheads. This can reduce the amount of shark finning occurring. In Hong Kong fin trading, it has been estimated that 1.3-2.7 million scalloped as well as smooth hammerheads have been killed for their fins (Wells et al. 2018). Due to the drastic decline in scalloped hammerheads in 2014, they were the first shark species to be protected under the U.S. Endangered Species Act for the areas of the eastern Atlantic and Pacific Oceans (NOAA). With scalloped hammerheads being protected under this act there is hope that their population will start to increase which can eventually lead to them not being endangered.

There can be fishing management practices in place to ensure the safety of sharks and other vulnerable species. For example, Florida has implemented systems called Marine Protected Areas (MPAs) and the goals for Marine Protected Areas are to reverse biodiversity loss and maintain ecosystem services. MPAs also try to recover and maintain resources that may have been damaged (Costa et al.2016).

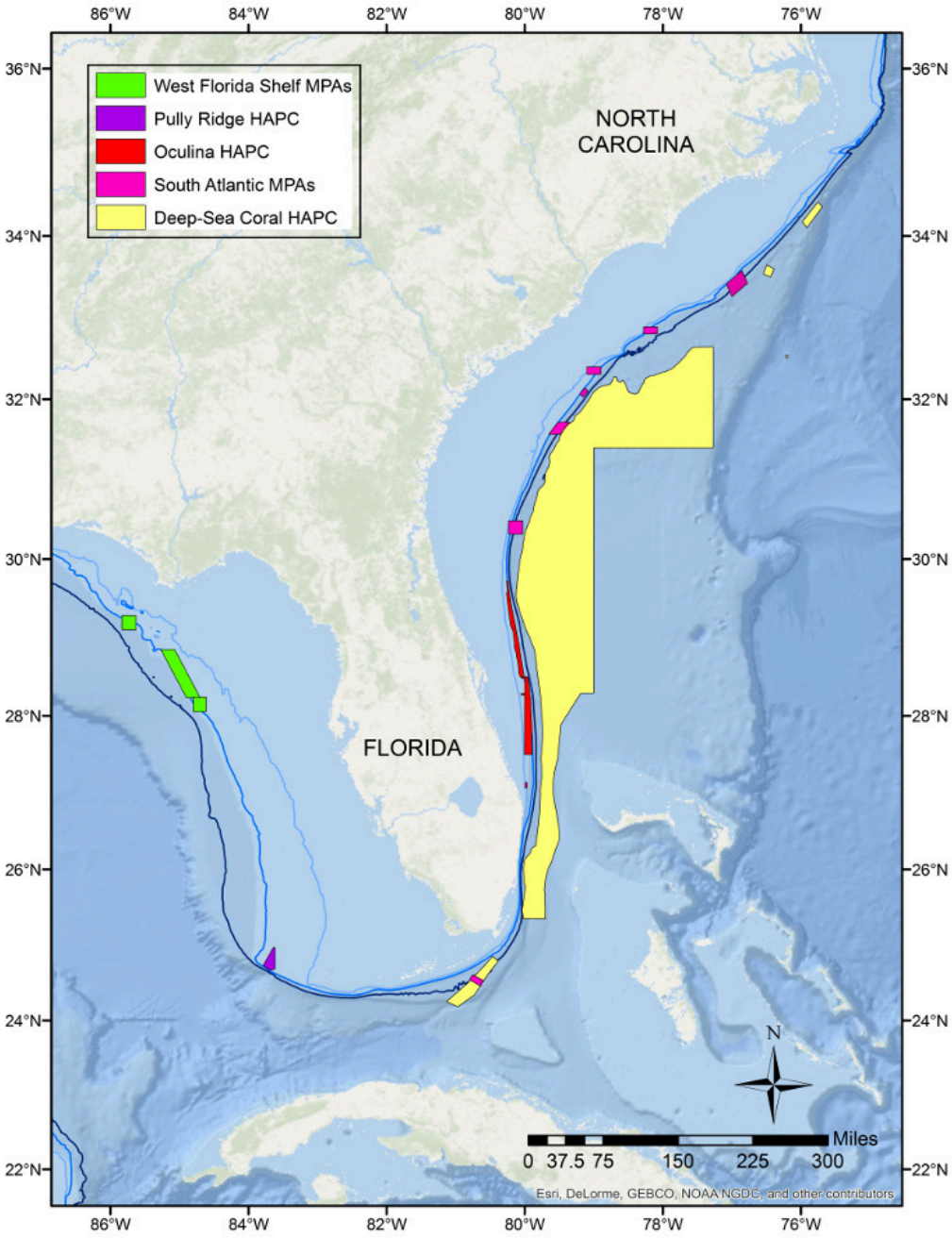


Figure 1: Map displaying the five major Marine Protected Areas projects for the state of Florida. The five major MPAs are West Florida Shelf MPAs (Green color), Pulley Ridge HAPC (Purple color), Oculina HAPC (Red color), South Atlantic MPAs (Pink color), and Deep-Sea Coral HAPC (Yellow color). These MPAs range from protecting certain fish to coral reefs (NOAA Fisheries n.d.).

Florida has implemented five major MPA projects (Figure 1) to help provide extra protection for vulnerable species such as juvenile reef fish. Hammerhead sharks are found in the open ocean as well as shallower waters in Florida. One MPA is located off the west coast of Florida, which is along the 100 m isobaths, the second location is called Pulley Ridge HAPC. This can be located off the southwest coast and is along the 60-70m isobaths. The third location is off the east coast of Florida at a depth of 70-100m. This is known as the Oculina HAPC. The fourth MPA extends from North Carolina to the southern top of Florida. This is known as the South Atlantic MPA and is at depths of 50-250m. Lastly, the fifth MPA, known as The Deep-Coral HAPC also extends from North Carolina to the southern tip of Florida (NOAA 2022). However, the main difference with this one is that the depth is much deeper - 200-600 m. Florida implemented these five major Marine Protected Areas to prevent the overfishing of fish species that can be of economic importance. Another reason they implemented this is to protect Florida's Coral Reefs (NOAA 2022).

There are nearly 1,000 marine protected areas in the United States Coastal, oceanic, and Great Lake waters (NOAA 2019). However, there is a continuous decline of hammerhead sharks and in most cases, the shark species status is going from endangered to critically endangered. Due to conservation impacts the bonnethead recovery rate has gone up 44% (IUCN Red List 2021). By adding more marine protected areas and other conservation routes the other hammerhead species might also have a chance to have a recovery rate to bring back their population before it is too late.

The goal of this project is to identify new locations for Marine Protected Areas for the four species of hammerhead sharks in the state of Florida. Before I can identify MPAs I will gather information on the ecological requirements of the sharks, recreational and commercial fishing impacts on the FL economy, and political hurdles.

Methods

Information was gathered on the four species of hammerhead sharks in Florida through scientific literature and Government databases such as NOAA. Gathering biological information for the scalloped hammerhead, great hammerhead, smooth hammerhead, and bonnethead sharks outlined habitat needs to understand where new Marine Protected Areas (MPAs) could be located. Research on migratory patterns and the water temperature was also conducted. After

looking into the ecological aspect of each species of hammerhead, I used the IUCN Red List to research species conservation and population trends status.

Before I can achieve the outcomes I researched Florida's politics and economics to have a better understanding of how much the state relies on commercial and recreational fishing for their economy. Laws based on commercial and recreational fishing and how this impacts the state of Florida's economy were evaluated to help understand where MPAs could be placed.

With the research I have on Florida's laws and regulations, I can have a better understanding of where MPAs can be placed legally and where they will not interfere with commercial and recreational fishing. Along with the research by the organization NOAA data, I have identified and located where the MPAs in Florida are (Figure 1). I identified where the four species of hammerhead sharks reside and if the MPAs that are implemented for all the hammerhead species are beneficial. With that research, I was able to effectively look into areas that can favor the other species of hammerheads that might not currently be protected.

How to Identify Hammerhead Sharks

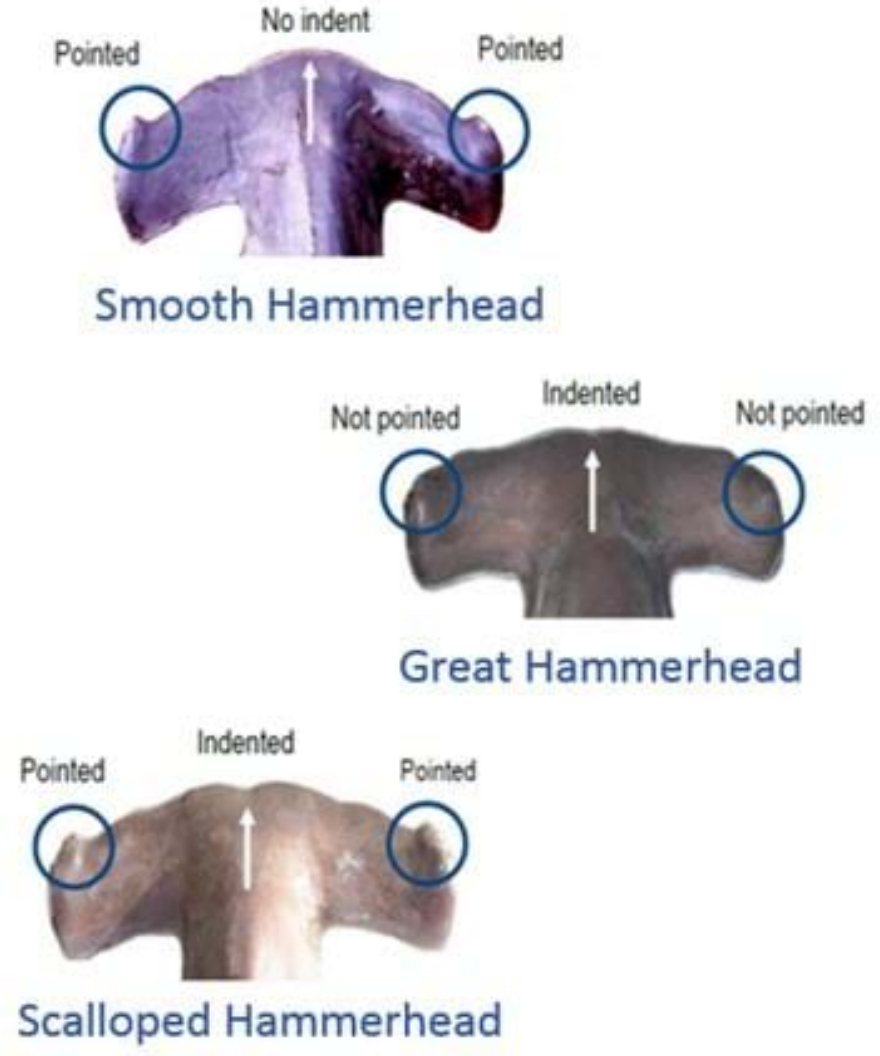


Figure 2: Identification of three out of the four species of hammerheads. This image helps show the difference with hammerheads. Smooth hammerheads have no indent in the midpoint but their sides of their heads are pointed. Great hammerheads are identified by the indentation by the midpoint. Lastly, scalloped hammerheads have an indent by the midpoint and the sides of their heads are pointed forward (Florida Fish and Wildlife Conservation Commision 2022)

Scalloped Hammerhead Sharks

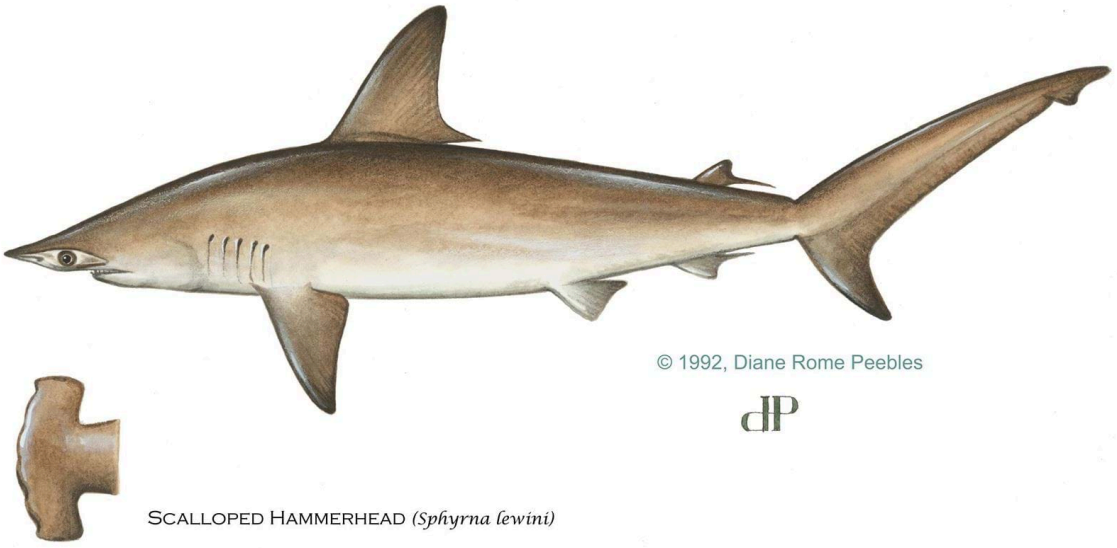


Figure 3: Image of a scalloped hammerhead (*Sphyrna lewini*) that shows the gray-brown to olive coloration as well as the flattened hammer like head. With the head it identifies the indentation at the midpoint and the sides of their head is pointed forward (Peebles, 1992)

Scalloped hammerhead sharks (*Sphyrna lewini*) are known for their flattened head that looks like a hammer. To help identify it from the other hammerhead sharks there is an indentation on front of head at its midpoint and they also have pointed sides by their eyes (Figure 2). Scalloped hammerhead shark's coloration is gray-brown to olive on the back and then it fades to white on the belly. The pectoral fin's underside is tipped with black coloration. These sharks also have a pelvic fin and can grow to be 3.35 meters long and weigh up to 151.953 kilograms (NOAA n.d.). The typical diet of these sharks are a mixture of fish, crustaceans, and cephalopods. However, their primary prey is squid.

Scalloped hammerheads are globally distributed but commonly found in the shelves of Atlantic Coast and Florida Gulf. They can also be located near the Flower Garden Banks National Marine Sanctuary (NOAA n.d) The sharks prefer tropical to warm temperature latitudes and are known to have extensive migration patterns (Wells et al., 2018). They can travel over 1,000,000 meters. With how much these sharks travel they have smaller home ranges. Scalloped hammerhead sharks have their pups in coastal lagoons and then when they become adults they move offshore coastal areas. The gestation period is typically 10-11 months and they typically brood range from 12-40 pups (NOAA n.d.).

According to the IUCN Red List, scalloped hammerheads are critically endangered and the population is continuing to decrease. The main threats to these sharks are bycatch, overfishing, and shark fin trading. Scalloped hammerheads mortality rate exceeds over 90%. Compared to other pelagic sharks, these sharks exhibit increased physiological sensitivity from

capture stress (Wells et al., 2018). Scalloped hammerhead shark fins are highly valued in shark trading. In Hong Kong fin trading it is estimated that 1.3-2.7 million scalloped hammerheads fins are used. Luckily, scalloped hammerheads were the first sharks to be protected under the U.S. Endangered Species Act for the populations that were found in the Eastern Atlantic and Pacific Ocean (NOAA n.d.)

Smooth Hammerhead

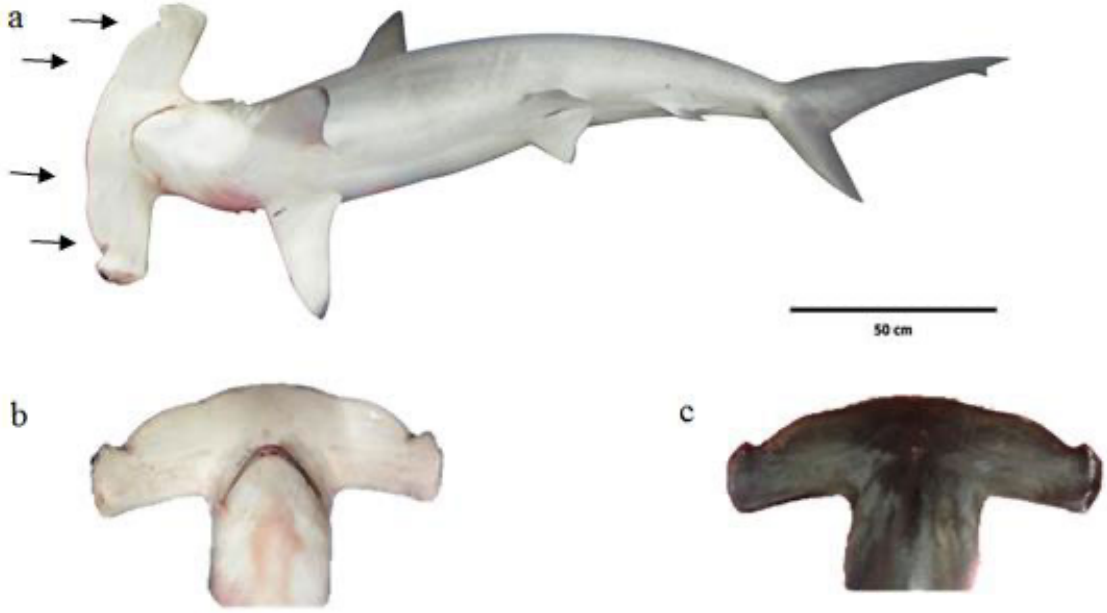


Figure 4: Image of a female smooth hammerhead. a. indicated that the smooth hammerhead shark is a female. It shows the ventral which is the front part of the hammerhead's body. It shows the four notches on the head (Bonfil 2017).

Smooth hammerhead sharks (*Sphyrna zygaena*) can be identified by their rounded heads that have no indention in the middle of the front margin Figure 2). Hence the name smooth hammerhead.These sharks have a 360 degree view of the area they are surrounding (Oceana n.d.) . The coloration of these sharks can be seen as a dark olive color to a brownish gray. Smooth hammerheads have white undersides as well. These hammerheads can average in length from 8 to 4.8768 meters and weigh up to 399.161 kilograms. Their diet consists of squid (Jumbo flying squid) and cephalopods. However, they are known to be active predators and eat other species such as hake, dolphins, skates, rays, crustaceans, sea snakes, and other sharks. Sometimes they will even eat their own species if it is small enough (Oceana n.d.).

Smooth hammerheads are very mobile; sharks can be spotted at depths up to 199.95 meters however they prefer to stay in shallow water around 19.812 meters deep. They are distributed worldwide but prefer tropical waters and temperatures. In Florida, they can be found closer to inshore water such as estuaries and bays.

These hammerheads are threatened by overfishing. Due to overfishing they are now vulnerable to extinction and their population continues to decrease (IUCN RedList). Due to them being closer to shore they are caught intentionally. On top of that, they are impacted by different fishing gears. They are also very valuable to fin trading. 1.3-2.7 millions fins are collected each year (Oceana n.d.). These sharks are also valued for their liver oil. Smooth hammerheads liver oil can be used in various different things such as vitamins. However in the Florida and Caribbean market their food can be sold there for human consumption (Oceana n.d.). In Florida, there are private events at Panama City Beach where people can fish these hammerheads.

Great Hammerhead

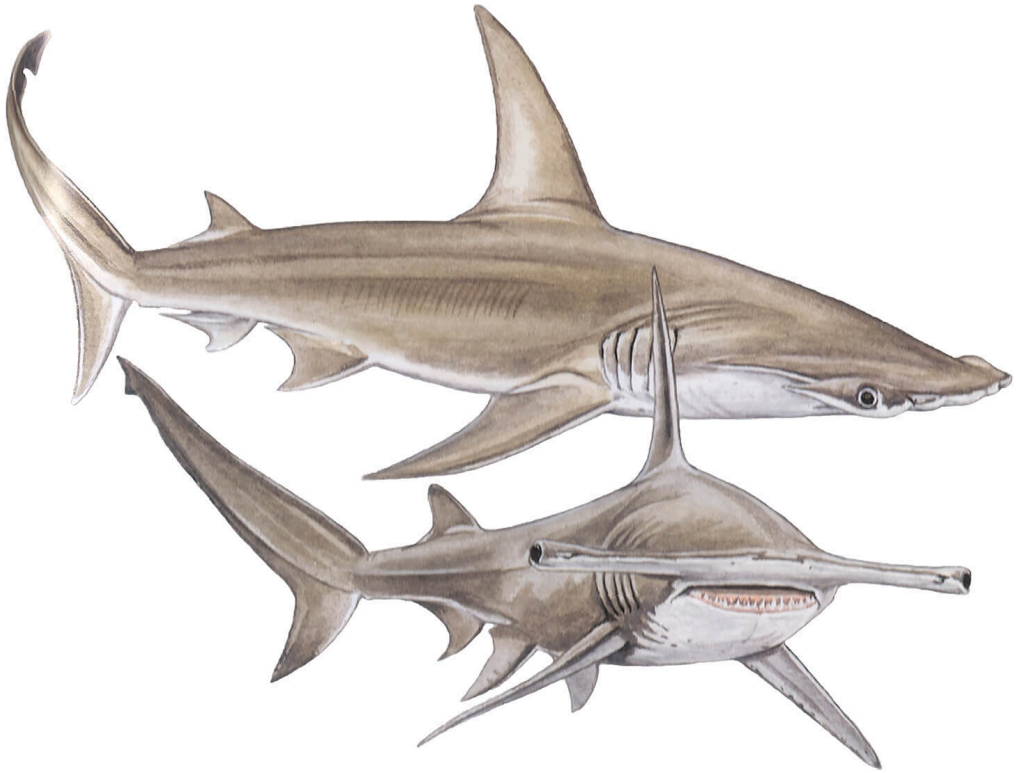


Figure 5: Image of a Great hammerhead shark (*Sphyrna mokarran*) that shows the brownish gray coloration with the white underside. This image also shows off the unmarked ventral tops of the hammerheads pectoral fins (Dando 2015)

Great hammerhead sharks (*Sphyrna mokarran*) are the largest hammerhead in the Sphyrnidae family (Florida Museum n.d.). Their average length is 3.99 meter and weigh up to 226.8 kilograms They can be identified for their straight hammer like head with an indent in the middle of the head (Figure 1). The coloration of this shark is a lighter brown which leads into a grayish coloration around the dorsal fin area. Their dorsal fins are very tall and recurved. Then its stomach is a light cream color on the stomach. Great hammerheads are apex predators so their

diets consist of invertebrates, stingrays, and sharks. Like smooth hammerheads, they do have cannibalistic tendencies and will eat their own species but it is typically when food is scarce (Florida Museum n.d.).

These hammerheads are found worldwide and can be found in coastal as well as open oceans (Oceana n.d.). They prefer to be in solitary. Great hammerheads can migrate alone and have been seen to migrate super long distances that are estimated to be 1216700 meters These sharks prefer to migrate off-shore into pelagic regions. It has been seen that these sharks core habitats are almost entirely within Florida state waters (Sentinel 2017). Great hammerheads can be spotted both the Gulf and Atlantic Coasts of Florida.

According to the IUCN Red List, they are critically endangered and their population continues to decline. If things do not change the next problem they will have will be extinction in the wild. Great hammerheads are vulnerable to overfishing. These sharks are typically caught incidentally as well as commercially. This is due to their fins since their fins are valuable. Typically they are caught in longlines, bottom trawl, gillent, and hook-and-line fisheries (Gallagher et al., 2018). However, if they were caught by accident and released they would not survive. More than 90% of great hammerheads die once they are captured and released due to their high mortality rate (Oceana n.d.). It has been stated that these hammerheads have suffered the most with population decline compared to any other species of sharks (Gallagher et al., 2018). Florida has been trying to make efforts and have made it illegal to kill them 4828.032 meters offshore.

Bonnethead

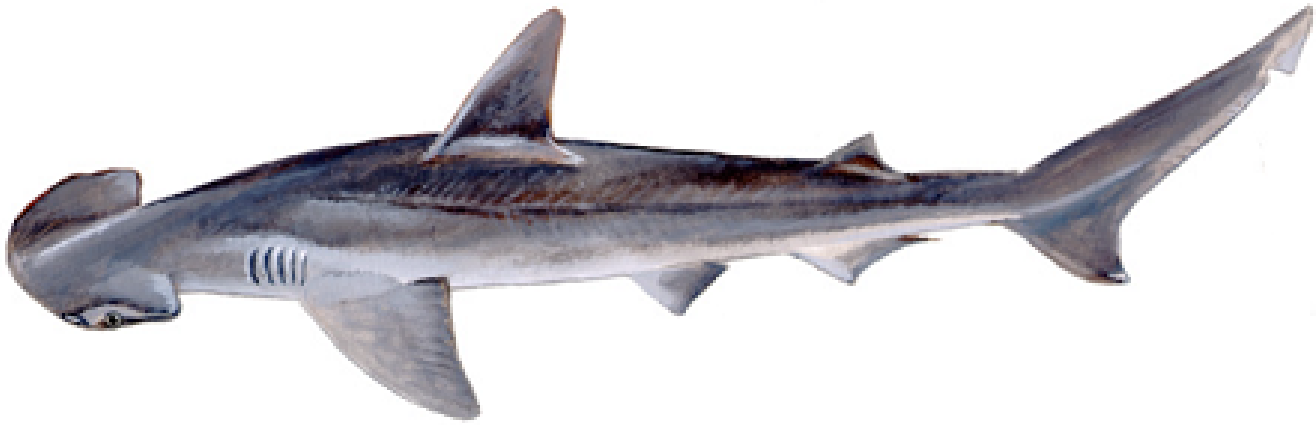


Figure 6: Image of a Bonnethead shark (*Sphyrna tiburo*) shows their unique straight head with notched edges. The image also shows the gray-brown shading near the dorsal fin with a lighter gray or white coloration on the underside of the hammerhead. Bonnetheads are also the smallest hammerhead species (Harvey 2015)

Bonnetheads (*Sphyrna tiburo*) are different compared to the other species of hammerheads. They are known to be the smallest hammerhead as they range in size from 0.70 - 1.524 meter in length. They are known for their head shape as their head is smooth and round between the eyes (Aquarium of The Pacific n.d.). Unlike the other sharks they do not have the points near their eyes as well as the indents. Their coloration is a grayish color with shading of brown near the dorsal fin area. Their stomach area is also a lighter gray that is almost white. This hammerhead diet consists of crabs, shrimps, bivalves, snails, small bony fishes, and seagrasses. They prefer hard shelled invertebrates and are known for their foraging activities (Aquarium of The Pacific n.d.).

Bonnthead sharks live nearshore in Florida waters and can be found in shallow sandy areas (FWC n.d.). They can also be found near the continental shelf. The depth for these is around 80 meters but it is common to see them 10-25 meters as well (Carlson et al., 1997). These sharks are highly migratory and will migrate into deeper coastal waters once the temperature becomes too cold.

Bonnetheads are endangered and their population is largely depleting and continues to decline (IUCN RedList). These sharks are threatened by numerous issues such as unsustainable fisheries, international fin trading, habitat degradation, as well as climate change. If they are caught they are sometimes killed and used for their meat. Due to bonnetheads prefer being closer to inshore they are now being impacted by the coast developments. These are destroying their habitats and impact their survival in general. In NOAA'S National Marine Fisheries Service laboratory in Florida they are conducting research and created a population modeling on these bonnetheads in the area of Panama City. The results so far have shown that young bonnetheads have a high mortality rate (Aquarium of The Pacific n.d.).

Marine Protected Areas

Marine protected areas are defined regions designated and managed for the long term conservation of marine resources, ecosystems services, or cultural heritage (NOAA n.d.). There are over 1,000 marine protected areas in the United States and 41 in the state of Florida. They can be found within the U.S coastal, the Great Lake water, and oceanic (NOAA n.d.).

There are stages and levels for creating marine protected areas. There are four stages for creating a marine protected area:

1. Proposed/ committed
    a. The proposal is through a submission to the Convention of Biological Diversity with the goal of publicly creating a marine protected area (UN WCMC n.d.).
2. Designated
    a. The designated period is when a marine protected area was established through legislation and now exists on paper.
3. Implemented
    a. During the implemented period it is becoming operational and now has boundaries as well as objectives. There is also a management strategy being created to protect species and habitats.
4. Actively Managed
    a. This is an ongoing process as it is monitoring and making changes as needed to achieve the social and ecological goals.

The next step is figuring out level of protection:

1. Fully protected
    a. With a marine protected area being fully protected there is no destructive allowed. All impacts that may be negative to the area being protected are minimized.
2. Highly protected
    a. A highly protected area only allows little activities that may harm the area as well as low activities and extractions. These areas only allow traditional activities.
3. Lightly protected
    a. Lightly protected areas have some protection to the designated spot. These areas allow moderate extractions as well as impacts.
4. Minimally protected
    a. Minimally protected areas provide little conservation benefits to the site. Destructive impacts such as industrial fishing are allowed in these areas.

After this it is expected to have social as well as ecological outcomes. These outcomes also depend on the level of protection that was decided. If implemented and managed correctly and well the outcomes can show that there would be an increase in biomass and marine life.

In the state of Florida there are four marine protected areas (Figure 1). The names of these are West Florida MPAs, South Atlantic Bight MPAs, Oculina Habitat Area of Particular

Concerns, Pulley Ridge Habitat Area of Particular Concern, and South Atlantic Bight Deep-Sea Coral Habitat Area of Particular Concerns. These marine protected areas allow scientists to conduct research. They are typically conducting fishery surveys as well as habitat research (NOAA n.d.).

West Florida Marine Protected Areas

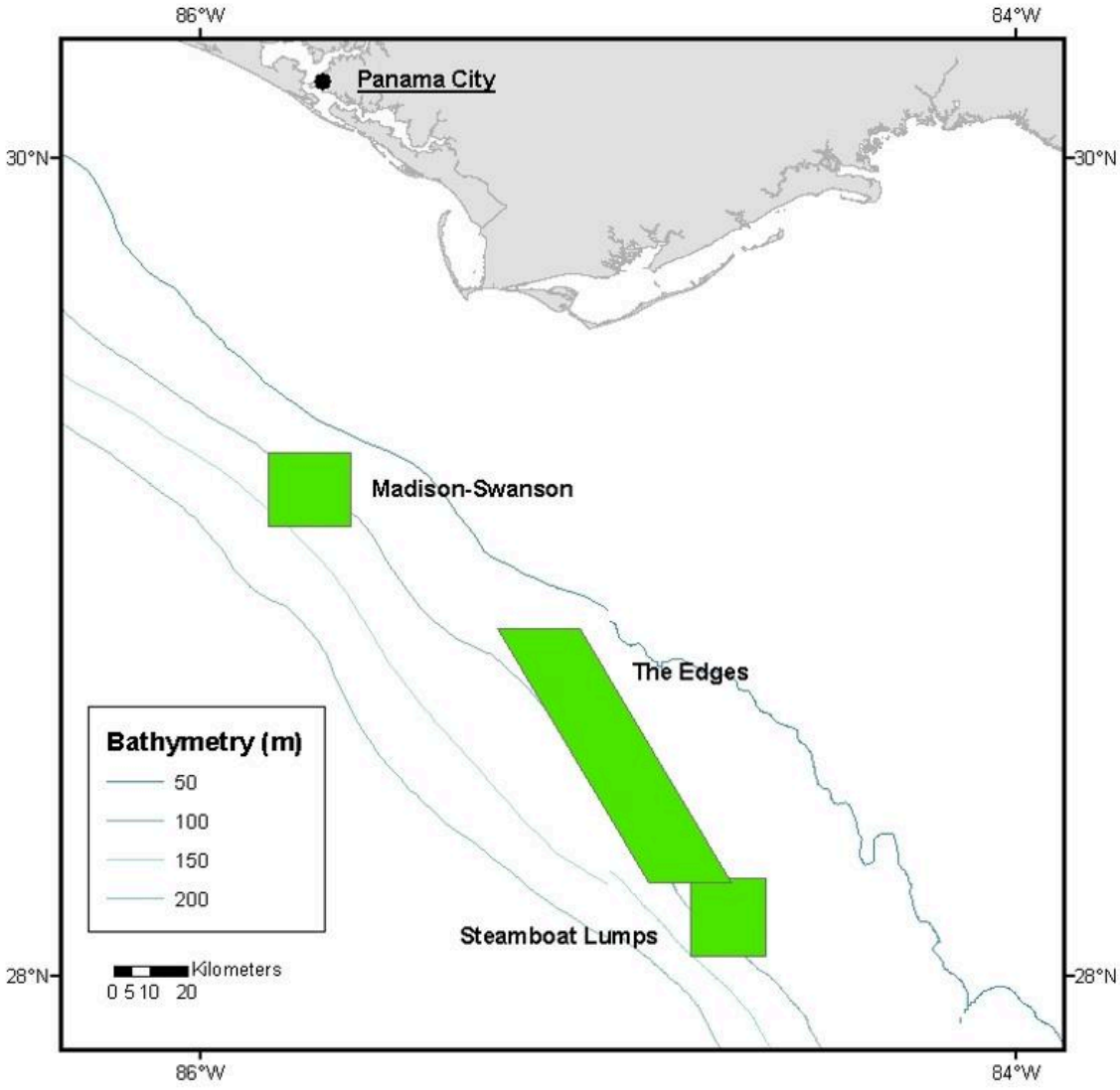


Figure 7: The green boxes indicate where the West Florida Marine Protected Areas are in the Gulf of Mexico (NOAA n.d.)

The West Florida Marine Protected Area is divided into two sections. The Fishery Management Council created these two marine protected areas outside of the Gulf of Mexico in June 2000 (NOAA n.d.). These MPAs are located along the 100m isobath of the West coast of Florida (Figure 7). The goal of this marine protected area is to protect Gag groupers (*Mycteroperca microlepis*) as they were becoming vulnerable to extinction by overfishing.

South Atlantic Marine Protected Areas

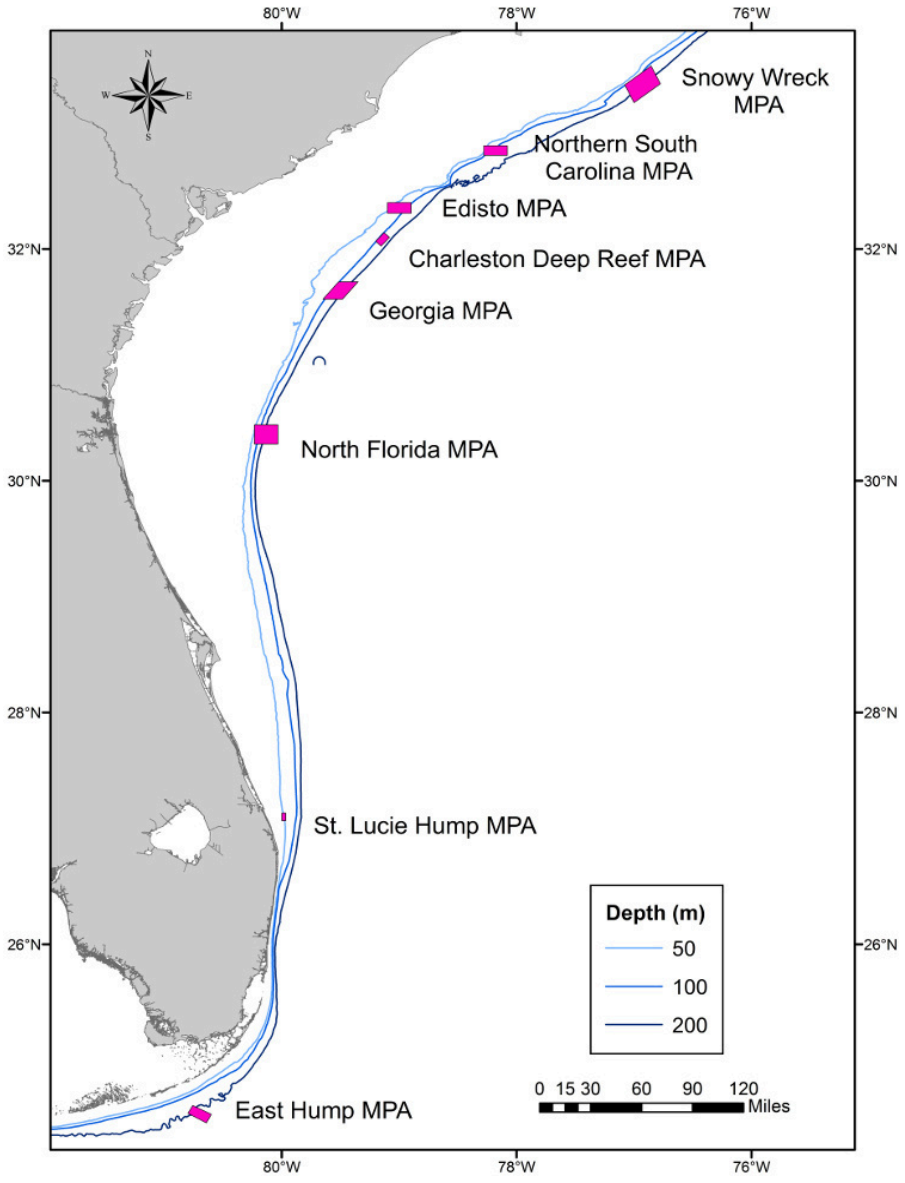


Figure 8: The pink boxes indicate the eight marine protected areas in the South Atlantic Marine Protected Areas. These areas are between Cape Hatteras, North Carolina and the Florida Keys (NOAA n.d.)

The South Atlantic Marine Protected Areas have eight MPAs clustered together. They are the Snowy Wreck MPA, Northern South Carolina MPA, Edisto MPA, Charleston Deep Reef MPA, Georgia MPA, North Florida MPA, St Lucie Hump MPA, and East Hump MPA. These were implemented in February 2009 by the South Atlantic Fishery Management Council in hopes to protect the seven species of snapper groupers (*Epinephelinae*) from overfishing (NOAA n.d.).While allowing reef species to be contained in closed areas, they are also protecting habitats for other fish species with economic value.

Oculina Habitat Area Of Particular Concern

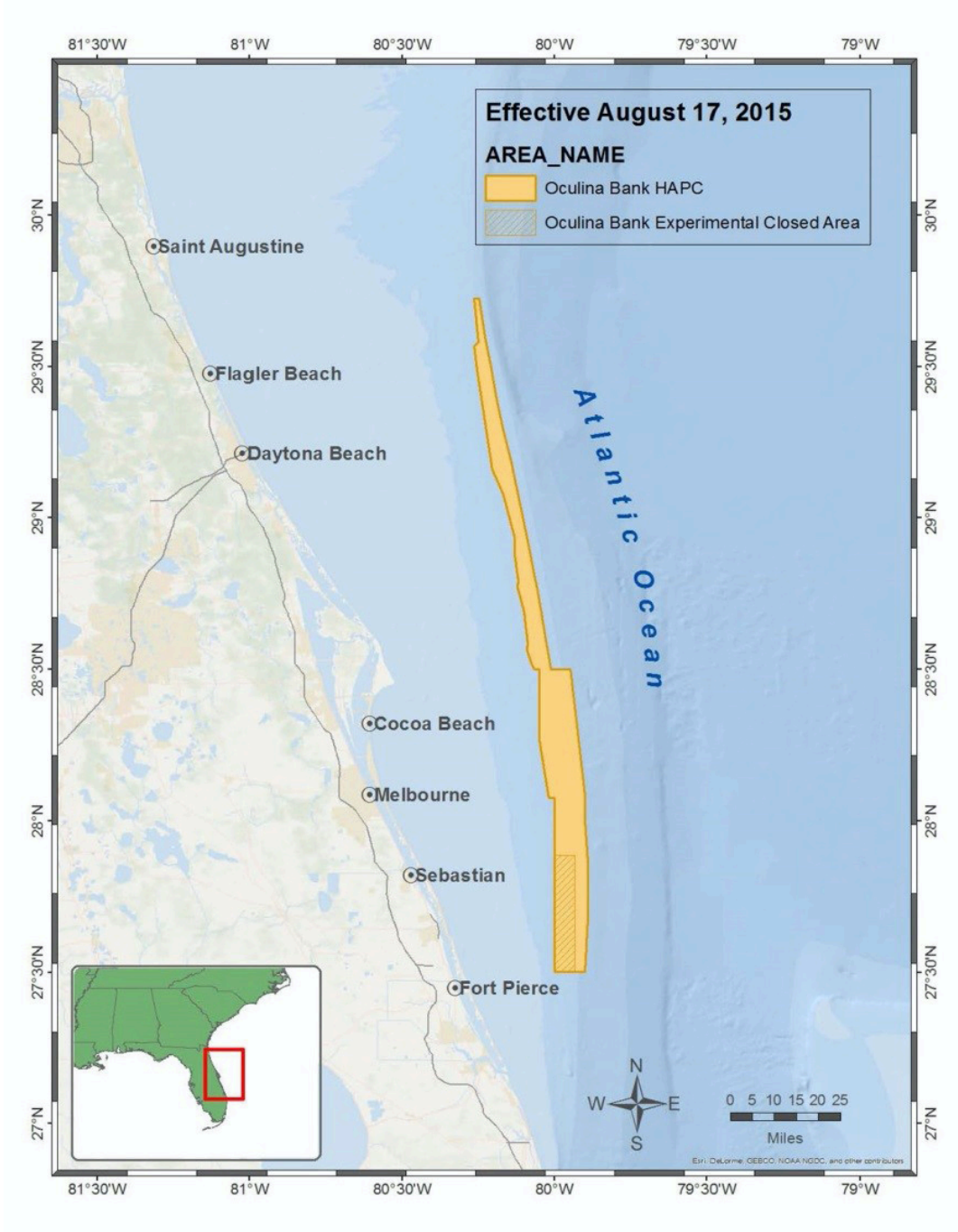


Figure 9: The yellow box indicates the Oculina Habitat Area of Particular Concern marine protected areas. This is a deepwater coral area that is located in the southeastern United States and the east coast of Florida. **(**NOAA n.d.**)**

The Oculina Habitat Area of Particular Concern (OHAPC) was created in 1984 by the South Atlantic Fishery Management Council. According to NOAA, it was the first marine protected area closed to protect habitats in the federal waters of the U.S. East Coast and it is 148060. These areas are to protect coral from bottom fishing gear such as trawls that may destroy them. It has continued to expand since 2015 by the South Atlantic Fishery Management Council. This council continues to monitor and tries to restore fish population as well as coral habitat through an ecosystem based approach. With the ecosystem based approach they attempt to sustainably manage these areas by considering social, economic, and ecological trade offs across the protected areas (NOAA n.d.).

Pulley Ridge Habitat Area of Particular Concern

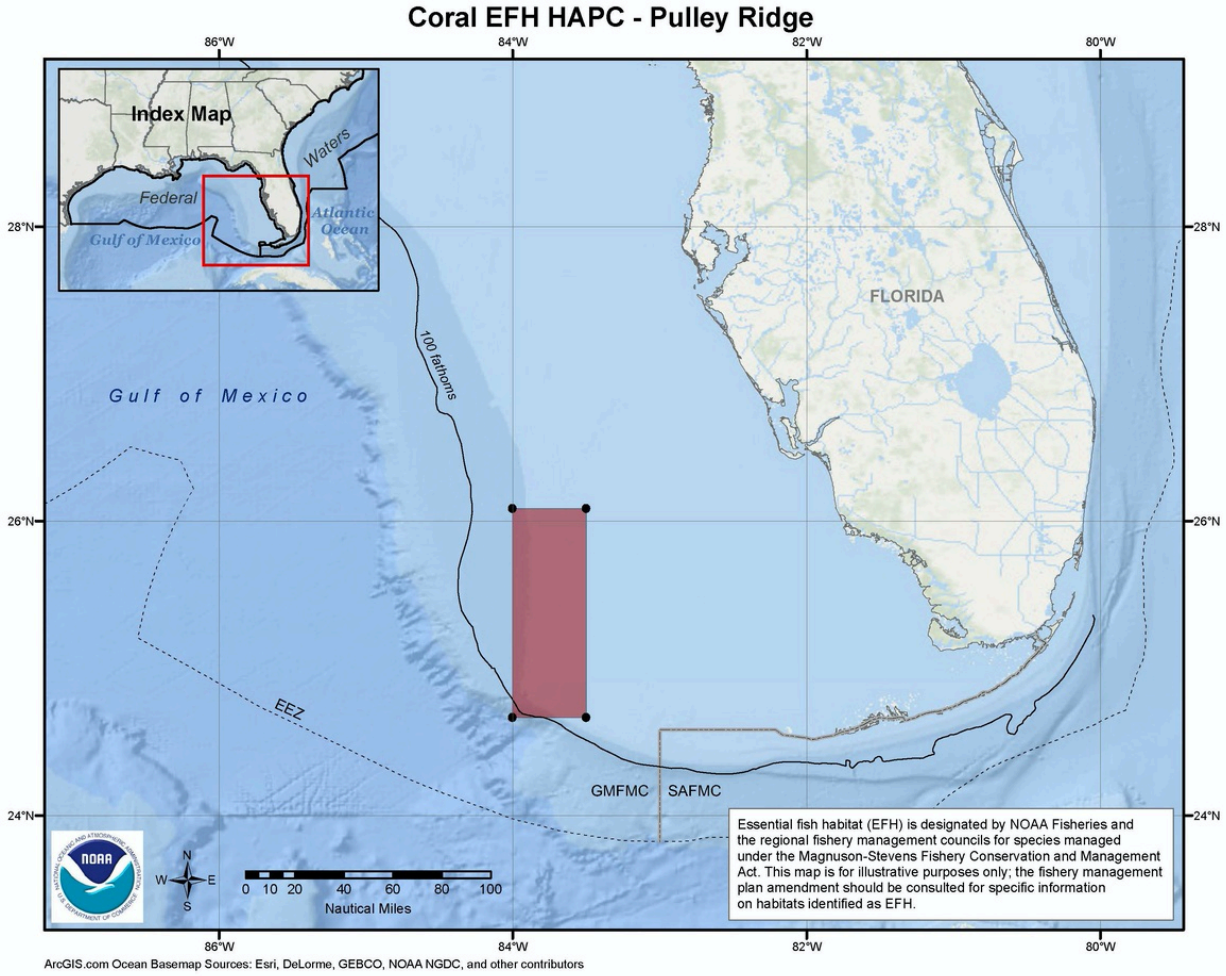


Figure 10: The pinkish purple block indicates the Pulley Ridge Habitat Area of Particular Concern. This marine protected area is located off the southwest coast of Florida (NOAA n.d.)

The Pulley Ridge Habitat Area of Particular Concern was created by the Gulf of Mexico Fishery Management Council. They were concerned about the damage due to fishing and how this is impacting habitats and fishes. With research, scientists goals as well as the Gulf of Mexico Fishery Management Council are to determine the extent and magnitude of scleractinian corals, other adjacent data and associated fish assemblages, as well as gather quantitative data on habitat (NOAA n.d.).

South Atlantic Deep Sea Coral Habitat Area of Particular Concern

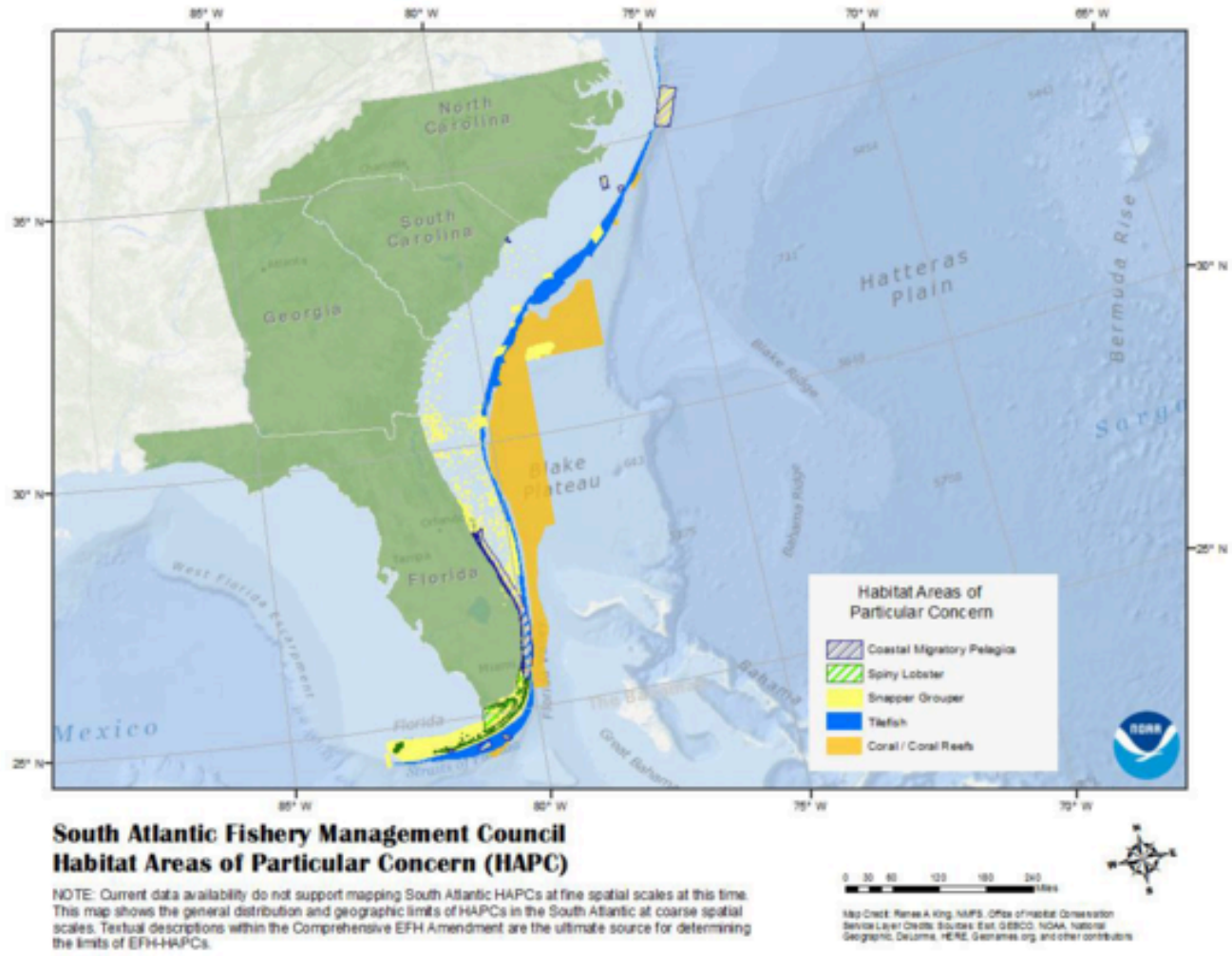


Figure 11: This image shows 5 designated marine protected areas for the South Atlantic Deep-Sea Coral Habitat Area of Particular Concern. These marine protected areas cover around 60,000,000 meters from North Carolina to the Florida Keys (NOAA n.d.).

The South Atlantic Deep Sea Coral Habitat Area of Particular Concern was created in 2010 by the South Atlantic Fishery Management Council. There are five areas and they cover 60,000,000 meters between Florida Keys and North Carolina. The goals with protecting and studying these areas is creating conservation of Atlantic deep coral ecosystems, determining connectivity of deep coral ecosystems across the Atlantic Ocean, and establishing shared and standardized research methodologies and products among regions (NOAA n.d.).

Hammerheads Caught In the State of Florida:

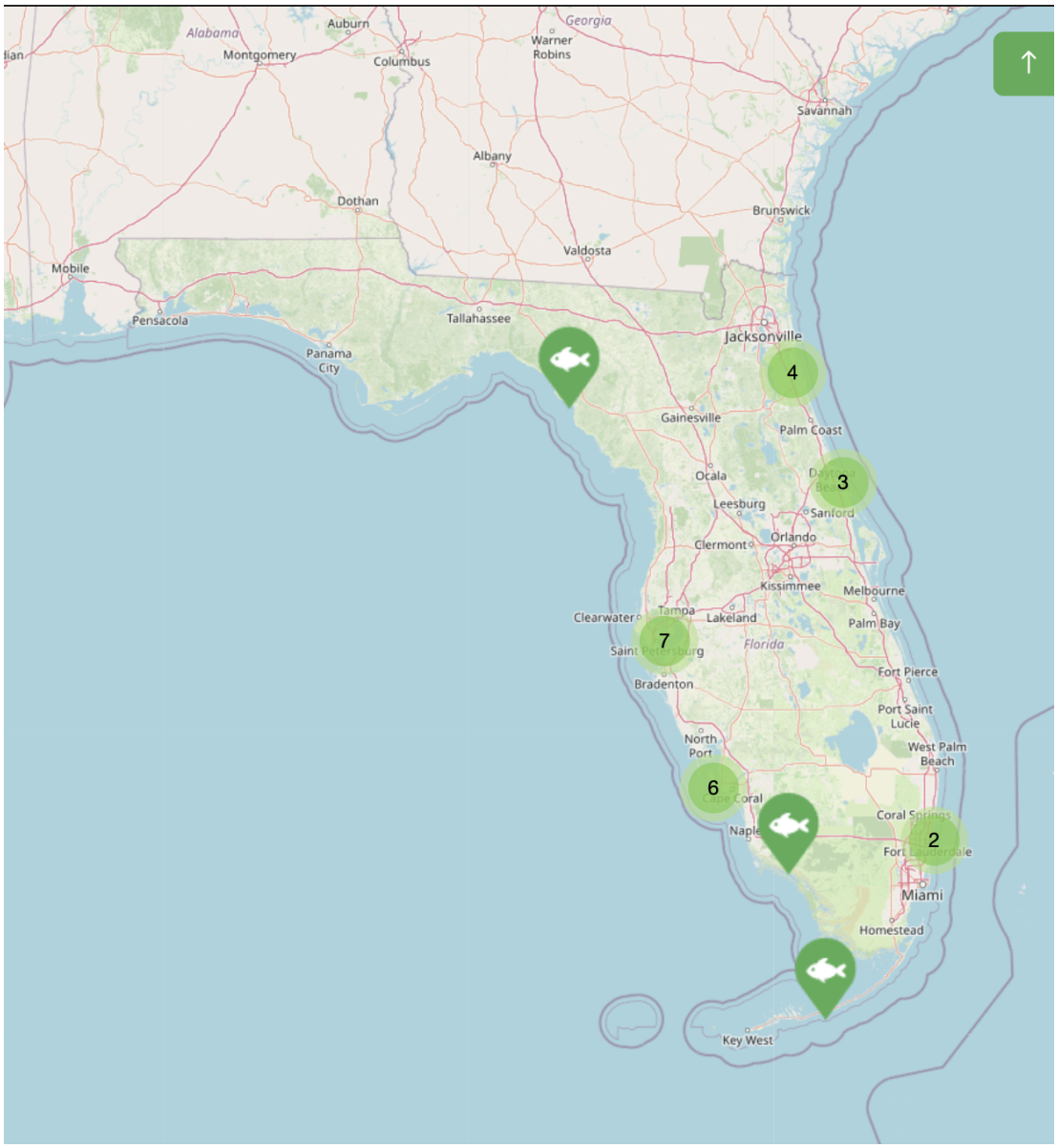


Figure 12: A map of Florida and the 27 recorded hammerhead catches throughout 2017 - 2024. However, it is unknown what species were caught (FisherMap 2024).

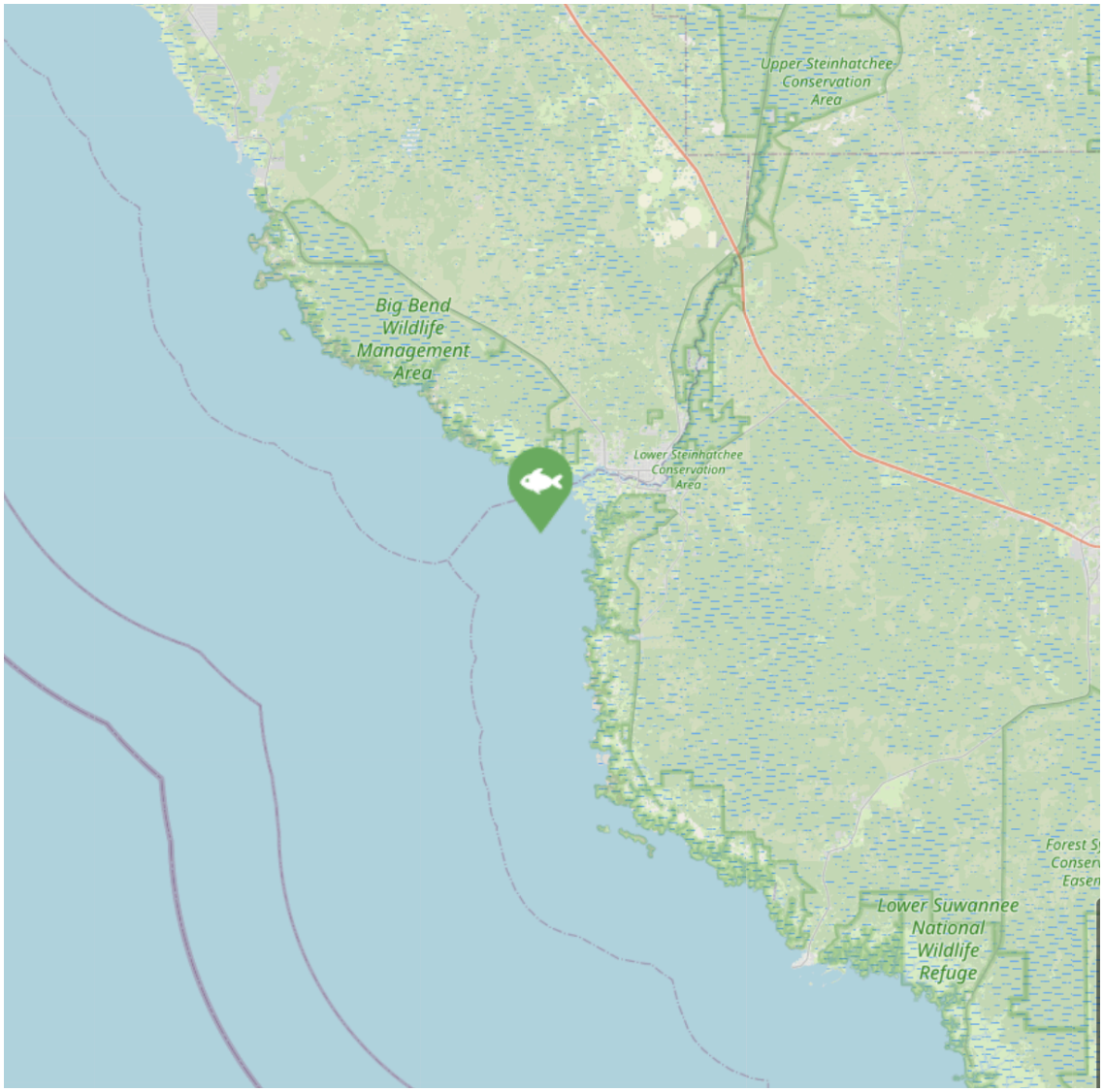


Figure 13: This hammerhead was caught 2020-06-05 . The coordinates for this hammerhead catch was 29.64286944, -83.43047222 (FisherMap 2020).

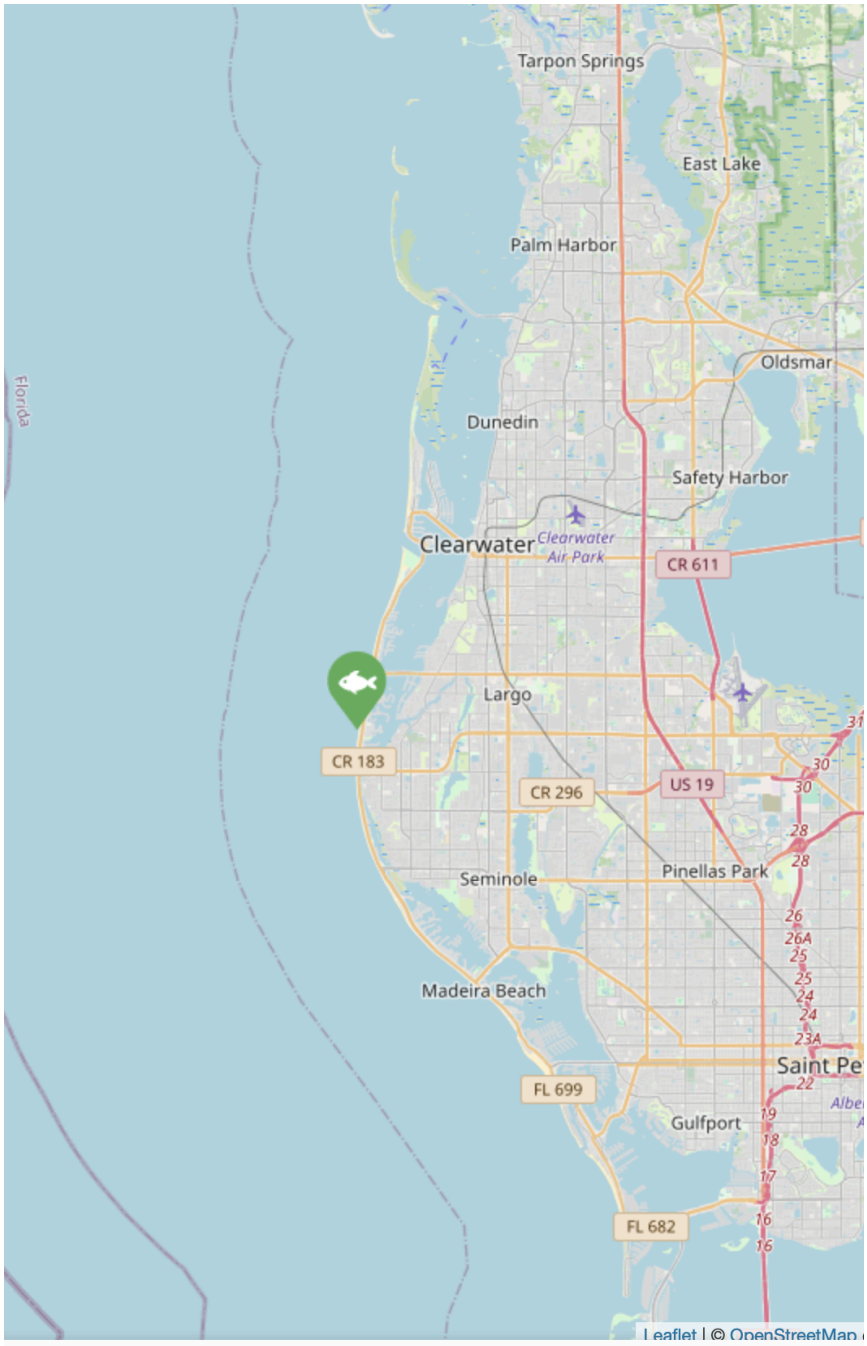


Figure 14: This hammerhead was caught 2017-10-14 and the coordinates for this catch was 27.89579417, -82.85038948 (FisherMap 2017).

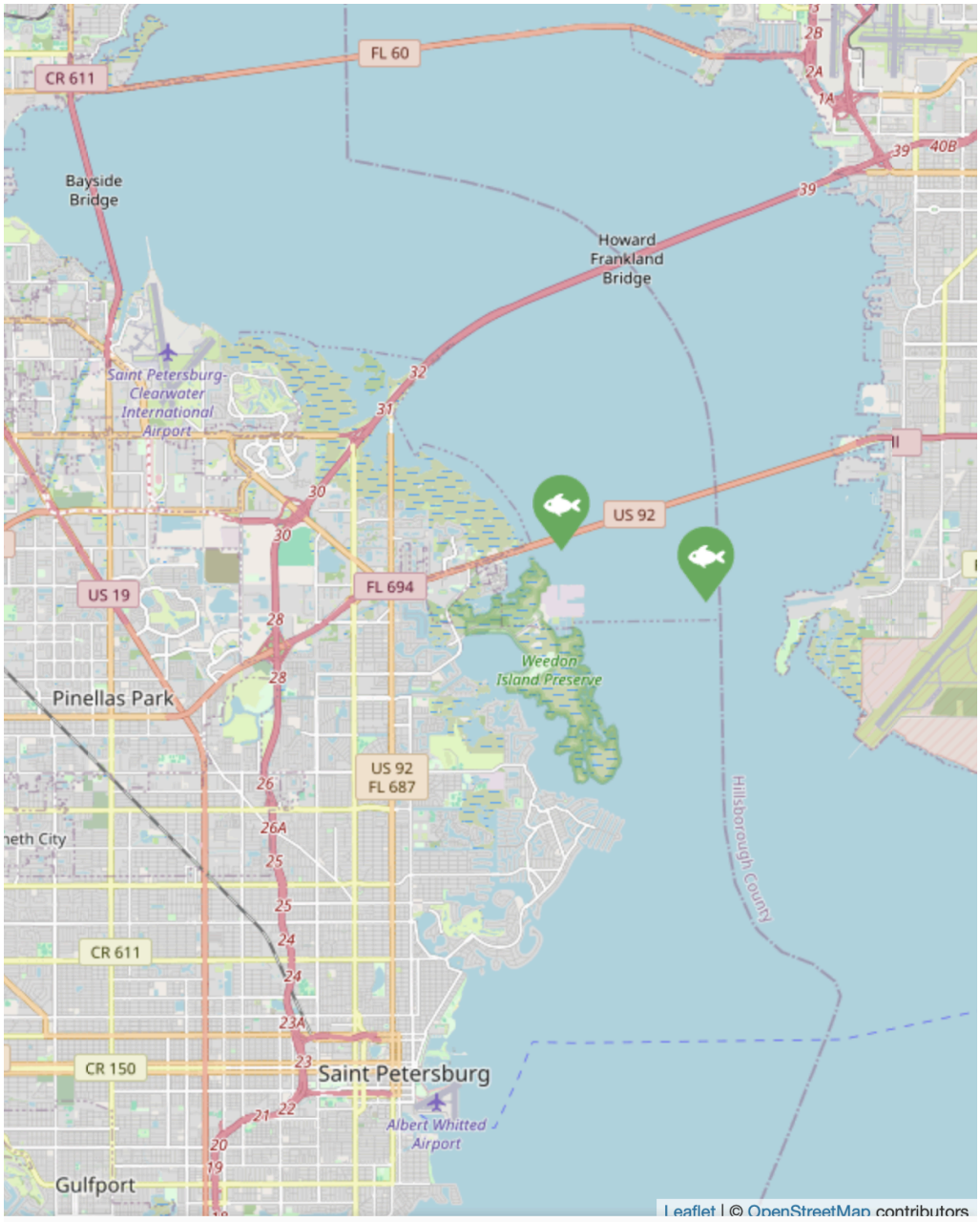


Figure 15: The hammerhead caught by US 92 was documented at 11:07am and was caught 2019-12-27. The coordinates for this catch was 27.87134472, -82.60154417 (FisherMap 2019). The second hammerhead that the document caught near the Hillsborough County line was caught 2016-06-16 and the coordinates for this catch was 27.861125, -82.56993056 (FisherMap 2016)

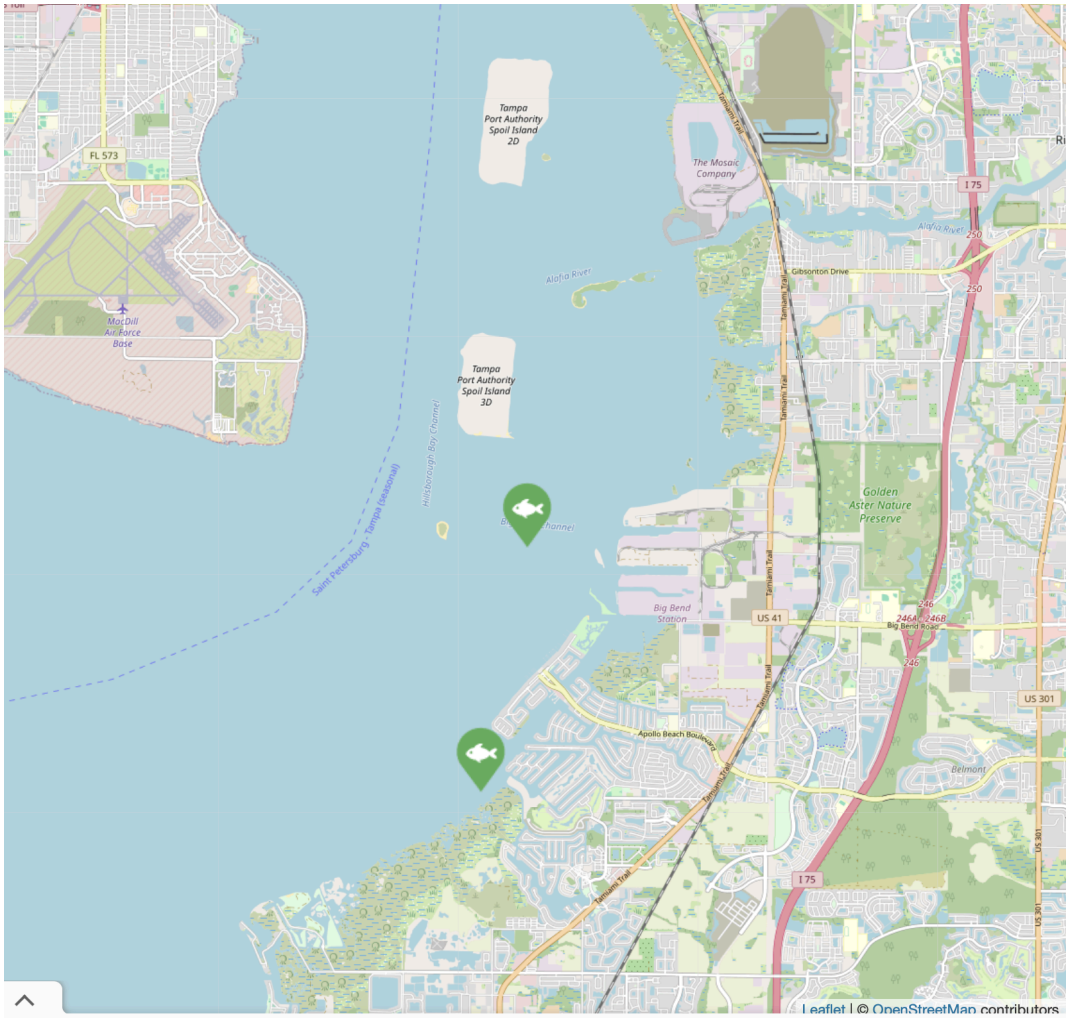


Figure 16: The hammerhead caught near Tampa Port Authority/ Big Bend Channel was caught on 2014-02-05 and the time document for the catch was 14:29. The coordinates for this catch was 27.80450556, -82.42858889 (FisherMap 2014). The second hammerhead caught was in 2018-07-08. The coordinates for this catch was 27.76467168, -82.43698597 (FisherMap 2018).

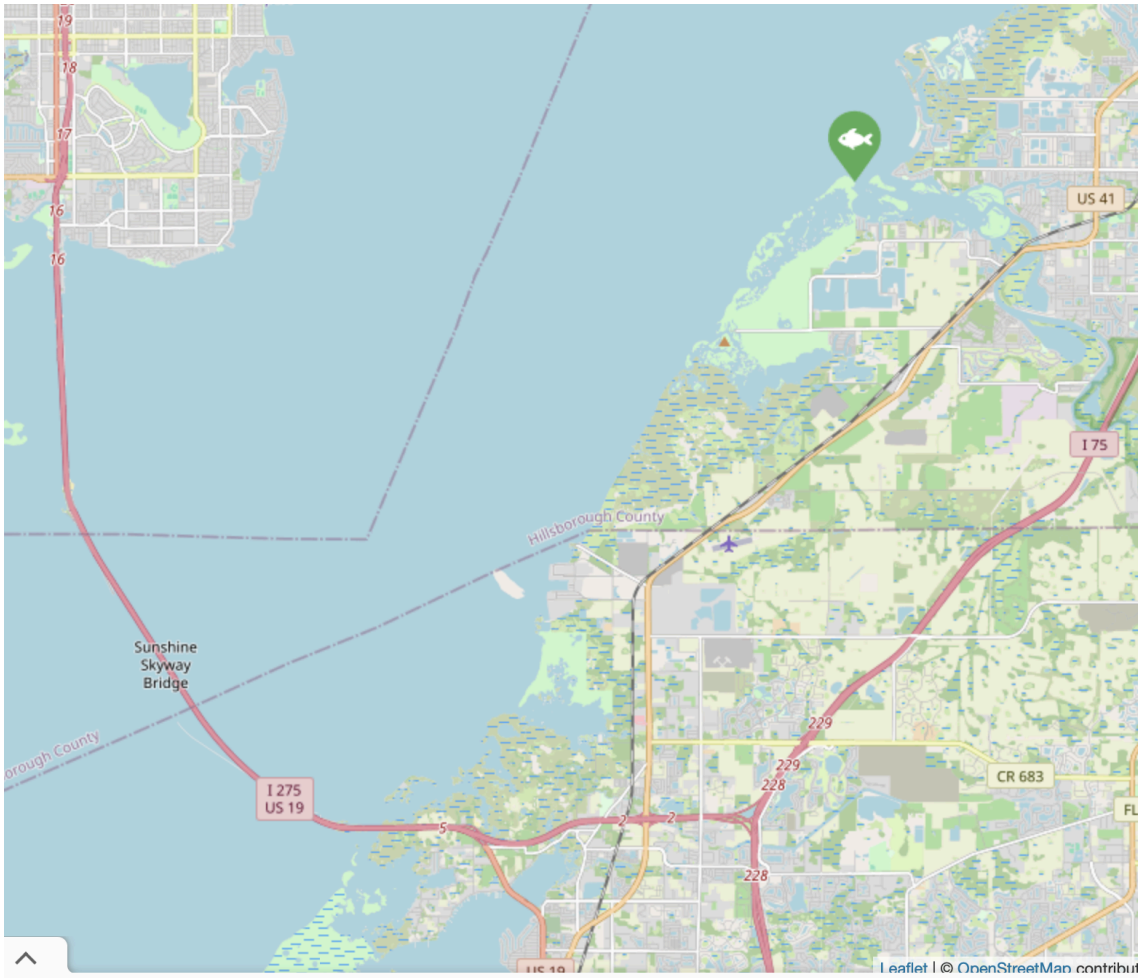


Figure 17: Hammerhead catch date was 2022-06-11 around 12:32pm. The coordinates for this hammerhead catch was 27.71784722, -82.490875 (FisherMap 2022).

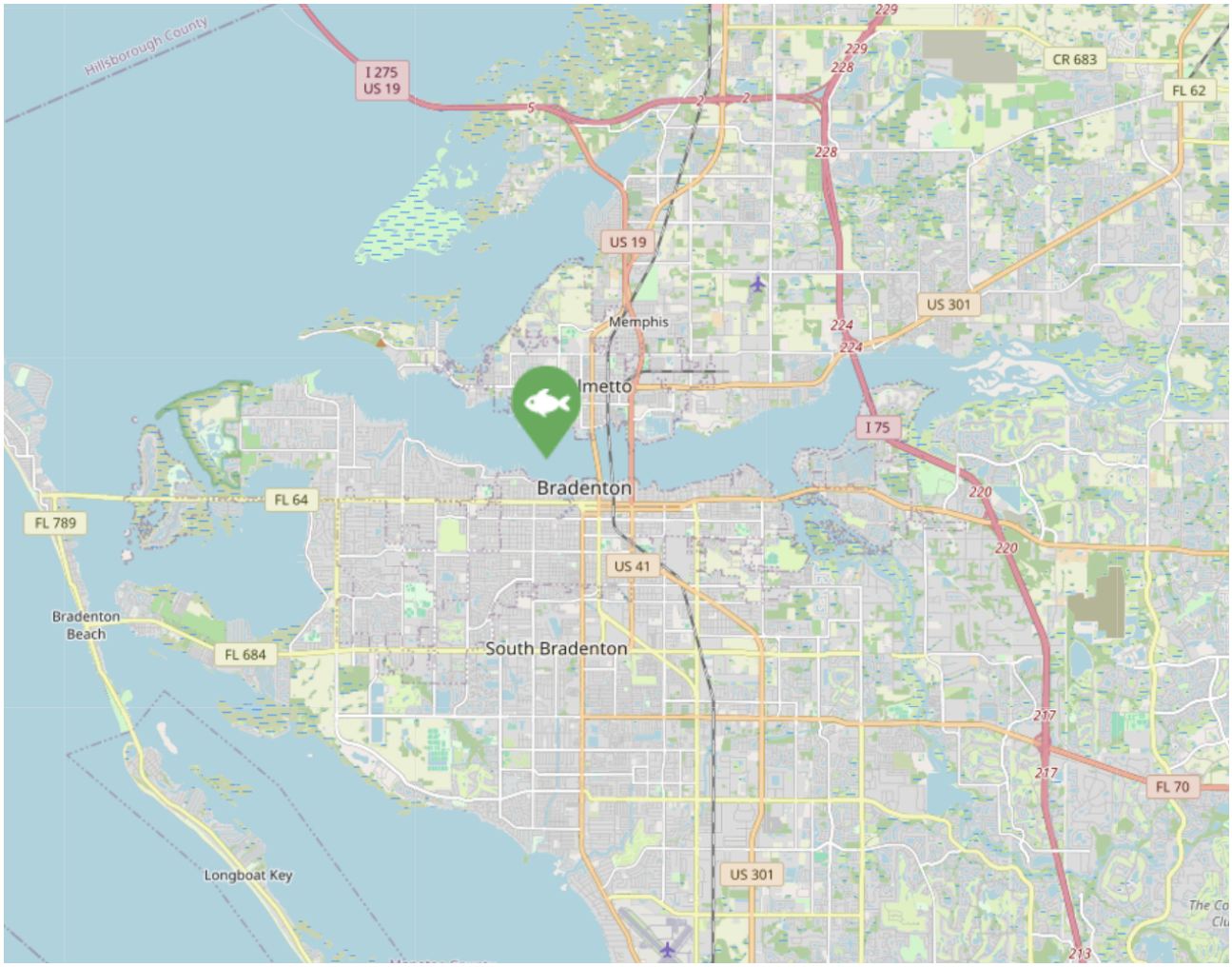


Figure 18: This documented catch occurred 2018-04-10 and the coordinate for this catch was 27.50476951, -82.58371353 (FisherMap 2018).

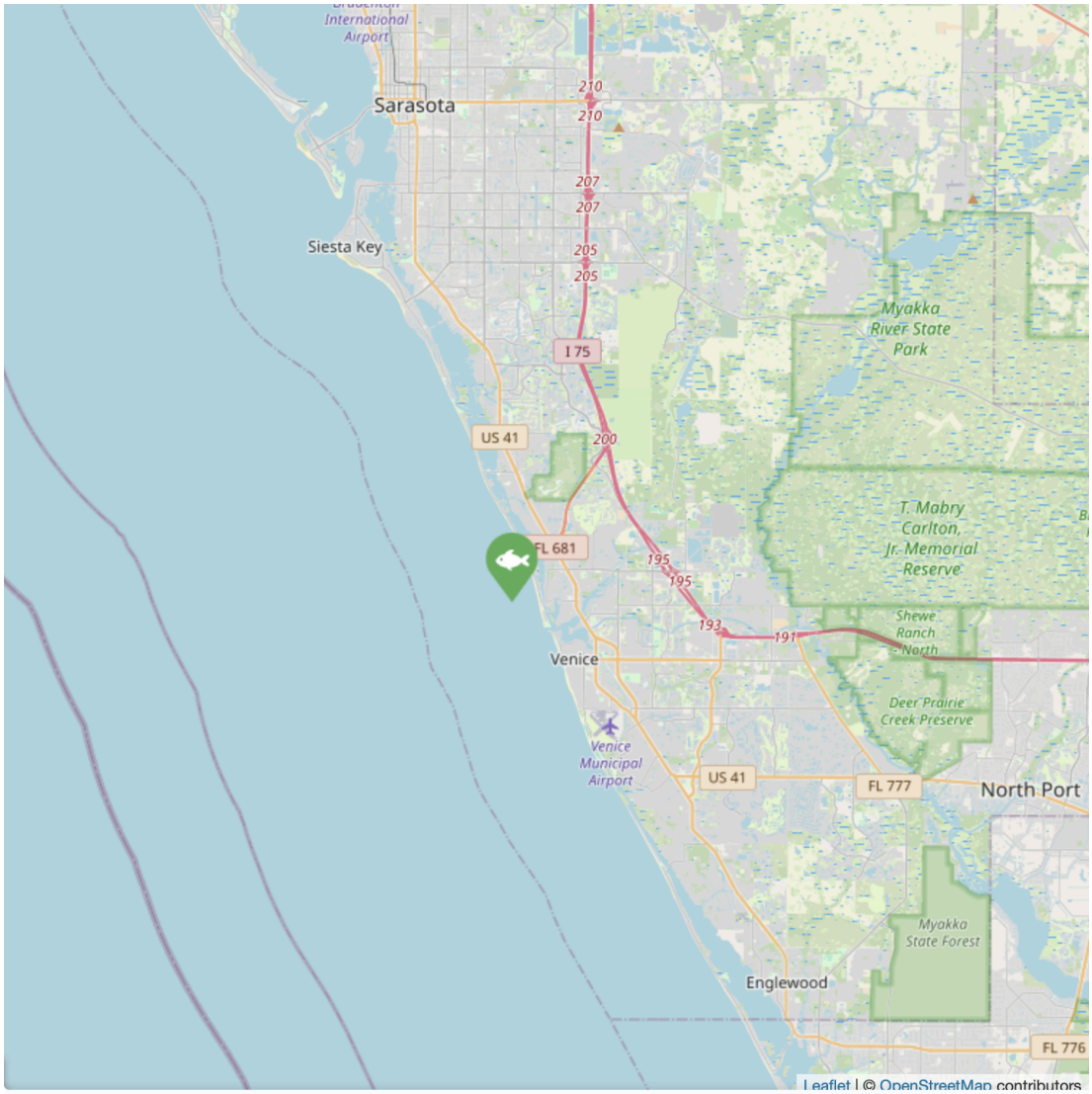


Figure 19: These hammerheads caught the date 2020-07-28 and it was around 13:40. The coordinates for this catch was 27.12377222, -82.48386389 (FisherMap 2020).

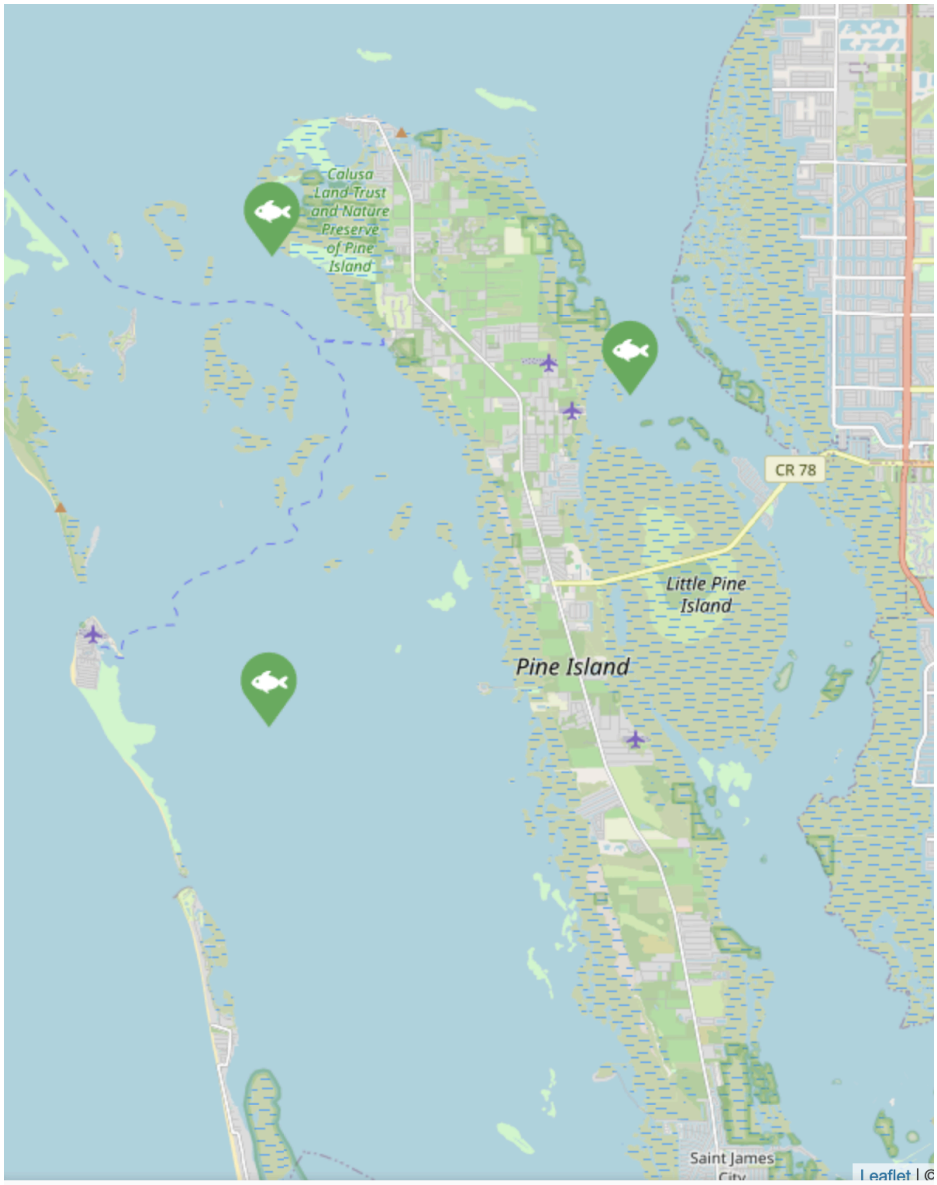


Figure 20: The hammerhead caught near Calusa Land Trust and Nature Preserve of Pine Island was caught 2021-01-23 and the coordinates for this catch was 26.6784783, -82.180242. (FisherMap 2021) The second hammerhead caught was in 2019-03-30 near the Gulf Intracoastal Waterway. The coordinates for this hammerhead catch was 26.58491967, -82.18073845 (FisherMap 2021). The third hammerhead that was caught was in 2022-03-18 and that was near the airport. Its coordinates for the catch was 26.65071389, -82.10079167 (FisherMap 2022).

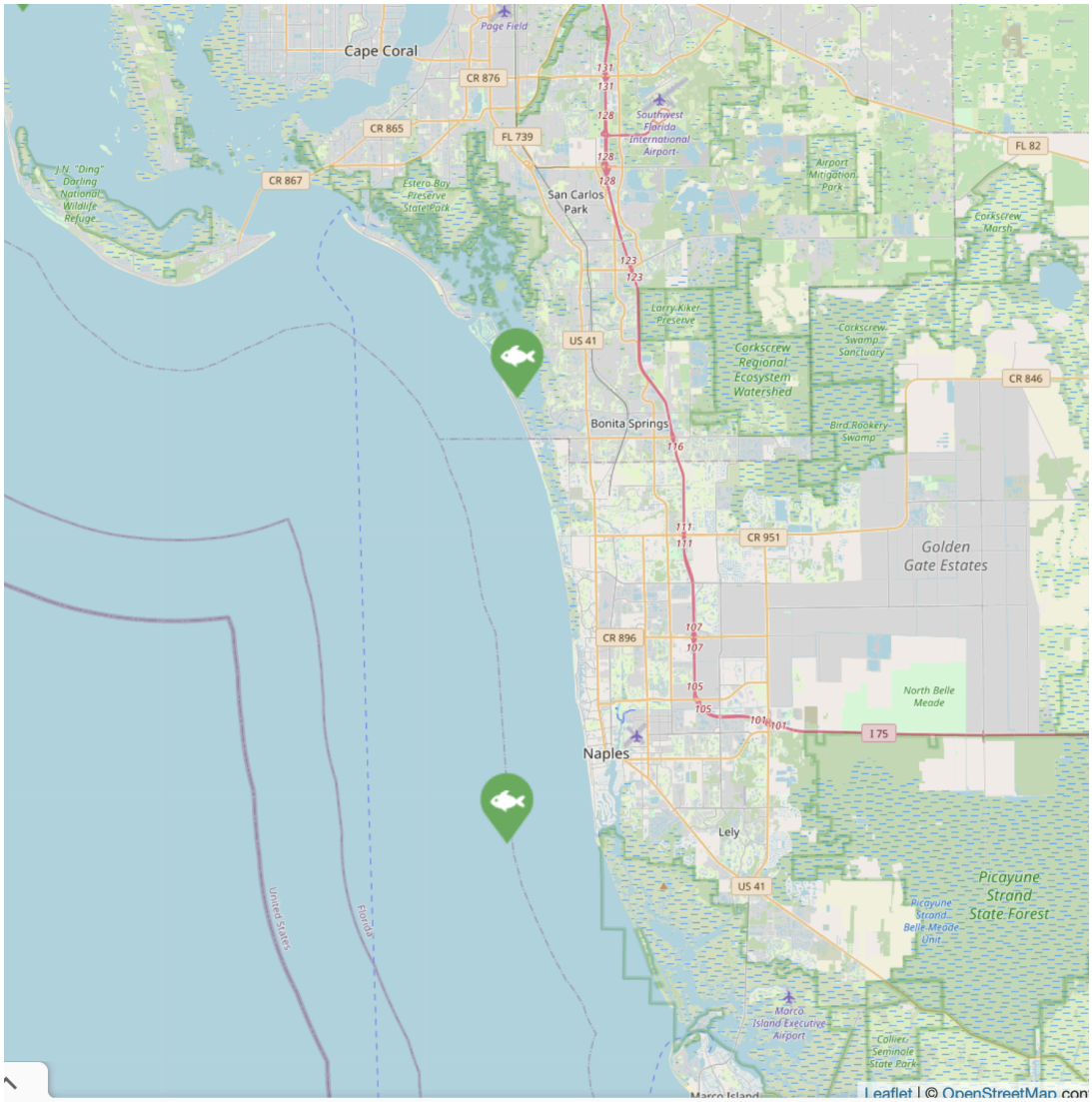


Figure 21: The hammerhead caught near the Hague Channel was caught 2017-03-01 at 13:01. The coordinates for this catch were 26.35360833, -81.85279444 (FisherMap 2017). The second hammerhead catch on this image was caught in 2017-02-23 on the border of Collier County. The coordinate for this catch was 26.08700485, -81.859598175 (FisherMap 2017).

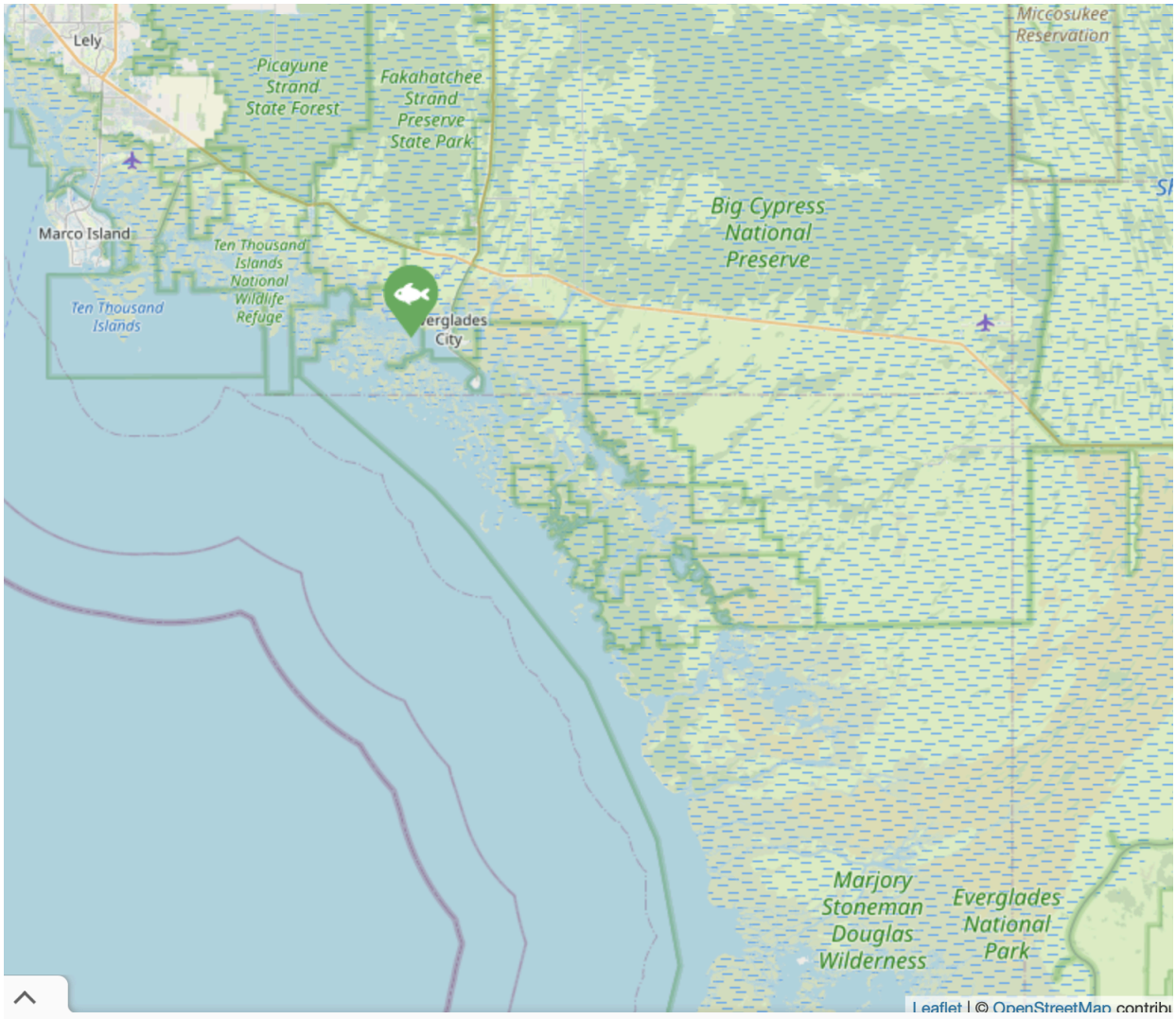


Figure 22: This hammerhead was documented at 2016-04-05 at 8:34am. The coordinate for this catch was 25.84879444, -81.41889444 (FisherMap 2016).

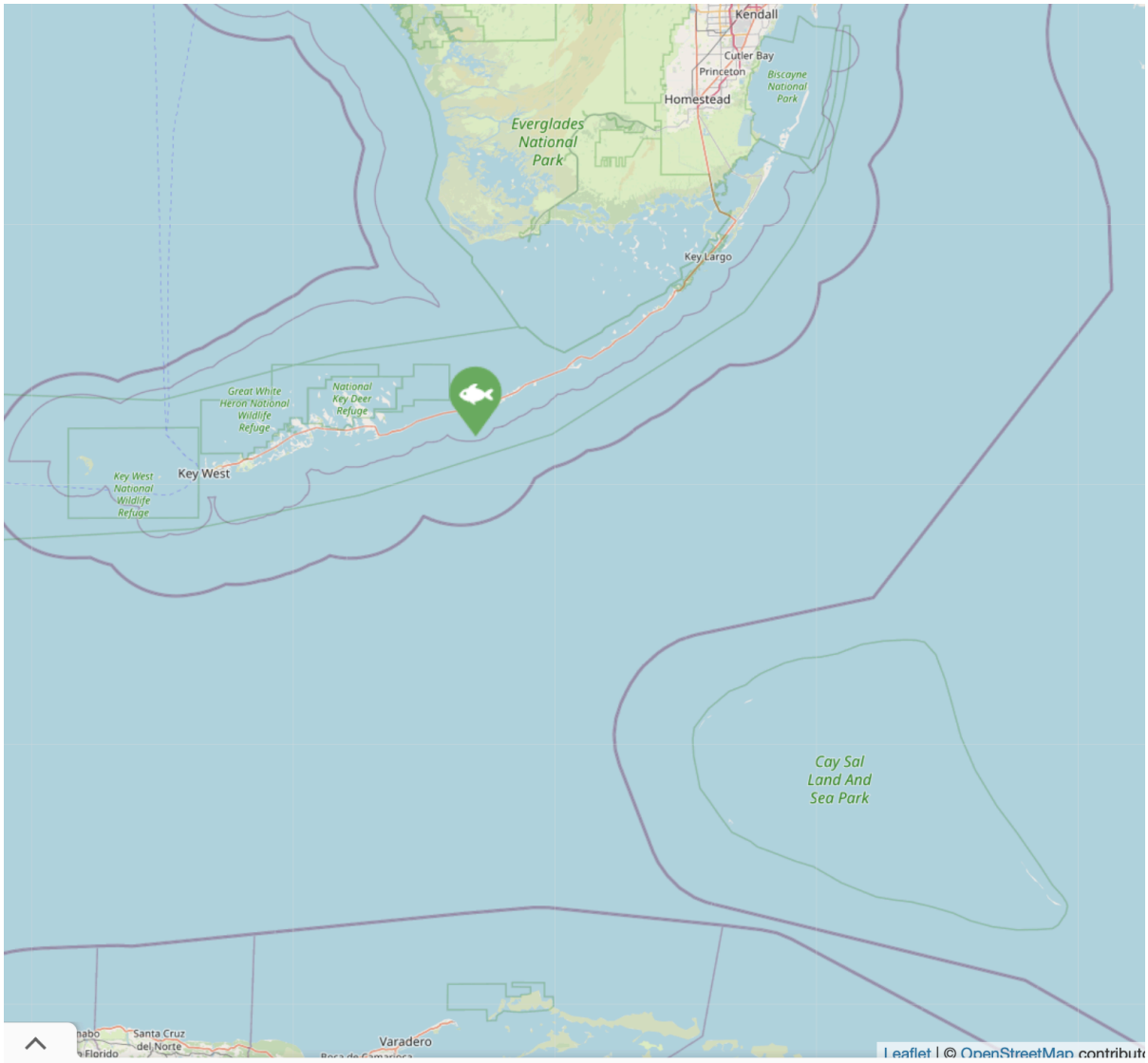


Figure 23: The caught date for this hammerhead was 2017-07-26 and the coordinates were 24.64327258, -81.0736084 (FisherMap 2017).

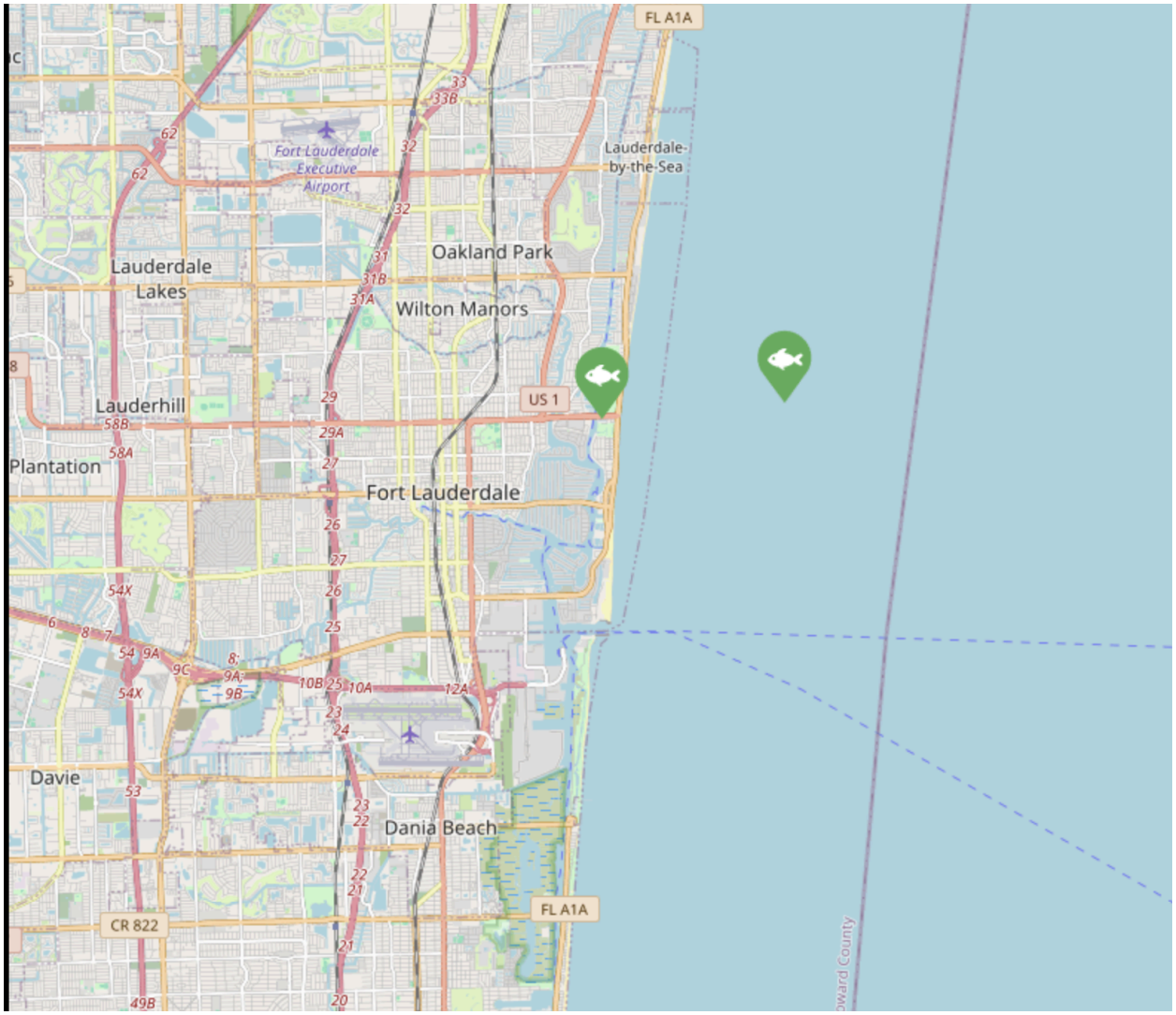


Figure 24: The first hammerhead that was caught in 2012-04-27 was near the bay. The coordinate for this catch was 26.137275, -80.1064 (FisherMap 2021) The second hammerhead that was caught was 2013-08-09 and the coordinates were 26.14066667, -80.06416667 (FisherMap 2013).

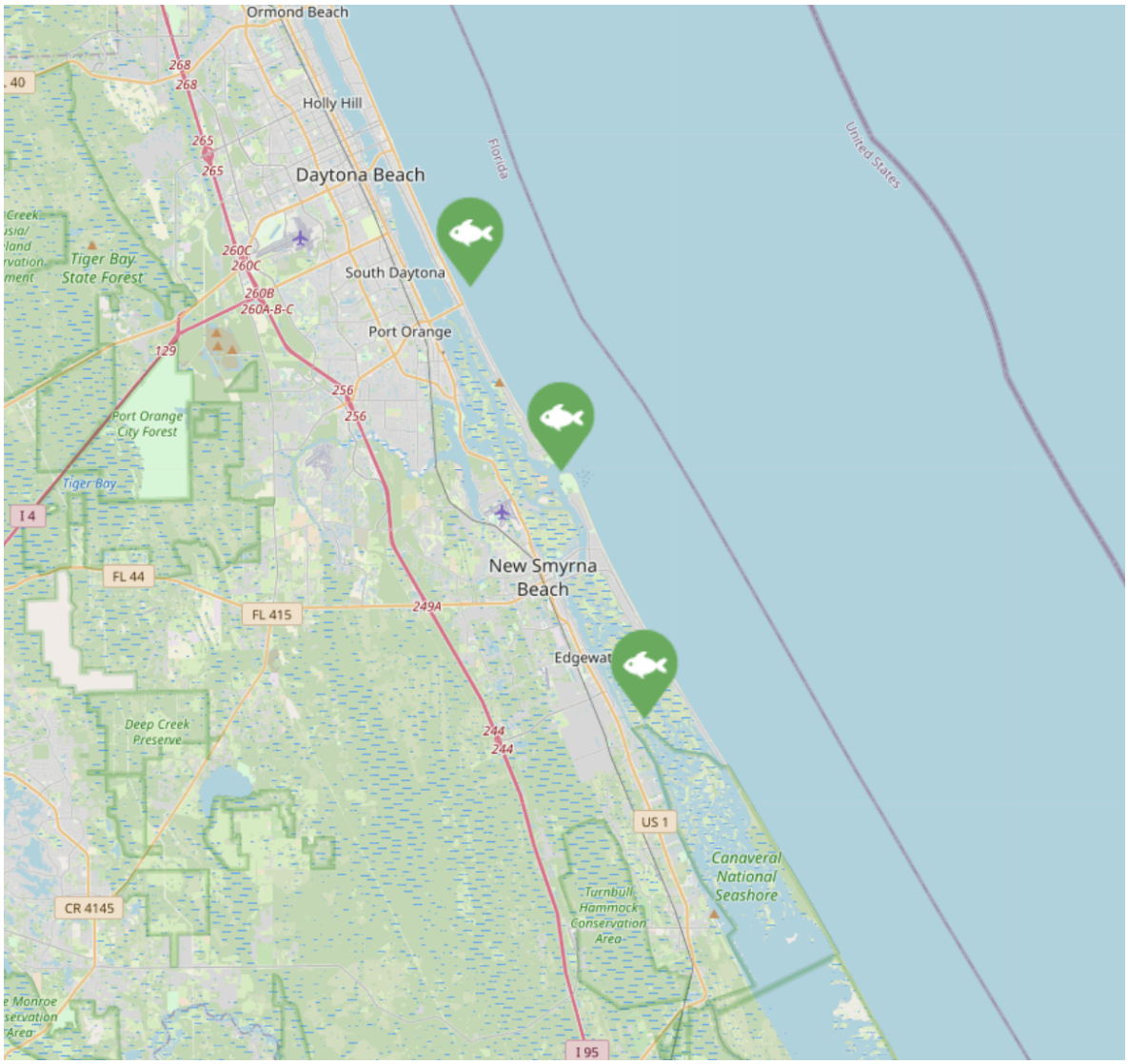


Figure 25: Caught dates: The hammerhead caught by Daytona Beach was caught 2020-01-28 and the coordinates were 29.1584576, -80.96477509 (FisherMap 2020). The hammerhead caught by Smyrna Dunes Park was caught 2015-04-08 at 13:13. The coordinates for this catch was 29.073625, -80.917825 (FisherMap 2015). Last hammerhead caught was near Edgewater and that was on 2018-09-21 at 10:17am. The coordinates for this catch are 28.95908333, -80.87406111 (FisherMap 2018).

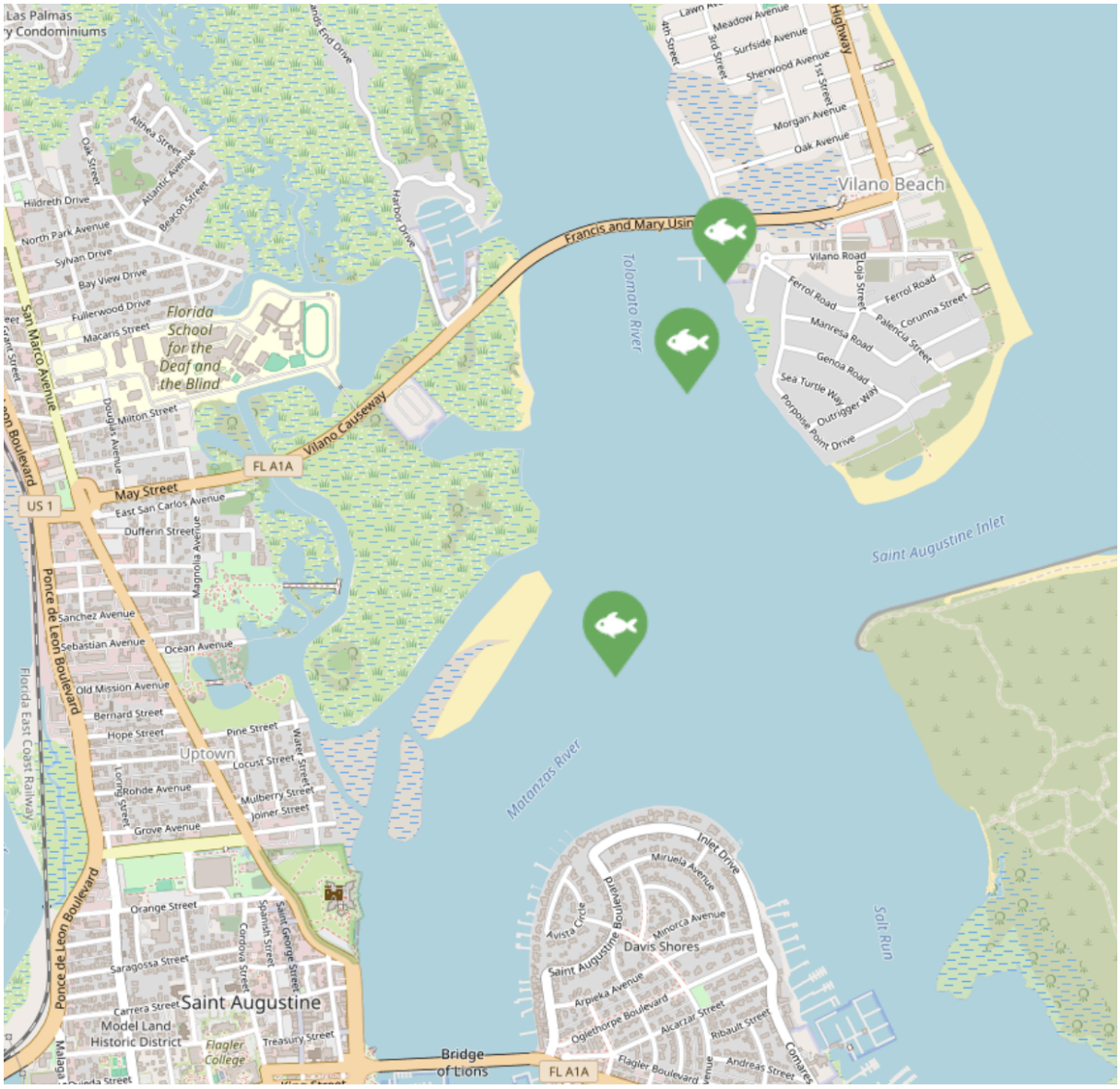


Figure 26: The hammerhead caught by the Vilano Beach Pier was caught on 2017-07-24. The coordinates for this catch was 29.91588976, -81.29842043 (FisherMap 2017). The hammerhead in the middle of the image was caught in 2017-07-26. The coordinates for this catch was 29.9126117, -81.29972935 (FisherMap 2017). The third hammerhead was caught on 2017-08-08 and the coordinates were 29.90424169, -81.30217552 (FisherMap 2017).

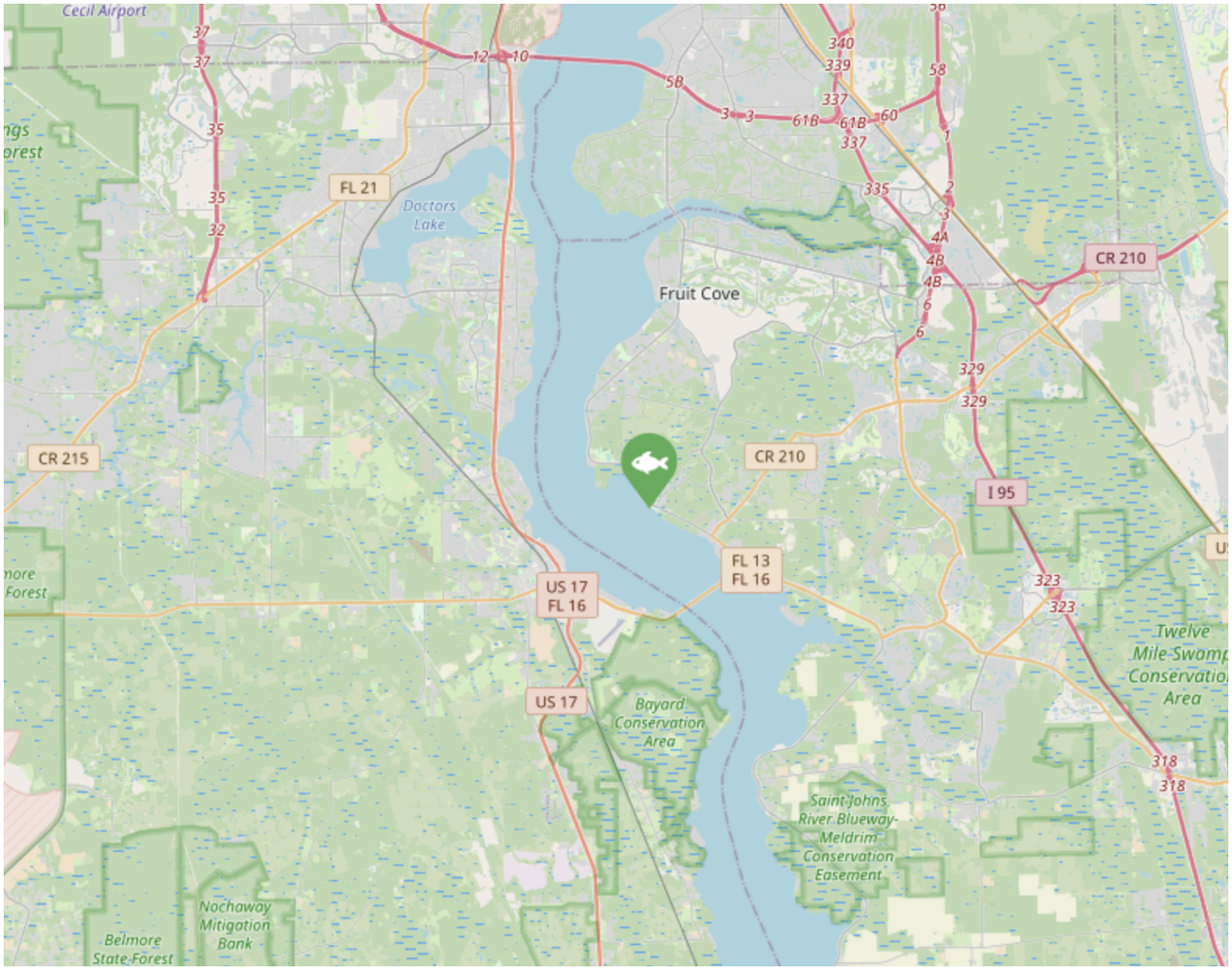


Figure 27: This hammerhead was caught on 2018-12-06 and its coordinates were 30.01855, -81.64018 (FisherMap 2018). Along with the hammerhead being caught so was a Crevalle Jack (*Caranx hippos*) and a Whiting Fish (*Merlangius merlangus*).

Future Marine Protected Areas Consideration

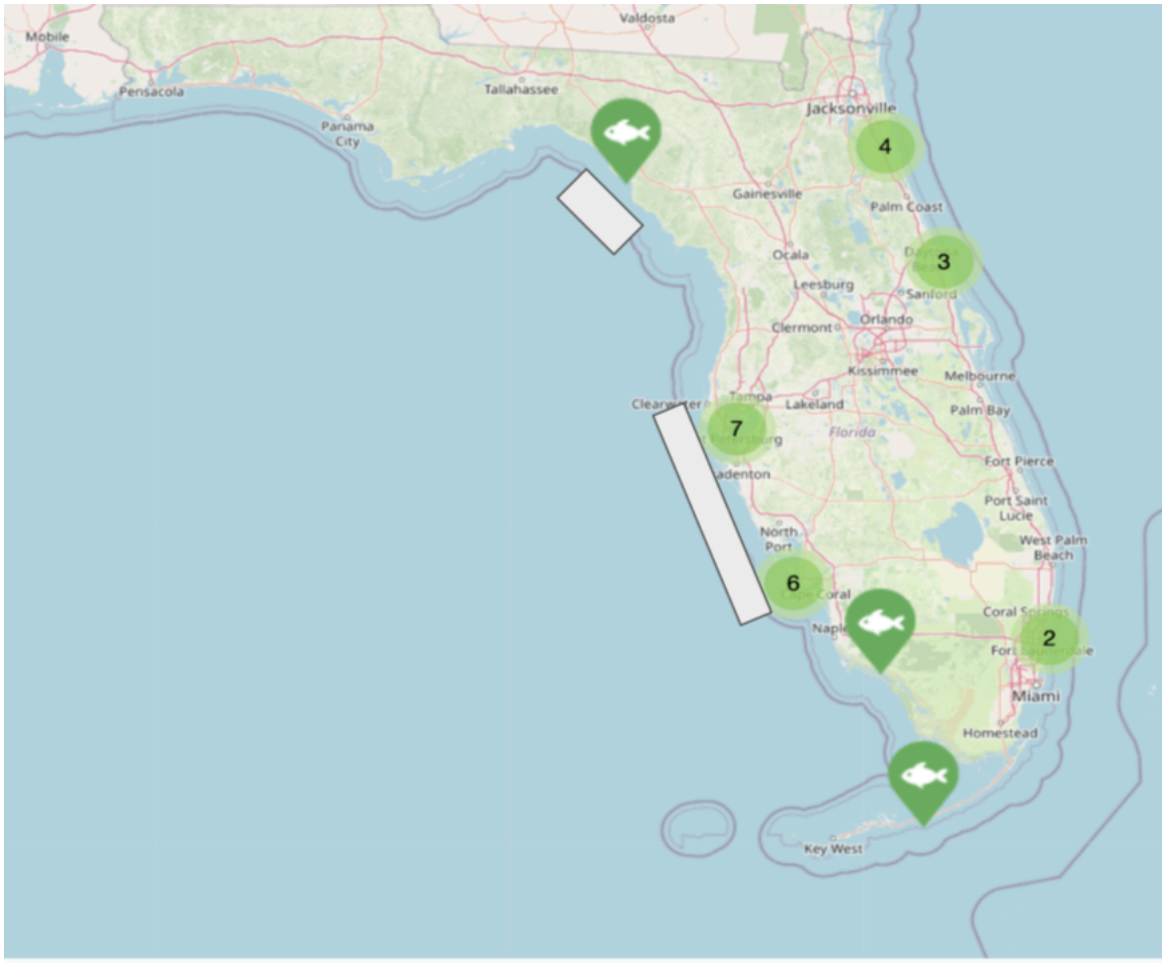


Figure 28: This image shows where there have been documented hammerhead catches. The white boxes represent where the state of Florida should implement marine protected areas for the safety of the four species of hammerhead sharks (FisherMap 2020).

It can be seen that hammerheads are being caught closer as well as spending more time near shore. However, the four species of hammerheads may be utilizing some of the four main marine protected areas in the state of Florida. The two main marine protected areas that these hammerheads could be utilizing is South Atlantic Deep Sea Coral Habitat Area of Concern and Oculina Habitat Area of Particular Concern. Most of the catches occurred in those areas (Figure 12 and 1). These protected areas protect coral habitats that the four species of hammerheads reside in.

It can be seen that there are not any marine protected areas on the west side of Florida besides West Florida Shelf MPAs. However, those protected areas are a lot farther out than where

the catches were documented. A recommendation is to create marine protected areas closer to where the catches were (Figure 28). This area should be highly protected to only allow light extractive activities to minimize the impact. This is also important for the Big Bend Wildlife Management Area as a hammerhead was still caught there in 2020. This marine protected area can focus on protecting great and smooth hammerheads as they are the ones who are being caught the most in the state of Florida (Guiney 2021). The MPA would be broken into two sections similar to West Florida Shelf MPAs. The first one would be closer to Big Bend Wildlife Management Area. As it's already a wildlife management area there should be protection to the area but by implementing a MPA there could be stricter enforcement. The marine protected area can protect hammerheads as well as other species that may be in harm due to human activities. It can also ensure that there is no commercial and recreational fishing in that area. Similarly to the first MPA recommended there will also be a bigger one near Tampa down to Naples. This will be bigger due to more human activities with fishing. There were a lot more catches in those areas as well. Same as the first one, the MPA implemented would enforce stricter regulations with fishing and protect species and their habitats.

Another recommendation would be to reevaluate the South Atlantic Deep Sea Coral Habitat Area of Concern and Oculina Habitat Area of Particular Concern. By reevaluating the level that the MPA the government can see how beneficial these areas have been. By making these two marine protected areas highly protected the government is ensuring that there will be no destructive activities occurring. This will protect the hammerheads as well as the coral reefs and other species that rely on these protected areas as shelter. Due to the hammerheads being caught closer to shore it would be harder to create marine protected areas.

Laws and Regulations

Laws and regulations can also be implemented to protect the four species of hammerheads. Florida has already implemented a law indicating that if a person catches one of the four species of hammerhead they must release them. They are not allowed to keep, kill, or exchange. However, this is only a state law instead of federal laws. If it could be federal then there might be more progress in increasing populations (NOAA n.d.). By signing bills into law it erases loopholes. An example of a loophole is the FWC allows commercial fisherman to harvest great and smooth hammerheads in federal waters and bring them back to shore. By signing bills

into laws you can also strengthen penalties to make it harder for people to illegally fin and fish these sharks. If they do then they can be fined more easily (Guiney 2021).

There are 10 states and territories that follow the Shark Conservation Act. This act strengthens the US ban on shark finning. In 2018, commercial fishermen collected over 28,000 pounds of hammerhead sharks just in the Gulf of Mexico. Commercial fishermen can still export shark fins if they have a valid federal shark fishing permit in the state of Florida (Guiney 2021). There are three rules that are followed with the Shark Conservation Act to ensure the protection of hammerheads. First rule is international provision . This rule ties into the Moratorium Protection Act which helps with shark conservation beyond a national jurisdiction (NOAA n.d.). Second rule is the saving clause which is for individuals who are fishing commercially for smooth dogfish. The last rule is domestic provision. This rule makes sure that shark fisheries are managed sustainably. This allows the harmful practice of finning to be eliminated (NOAA n.d.).

Due to the hammerheads being caught closer to shore it would be harder to create marine protected areas due to recreational activities. Instead, Florida has to break the stigma that hammerheads are dangerous to humans. By doing this they can educate the public on how to save these sharks. Educating the public about how human activities impact sharks might reduce some activities that are harming these sharks such as fishing. If Florida's beaches have social media they can post when hammerheads are out and where they were last spotted. This can let the public know the sharks are out and not to go fishing. Along with posting that, they can post conservation companies that are protecting hammerheads. By doing this, people can donate money to help protect these sharks but also educate themselves more. If there are hammerhead nurseries the state can block them off and restrict human activities in that area.

Limitations and Future directions

There were some limitations with this project. One of the biggest issues was not knowing what exact species of hammerhead was caught. Knowing what hammerhead species was caught could have helped with the idea of creating regulations to protect said species. With the documented catches there were not any recent catches in 2023-2024. The most recent catch was in 2022 which makes it more difficult to know if any hammerheads have been caught in the last year. Another issue faced was not knowing if the hammerheads were exactly using any of the

main five marine protected areas. It was an educated guess and using information from what habitats they live in and where the recent catches were to see if they aligned.

For future direction, using GIS would be beneficial to help organize the data and have a more accurate imaging to see if the hammerhead catches overlapped with the marine protected areas. Using GIS would also give a better accurate recommended MPAs.

Conclusion

Hammerhead sharks are a species of conservation concern as their population is drastically declining to extinction. Hammerheads are extremely important to the ecosystem as they keep the species diversity balanced as they are apex predators. The four species of hammerheads in the state of Florida are declining due to human activities such as overfishing and shark finning. With hammerheads high mortality rates, catch and release is also dangerous for them as they typically die right afterwards. There needs to be protection for hammerheads such as marine protected areas, management plans, laws and regulations, and fishing management plans.

There are five major marine protected areas in the state of Florida however there are approximately forty one in total. Majority of these marine protected areas here protect Florida's Coral Reefs, prevent and reduce overfishing for species that have economic importance, and in some cases to prevent water pollution (Bates 2022). Marine protected areas are important to our oceans for multiple reasons. They provide habitat and shelter for species that are endangered and threatened from human activities. MPAs also limit human activities such as bottom trawling fishing.

It can be seen that there should be new management plans, laws and regulations, and stricter marine protected areas for not only the well being of hammerheads but also for other species. There are different loopholes in the state of Florida that fishermen are using to continue shark finning for their own economic value. By signing a bill into a law for shark finning you are destroying any loopholes as well as eliminating illegal shark fin smuggling (Guiney 2021). This is important for Florida to do because the hammerhead populations continue to decline which unbalances the ecosystem.

Changes need to be made to protect these hammerheads. Marine protected areas are important for the future. They are protecting hammerheads and other marine species that may be

declining, threatened, or endangered from going extinct. By protecting MPAs, society is also helping to protect habitats that are crucial to the species. Hammerheads are vital to the ocean's ecosystem and need as much protection as possible.

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