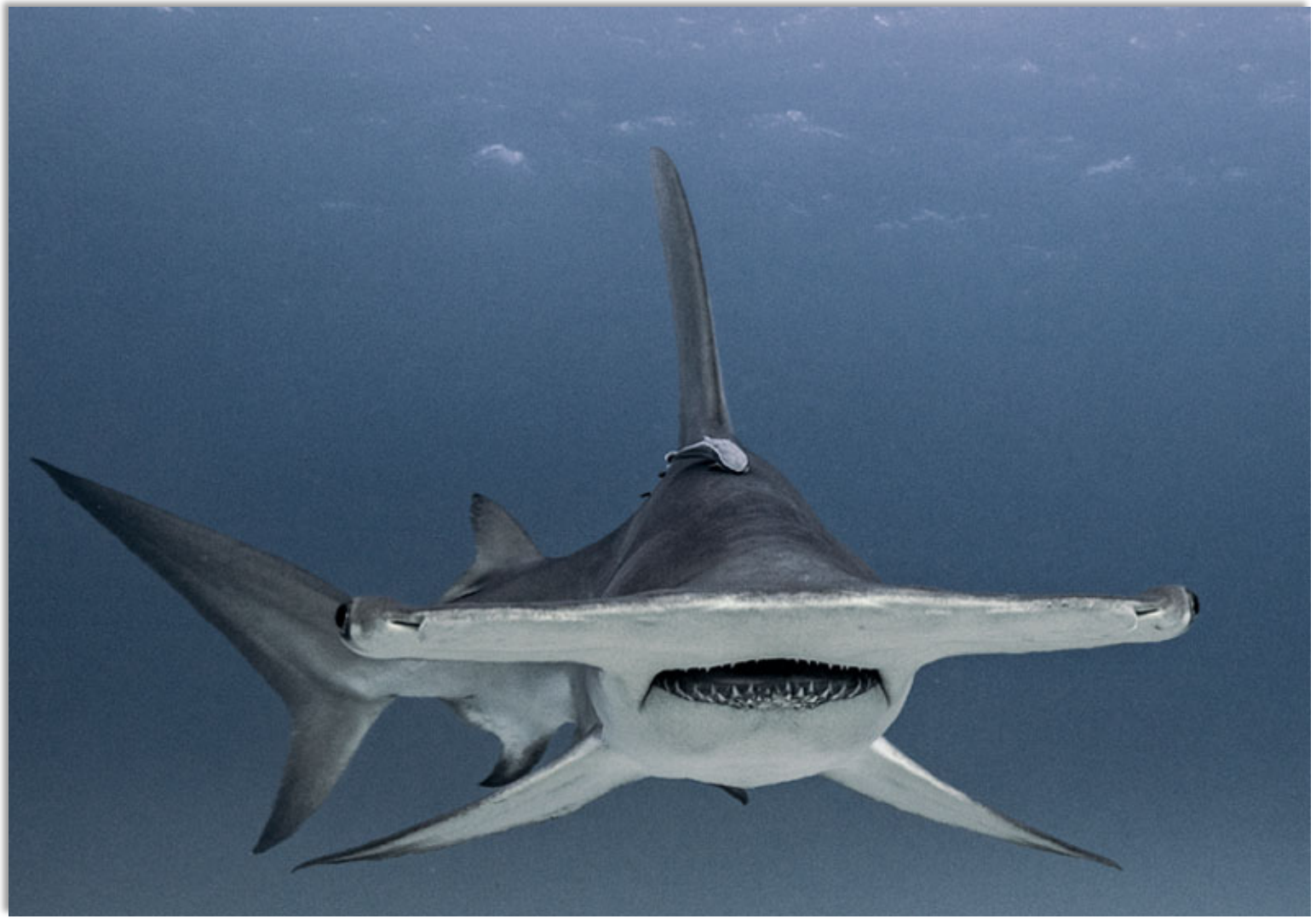
GREAT HAMMERHEAD SHARK VALUATION

21 June 2022

The Bahamas

Table of Contents



This report has been prepared by Endangered Wildlife OÜ on behalf of Shark Allies to assess the value of the great hammerhead shark population around the Bahamas. Endangered Wildlife OÜ and Shark Allies would like to thank Dr Tristan Guttridge for his expert advice in preparing this report and ElasmOcean e.V. for their financial support.

Global Great Hammerhead Shark Overview

The great hammerhead shark (*Sphyrna mokarran*) is the largest of the *Sphyrnidae* family. They are both coastal-pelagic and semi-oceanic sharks that have been found worldwide inhabiting tropical seas.

Their cephalofoil and disproportionately large, sickle-shaped dorsal fin are their iconic, distinctly identifiable features. The cephalofoil has adapted to allow them to become specialist stingray hunters, whereby their hammer shaped head allows them to find buried stingrays through electroreception.

Unfortunately the population size of these unique sharks has declined significantly. According to the Mokarran Protection Society, the population has collapsed more than 80% in 70 years, resulting in the IUCN in 2019 declaring the species as Critically Endangered.

According to the IUCN, the main reason for the global population declines is that the great hammerhead shark is caught both as a target and as bycatch in commercial and small-scale pelagic longline, purse seine, and gillnet fisheries. It is also often caught in coastal longlines, gillnets, trammel nets and sometimes trawls. Those that are caught are often kept for their fins. Fins from hammerhead species are one of the main fins sold in the fin trade and so a popular species for shark fin soup.

In addition to the fins, the hammerheads are used for meat, liver oil, skin, cartilage, and jaws.

Global Great Hammerhead Shark Threats

Threat	Stress	Scope	Impact score
Intentional use: subsistence / small scale / harvest	Species mortality	Majority (50-90%)	Medium Impact: 6
Intentional use: large scale / harvest	Species mortality	Majority (50-90%)	Medium Impact: 6
Unintentional effects: subsistence / small scale / harvest	Species mortality	Majority (50-90%)	Medium Impact: 6
Unintentional effects: large scale / harvest	Species mortality	Majority (50-90%)	Medium Impact: 6

Source: IUCN

While the practice of shark finning is illegal in many countries, it continues to pose a significant threat to the shark populations. This is driven by the monetary value of the fin industry, with the three hammerhead species representing 4% of Hong Kong shark fin imports in 2014.

To quantify this value, according to Shark Alliance the market value of a dried primary fin set can fetch up to USD 570/kg, with one bowl of shark fin soup costing in excess of USD 100/bowl.

To estimate the value of a set of great hammerhead shark fins, it is assumed that one shark has an average weight of 230kg. According to the EU, fins weigh up to 5% of body weight, which correlates to a study carried out by the National Fisheries Research and Development Institute who found the average fin to body weight ratio for the smooth hammerhead was 5.0% and the scalloped hammerhead was 5.4%. According to Biery and Pauly (2012), the average wet fin-to-body ratio specifically for the great hammerhead is 1.96%, implying that a set of ”wet” fins could weigh on average 4.5kg.

According to Biery and Pauly (2012), in order to convert from “wet” to “dry” fin mass, a ratio of 0.43 can be applied. This again corresponds with the National Fisheries Research and Development Institute research.

Based on these estimates, it would imply that an average set of “dry” great hammerhead fins weigh c.a. 1.9kg. At the rate of USD 570/kg of dried fin weight, it is estimated that one great hammerhead shark has a fin value at the end of the supply chain of around USD 1,105.

In order to try to combat the declining population, there are several laws in place both globally and locally. These include:

- Global: The great hammerhead shark was initially listed on the IUCN Redlist as Endangered (before being upgraded to Critically Endangered in 2019) and included as a CITES Appendix II species in 2014. In addition, due to the migratory nature of the sharks, they were added to Annex I of the UN Convention on the Conservation of Highly Migratory Species. This step was taken to encourage all participating countries to work towards the management of the shark.
- The Bahamas: The Bahamas have instituted a strong policy prohibiting the sale of sharks, shark parts or shark products. This extends to the Bahamas and the Exclusive Fishery Zone of the Bahamas.

While the laws may help to reduce targeted fishing, hammerheads are still caught as bycatch. Various Regional Fisheries Management Organisations have developed policies to manage hammerhead bycatch.

In 2011, ICCAT passed Recommendation 10-08 BYC. This recommendation states, among other conditions, that Contracting Parties, and Cooperating non-Contracting Parties, Entities or Fishing Entities (CPCs):

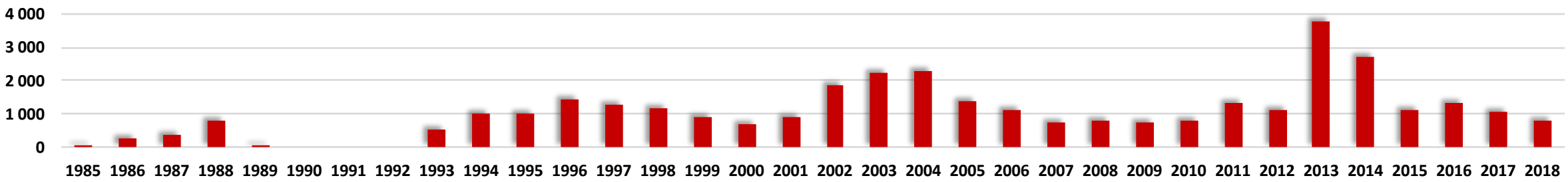
- "shall prohibit retaining onboard, transshipping, landing, storing, selling, or offering for sale any part or whole carcass of hammerhead sharks of the family *Sphyrnidae* (except for the *Sphyrna tiburo*)"; and
- "shall require vessels flying their flag, to promptly release unharmed, to the extent practicable, hammerhead sharks when brought alongside the vessel."

This was followed in 2018 with IATTC's Resolution C-16-05 that states that CPCs:

- "shall require purse-seine vessels flying their flag to follow safe release requirements for all sharks, except those retained aboard the vessel. Any shark (whether alive or dead) caught in the Convention Area that is not retained must be promptly released unharmed, to the extent practicable, as soon as it is seen in the net or on the deck, without compromising the safety of any persons."

The IATTC continues to prescribe a suggested shark release procedure. This includes either (1) releasing them directly from the brailer into the ocean, or (2) by using a ramp, escape hatches, a sling, a crane, a deck connecting to an opening on the side of the vessel or similar equipment to safely release the shark.

Cumulative observed and fisher reported bycatch of hammerhead sharks, within available Regional Fisheries Management Organisations



Source: BMIS, IATTC, ICCAT, IOTC, WCPFC

The Bahamas

According to the Professional Association of Diving Instructors, the Bahamas offer the second best site for hammerhead shark diving. It is also a popular location for diving with tiger sharks, bull sharks, reef sharks, and black-nose sharks.

The Bahamas is an ideal location for shark diving due to its proximity to the Gulf Stream. This means that the region provides warm, nutrient-rich waters that support marine life and mangrove nurseries.

In particular, Tiger Beach and Bimini are known for their shark diving experience, and is one of the few locations where hammerhead shark dives can be arranged. Shark species in the vicinity include tiger sharks, lemon sharks, and the great hammerhead shark. The clarity of the water makes it an ideal environment to experience a shark up close and personal.

Sharks are deemed protected in the Bahamas and play a vital role in supporting the local economy and, as an apex predator, maintaining a healthy local ecosystem. In 2011, the Bahamas declared 200 nautical miles from the Bahamian shoreline as a shark sanctuary. This meant that it became forbidden to commercially fish sharks, or to sell, trade or even possess sharks or shark parts.

The Bahamas have set the standard for shark conservation. An initial local study in 2011 determined the value of the Caribbean reef shark to tourism was USD 250,000 which was significantly greater than the USD 50 value for a dead reef shark's parts. This was supported by the fact that 43% of divers who visited the Bahamas wanted to dive with sharks (Haas *et al., 2017*).

In addition, many operators in the Bahamas feed the sharks during dives, which encourages resident behaviour. As such, the shark diving industry has flourished and shark tourism, according to Haas *et al. (2017),* generates over USD 100m annually for the Bahamas. This value may even be understated due to undeclared shark diving day trips coming across from Florida.

Shark bite incidences in the Bahamas are low, with 2018 recording only one non-fatal incident. This is considered to be a particularly low number when comparing this number with the number of people participating in aquatic recreational activities during the year.

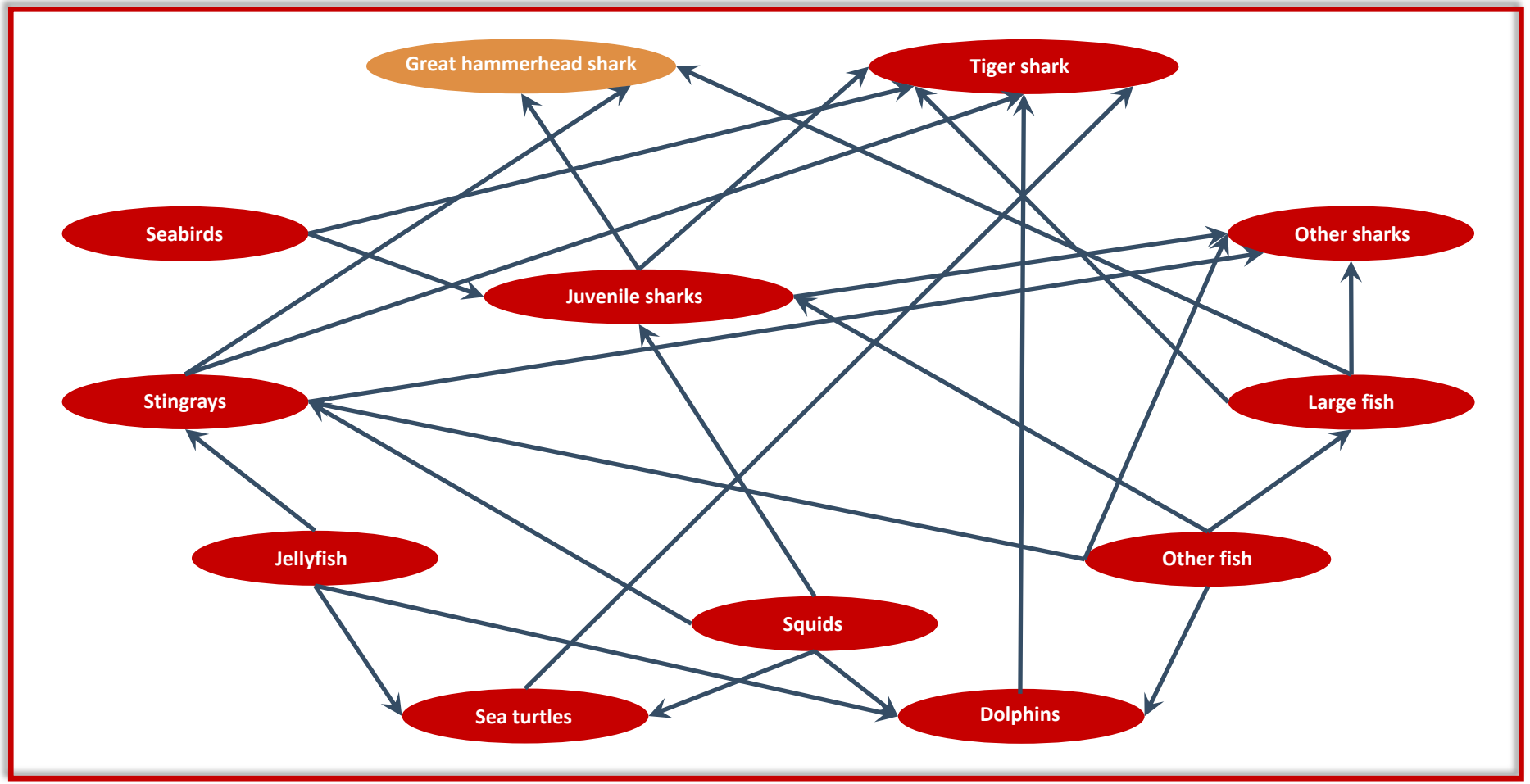
Despite the fact that shark bites are uncommon in the region, when one does occur (such as the 2019 fatality of an American snorkeler), it still receives worldwide media coverage.

The Bahamas

Source: Google Maps

Great Hammerhead Shark Valuation

The Bahamas great hammerhead shark population is valued against its aesthetic, economic, hedge and impact values. This valuation includes analysing the local food web interactions.



The Relationship Network depicted alongside represents the key local food web interactions for the great hammerhead shark in the waters around the Bahamas and other species that cohabit with the great hammerhead sharks.

This includes any predators, key prey and the other interactions present in the region. In terms of the other species that the sharks directly or indirectly interact with, these include competitors and other species that share the waters with the sharks.

The relationship matrix is vital to understand the importance of the great hammerhead shark relative to the other species. It was developed based on Oceana, Save Our Seas and three peer-reviewed scientific studies.

Great Hammerhead Shark Valuation Summary

Aesthetic Value: USD 0.5m

Aesthetic Value is the value created by biodiversity through the beauty and quality of life created by the species and environment. It is calculated as the maximum price a person is willing to pay to see the species, plus the price a person is willing to pay for a product related to the species on e-commerce platforms.
Source: Bimini Biological Field Station Foundation, Our Endangered World, Save Our Seas Foundation, Social media data processed through Endangered Wildlife OÜ's internal algorithms

Economic Value: USD 19.8m

Economic Value is defined as the value that is created by biodiversity through their contribution directly to the economy, taking into consideration up to 28 different economic sectors.

Source: Multiple company, entertainment, media and tourism websites, statistical departments, Endangered Wildlife OÜ's internal algorithms

Hedge Value: USD 3.7m

Hedge Value is a statistically-driven financial value that a stakeholder would be willing to pay to maintain a population between the Minimum Viable Population and the Carrying Capacity. It represents an "insurance" against exposure to changes in the population sizes.

Source: More than 10 peer reviewed scientific studies, Oceana, Save Our Seas Foundation, iNaturalist, Endangered Wildlife OÜ's internal algorithms based on the Black Scholes Pricing Model

Species Existence Value: USD 24.0m

Species Existence Value is the sum of (i) Aesthetic Value, (ii) Economic Value and (iii) Hedge Value. It is base economic value that the species generates and the equivalent opportunity cost to society if the species population were to decline or to become extinct.

Source: Endangered Wildlife OÜ's internal algorithms

Impact Value: USD 5.4m

Impact Value is the added value that is created by increasing the population sustainably through active conservation or species management taking into account management, ecosystem and exogenous factors.

Source: More than 10 peer reviewed scientific studies, Oceana, Save Our Seas Foundation, iNaturalist, Endangered Wildlife OÜ's internal algorithms

Total Conservation Value: USD 29.4m

Total Conservation Value is the sum of (i) Species Existence Value and (ii) Impact Value. It represents the total value created by the species population when it is sustainably and actively protected and managed.

Based on the 100 sharks that are regularly seen in the region, the implied average value per individual over 30 years is USD 293,743.

Source: Endangered Wildlife OÜ's internal algorithms

Note: The calculated values represent the values that the estimated Bahamian great hammerhead shark population contribute to society, the economy, and the environment over a 30-year period. The valuation period is defined as 30 years to represent the value created during one human generation and is standardised for the Endangered Wildlife OÜ valuation methodology so as to allow for comparability across species population groups.

Great Hammerhead Shark Population Modelling

One complexity when it comes to the valuation of the sharks in the Bahamas is the limited available survey data. In order to overcome this challenge, the shark's population trends were inferred using research-grade occurrence data.

This is a well established approach that can be used to extrapolate the population trends, provided that there are a sufficient number of records. It is a valid approach that has been adopted by researchers, including Kery *et al.* (2010), Isaac *et al.* (2014), Horns *et al.* (2018), Hertzog *et al.* (2021), and Boersch-Supan and Robinson (2021).

The ability to model the target species population is vital as it is one of the fundamental processes for valuing biodiversity. This requires an understanding of the local and generic population dynamics.

Based on Smukall in the Save Our Seas Foundation's 2019 annual report there are 30 individual great hammerhead sharks marked and tracked by the Bimini Biological Field Station Foundation using satellite and acoustic trackers. This can be considered the baseline population size and only official published number. However, according to communications with Dr Tristan Guttridge, there should be closer to 100 individuals.

While we use this as the source of reference, it is acknowledged that the population may be even larger, as some individuals may not have been surveyed.

The baseline model was built relative to multiple scientific studies, including:

- Gallagher and Klimley (2018): The authors provide insights into the diet, current distribution, qualitative population trends, and other data relative to the biology of the great hammerhead shark and the other hammerhead shark species.
- Harry *et al.* (2011): The paper reviews the life histories of the various hammerhead sharks in Australia, providing information about fertility, longevity, age at maturity and length at maturity.
- Piercy *et al.* (2010): This study reviews the life histories of the great hammerhead sharks specifically in the Caribbean and the Atlantic, focusing on their ages and growth. It provides estimates for longevity, age at maturity, body size, growth coefficients and other relevant data.
- Simpfendorfer *et al*. (2008): The authors present a method that was used to estimate the age-based mortality of great hammerhead sharks, which follows a modification proposed by Cortes (1999) of the Chen and Watanabe (1989) methodology.

Based on these core studies and other supporting papers, the baseline model structure includes the following attributes:

- The population is polygynous with a maturity age of nine years for females and eight years for males.
- All females are assumed to be able to produce offspring during their average 40-year lifespan.
- The sex ratio is set at 1:1.
- The average progeny number was considered to be 11 pups. There is some discrepancy in terms of the minimum number of progeny – the number varies between six and 15 pups depending on the author.
- Several authors have shown that great hammerhead sharks have a biannual cycle. This is reflected in the model by assuming that half of the females reproduce every year. This implies that, on average, the expected number of reproductive events during the course of the 30-year simulation is 15 or once every two years for each female of reproductive age.
- The mortality rates were calculated using the growth and aging estimates published by Piercy *et al*. (2010) and processed using the formula summarized by Simpfendorfer *et al*. (2008).
- It is calculated that the average mortality rate across all years is 17-19%, but mortality rates is one of the least studied aspects of the shark's life history.

- In addition, it is assumed that this is a closed population, with no removals, catastrophes, genetic options or additions. Removals and additions should ideally be considered due to the high level of bycatch and the evidence of philopatry and migration in hammerhead sharks. However, there is insufficient information about these rates or estimated number of individuals. As such, these factors cannot be reliably modeled for the species.

Baseline Scenario

The baseline scenario results in an increasing population dynamic, resulting in an increase in the number of individuals to 149. This scenario calculates a probability of extinction of 0.1%. This extinction probability is likely overestimated due to the initial population size used for the simulation being a minimum population size, which is likely to be lower than the actual population size.

Carrying Capacity Population

There are no estimates of carrying capacity for great hammerheads in the Bahamas. As there are no protocols to calculate the carrying capacity for this species, the carrying capacity was assumed to be 300 individuals – 3x the current estimated population size. This method of estimating carrying capacity is consistent with other research where carrying capacity is unknown.

In order to reach carrying capacity during the 30-year scenario analysis, the mortality rate for all ages needs to be reduced significantly to 10%. This reduction causes a large increase in the population size, resulting in an average total of individuals of 332, with a probability of extinction of 0.0%.

Minimum Viable Population

The minimum viable population size was estimated at 60 individuals.

A model using 60 individuals as the initial population showed a probability of extinction of 1% over 30 years. Under this scenario, the population size would reach 106 individuals in 30 years' time.

In order to simulate a crashed population, a scenario was run crashing the current population to 60 individuals. This was achieved by increasing the age-based mortality by 3% in the first year for both sexes, 8% for the females and 3% for the males in the second year, 3% for the females and 2% for the males in the third year of life, and 0.5% in the rest the life stages.

This scenario resulted in a mean number of individuals of 62, with a probability of extinction equal to 0.0%.

Conservation Scenario Population

This scenario assumed a small 2% reduction in mortality at all ages due to conservation efforts in the region. The reduction in the mortality rate resulted in an increase in the population size to 198 individuals, with a probability of extinction of 0.0%.

Final Considerations

The great hammerhead shark is an understudied species which requires more scientific research. For example, new studies on its life history and more accurate population survey results would allow the population modeling and valuation to be further refined.

Additionally, there is no survey clarity in terms of whether there is a greater number of juvenile individuals compared to adults. These factors would impact and alter the probability of population depletion.

Aesthetic Value

The Aesthetic Value for the great hammerhead shark population is calculated by summing the Willingness to Pay (WTP) with the Virtual Willingness to Pay (VWTP).

The WTP is defined by the consumer surplus per visit to a defined location, using social media as a proxy. This uses extracted geotagged data for the ocean around the Bahamas.

For each data point the home location of users is determined, based on the lowest possible administrative level. This allows for the calculation of actual direct travel cost to the target location, and the opportunity cost of travel. This data is used to run a truncated Poisson regression, which calculates the willingness to pay per individual visitor.

The value is calculated relative to the total number of visitors to the region and the weighted expressed interest in the great hammerhead shark population.

The great hammerhead shark is one of the sharks targeted by the diving industry in the Bahamas. There are specifically designed diving tours especially in February to allow tourists to experience these rare and unique sharks up close and personal. This allows the great hammerhead shark to be a premium diving target. They are a popular shark species and generally deemed harmless to humans. However, due to the population decline, they have become more rare even in the Bahamas which is known for its great hammerhead shark diving and the health and diverse range of shark populations.

Aesthetic Value	
Willingness to Pay (WTP)	USD 453,932
… Average WTP per individual	USD 802
… Number of great hammerhead shark-specific visitors	566
Virtual Willingness to Pay (VWTP)	n.a.
… Global VWTP	n.a.
… Local great hammerhead shark population size	n.a.
Total Aesthetic Value	**USD 453,932**
Source: Endangered Wildlife OÜ	

The VWTP reflects the role that social media plays in driving a global interest in the great hammerhead.

It is therefore calculated on the price a person is willing to pay online to purchase a great hammerhead shark-related product, including toys, books and DVDs. This is regardless of whether or not they are able to travel to see sharks.

This VWTP is based on the average price of products related to the sharks that are listed on e-commerce websites. In order to estimate the demand for these products, relevant influencers on major social media photo and video sharing platforms are identified, based on the number of followers.

It is assumed that, if these influencers promote great hammerhead sharks regularly, then they have the ability to influence their followers to purchase related products. Depending on the social platform, there are standard average click-through and conversion rates that can be applied to influencer-driven purchasing habits. As such, the e-commerce value is then calculated relative to the average price of products applied to the average number of daily posts per platform; and the average platform click-through and conversion rates. However, due to a lack of reliable global population data, it is not possible to calculate a local great hammerhead shark VWTP.

Economic Value

The shark's Economic Value comprises of two parts:

- Eight economic and investment categories; and
- The dependency of the Bahamas shark diving tourism relative to the size of the shark population.

The Economic Values are calculated using a unique, adapted version of a discounted cash flow valuation model. The dependency model is then based on a relationship statistical model that assesses the degree to which the value of entertainment relating to the Bahamas will be affected by a change in the probability of the target species population size.

In addition, the valuation also takes into account the local Bahamian economy, including interest and inflation rates. As a result, the value is influenced by the region.

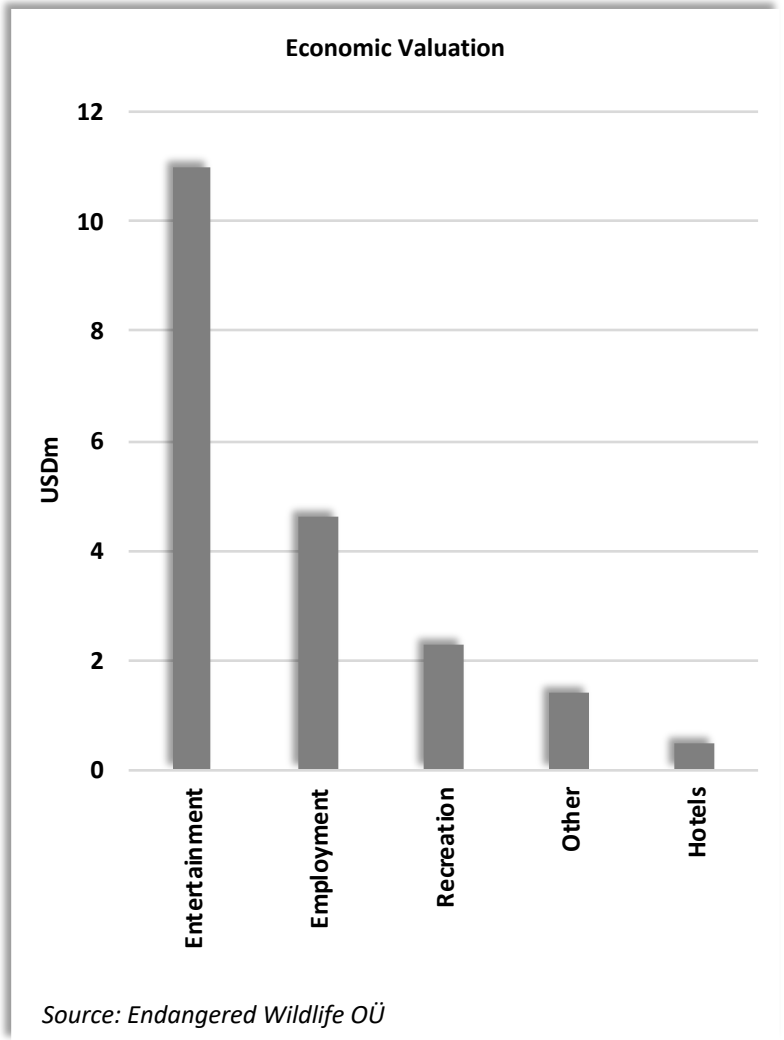
The greatest economic value that is generated by the great hammerhead shark population is currently the cumulative shark dive tourism-related value. In total, the estimated present value of tourism created by the sharks is USD 7.8m, including:

- Tourism employment: USD 4.6m
- Recreation income: USD 2.3m
- Hotel income: USD 0.5m
- Restaurant income: USD 0.4m

This is based on an initial forecasted 2022 estimate of c.a. 566 tourists who specifically travel to the Bahamas to dive with the great hammerhead shark. On average they stay five nights and these divers pay several thousand dollars to participate in shark dives, as well as towards accommodation, meals and transportation. The diving activities, which are recommended between October and May, also create jobs for the islands.

The sharks also directly and indirectly create value for the entertainment industry, specifically relating to the growing interest in the great hammerhead shark in events such as Shark Week. Over the last decade, there have been more episodes starring the great hammerhead shark in the Bahamas, with 10 airing over 2017-2022. Considering also other productions, this implies an average of at least 1.7 relevant episodes per year which, assuming the average Shark Week revenue per episode of USD 1.0m and budget per episode of USD 0.3m, equates to a total value of USD 11.0m.

The total economic value of the great hammerhead sharks in the region is calculated as the sum-of-the-parts, with a final value of USD 19.8m.



Source: Endangered Wildlife OÜ

Hedge Value

The Hedge Value follows the structure of a financial hedge and is calculated using a modified Black Scholes Pricing Model that is specifically adapted to form a specialised model for individual species of biodiversity. It represents an "insurance" against exposure to changes in the population sizes.

While this is a less traditional form of biodiversity valuation, it is an important value in that it is comparable to other biological asset valuations.

The Carrying Capacity (CC) and Minimum Viable Population (MVP) forecasts are based on 30-year population simulations. These two population levels are estimated using a Population Viability Analysis, which simulates population trends taking into account:

- Species-specific data;
- Population-specific data;
- Management data; and
- Probability of stochastic events.

The shark population is first valued relative to the probability of the population reaching CC. When a population crosses the CC threshold, there is a risk that the population becomes destructive and erodes value. The shark population is then valued relative to the probability of the population falling to the MVP. When a population falls below the MVP, there is a risk that the population may go extinct and therefore lose all value.

The final Hedge Value of the species is calculated as the difference in value between the MVP and CC values.

As previously described, it is estimated that the population's Carrying Capacity is 300 individuals, while the Minimum Viable Population is 60 individuals. The population models indicated that:

- There is a 43.4% probability that the current population will reach high population levels;
- There is a 60.8% probability that the Carrying Capacity Population will reach high population levels; and
- There is a 29.9% probability that the Minimum Viable Population will reach high population levels.

Based on current geopolitical and economic conditions, combined with the shark's population dynamics, the calculated hedge value for the great hammerhead shark is USD 3.7m.

Hedge Value	
Minimum Viable Population Value	USD 13,930,236
Carrying Capacity Value	USD 28,326,366
Hedge Value	**USD 3,743,397**
Source: Endangered Wildlife OÜ	

Species Existence Value

The Species Existence Value reflects the base value that the species generates and the equivalent opportunity cost to society if the species population were to decline or to become extinct. It is calculated by adding:

- Aesthetic Value
- Carbon Value
- Economic Value
- Hedge Value

In the case of the great hammerhead shark population in the Bahamas, it is currently possible to calculate the Aesthetic Value, Economic Value and Hedge Value. However, there is insufficient scientific research available to calculate a justifiable Carbon Value.

It is known for a fact that sharks in general play a role in the Blue Carbon ecosystem from two perspectives:

1. As apex predators, sharks help to control the herbivorous populations, which prevents them from overgrazing the seagrass meadows, and sharks exert indirect control over pelagic consumers. This is crucial as seagrass, phyto and zooplankton all play an vital role in carbon sequestration.

2. Approximately 10-15% of a shark's body is carbon. When a shark dies, this carbon is trapped within their bodies. Their carcasses act as a natural carbon sink and, if left in the ocean, they sink to the ocean floor and the carbon is ultimately sequestered into the sediment.

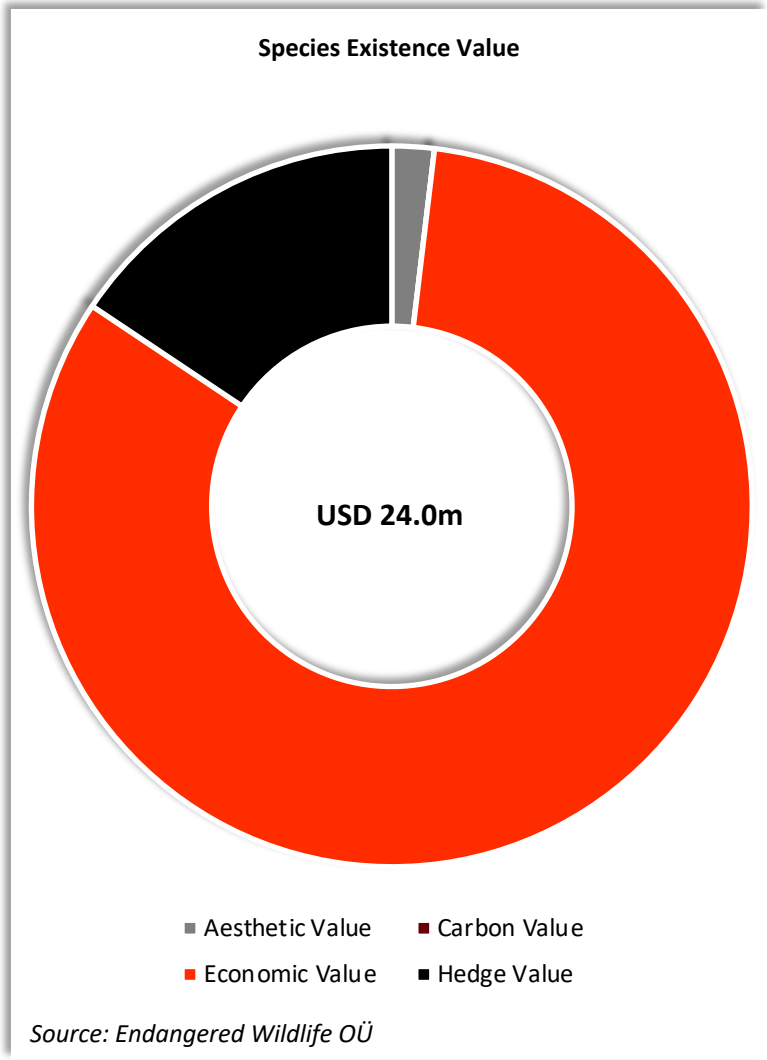
Unfortunately, though, sharks share a common prevailing carbon challenge. While it is understood that sharks contribute to solve the planet's carbon threat, there is a lack of scientific evidence that can justify their actual impact in terms of carbon value.

As a result, the Species Existence Value for the great hammerhead shark population in the Bahamas is calculated as the sum of:

- Aesthetic Value – USD 0.5m
- Economic Value – USD 19.8m
- Hedge Value – USD 3.7m

This results in a total baseline Species Existence Value of USD 24.0m, with the main contributing value being the Economic Value which accounts for c.a. 82.5% of the total value.

This baseline value is dependent on current conditions and is subject to change periodically if and when any underlying assumptions are revised.



Source: Endangered Wildlife OÜ

Impact and Total Conservation Value

The Impact Value is calculated using a combination of environmental statistics and pure statistics to calculate the value created through the active management of a target species. As such, it represents the respective relative change in the Species Existence Value.

More specifically, the Impact Value is calculated by running a Population Viability Analysis scenario based on the implementation of the conservation effort to support or increase the population of the shark over a 30-year forecast period.

This scenario is then integrated into a pure statistical network, which assesses the relationship between the probability of the future simulated shark population, relative to the probability of the populations of other species with which the sharks interact. These include:

- Other shark and stingrays
- Cetaceans
- Seabirds
- Fish
- Cnidaria
- Sea turtles

The large sharks in general are apex predators, and thereby help to balance and maintain the ecosystem.

Within the Bahamas, the sharks are protected and therefore there are few threats to the adult great hammerhead sharks in the region. The risk, though, is that sharks are migratory and could face threats outside of the protected Bahamian waters.

The analysis indicates that there is a 53,2% probability that, if the shark population continues to be protected over the next 30 years, it could reach a high population level. This can be interpreted as an Impact Value in monetary terms of USD 5.4m (a relative increase in value of 22.6%).

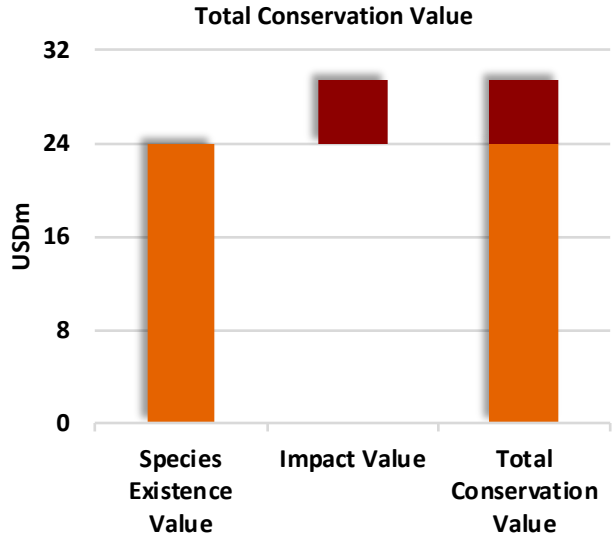
While the Species Existence Value alone urges for the need to ensure the longevity of the population, the calculated Impact Value justifies the active conservation of the Bahamas great hammerhead shark population.

By summing the Species Existence Value and the Impact Value, the region's calculated Total Conservation Value for the great hammerhead shark population is USD 29.4m.

This value is a minimum baseline value for the sharks present in the Bahamas. There is an upside potential to this value based on (1) improved shark monitoring and tagging, and (2) being able to quantify the understood carbon sink value of the sharks.

Impact Value	
Species Existence Value	USD 23,963,203
… Probability of high population	53.2%
Impact Value	**USD 5,411,046**

Source: Endangered Wildlife OÜ



Source: Endangered Wildlife OÜ

Conclusion

This report has been prepared so as to demonstrate the holistic value of the great hammerhead shark in the Bahamas. It clearly indicates that the shark is worth far more than the value generated through the sale of its body parts. The Bahamas population not only supports the local marine ecosystem, it also contributes to the Bahamas and US economies.

Tourism Value

The great hammerhead shark is a key contributor to the shark diving economy in the Bahamas. According to a study by Haas *et al.* in 2017, the authors demonstrated that the great hammerhead shark generated a global expenditure of USD 1.0m or 3.8% of total revenues generated by dedicated shark dive operators in the Bahamas. From a global perspective, this makes them the third most valuable diving shark in the Bahamas, and from a local level, they are the second most valuable species.

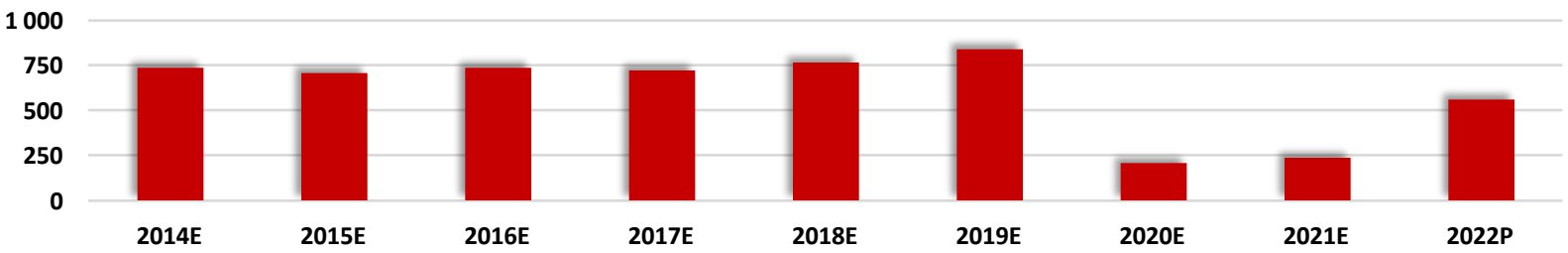
This is one of the main value-generating attributes of the great hammerhead shark in the Bahamas. The increasing rarity of these sharks, though, even in the protected area may impact the local economy especially considering the value it generates. This should further incentivise the protection of the sharks.

Revenues Generated by Dedicated Shark Dive Operators in the Bahamas

Species	National Expenditure	%	Global Expenditure	%
Caribbean reef shark	$16,223,802	93.7	$21,920,448	81.8
Great hammerhead shark	$638,070	3.7	$1,029,126	3.8
Tiger shark	$176,370	1.0	$3,289,608	12.3
Oceanic whitetip shark	$122,610	0.7	$371,718	1.4
Lemon shark	$74,262	0.4	$91,164	0.3
Nurse shark	$66,000	0.4	$80,250	0.3
Bull shark	$17,982	0.1	$23,754	0.1
Total	**$17,319,096**	**100.0**	**$26,806,068**	**100.0**

Source: Haas et al. (2017)

Estimated Annual Great Hammerhead Shark Divers



Source: Endangered Wildlife OÜ

Filming and Entertainment Popularity

As indicated in the report, there seems to be a shift in interest towards the great hammerhead shark, and the sharks in the Bahamas in general. Between 2017-2022, there were 10 Shark Week episodes alone showcasing great hammerhead sharks in the region.

Shark Week (SW) Episodes: 2017-2022

Name	Year	Episode
Great Hammerhead Invasion	2017	SW04
Shark School with Michael Phelps	2017	SW17
Cuba's Secret Shark Lair	2018	SW07
Guy Fieri's feeding Frenzy	2018	SW08
Sharkcam Stakeout	2018	SW13
Naked and Afraid of Sharks	2018	SW23
Monster Sharks of Andros Island	2021	SW17
Josh Gates Tonight: Not Feeling Salty	2021	Special SW0x25
The Great Hammerhead Stakeout	2021	Special SW0x28
Rise of the Monster Hammerheads	2022	TBC

Source: TheTVDB.com, Entertainment Weekly

This increased exposure is likely to drive more interest in the sharks for future filmmakers and divers to the area. The great hammerhead has also drawn attention at SharkFest, though these episodes tend to be on the American coastline rather than in the Bahamas.

Credit: Ubisoft – Hungry Shark Evolution

Added to this, the unique shape of the hammerhead has made it an ideal character in mobile gaming. While the value of gaming is not incorporated in the total value of the sharks, the hammerhead in *Hungry Sharks* and *Hungry Sharks Evolution* provides added amusement to the game. Even though the base character and the upgraded, evolved version of the hammerhead are not exactly true to form, it would appear that they receive popular attention.

Final Value for the Bahamas Population

As previously discussed, using average market prices, weights and conversion rates, the fin value of the great hammerhead shark is estimated at USD 1,105. There is also a market for the skulls. For example, a skull with a CITES permit to be sold has been available for sale for around USD 9,000. Each tooth sells in a range of USD 2 to USD 40.

However, based on the valuation described in this report, it is calculated that the baseline value of the great hammerhead shark population in the Bahamas waters is USD 29.4m. Approximately 18.4% of this value is generated from the environmental impact value of supporting a sustainable shark population in the region over the coming 30 years. Averaging the total value over the estimated population size of 100 individuals, the value per individual is USD 293,743. This is significantly higher than the estimated individual shark's fin, jaw or tooth values.

This significant discrepancy in value only stresses the need for why these unique sharks should be protected. They are at such a critical population level and should not be discarded merely due to the fact that they are a shark. They play a far more important economic and ecological role surviving and living within their natural habitat.

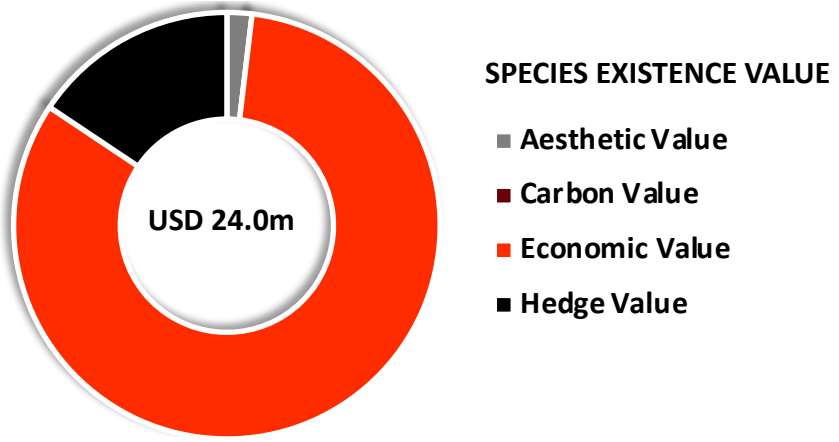
Great Hammerhead Shark

Shana Vida Gavron, Aristi Andrikou-Charitidou, Carlos Caceres & Kamal El Harty

Sphyrna mokarran

The Bahamas

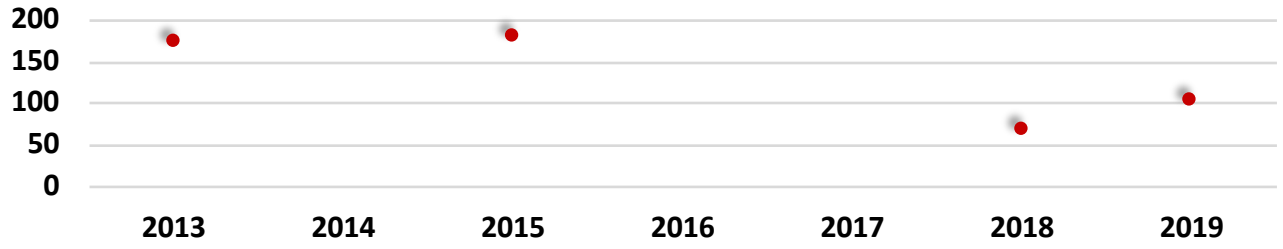
TOTAL CONSERVATION VALUE **USD 29,374,250**

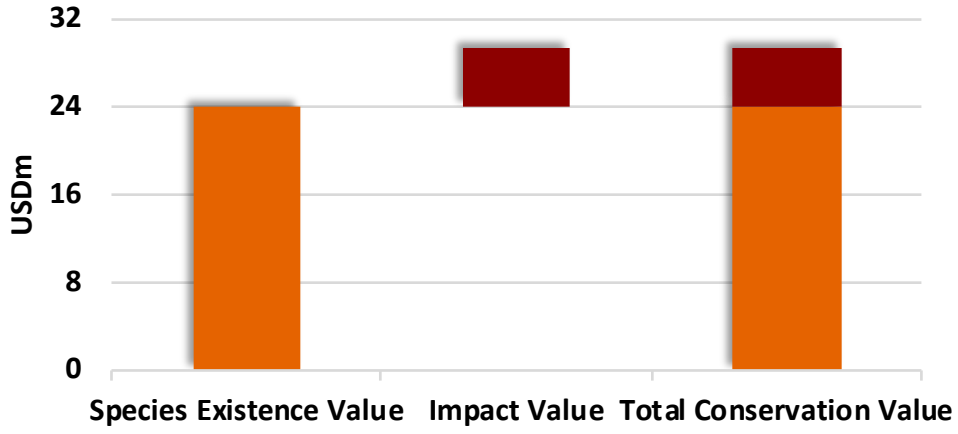


IUCN RED LIST RATINGS

NE	DD	LC	NT	VU	EN	CR	EW	EX

INFERRED POPULATION TREND





Glossary of Terms

Aesthetic Value is traditionally defined as the value created by biodiversity through the beauty and quality of life created by the species and environment. It is calculated as a willingness to pay, i.e. the maximum price a person is willing to pay to see the species, plus a virtual willingness to pay, i.e. the price a person is willing to pay for a product related to the species on e-commerce platforms.

Carbon Value is defined as the value of the CO_2e removed from the atmosphere by a particular species at the time of the valuation and the expected CO_2e to be removed in the future.

Economic Value is defined as the value that is created by biodiversity through their contribution directly to the economy, taking into consideration up to 28 different economic sectors.

Hedge Value is defined as the statistically-driven financial value that a stakeholder would be willing to pay to prevent the population from falling below the Minimum Viable Population or rising above the Carrying Capacity.

Species Existence Value is the sum of the four parts – the base economic value that the species generates and the equivalent opportunity cost to society if the species population were to decline or to become extinct.

Impact Value is the added value that is created by increasing the population sustainably through active conservation or species management taking into account management, ecosystem and exogenous factors.

Total Conservation Value is the sum of the Species Existence Value and the Impact Value, and represents the total value created by the species population when it is sustainably and actively protected and managed.

Credits & Disclaimer

Endangered Wildlife OÜ is the Estonian ESG tech for good behind the development of the Biodiversity Valuator, a software solution that uses machine learning to calculate the financial value of individual species of biodiversity in specific locations based on an internally developed biodiversity valuation methodology that combines pure finance with pure statistics, environmental statistics and environmental economics.

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