THE VALUE OF THE GLOBAL MARINE PROTECTED AREA NETWORK IN THE CONSERVATION OF MIGRATORY, ENDANGERED SHARKS

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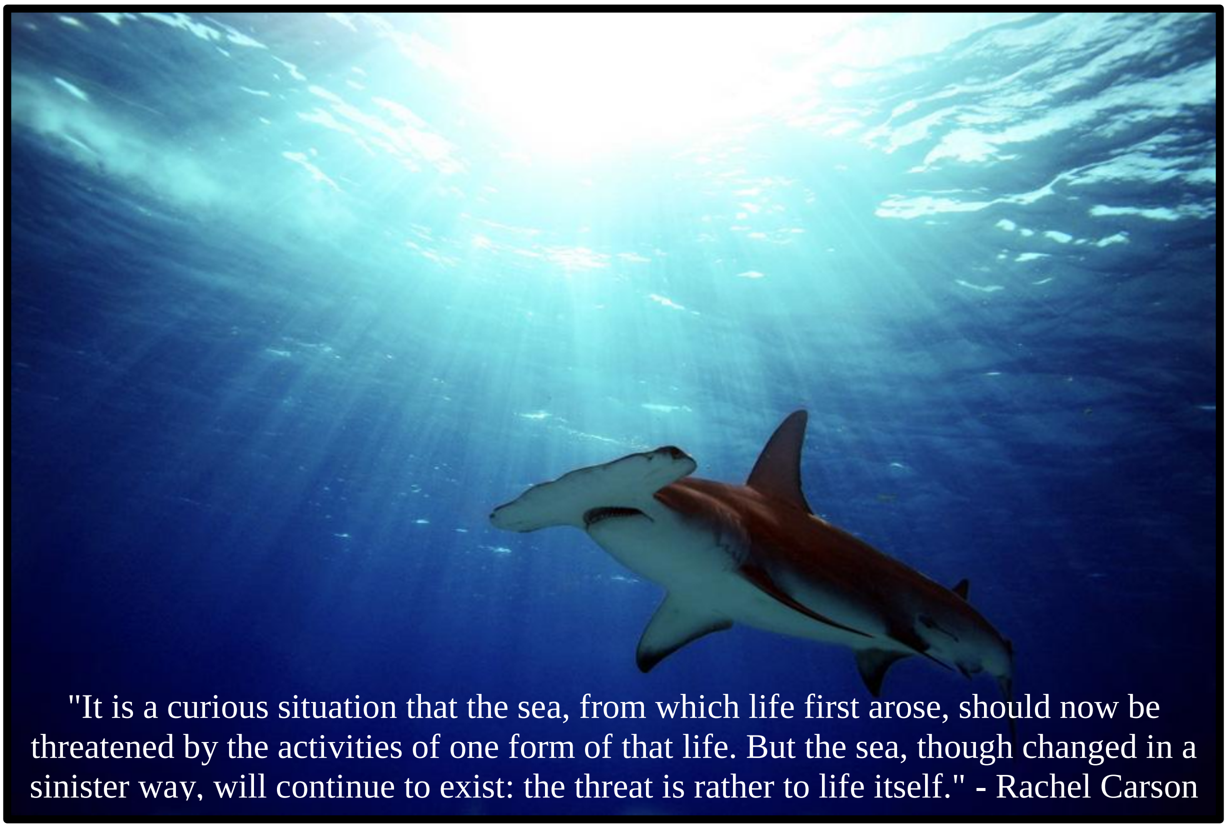

A thesis submitted in partial fulfilment of the requirements for the degree of Master of Science and the Diploma of Imperial College London

DECLARATION OF OWN WORK

I declare that this thesis

The Value of the Global Marine Protected Area Network in the Conservation of Migratory, Endangered Sharks

is entirely my own work and that where material could be construed as the work of others, it is fully cited and referenced, and/or with appropriate acknowledgement given.

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TABLE OF CONTENTS

List of Figures and Tables

Figures

Tables

LIST OF ACRONYMS

Acronym	Full Title
MAB	Man and the Biosphere
CBD	Convention on Biological Diversity
CITES	Convention on International Trade of Endangered Species of Wild Fauna and Flora
CMS	Convention on Migratory Species
CoP	Conference of the Parties
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organization
GBIF	Global Biodiversity Information Facility
GIS	Geographic Information System
GPS	Global Positioning System
GSDD	Global Shark Distribution Database
IUCN	International Union for Conservation of Nature
MOU	Memorandum of Understanding
MPA	Marine Protected Area
OBIS	Ocean Biogeographic Information System
QGIS	Quantum Geographic Information System
UD	Utilisation Distribution
UNESCO	United Nations Educational, Scientific and Cultural Organization
WDPA	World Database on Protected Areas
WHS	World Heritage Site

ABSTRACT

Global marine conservation continues to trail far behind terrestrial conservation. In spite of this failing, the global community continues to work towards the 2020 Convention on Biological Diversity (CBD) biodiversity targets. As a result, marine protected areas (MPAs) are increasingly being used to support the conservation of marine species and habitats. Current protection provided by the global network of MPAs includes 2.53% of the ocean, with global no-take coverage totalling 0.649%. The majority of ocean protection is provided by just 2% of all MPAs, and is unequally distributed across the globe. MPAs are also suggested for the conservation of highly endangered migratory species, such as sharks and whales. Using a subset of 10 shark species, MPAs provide coverage for less than 6% of the species' estimated distribution. Additionally, global species diversity patterns differ from observations within MPAs. A number of locations for future MPA development are recommended based on the Food and Agriculture Organization (FAO) catch data and migratory paths. Future work acquiring fine-scale data on sharks and other migratory species will help determine how increased understanding of species movements can be used for MPA development. Combined with continuing commitment to effectively utilising MPAs, this information can contribute significantly to conversation and biodiversity goals throughout the world's oceans.

WORD COUNT

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Imperial College London ZSL LIVING CONSERVATION UNEP WCMC UNIVERSITY of HAWAIʻI MĀNOA

CHAPTER 1: INTRODUCTION

1.1. OCEAN CONSERVATION

As ecosystems continue to degrade, it is imperative that researchers and policy makers develop successful methods for species and habitat protection. Although marine conservation lags behind terrestrial systems, marine protected areas (MPA) have emerged as a viable method for marine conservation. The creation of MPAs around the world is increasing (IUCN and UNEP-WCMC, 2012), despite corresponding collapses in marine resources as a result of multiple anthropogenic threats, including climate change and overharvesting (Fenberg et al., 2012).

In 2010 the Convention on Biological Diversity (CBD) set the protection goal:

> *by 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services.* (CBD, 2013)

Current MPA coverage is far from the 10% target, and it is unlikely that enough new MPAs will be created in time. Even with the impressive increase in protection over the past decade, MPAs still only protect 2.3% of the world's oceans (Spalding et al., 2013). Despite falling short of established goals, MPAs are an important conservation tool (Wood et al., 2008; Al-Abdulrazzak & Trombulak, 2012; Spalding et al., 2013) and should continue to be supported by the global community.

1.2. THE IMPORTANCE OF MARINE PROTECTED AREAS

MPAs have been defined multiple ways, each providing insight into the purpose of the area. Monteiro et al. (2010) identify two main reasons for the development of MPAs: the protection of biodiversity, and to strengthen fisheries management. MPAs established as fisheries and extraction management areas are not explicitly designed to safeguard biodiversity, although they help protect sensitive habitats and species from destructive practices, e.g. bottom trawling. Each MPA within a country's exclusive economic zone (EEZ) is under different legislative and regulatory policies outlined by that country. Therefore, 'standardising' MPAs with precise rules and regulations is impractical (Agardy et al., 2003).

Commercial fishing creates a serious impact for marine species and habitats (Barkin & DeSombre, 2013). Completely banning fishing within MPAs would ensure total protection, potentially resulting in no-take MPAs, although no-take MPAs also restrict other extractive practices, such as mining. No-take MPAs are the most identifiable measure of protection for marine biodiversity. While there have been previous global assessments of no-take coverage (Wood et al., 2008), it is incomplete. No-take MPAs are the only clear line in spatial protection, and collecting these data will support understanding the degree of complete ocean protection.

1.3. THE USE OF MPAS IN THE CONSERVATION OF MIGRATORY SPECIES

Effectiveness of MPAs in increasing biodiversity and biomass has been repeatedly illustrated through scientific research (e.g. Hoskins et al., 2011; Vanderpeere et al., 2011). Nevertheless, the usefulness of MPAs in migratory species conservation continues to be questioned (Kaplan et al., 2013). While properly placed protected areas can help guard migratory species (e.g. Guidetti et al., 2008), it is not clear how the existing MPA network overlaps with species migratory patterns.

Sharks are one of the most endangered taxa of fish, inhabiting a diversity of marine habitats and distributed circumglobally (Dulvy et al., 2008). An estimated three-quarter of sharks and rays are threatened by overfishing (Dulvy et al., 2008), and shark by-catch makes up a significant part of other targeted fisheries (Morgan 2010), exacerbating population declines.

Many shark species are pelagic, spending most of their time in the open ocean (Camhi et al., 2009), and exhibit migratory behaviour, swimming along continents and across oceans (Eckert & Stewart, 2001). The protection provided by MPAs for such widely distributed species is minimal, with only 2% of MPAs covering pelagic waters (Guidetti, Notarbartolo-Di-Sciara, & Agardy, 2013). However, pelagic MPAs as tools to assist in the conservation of migratory species have faced criticism (Game et al., 2009), as distances swam can be well beyond the appropriate size of an MPA.

To assess the coverage of MPAs for migratory species, a subset of sharks were selected. These sharks are listed on the Convention on Migratory Species (CMS) Memorandum of Understanding (MOU) on the Conservation of Migratory Sharks (CMS, 2006), and/or one of the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (CITES, 2013). The international community widely accepts these two conservation conventions, and the timing of this work is relevant: The 11th CMS Conference of the Parties (CoP) will take place in 2014, and CITES CoP16 concluded in March 2013.

1.4. AIMS

This project was aimed first at assessing the level of global no-take MPAs, while verifying, editing, and adding to the data in the World Database on Protected Areas (WDPA). This information will be available to researchers for future work using the WDPA. The second aim was to explore how the current network of MPAs overlaps with the distributions and movements of 10 relevant shark species. The white shark (*Carcharodon carcharis*) is used as a case study for exploring how fine-scale data on migration patterns can be used in identifying areas for future MPAs. In addition to data on shark distributions and movements, fishing effort and species richness was examined to identify priority areas for future MPA development.

This project documents the current level of MPA and no-take coverage, and begins to assess how endangered, migratory species overlap with MPAs. The exploration into how migratory species interact with MPAs will help extend information about the utility of the current MPA network for migratory species.

CHAPTER 2: BACKGROUND

2.1. MARINE PROTECTED AREAS

2.1.1. WHAT IS A MARINE PROTECTED AREA?

Marine conservation continues to trail behind terrestrial protected area planning (Agardy, 1994; De Santo, 2013), perhaps hampered by a historically inaccurate view that the ocean contains limitless resources. In truth, marine resources are declining, and it has become necessary to develop methods for successful marine conservation. MPAs are used in the suite of management tools for successful conservation of habitats and species (Wood et al., 2008). However, the development of successful MPAs remains difficult; the dynamic nature of the oceans increases the challenges of identifying appropriate areas, economically and scientifically, for protection (Agardy, 1994).

MPAs are defined several ways. A frequently used definition comes from the International Union for Conservation of Nature (IUCN):

> *A protected area is a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.* (Day et al., 2012)

Despite the universality of the IUCN, there is no agreement on what constitutes an MPA (Wood, 2011). Though there are sub-definitions for protected areas provided by the IUCN (Day et al., 2012), the overall definition is vague: it encompasses a variety of protection and management options, allowing for different interpretations of what qualifies as adequate protection without outlining key and measurable components (Wood 2011). As a result, each country and governing body may interpret the definition to best meet its particular needs. While this practice provides freedom and flexibility, it denies consistent security for species, habitats and ecosystems within MPAs.

In some countries, MPAs provide a significant amount of protection, while other countries maintain a fleet of ‘paper parks’ (Spalding et al., 2013). Paper parks are formally designated protected areas, but provide inadequate protection to the ecosystem, caused by deficient funding, support, and/or management (White, 2001). For example, the Galápagos Island Marine Reserve was designated in 1986, yet a management plan was not developed until 1992 (Roberts & Hawkins, 2000). It was not until 1998 that local participation was incorporated into the reserve management, with measures to improve the effectiveness being put in place only recently (Jones, 2013). Therefore, the protection provided by the Galápagos Marine reserve has varied throughout its existence (Jones, 2013).

Numerous studies provide evidence that conservation and economic goals can be accomplished through effective MPA design (Halpern, Lester & McLeod 2010; Pitchford, Codling & Psarra, 2007). MPAs can increase biomass and species density (Palumbi, 2004; Al-Abdulrazzak & Trombulak, 2012), and help prevent population crashes by buffering against uncertainty in the stochastic environment of the ocean (West et al., 2009). But, the objectives of the protected area must be clear in order to effectively assess its success (Agardy et al., 2003; Pomeroy et al., 2005).

2.2. Current Coverage of MPAs

All MPAs are established by national or international legislation, and respective governments are responsible for ensuring MPA goals are met (Day et al., 2012). Each MPA has a marine component, even if it is a minor part of the overall protected area, or not specifically designated as an MPA.

The world's oceans cover approximately 360,000,000 km^2 (71%) of the total surface area of Earth (Eakins & Sharman, 2010). In 2008, 2.35 million km^2 of the ocean was protected through MPAs (Edgar, 2011). More recent estimates cite 8.3 million km^2 of ocean as included in MPAs, equating to 2.3% of global ocean coverage (Spalding et al., 2013). Despite this 250% increase in protection, there has been little progress in coverage when compared to the current status of terrestrial conservation, which has 12% protection (Fox et al., 2012).

The 6 million-km^2 surge in coverage is helped by an international trend to develop 'mega marine reserves' covering thousands of kilometres (Pala, 2013). With the recent creation of MPAs such as Chagos (640,000 km^2), the Coral Sea (503,000 km^2), and the Cook Islands (1,000,000 km^2) (Pala, 2013), the largest 20 MPAs comprise 5 million km^2 of total marine protection (Spalding et al., 2013). Effort by some countries to increase MPA coverage is welcomed by the international community (Pala, 2013), but 111 countries have less than 1% of their EEZs protected (Spalding et al., 2013). Only 28 of the 193 CBD parties have met or exceeded the 10% target, with 11 countries having zero MPA coverage (Spalding et al., 2013).

2.2.1. *GLOBAL MPA DATABASE*

Much of the data on MPAs come through the World Database on Protected Areas (WDPA), managed by the World Conservation Monitoring Centre of the United Nations Environment Programme. Governments and managers submit data on the size, IUCN classification, no-take area, establishment date, etc., which is inputted into the most comprehensive existing dataset on protected areas (WDPA, 2013). The WDPA classifies protected areas as marine or terrestrial, and data can be downloaded and analysed for conservation and management.

2.3. LEVELS OF MPA PROTECTION

Within the global MPA network, the IUCN definition encompasses a range of MPA types, from those allowing multiple activities, to others with strict no-take prohibitions (Caveen et al., 2013). Because the current definition of an MPA encompasses this scope of protection, it is difficult to compare effectiveness across MPAs. Furthermore, it is challenging to acquire a thorough understanding of the extent of the ocean that is protected from any particular threat (Agardy et al., 2003).

2.3.1. *NO-TAKE MPAS*

In the spectrum of marine conservation, no-take MPAs have been utilised to address serious threats to marine ecosystems from other extractive activities (Thurstan et al., 2012). As with the overarching MPA definition, no-take MPAs have been defined multiple ways (i.e. Roberts & Hawkins, 2000), but their general aim is to, "…prohibit extractive or depositional activities and to maintain or recover the ecosystem(s) to a natural state in which marine life can thrive and natural processes dominate ecosystem dynamics" (Thurstan et al., 2012).

No-take MPAs are designed to provide full protection to oceanic communities (Lester et al., 2009): They are the clearest measure of spatial protection. Unlike other MPAs or fisheries management areas, no-take MPAs provide protection for all species that reside within their boundaries. Studies have shown that no-take MPAs support both fisheries management and biodiversity conservation goals (Claudet et al., 2010).

Less than 0.1% of oceans were categorized as no-take MPAs in 2008 (Edgar, 2011). This number is boosted by the few no-take mega-MPAs such as the Chagos Marine Reserve (formally designated as the British Indian Ocean Territory Marine Protected Area), with its 640,000 km^2 area designated as completely no-take (Sheppard et al., 2012). Mega-MPAs increase the proportion of ocean that is protected, but do not insure successful conservation (Pala, 2013). While mega-MPAs help meet global targets, distribution of the areas is uneven and unrepresentative on multiple scales, including in habitat protected and geographic location (Wood et al., 2008).

2.3.2. MPA Zoning

The zoning of MPAs into areas with different management strategies has been used as a way to improve management of large and complex ecosystems (Mangi & Austen, 2008). Utilisation of management zones allow for different activities to occur throughout a protected area (Al-Abdulrazzak & Trombulak, 2012). In a number of MPAs, one or more of the management zones have been designated as no-take. For example, the Macquarie Island Commonwealth Marine Reserve in Australia is divided into two zones. Of the Reserve's 162,000 km^2 area, approximately one-third is zoned as a 'sanctuary zone,' which is no-take and provides complete protection. The remaining area is classified as a 'habitat protection zone' partially limiting activities, but not as strict as the sanctuary zone (DSEWPC, 2013).

No-take zones are important for marine conservation, just as completely no-take MPAs. However the existence of zones complicates researchers' understanding of the success of the MPA as a whole (Al-Abdulrazzak & Trombulak, 2012). In order to fully grasp protection provided by no-take areas, it is important to include coverage provided by no-take zones alongside entirely no-take MPAs.

2.4. Challenges Associated with MPAs

2.4.1. Designation Efforts

The establishment of MPAs remains politically charged (Fox et al., 2012). In the development of an MPA, countries must balance international targets with national concerns, such as economic stability and human development (Mora & Sale, 2011).

During the MPA designation process, cooperation and involvement of dozens of stakeholders potentially affected by the MPA must be ensured (Stewart & Possingham 2005; Klein et al., 2008). Buy-in from stakeholders is essential to effective conservation (Stewart & Possingham, 2005). When creating no-take areas, which commonly restrict economic activities, it is critical to consider economically driven stakeholders, such as fishermen. These fishermen may continue fishing in a different area, resulting in displacement of fishing activity – an often-unexamined consequence of MPA development (Baum et al., 2003; Agardy, Di Sciara & Christie, 2011).

2.4.2. Enforcement

Numerous problems face the management of MPAs, influencing the success of the protected area. These problems include politics (Fox et al., 2012), economics (Balmford et al., 2004), and logistics (Fenberg et al., 2012). Enforcement is a significant problem that bridges all three issues.

Illegal fishing is one of reasons that MPAs fail to protect valuable species (Edgar, 2011). Attention to this issue has manifested in a number of highly publicized ways. In 2012, Greenpeace spotted two Sri Lankan fishing vessels in the Chagos Marine Reserve. Chagos is entirely no-take and any commercial fishing in the area is illegal (Greenpeace, 2012), calling into question the success of enforcement of the MPA. Illegal, unreported, and unregulated fishing commonly takes place in both no-take and multiple-use MPAs (De Santo, 2013).

Part of the reason illegal fishing, and other violations, occurs is the lack of resources available for enforcement and effective management (Gravestock, Roberts & Bailey, 2008). Effective enforcement is critical for a successful MPA (Fenberg et al., 2012), and is a result of a strong management plan coupled with the resources and capacity to fully implement that plan. As MPAs get larger, enforcement becomes more challenging (Monteiro, Vazquez & Long, 2009) – a problem that is now highlighted in the increasing number of mega-MPAs. Similarly, as MPAs move further away from the coastline, enforcement challenges increase (Monteiro, Vazquez and Long, 2009), a problem likely to be faced by offshore MPAs.

2.4.3. The Cost of MPAs

The cost to maintain the current network of MPAs is estimated at US$870 million per year (Cullis-Suzuki & Pauly, 2010). Assuming the ecosystem services provided by MPAs is evenly distributed, protection can be valued at approximately US$6 trillion per year (Costanza et al., 1997 adjusted for inflation). A country’s MPA coverage is positively correlated with its economic status (Marinesque, Kaplan & Rodwell, 2012). The top 27 advanced economies represent over 60% of the total MPA numbers, and 68% of total ocean area protected (Marinesque, Kaplan & Rodwell, 2012). Conversely, the 29 poorest economies make up only 3% of total MPAs (Marinesque, Kaplan & Rodwell, 2012).

Considering the cost of establishing new MPAs in essential. McCrea-Strub et al. (2011) showed that establishment cost, including the cost and time of planning, developing, and designating the MPA, could range between US$20,500 and US$38 million. This cost is positively correlated to size and time needed to establish the MPA. However, establishing larger MPAs require fewer resources per square-kilometre (McCrea-Strub et al., 2011), another potential driver in mega-MPA development.

A recent study estimated that the management cost would be US$500 million per year to create the level of protection required to meet the CBD target (Roman et al., 2009 cited in Dulvy, 2013). Although high, this cost is a fraction of most government budgets (Dulvy, 2013). Countries continue to create new MPAs without considering the need for continued resources for management and maintenance. This behaviour has resulted in a fleet of paper parks, providing little or no conservation benefits (Edgar, 2011). It is fair to ask if an unenforced, unsuccessful designated MPA is worse than having no MPA at all (Dulvy, 2013).

2.5. THE CONSERVATION OF SHARKS

2.5.1. CURRENT STATUS AND THREATS

Sharks are a circumglobal species group, distributed across all oceans and varied marine habitats (Dulvy et al., 2008). Despite their global distribution, sharks remain one of the most threatened taxonomic groups in the world (Knip, Heupel & Simpfendorfer, 2012). Sharks face population declines from numerous threats, including habitat destruction and overfishing (Knip, Heupel & Simpfendorfer, 2012; Morgan, 2010). Many shark species are hunted for meat, fins, and oil, while other species are commonly caught as by-catch (Morgan, 2010). An estimated 25% of total catch in tuna and swordfish long-line fisheries is made up of shark by-catch (Morgan, 2010).

The life histories of most shark species make them especially vulnerable to high levels of exploitation and by-catch. Species are slow growing, mature late, and experience low fecundity (Lucifora, Garcia & Worm, 2011). Of the over 500 species of rays and sharks assessed by the IUCN, 17% are considered Threatened, and 2% are Critically Endangered. Thirteen percent are Near Threatened, 23% Least Concern, and 47% of species are Data Deficient (Morgan, 2010).

An estimated three-quarter of pelagic sharks and rays are threatened by overfishing (Dulvy et al., 2008). Overexploitation of shark species has been partially driven by the economic value of many species, resulting in increased global shark catch (Camhi et al., 2009). The market for shark products has increased since the 1980s (Baum et al., 2003) as a result of demand, most prominently from Asia, for shark fin (Morgan, 2010). An assessment of the Hong Kong fin market estimated that 26-73 million sharks are killed annually, equating to 1.21–2.29 million tons of shark meat and by-products for trade (Morgan, 2010).

2.5.2. Shark Distributions

Sharks inhabit coastal regions and the open ocean, with common migrations along coasts and across oceans (Ferretti et al., 2010; Gore et al., 2008; Abascal et al., 2011). The migratory nature of sharks increases the difficulty of developing successful conservation plans for the species. Pelagic sharks are highly vulnerable to fishing pressures (Dulvy et al., 2008), and pelagic species are afforded little protection from the current network that is dominated by coastal MPAs (Game et al., 2009; Fox et al., 2012).

2.5.3. Pelagic MPAs

The majority of MPAs are concentrated in marine coastal environments (Hyrenbach, Forney & Dayton, 2000; Game et al., 2009; Fox et al., 2012), which represent 1% of the ocean (Game et al., 2009). Pelagic waters, areas beyond the continental shelf (Pelagic Zone, 2013), constitute the majority of the world's oceans, yet only 2% of global MPA coverage falls in the pelagic zone (Guidetti, Notarbartolo-Di-Sciara & Agardy, 2013). This leaves many pelagic species subject to external pressures. Developing a method for pelagic MPAs may be critical for effective protection for pelagic species.

One of the major criticisms of pelagic MPAs is that pelagic species have the potential to be highly migratory, covering thousands of kilometres (Game et al., 2009) – areas thought to be well beyond the reasonable limits of MPA size. Some mega-MPAs, like Chagos, cover the extent of the country's EEZ, 200nm from land. If a shark swam directly across such an MPA, the total distance would be approximately 800km. This is a fraction of what is seen in some shark species, such as white sharks that have been known to travel over 2,000 km across the Pacific Ocean (Weng et al., 2007).

In recent years a debate has been launched over the effectiveness of pelagic MPAs for migratory species conservation, and if it is responsible to create MPAs for species that may spend little time in their boundaries (Guidetti, Notarbartolo-Di-Sciara & Agardy, 2013) In the past, it was thought that MPAs were only successful in protecting sedentary species that stay within the protected area boundaries (Claudet et al., 2010). However, recent work has shown that pelagic species can also benefit (Knip, Heupel & Simpfendorfer, 2012), as they are subject to fewer stressors for the duration of their stay in the MPA, resulting in potentially increased fitness (Game et al., 2009).

Countries have not actively assisted in the protection of marine species, resources, and ecosystems on the high seas (areas beyond national jurisdiction and outside of a country's EEZ) (Ardron et al., 2008). Instead, nations are benefitting from the few regulations governing the high seas (Verity, Smetacek & Smayda, 2002; Sumaila et al., 2007; Claudet et al., 2010). In one of the classic cases of the tragedy of the commons (Hardin, 1968), ocean resources in the high seas have been, and continue to be, exploited. The high seas make up 64% of the ocean (WWF, 2013), resulting in additional barriers to MPA development and effectiveness in the majority of the ocean. Most pelagic waters fall within the high seas.

Some of the most vulnerable shark species travel across the high seas, for example the white shark, *Carcharodon carcharias*, and whale shark, *Rhincodon typus* (Camhi et al., 2009). The migratory nature of these species results in increased probability of being caught as by-catch or by targeted fisheries (Hyrenbach, Forney & Dayton, 2000; Dulvy et al., 2008; Morgan, 2010). In conjunction with the existing MPA network, pelagic MPAs may assist by linking vital areas together as species move in and out of protected areas (Guidetti, Notarbartolo-Di-Sciara & Agardy, 2013). Therefore, the establishment of a network of pelagic MPAs may be useful in species conservation.

2.5.4. Migratory Sharks

The migrations of different shark species complicate traditional conservation efforts because they require greater understanding of the movement of individuals within a population (Hyrenbach, Forney & Dayton, 2000). Fortunately, technological advancements have allowed researchers to learn about the movement patterns of species through studies on tagged individuals (Hammerschlag, Gallagher & Lazarre, 2011). A study of tagged whale sharks showed the migratory potential of species by tracking an individual from the Sea of Cortez, Mexico, across the North Pacific Ocean beyond the Marshall Islands (Eckert & Stewart, 2001).

For some species, migration paths are highly predictable, but it would be challenging to protect an entire oceanic pathway (Hyrenbach, Forney & Dayton, 2000). Advancements in knowledge and understanding of populations and movement patterns will continue to help researchers identify areas that may be suitable for future MPAs. Despite the potential benefits of MPAs for migratory species, it is still necessary to understand any negative stressors that occur outside of an MPA, and mitigate them accordingly (Hyrenbach, Forney & Dayton, 2000).

CHAPTER 3: METHODS

3.1. GATHERING NO-TAKE MPA DATA

To gather data on the status of no-take areas within existing MPAs, the WDPA was used. WDPA data include the total reported area, marine area, and no-take area when appropriate. Each MPA also has a no-take status: all no-take, part no-take, no no-take, or not reported. Data on the MPAs in the WDPA were downloaded on April 26, 2013 from their website (www.protectedplanet.net). To ensure initial confidence with the data, the ten largest entirely no-take MPAs were examined. Nine out of the ten were correct, and one was incorrect (Malpelo Fauna and Flora Sanctuary) because of conflicting size information between the WDPA and what was found through the search. A further check was conducted on the ten largest MPAs that were categorized as part no-take producing similar results.

The majority of MPAs in the WDPA were categorized as 'Not Reported' for no-take status. These MPAs were sorted largest to smallest by area, and were systematically assessed. A Google search (www.google.com) was used for each area, searching the name and designation type (i.e. National Park, Wildlife Sanctuary) of the MPA. When official websites were available, they were used as the primary source of information. Additionally, any accessible government-run website was searched. For Ramsar and United Nations Educational, Scientific and Cultural Organization (UNESCO) sites, the official websites for the organisations were reviewed. The ideal search resulted in a management plan, which was reviewed to gather information on the existence of no-take areas and verify MPA size. When a management plan was not in English, Google translate (www.translate.google.com) or a native speaker was used. Finally, Marine Protected Areas for Whales, Dolphins and Porpoises (Hoyt, 2011) was used to acquire information about no-take status and MPA size. If the pertinent information was not available upon first search, additional search terms were added, such as management plan, no-take area, and management zones.

When there was little to no information regarding an MPA, it was noted and assessment moved to the next MPA on the list. When information was difficult to find but an email address was available, emails were sent inquiring about the status of no-take areas within the MPA and the management of the area. The majority of these emails were not returned. An estimated 230 hours were spent finding information on the WDPA MPAs.

No-take area was acquired for 56% of the MPAs reviewed. In addition to the no-take area in each MPA, the total area and marine area recorded in the WDPA database were confirmed. On occasion, the areas recorded in the WDPA were different from data in management plans or management websites. The figures provided by the management plan were assumed to be correct and were recorded as an update to the WDPA. Most areas were recorded in square-kilometres, but a few MPAs had incorrectly recorded size in hectares. These areas were converted to square-kilometres, with any other errors noted and addressed.

After an initial list of assessed MPAs was collected, telephone calls were made to verify the existence and size of no-take areas. Calls for information were made to conservation organisations, management bodies, and government agencies. For MPAs in non-English speaking countries, native speakers were used to remove language barriers whenever possible. Over 2.5 hours were spent calling 11 different countries.

A total of 151 MPAs were newly assessed during this process. In addition to the MPAs examined, a cursory examination of MPAs categorized as all no-take and part no-take in the WDPA was conducted. Any major errors were noted, such as the total reported area being smaller than the marine area reported, or the no-take area being larger than the total marine area reported. In instances where reported areas conflicted, a difference of less than 1% was regarded as error from different measurement techniques and retained. Remaining MPAs with errors were removed prior to analysis. A number of MPAs were classified as all no-take but did not have a marine area reported. For these MPAs, it was assumed that the no-take area was equal to the marine area and were included in analysis.

A final list of 4774 MPAs was used in analysis to calculate the global MPA coverage and global no-take coverage. This list included the WDPA record of all, part, and no no-take MPAs, the MPAs assessed in this study, and the remaining MPAs that do not have a no-take status reported. The percent coverage of ocean area was calculated using a global ocean area of 360,000,000 km^2 (Eakins & Sharman, 2010).

3.2. SHARK DATA

3.2.1. SHARK DISTRIBUTION DATA

For this work, ten species of shark were assessed: whale shark (*Rhincodon typus*), basking shark (*Cetorhinus maximus*), white shark (*Carcharodon carcharias*), longfin mako shark (*Isurus paucus*), shortfin mako shark (*Isurus oxyrinchus*), porbeagle shark (*Lamna nasus*), oceanic whitetip shark (*Carcharhinus longimanus*), scalloped hammerhead shark (*Sphyrna lewini*), great hammerhead shark (*Sphyrna mokarran*), and smooth hammerhead shark (*Sphyrna zygaena*).

Sighting data for each shark species was collected using the Global Biodiversity Information Facility (GBIF) and the Ocean Biogeographic Information System (OBIS) databases (Global Biodiversity Information Faculty, 2013; Intergovernmental Oceanographic Commission of UNESCO, 2013). Data were downloaded on May 4, 2013. The statistical program R (version 3.0.1) was used to identify points for which the same latitude and longitude were recorded in both databases, and only one record was kept. Coordinates were rounded to two decimal places before removing duplicates. This allowed for removal of coordinates that were likely the same, but with different levels of accuracy.

Once the duplicates were removed, data were uploaded into the Quantum Geographic Information System (QGIS version 1.8.0) mapping software. In QGIS, any data points that were plotted on land or at 0° latitude/0° longitude were removed. Some of the points from the databases were expressed as an equal-area grid. These data are point representations of extent of occurrence estimates rather than direct observations, and were removed from analysis.

The IUCN distribution of each species (IUCN, 2013) was used to verify points GBIF and OBIS Data. The IUCN distribution for species is created using known occurrences, habitat preferences, potential habitat, and additional expert information (IUCN Red List Spatial Data, 2013). A 1-degree buffer around the IUCN distribution was mapped and any points that fell outside the buffer were removed. This is in line with other research that has assessed the accuracy and utility of the observation-based databases (Yesson et al., 2007).

In addition to the points downloaded by GBIF and OBIS, data for each species were downloaded from Global Shark Distribution Database (GSDD) (Lucifora, Garcia & Worm, 2009). While these data include GBIF and OBIS observations, they also include information from the literature and fisheries reports.

3.2.2. Migration Data

Fine scale migration patterns were assessed for the white shark. Raw data were received from Dr. Kevin Weng from the University of Hawaii, Manoa, based on the tagging of 20 individuals (Weng et al., 2007). Data from 15 of the individuals transmitted GPS (global positioning system) points and were used in analysis.

GPS locations were analysed using the adehabitatHR package (Calenge, 2011) in R. This package allowed for the calculation of the utilisation distribution (UD) for each individual as well as for the entire group. The UD probability value for each GPS point was calculated and the data were mapped in QGIS.

3.3. MAPPING DATA

3.3.1. SHARKS AND MPAS

To determine the overlap of shark presence and global MPAs, data were plotted in QGIS. For each of the ten species, the IUCN distribution and GBIF/OBIS data were overlaid with the global MPA network.

Using QGIS, the area covered by the IUCN distribution was calculated, as was the area of the MPAs that fell within the distribution. The area and percentage covered by the MPAs within the IUCN buffer was calculated. Areas were calculated in QGIS using the equal area projection system ESPG:3410 (NSIDC EASE-Grid Global).

For the GBIF/OBIS data, the number of points that fell within MPAs was determined, and percentage calculated. A chi-squared test was performed to determine whether observations were over or underrepresented within the MPA network. The global coverage of the MPA network was used as the expected proportion, and the proportions of points within MPAs was observed. Analyses were performed in R.

3.3.2. SHARK SPECIES RICHNESS

Species richness for sharks was created using the point-based distributions from the GSDD. The map was created in QGIS using point density for all sharks compiled by Lucifora et al. (2011) using a 1-degree grid. A species richness map was also made using the same technique for the 10 focal shark species. These data were overlaid with the global MPA network. The number of species found within the 1-degree cells was recorded for the entire ocean and for cells within MPAs. These data were graphed in R for all shark species and for the 10 focal species.

3.3.3. MPA MAPS

From the WDPA, a vector GIS layer shapefile of the global network of MPAs was downloaded. The file was edited to remove any terrestrial components of MPAs using an ocean reference layer. In addition, incorrect files were removed to minimize error in calculations and analysis. In order to calculate total MPA area coverage, the MPA layer was dissolved to merge spatially overlapping areas.

The file was also edited to include the no-take status of MPAs for which the status was known. No spatial information was added. The MPAs that had a no-take component were extracted and used in mapping analysis of no-take MPA coverage. The area of each MPA was calculated directly from the equal area projection system ESPG:3410 in QGIS.

MPA coverage was analysed for each of major fishing area outlined by the Food and Agricultural Organization (FAO). There were 19 FAO areas identified and used in analysis. For each fishing area, the total area was calculated, as was the area of MPAs within the area. The area of MPAs with a no-take component was also calculated for each fishing area. A chi-squared test was performed to determine if the MPA coverage in each fishing area was greater or less than what would be expected based on equal MPA coverage. The global coverage of the MPA network was used as the expected proportion, and the current MPA area in each FAO area was observed. This was repeated for no-take MPAs. Analyses were performed in R.

3.4. FAO Shark Catch Data

The historical catch data for each shark species were downloaded from the FAO database (www.fao.org/fishery/statistics/global-capture-production/en) and analysed by major fishing area. FAO fishing areas cover between 6.7 and 50.9 million km^2. Catch quantities from the FAO reflect "nominal catches…refer[ing] to the landings converted to a live weight basis" (FAO, 2013) in tonnes. Only eight of the 10 shark species could be assessed. There was no data on whale shark or great hammerhead shark. In addition to FAO data for the eight shark species, overall catch data for sharks, rays, and chimaeras were downloaded. The FAO data assessed are catch records from 1950 to 2011. The total catch in each fishing area was calculated and normalized based on the size of the FAO area.

CHAPTER 4: RESULTS

4.1. GLOBAL MPA COVERAGE

4.1.1. WDPA MPA COVERAGE

For this study, the term all no-take refers solely to the marine component of the MPA. The regulations for the terrestrial part of the MPA are not examined, and 'all no-take' MPAs may have a terrestrial component in which extraction occurs.

The WDPA currently lists 9,543 sites as marine protected areas. Of that number, 464 and 297 are classified as either all no-take or part no-take, respectively. Nine MPAs are classified as no no-take, with the remaining MPAs categorized as not reported. Without editing or removing any data from the WDPA MPA database, 3.06% of the world's oceans are designated as MPAs, with no-take coverage of 0.49%.

Thirty-three MPAs marked as all no-take were removed from analysis due to errors in the database, leaving 431 for analysis. An additional 119 MPAs categorized as part no-take were removed due to errors. MPAs classed as 'not reported' in reference to no-take status were edited, with any MPAs with missing data removed.

Of 263 MPAs analysed in this work, 151 could be verified (Figure 1). An additional 37 MPAs that were reviewed were categorized as either no no-take or part no-take but could not be included in analysis due to lack of information on marine and/or no-take area; 15 of these MPAs were classified as part no-take. Additionally, any duplicate entries were removed.

In the initial WDPA list, there were 16 MPAs classified as part no-take but for which the marine area was equal to the no-take area. These MPAs were reclassified as all no-take. A final list of MPAs was created with the newly classified MPAs from this study, the originally classified all, part, and no no-take MPAs, and any MPAs with an unreported no-take status. Final analysis included data on 4,774 MPAs of which 470 were all no-take, 188 part no-take, 107 no no-take, and 4,009 for which the no-take area was not reported. A full list of all and part no-take MPAs used in analysis can be found in Appendix I.

Based on the work in this study, MPAs cover over 9 million km^2 of marine area, which corresponds to 2.53% of the global ocean area. Including the terrestrial component of MPAs (e.g. islands in a national park), global coverage is approximately 11.5 million km^2.

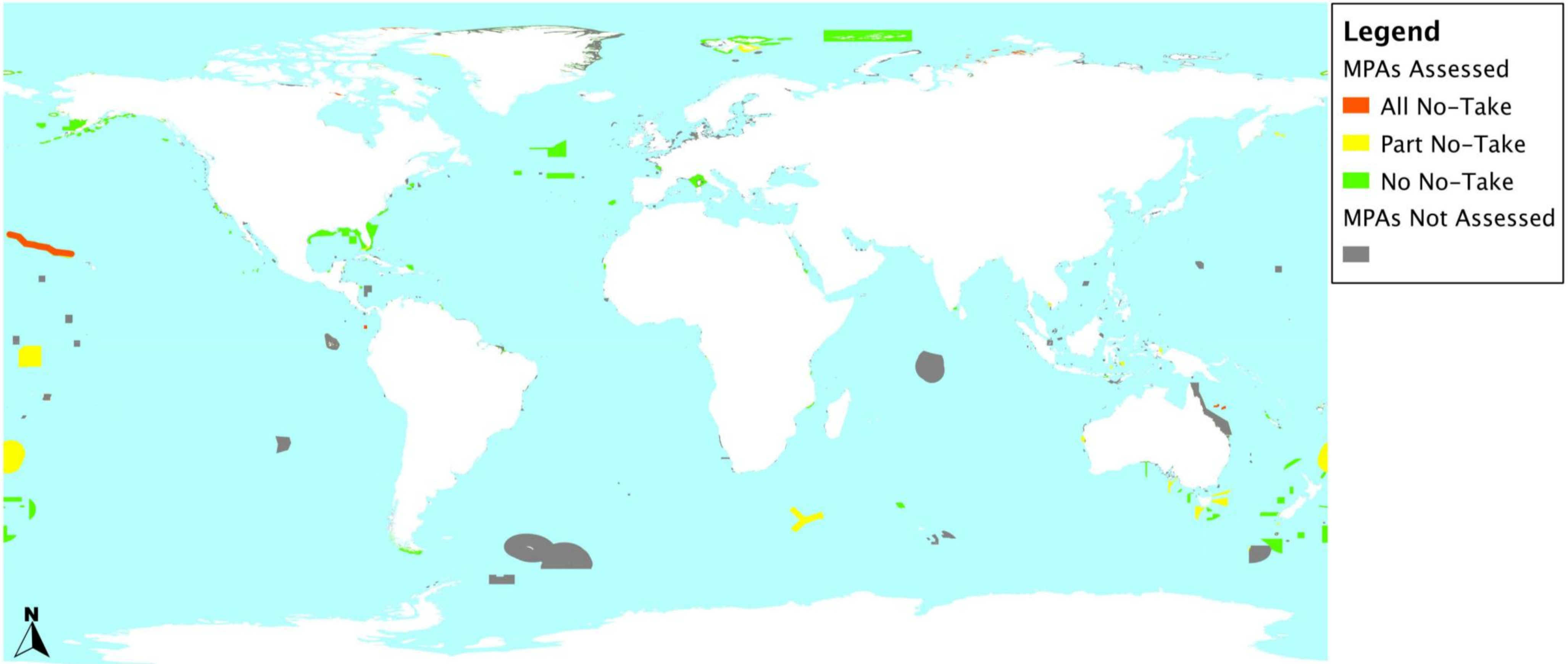


Figure 1: Map of the MPAs newly assessed in this study. MPAs are coloured by no-take status, with orange as all no-take, yellow as part no-take, and green as no no-take. MPAs in grey were not assessed in this study.

4.1.2. *Global No-Take MPAs*

The total no-take area from the MPAs in this study is 2,336,186 km^2. Global no-take coverage of the oceans was calculated to be 0.649%. This no-take coverage is over 30% more than what was reported by the WDPA.

Forty-nine countries have MPAs with a no-take component, with Australia and South Georgia and the South Sandwich Islands having the highest total marine area protected by all and part no-take MPAs (Appendix II). The United States has the highest no-take area covered, with a total 709,072 km^2.

4.1.3. *The Largest MPAs*

The 100 largest MPAs, based on total area, cover 10,107,703 km^2 with 8,311,231 km^2 marine coverage. The no-take area is 2,238,896 km^2 and covers 0.622% of the ocean (Table 1).

The 200 largest MPAs, based on total area, represent 8,497,950 km^2 of marine coverage. The no-take area covers 2,298,013 km^2 and includes 0.638% of the ocean (Table 1). By adding the next 100 largest MPAs to the first 100 largest MPAs, the total area protected increased by 2.9%, with no-take coverage increasing by 2.6%.

Table 1: The total area, marine area, and no-take area for the 100 and 200 largest MPAs.

	Total Reported Area (km^2)	Total Reported Marine Area (km^2)	Total Reported No-take Area (km^2)	Percent No-take area of total Marine Area	Percent No-take Area of the Ocean
Top 100	10,107,703.9	8,311,231.6	2,238,896.9	26.94	0.622
Top 200	10,399,783.2	8,497,950.3	2,298,013.8	27.04	0.638

4.1.4. *Mapping Global MPA Coverage*

The WDPA QGIS map was edited to include only marine components of MPAs. The final file resulted in 8407 MPAs. The reported marine area in the WDPA for these MPAs was 12,851,885 km^2. QGIS calculated the total area of the coverage as 10,955,753 km^2, a 14.7% difference between reported and calculated values. This difference could be a result of missing data on marine area in the WDPA shapefile. Of the 8407 MPAs, 816 had a no-take area greater than 0, inclusive of the MPAs assessed in this study (Figure 2). The MPAs with partial or complete no-take protection cover 9,157,755 km^2, however little of this area is actually no-take.

4.1.5. MPAs and Exclusive Economic Zones (EEZs)

MPAs within the EEZs of countries cover 323,395,011km^2, and make up 95.1% of the current network of MPAs. Of these MPAs, 611 have a no-take component.

4.2. Sharks and Marine Protected Areas

4.2.1. MPA Coverage for Shark Distributions

For each shark species in this study, the IUCN distribution and GBIF/OBIS data were mapped (Figure 3). The data points from the GSDD overlapped with the IUCN distribution, and were therefore not included in analysis.

Within each shark's IUCN distribution, the number of MPAs was calculated (Table 2), with an average of number of MPAs being 3,917. The area of these MPAs was also calculated (Table 2), with shortfin mako having the largest MPA coverage of 6,769,907 km^2 and the smooth hammerhead shark having the smallest, 779,118 km^2. The average MPA coverage was 4,270,561 km^2. The size of each MPA within the IUCN distribution of each shark species ranged from 1,535 km^2 to 271 km^2 (Table 2), with the average size being 1,012 km^2.

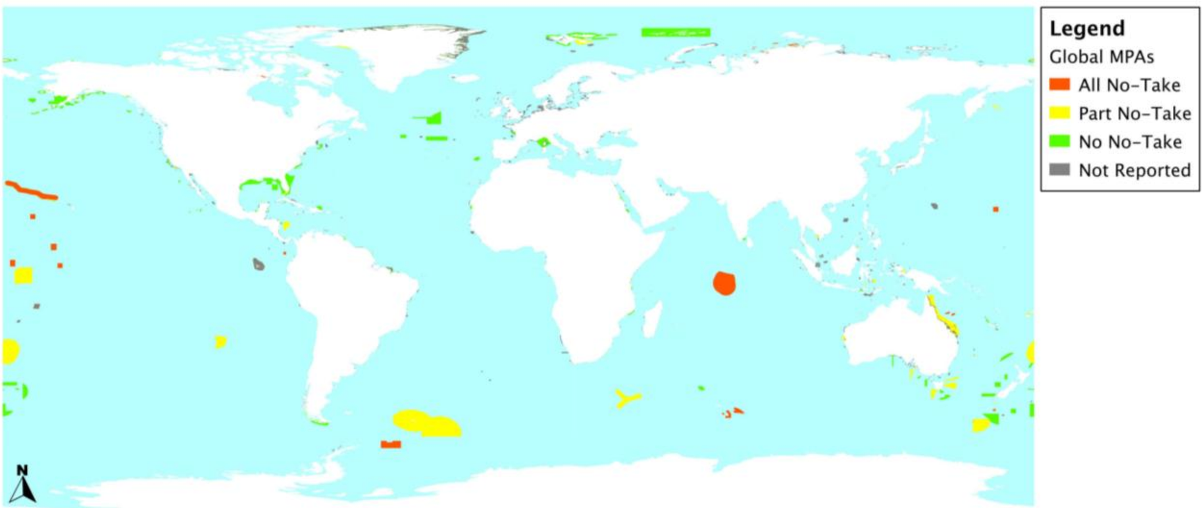


Figure 2: The global MPA network as assessed by the WDPA. MPAs are coloured by no-take status.

For MPAs that have a no-take component, the average number of MPAs fell to 422 within IUCN distributions for the 10 shark species. The average size of the no-take MPAs was larger, on average, than when looking at MPAs regardless of no-take status. Sizes ranged between 13,141 km^2 and 520 km^2 (Table 2). The average area of these no-take MPAs was 2,441,372 km^2. Note that the no-take coverage is smaller than total MPA coverage reported.

4.2.2. Shark Sightings

The GBIF and OBIS data points were mapped with the current network of MPAs and no-take MPAs. For each species a number of points were removed because a) they fell outside of the 1-degree buffer zone of the IUCN distribution, or b) they were mapped on land. On average, 42% of data points were filtered. Approximately 32% of data removed were from point representations of extent estimates. The final number of points used in analysis can be found on Table 2.

The number of sightings that occurred within an MPA was significantly higher than would be expected for all shark species with the exception of the smooth hammerhead (Table 2). Anywhere between 3% and 41% of total sightings occurred within an MPA (Table 2).

Fewer sightings occurred in MPAs with a no-take component. Three shark species, the great hammerhead, the scalloped hammerhead, and the whale shark, had significantly higher numbers of sightings than would be expected in no-take MPAs. Basking shark had significantly fewer sightings in MPAs than expected (Table 2).

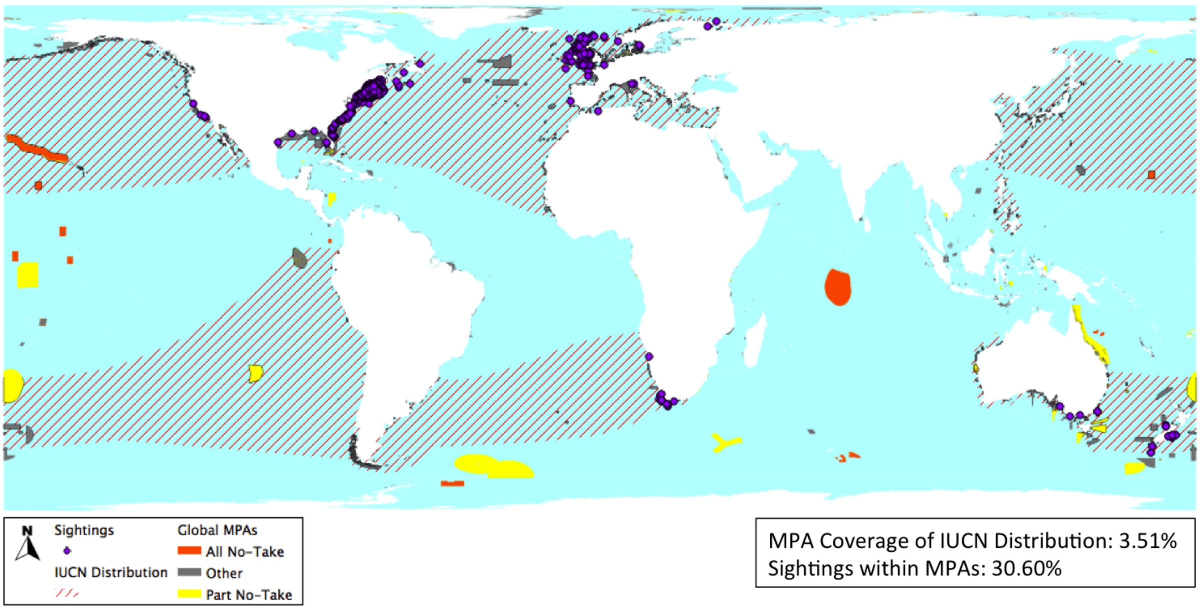


Figure 3: The distribution and sighting for basking sharks. MPAs classified as “other” are either no no-take or do not have a reported no-take status. See Appendix III for the remaining nine species assessed.

Table 2: The area of the IUCN distribution for each shark species, and the MPA coverage within each species' respective distribution. Global MPAs and MPAs with a no-take area are assessed separately. The final row is the global totals for MPA coverage. Percent coverage of MPAs with no-take component reflect the sum of the total MPA area, rather than the no-take area within the MPAs. All p-values are < 0.05.

Shark Species	IUCN Distribution									GBIF/OBIS Data Points		
		Global Network of MPAs				MPAs with a No-Take Component						
	Total Area (km^2)	*N*	*Area (km^2)*	*% of IUCN Distribution*	*Average MPA Size (km^2)*	*N*	*Area (km^2)*	*% of IUCN Distribution*	*Average MPA Size (km^2)*	*N*	*In an MPA (%)*	*In an MPA with No-take area (%)*
Basking Shark	134,474,241	4,213	4,722,565	3.51	1,121	282	2,109,893	1.57	7,482	1438	441 (30.6)***	3 (0.2)^
Great Hammerhead	19,502,836	2,642	1,136,829	5.83	430	107	385,215	1.98	3,600	286	86 (30.1)***	32 (11.2)***
White Shark	278,149,567	5,275	8,096,324	2.91	1,535	576	4,714,878	1.70	8,186	186	33 (17.7)***	2 (1.1)
Longfin Mako	185,626,849	4,154	5,918,266	3.19	1,425	385	3,787,181	2.04	9,837	307	18 (5.7)***	1 (0.3)
Oceanic Whitetip	180,575,574	4,066	6,184,326	3.42	1,521	492	4,017,528	2.22	8,166	1238	93 (7.5)***	11 (0.9)
Porbeagle	100,975,324	3,634	2,875,047	2.85	791	307	1,646,503	1.63	5,363	155	15 (12.3)***	0 (0.0)
Scalloped Hammerhead	27,120,716	3,270	1,563,841	5.77	478	895	465,490	1.72	520	903	375 (41.5)***	22 (2.4)***
Shortfin Mako	223,003,635	5,532	6,769,907	3.04	1,224	590	4,174,726	1.87	7,076	1852	95 (5.1)***	18 (1.0)
Smooth Hammerhead	14,452,419	2,870	779,118	5.39	271	323	193,030	1.34	598	408	14 (3.4)	3 (0.7)
Whale Shark	171,809,449	3,516	4,659,388	2.71	1,325	451	2,919,275	1.70	6,473	1006	292 (29.0)***	31 (3.1)***
Global Totals	---	8,407	109,55,753	---	1,303	816	9,157,756	---	11,223	7,779	1,462 (18.8)	123 (1.6)

^Underrepresentation *Overrepresentation

4.2.3. Species Richness

For all sharks assessed in the GSDD, the highest concentration of species was around the Gulf Coast of the USA and South-East Asia, with a peak density around Japan and Taiwan (Figure 4a). For the 10 focal species, shark density peaked along the east coast of the USA, Western Africa, and South-East Asia (Figure 4b).

The total number of species within each 1-degree grid was examined for inside and outside of MPAs. MPAs have a higher proportion of cells with more than 11 global shark species compared to outside of MPAs (Figure 5a). MPAs also have the highest proportion of cells in which 1-10 global shark species are found, and the proportion of cells decreases with increased species number (Figure 5a). A similar trend can be seen for the 10 species assessed. Cells with four species make up the highest proportion of cells when at least one shark species is present (Figure 5b). For both global shark species and the 10 assessed in this work, approximately 60% of cells had zero shark species (Figure 5a,b).

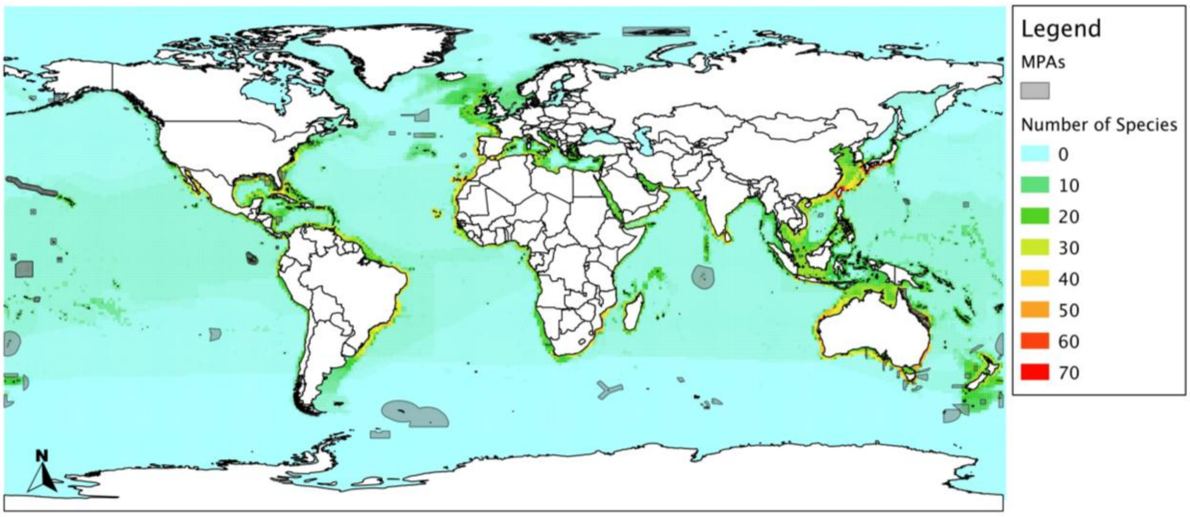
4.3. Fishing Effort and Marine Protected Area Coverage

4.3.1. FAO Major Fishing Area Coverage

The area of each FAO fishing area was calculated, with an average area of 23,888,493 km^2 (Table 3a). The total MPA coverage in each FAO area ranged from zero in the Northeast Pacific to 2,674,378 km^2 in the East-central Pacific (Table 3a). Within each fishing area, MPA coverage was significantly different than would be expected if MPA coverage was equally distributed across oceans (Table 3a). The average size of MPAs within each FAO area varied, with the overall average being 6,250 km^2. The Atlantic Antarctic Ocean had the highest average size, with 38,686 km^2 per MPA (Table 3a).

For MPAs with a no-take component, the average number of MPAs within each FAO fishing area was 35 (Table 3a). The total MPA area within each FAO fishing area ranged between 0 km^2 in the Pacific Antarctic Ocean, and 1,810,767 km^2 in the West-Central Pacific Ocean (Table 3a). MPAs with a no-take component covered, on average, 473,486 km^2 in each FAO area, with the average size of each MPA being 49,357 km^2 (Table 3a). The average no-take MPA size was more than eight times larger than the average size of the entire MPA network. The percent coverage of no-take MPAs was less than 8% in each fishing area, with 12 of the 19 areas having a no-take MPA coverage of less than 1% (Table 3a).

A



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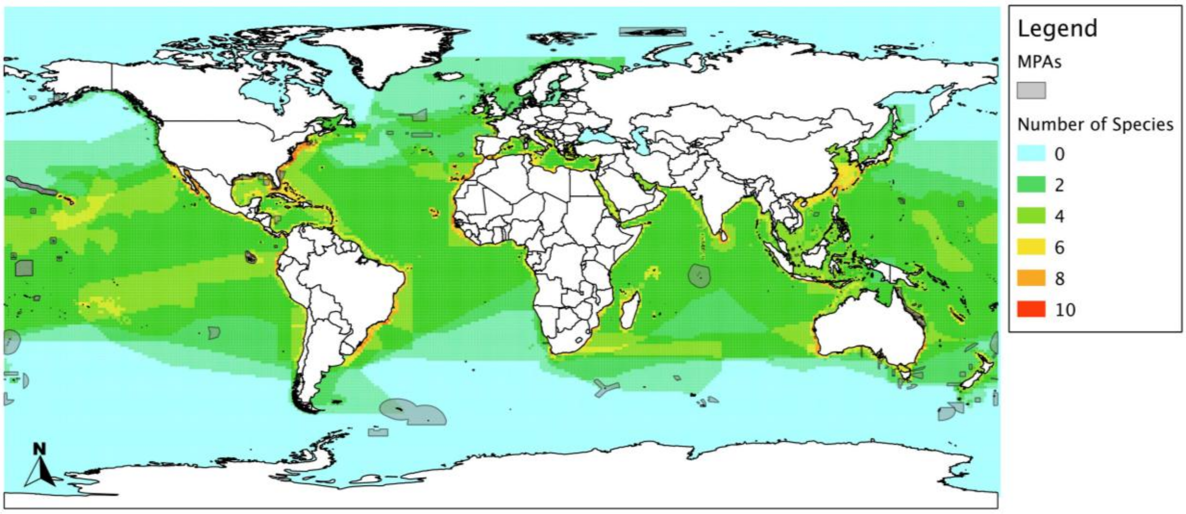
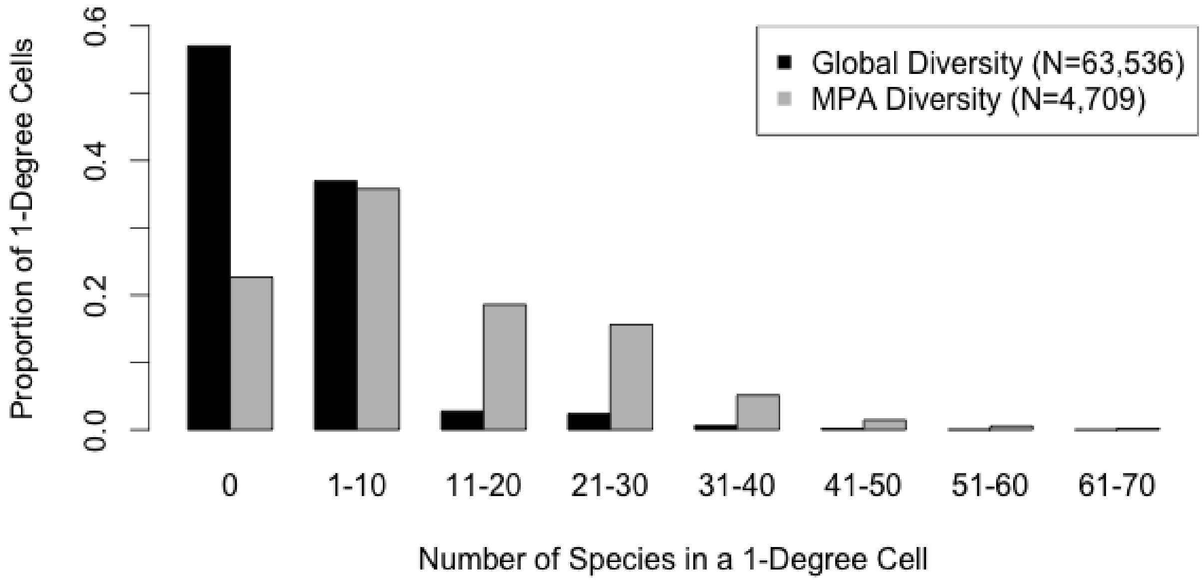


Figure 4: Species richness based on 1-degree cells using distribution data from the Global Shark Distribution Database (GSDD). MPAs are in grey. A) For all shark species in the GSDD. B) For the 10 focal shark species.

A)



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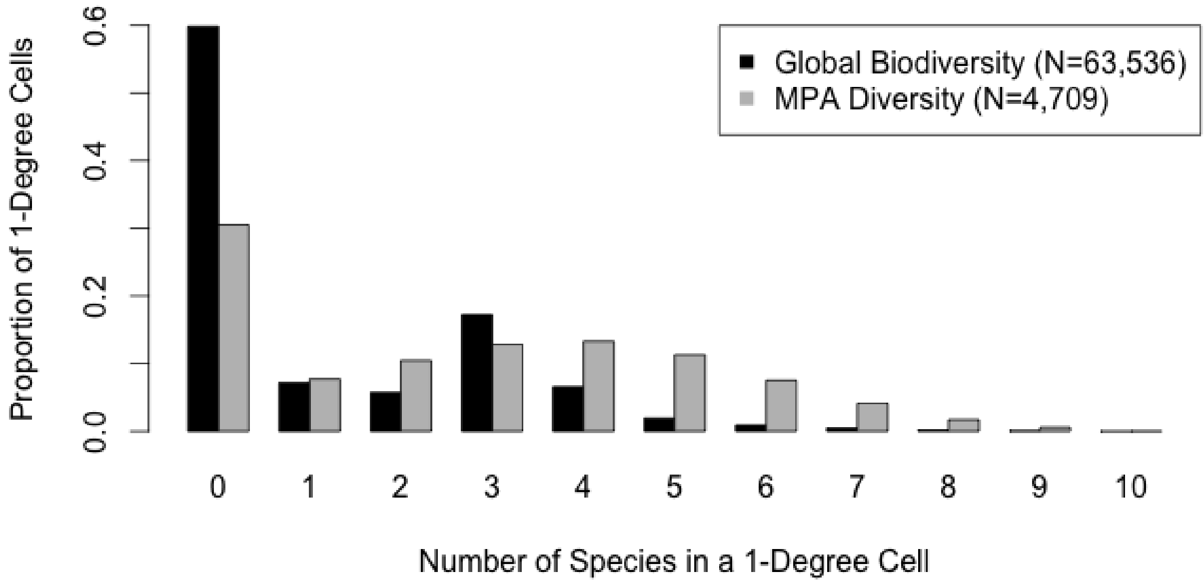

Figure 5: The proportion of 1-degree cells that contain a varying number of shark species for the entire ocean and within MPAs. A) For all shark species assessed by the GSDD. B) For the 10 focal shark species.

Table 3a: Total area of each FAO major fishing area, with the coverage of global MPAs and MPAs with a no-take component by each area. The final row is the global total of ocean area and MPA coverage. Note the percent MPA coverage varies in this table due to the use of the total FAO fishing area calculation, rather than the 360,000,000 km^2 used in other estimates. Percent coverage of MPAs with no-take component reflect total MPA area, rather than the no-take area within the MPAs. Abbreviations: E=Eastern, EC=East-central, Med. = Mediterranean, NE=Northeast, NW=Northwest, SE=Southeast, SW=Southwest, W=Western, WC=West-central. All p-values area < 2.2e-16.

FAO Fishing Area		Global MPA Network				MPAs with a No-Take Component			
	Total Area (km^2)	*N*	*Total MPA Area (km^2)*	*Percentage Coverage*	*Average MPA Size (km^2)*	*N*	*Total MPA Area (km^2)*	*Percentage Coverage*	*Average MPA Size (km^2)*
Arctic	17,790,119	100	164,034	0.92^^^	1,640	16	37,590	0.21^^^	2,349
Atlantic Antarctic	15,583,101	30	1,160,586	7.45***	38,686	2	1,157,076	7.43***	578,538
E Indian	39,499,032	456	400,717	1.01^^^	879	38	177,433	0.45^^^	4,669
EC Atlantic	15,311,473	154	57,343	0.37^^^	372	1	1,209	0.01^^^	1,209
EC Pacific	50,987,002	478	2,674,378	5.26***	5,595	86	2,146,359	4.21***	24,958
Indian Antarctic	19,276,960	6	251,722	1.31^^^	41,954	3	251,717	1.31***	83,906
Med. and Black Sea	6,728,899	685	194,077	2.88***	283	33	4,176	0.06^^^	127
NE Atlantic	18,894,295	2,316	1,065,286	5.64***	460	2	24,164	0.13^^^	12,082
NE Pacific	10,430,313	333	277,676	2.66***	834	5	8	0.00008^^^	2
NW Atlantic	8,578,149	538	95,057	1.11^^^	177	5	5,839	0.07^^^	1,168
NW Pacific	35,979,584	456	1,719,550	4.78***	3,771	11	1,251,483	3.48***	113,771
Pacific Antarctic	12,753,090	8	161	0.001^^^	20	0	0	0.00^^^	0
SE Atlantic	19,587,966	53	33,097	0.17^^^	624	11	2,976	0.02^^^	271
SE Pacific	34,075,685	68	505,925	1.48^^^	7,440	5	308,683	0.91***	61,737
SW Atlantic	20,775,745	195	126,907	0.61^^^	651	3	433	0.002^^^	144
SW Pacific	28,278,128	146	1,460,995	5.17***	10,007	48	903,938	3.20***	18,832
W Indian	42,806,779	341	925,473	2.16^^^	2,714	31	828,558	1.94***	26,728
WC Atlantic	17,475,377	1,047	749,396	4.29***	716	75	83,829	0.48^^^	1,118
WC Pacific	39,069,669	1,136	2,184,806	5.59***	1,923	293	1,810,767	4.63***	6,180
Global Totals	453,881,365	8407	109,55,753	2.41	1,303	816	9,157,756	2.02	11,222

^Underrepresentation *Overrepresentation

Table 3b: The total catch (tonnes) and normalized catch (tonnes per 1000-km^2) of sharks, rays, and chimaeras, and for eight of the 10 species assessed in this study by each FAO fishing area. The final row is the global total of catch and normalized catch for each FAO major fishing area. Abbreviations: E=Eastern, EC= East-central, Med. = Mediterranean, NE=Northeast, NW=Northwest, SE=Southeast, SW=Southwest, W=Western, WC=West-central.

FAO Major Fishing Area	Catch (Sharks, Rays, Chimaeras)		Catch (8 Species Assessed)	
	Total (tonnes)	*Normalized Catch (tonnes/1000-km^2)*	*Total (tonnes)*	*Normalized Catch (tonnes/1000-km^2)*
Arctic	0	0.00000	0	0.00000
Atlantic Antarctic	5	0.00032	1	0.00006
E Indian	104,818	2.65369	25,528	0.64629
EC Atlantic	81,887	5.34808	19,733	1.28877
EC Pacific	33,796	0.66284	4,148	0.08135
Indian Antarctic	492	0.02552	3	0.00016
Med. and Black Sea	16,727	2.48585	287	0.04265
NE Atlantic	48,347	2.55881	344,557	18.23603
NE Pacific	12,397	1.18855	3	0.00029
NW Atlantic	33,331	3.88557	49,731	5.79740
NW Pacific	42,392	1.17822	0	0.00000
Pacific Antarctic	5	0.00039	0	0.00000
SE Atlantic	16,353	0.83485	23,378	1.19349
SE Pacific	30,921	0.90742	20,926	0.61410
SW Atlantic	93,637	4.50703	19,113	0.91997
SW Pacific	19,935	0.70496	6,310	0.22314
W Indian	94,805	2.21472	9,787	0.22863
WC Atlantic	31,188	1.78468	2,033	0.11634
WC Pacific	105,028	2.68822	4,395	0.11249
Global Total	766,064	34	529,933	29.50118

4.3.2. FAO Catch Data

The average historical catch of sharks, rays, and chimaeras for each fishing area is 40,319 tonnes, with a global total of 766,064 tonnes (Table 3b). The normalized historical catch ranges from zero to 5.3-tonnes/1,000 km^2, with an average of 1.77-tonnes/1,000 km^2 (Table 3b). The major fishing area with the highest catch per unit area is the East-central Atlantic Ocean. Comparatively, for the eight species for which there were catch data, the average catch per unit area is 1.55-tonnes/1,000 km^2, with the highest level in the Northeast Atlantic Ocean, with 18.24-tonnes/1,000 km^2 (Figure 6). Total global catch for the eight assessed species is 29,933 tonnes (Table 3b).

By FAO fishing area, the maximum level of MPA coverage is 7.5%, with some areas containing less than 1% MPA protection. The Atlantic Antarctic Ocean has the highest percentage of MPA coverage, but has minimal historical catch of sharks, rays, and chimaeras (Table 3). Alternatively, the East-central Atlantic Ocean has the highest historical catch of sharks rays, and chimaeras, but with only 0.37% MPA coverage (Table 3). Similar trends can be seen when examining the catch for the eight species in this study (Table 3).

4.4. CASE STUDY: WHITE SHARK MIGRATION

The utilisation distribution (UD) test identified three areas of high probability for finding a shark: Coastal California, Hawaii, and the Pacific Ocean, at approximately 132°W longitude and 32°N latitude (Figure 7). The high UD by Hawaii is a result of three individuals, which migrated from California to Hawaii. Six individuals journeyed to the area in the Pacific Ocean. The remaining seven sharks did not move a long distance from the coast of California. For the third quartile of UD value, the points were focused around coastal California and in the Pacific Ocean area, with no points around Hawaii.

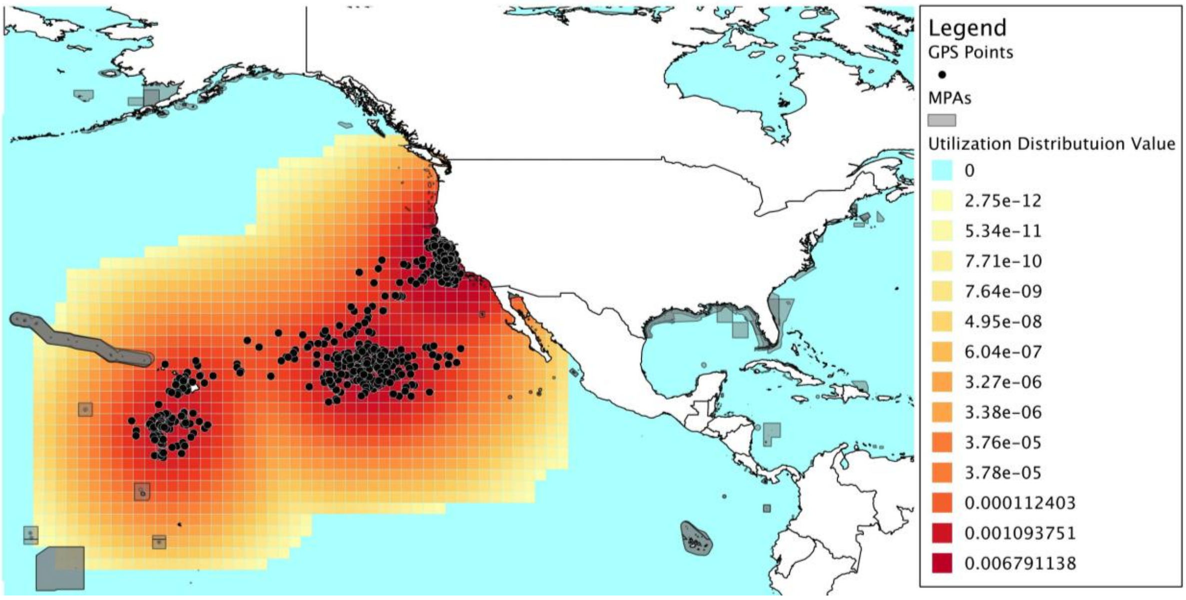

Figure 7: The utilisation distribution (UD) values based on the GPS points of tagged white sharks. Red represents a higher UD, with blue representing a UD of zero. The raw GPS coordinates are plotted in black. MPAs are in grey.

Chapter 5: Discussion

5.1. Current Status of Marine Protected Area Coverage

5.1.1. Global MPAs

The results of this study are in line with recent estimates of global marine protection. Spalding et al. (2013) calculated MPAs cover 2.3% of the ocean, and the results of the current work were able to provide a greater estimate of MPA protection, at 2.5%. Spalding et al. (2013) used WDPA data and added additional known MPAs, resulting in a higher number of protected areas assessed. Given the timeframe of this project, additional exploration was not possible, leaving only MPAs listed in the WDPA accessible for analysis. While not including other known MPAs potentially provides an underestimate of protection, it highlights the need for accurate, and up to date, information in the WDPA, which will help in more efficient research and conservation planning.

Total MPA coverage is skewed by the designation of mega-MPAs in recent years (Spalding et al., 2013); of the 28 largest MPAs, 22 were created after 2000 (De Santo, 2013). The results of this study are inline with previous work, showing that less than 2% of the MPAs examined comprised over 50% of global coverage.

5.1.2. MPA Effectiveness

This work did not address the effectiveness of MPAs, and therefore omits comment. Unfortunately, there are relatively few studies on the effectiveness of MPAs based on field observations (Edgar, 2011). In an assessment of papers published between 2009 and 2010 on MPAs, Edgar (2011) found that just under half of MPA research actually collected ecological field data. In those studies, the majority focused on one species, one MPA, or one year (Edgar, 2011). This single glimpse into time provides little insight if researchers want to understand how existing MPAs impact the protection of species and ecosystems over time.

Some consider ineffective MPAs damaging to conservation progress because they give the impression that goals for ocean conservation are being met, when in reality the MPAs do not provide protection, and instead provide a false sense of security (Dulvy, 2013). In light of the 2020 CBD target, the focus on reaching a global percentage goal may be undermining the achievement of long-term conservation goals (De Santo, 2013). By focusing on meeting a spatial target, researchers may be diverting valuable resources on a target that acts independently of real-world conservation needs, destabilising the desired outcomes of MPAs (Agardy et al., 2003).

5.1.3. No-take MPAs

This research continued the work conducted by Wood et al. (2008) in the assessment of global no-take MPA coverage. Using WDPA records, the previous estimate of no-take area was 0.08% of the ocean (Wood et al., 2008). Since 2010 the WDPA has asked MPA managers to report the no-take status and area (A. Milman, 2013, Pers. comm.). While this has increased the amount of no-take data, this effort leaves numerous records missing important information.

Results show that current no-take coverage is over eight times higher than the Wood et al. (2008) calculation. Furthermore, no-take coverage makes up almost one-third of the area within MPAs. This level of coverage is encouraging. Assuming MPA effectiveness, this coverage could have a strong positive effect in improving biomass and species richness within MPAs (Lester et al., 2009).

A number of MPAs were known to be part no-take but the actual no-take area was the only missing data. This missing information resulted in a total of 103 areas being removed from analysis. If these MPAs were included, global MPA coverage would increase to 2.61%. Using the average no-take area covered by part no-take MPAs, the change in no-take coverage would be inconsequential. However, if the no-take area constituted half of the marine area protected by the 103 MPAs, global no-take coverage would stand at 0.69%. These numbers highlight the effect of missing information on the understanding of global no-take coverage. These errors mean that the no-take coverage calculated in this study is likely to be an underestimation of the total area protected. Filling in these data gaps is the best way to get accurate information on no-take coverage.

The data do not identify the location of no-take zones within part no-take MPAs. Knowledge of these locations could be used in multiple studies and would provide greater insight into the types of habitats protected within MPAs. As additional MPAs are created and entered into the WDPA, it is recommended that management organisations include data on no-take zone locations.

5.1.4. *Working with WDPA Data*

Though errors exist, the WDPA is the most complete collection of protected area data in the world. A common issue with the WDPA is poor data recording, including not reporting the marine area or using incorrect units. Some of these problems are easily corrected, e.g. converting hectares to square-kilometres. However, multiple data points were removed from analysis because accurate information could not be acquired.

Studies have shown that inaccuracies and missing data in the WDPA can considerably bias estimates of protection (Visconti et al., 2013). These errors can lead to under or overestimations of protection, potentially resulting in a false perception of the conservation status of a species or the over-allocation of conservation resources (Visconti et al., 2013).

In addition to data record errors, a number of duplicate areas are recorded in the database. For example, the Greenland National Park and the Northeast Greenland UNESCO-Man and the Biosphere (MAB) Reserve cover the same area, and are both recorded in the WDPA. Duplicates are a common occurrence for sites that are nationally designated, Biosphere Reserves, UNESCO sites, and/or a wetland of international importance (Ramsar site). In other cases, the designated areas overlap. For example, the Florida Everglades contain a National Park, Ramsar site, and World Heritage Site (WHS). Each designation has a different area recorded, but the overlap is unclear. Additionally, some MPAs are included within larger designated areas, such as Glacier Bay National Park, which is a component of the Kluane/Wrangell-St Elias/Glacier Bay/Tatshenshini-Alsek WHS.

The repetition of the same area multiple times results in an inaccurate picture of marine conservation, and an imprecise understanding of protection. For example, at 972,000 km^2, including the Greenland National Park area twice can make a significant difference to global MPA coverage. And, while the removal of duplicate areas is common practice (Spalding et al., 2013), future efforts should establish a more efficient way of tracking these duplications.

Furthermore, the difference between the QGIS calculated area and the areas stated in the WDPA could be a reflection of the errors in reporting or in the duplications. Part of the differences in areas calculated could be the result of the removal of land components or the projection system used. The map used to edit the shapefile was relatively coarse meaning the amount of protection mapped on the land, and subsequently removed, could be higher than in actuality (Visconti et al., 2013). This study has given a rough estimate of the coverage based on the calculated area, and finer-scale maps may result in a more accurate estimate of coverage.

5.2. Shark Conservation

5.2.1. MPA Coverage of Sharks

The current network of MPAs covers less than 6% of the outlined distributions of the 10 shark species examined in this study. For some species, MPA coverage was less than 3% (Table 2). The IUCN distributions of species are based on expert opinion (IUCN Red List Spatial Data, 2013), rather than comprehensive surveys. The GBIF and OBIS data points reflect the differences between the IUCN distribution and observations of species. For a number of species few observations were recorded outside of the IUCN distribution (e.g. basking shark). However, some species had a number of observations outside their distribution (e.g. great hammerhead). The IUCN distribution is an estimate and is likely a coarser resolution than observation data (Jetz, McPherson & Guralnick, 2012) resulting in inaccuracies. MPA coverage for the real distribution of species is likely different than estimates made in this study because it is impossible to know the true distribution of these species without full surveys and tagging studies, of which there are few (Hammerschlag, Gallagher & Lazarre, 2011).

The GBIF and OBIS data used in this work come from a number of sources and have inherent bias (Yesson et al., 2007). Based on the chi-squared tests performed, there was significant overrepresentation of observations. This is, however, predictable. MPAs are concentrated in coastal waters (Spalding, Fish & Wood, 2008), and more shark sightings would be seen and reported in coastal areas where population densities are higher and access is easier. It is important to be aware of this bias, and not assume that the high proportion of observations in an MPA is a result of effective protection. This study cannot definitively evaluate effectiveness of MPAs for shark conservation. However, research has shown that shark densities can be higher inside MPAs, specifically no-entry zones, compared to outside these areas (Dulvy, 2006).

A study tagging two reef shark species showed how sharks utilised the space within an MPA and identified time spent inside and outside the protected area (Knip, Heupel & Simpfendorfer, 2012). The results of the work highlighted that time spent within MPAs is variable within and between species (Knip, Heupel & Simpfendorfer, 2012). Variations in how sharks utilise the space within an MPA make it difficult to design effective MPAs: even if a species is protected during its time within an MPA (which may be uncertain due to enforcement issues), it may face substantial threats once it leaves the protected waters. Little work exists on the effectiveness of MPAs, verifying the need for further research.

5.2.3. Species Richness

From both species richness maps created in this work, it is clear that areas of higher and lower species diversity exist. The species distribution for the 10 focal species (Figure 4b) aligns with global shark diversity (Figure 4a). Hypothetically, a subset of sharks could be used as a proxy for global shark diversity. Previous work shows that using a subset of species is effective in biodiversity surveys, especially when the species are difficult and/or costly to survey (Vellend, Lilley & Starzomski, 2007). However, there is weak congruence when using this method cross-taxa (Heino, 2010).

This approach should be used cautiously by including species that fit a range of habitats and movement patterns to get an accurate reflection of shark biodiversity. This work did not specifically aim to accomplish this, however the species selected seem to reflect global distribution patterns. More efficient and economical research is possible if researchers identify an appropriate subset of species.

The species richness maps were made using a 1-degree grid, resulting in inherent data bias: a 1-degree grid at the poles is a different size than one at the equator. The different grid sizes skewed the data by showing higher levels of diversity around the equator. However, this could be a reflection of the latitudinal diversity gradient hypothesis (Pianka, 1966; Hillebrand, 2004), and regardless of grid size more shark species exist around the equator.

5.2.4. FAO Catch Data and MPAs

A global assessment of shark by-catch is virtually impossible to conduct due to lack of data, so catch data were used to examine one of the interactions between species and commercial fishing. While there are other databases on shark catch, it was appropriate to use FAO data to be consistent with the global scope of this work. No appropriate catch data for use in this study existed for the great hammerhead or whale shark, reflecting data deficiency. It can be difficult to identify some sharks to species level, possibly causing the great hammerhead shark to be grouped with other hammerhead species (IUCN, 2013). Despite historical harvest of whale sharks (Hsu, Joung & Liu, 2012), it is unclear why there is no catch data.

It is unknown whether MPAs are effective in protecting species in highly fished areas, such as the East-central Atlantic Ocean. Similarly, it is unclear why some fishing areas, such as the Atlantic Antarctic Ocean, have such high levels of MPAs. It may be that MPAs are designated to protect other species and habitats. Results do not support a relationship between FAO catch and MPA coverage across major fishing areas (Appendix IV). Addressing these issues is vital to understanding the interactions between MPAs and global fishing efforts.

The creation of new MPAs in light of fishing pressures requires a strong understanding of the direct and indirect effects of fishing closures (Baum et al., 2003). A study modelling the impact of marine reserves on shark populations in the Northwest Atlantic Ocean showed that closures of different fishing areas caused varying responses in species, with some situations resulting in continued population decline, possibly caused by fishing displacement (Baum et al., 2003).

The average size of MPAs with a no-take component is larger than the average size when disregarding no-take status. This trend was observed in 14 of the 19 FAO major fishing areas (Table 3a). For some areas, MPA coverage is likely biased by the presence of mega-MPAs, such as the Chagos Marine Reserve in the Western Indian Ocean. The different average size may reflect that no-take areas are easier to include within larger MPAs. Additional research into the political, economic, and social factors that drive MPA development may be able to answer that question.

5.3. CONSIDERATIONS FOR FUTURE MPA DATA

5.3.1. ACQUIRING MPA INFORMATION

One of the most challenging components of this research was acquiring the appropriate information to fill in gaps in the WDPA. The main questions that needed to be answered were:

1. Does the protected area have a marine component, and if so what is the total area?
2. Are there no-take restrictions in the marine component? If so, what is the area covered by the restrictions?

It was necessary to confirm the marine area for a number of MPAs because, despite using the MPA filter on the WDPA, a number of records had no marine area reported. The Internet facilitated finding and accessing information. However, it became clear that the majority of MPAs assessed do not have their own website. Occasionally, the only information available was from tourist information websites, making accuracy hard to determine. This was especially true for African and South American MPAs.

MPAs with dedicated websites maintained through management organisations did not always have easily accessible information. Websites such as the Australian Commonwealth Marine Reserves (http://www.environment.gov.au/marinereserves/) provide an ideal example. The website gives detailed information about the marine reserve, including the areas of management zones, maps of the area, and a management plan.

Management plans were often used in this study. However, these plans did not necessarily include the pertinent information. Deciphering a management plan for various rules and regulations within an MPA could take at least an hour, especially for non-English documents. A number of MPAs did not have management plans, compounding the difficulty in finding information. It is fair to question whether MPAs without management plans should be included in the WDPA database, as an absence of a management plan may be an indication of poor enforcement.

Calling appropriate offices yielded slightly better results than sending cold emails, although the "appropriate" person (often the MPA manager) did not always have the information requested. The Papahānaumokuākea Marine National Monument was the only instance in which initial contact provided the information requested. Many of the organisations responded to follow-up emails, but they simply did not have the answers.

If MPA managers do not have basic information, such as the total marine area, how can researchers obtain the data to accurately understand the degree to which the ocean is protected? MPA managers should be urged to gather this information, and enter it correctly into the WDPA, allowing researchers to achieve a more accurate picture of marine protection.

5.3.2. Classifying No-Take MPAs

In the assessment of no-take areas, the rights of indigenous peoples arose. In some places, such as Canada, native peoples have rights that other citizens do not. In some MPAs assessed, the entire area was no-take, but Inuit fishing was allowed. In this study, these MPAs were marked as no-take, but a note of the exception was made. Further exploration into the level of extraction would be necessary to assess the quantity of resources removed by Inuit. In some MPAs, extraction may be so minimal that no-take status is appropriate, while other MPAs may need to be classified as no no-take due to the level of legitimate native extraction. It has been found that indigenous people are supportive of the restrictions of commercial and recreational fishing in MPAs, but are focused on ensuring their legal extraction rights are maintained (Ban, Picard & Vincent, 2008). Conversely, some MPAs have no legal regulation against extraction, but the area is so remote that people do not access the area (M. Mahy, 2013, Pers. comm.). In these cases, the MPA is functionally no-take without being legally no-take.

Another aspect that may be considered is whether an MPA should be categorised no-take if restrictions in an area are a result of other regulations. For example, the Arctic National Wildlife Refuge does not have any restrictions on fishing. However, it falls in the Alaskan Beufort Sea, where commercial fishing has been banned. Thus, the waters in the refuge are protected, but not by the MPA legislation (Dr. D. Payer, 2013, Pers. comm.).

5.4. FUTURE MPA DEVELOPMENT FOR SHARK CONSERVATION

Prioritising locations for new MPAs is difficult, but there are overarching trends that could be addressed in future MPA development. As this work focused on shark species, the priority areas identified are for the conservation of sharks.

Oceans with a high level of fishing for the target shark species and low MPA coverage are strong candidates for future MPA development. The East-central Atlantic Ocean would be a critical ocean basin to focus upon for new MPA development for the conservation of sharks, rays, and chimaeras (Table 3b). For the focal shark species, the Northwest Atlantic Ocean would be fitting for MPA development (Table 3b). Although large and generalised, these areas provide a starting point in MPA prioritisation. Accurate information on where species are caught, as by-catch or by targeted fisheries, will result in more focused areas for prioritisation.

Creating new MPAs can be difficult in areas with high levels of fishing, as economic and conservation priorities might conflict. However, MPAs can successfully aid in fisheries management, as designation of an MPA does not necessarily require the complete ban on fishing (Hilborn et al., 2004). Models have shown that MPAs can meet the needs of multiple stakeholders, both for conservation and economic activity (Klein et al., 2008). Providing adequate stakeholder engagement, in conjunction with political will and public support, it is possible for new MPA development in highly fished oceans.

In addition to areas of high fishing level, localities with high species richness can be used to identify priority areas for MPA development (Lucifora, Garcia & Worm, 2011). As seen in this work, areas around the equator have a high number of shark species. Research has also shown that there is high shark diversity around the continental shelves (Lucifora, Garcia & Worm, 2011). Selecting these priority areas could result in MPAs that have the capability to protect the greatest number of sharks.

5.5. Case Study: White Shark Migration

This research substantiates that there is a lack of data in species distributions and movements. Most of this study has made generalisations based on distributions and broad understandings of the species. This is because of the lack of research and available data at a finer scale; there are limited data available on species density and movements around the globe. Fine scale studies that track the movements of species will provide critical information needed to determine priority locations for future MPAs for sharks.

The available data on tagged white sharks (Weng et al., 2007) provides a glimpse into the way in which tagging data can help prioritise locations for MPAs based on the movements of the individuals. Results showed a high probability of finding white sharks off California and Hawaii, and in the Pacific Ocean. While there are a number of MPAs on either end of the migration path, there are none in between. The high probability of finding animals in this offshore area, informally coined the ‘White Shark Café’ (Jorgensen et al., 2010) makes this region a strong candidate for a new MPA for the protection of white sharks. One-third of the tagged sharks visited this area (Weng et al., 2007), and other research on tagged white sharks documents that a significant number of animals aggregate in the area (Jorgensen et al., 2010; Domeier & Nasby-Lucas, 2008).

The next steps would be to identify the reasons why white sharks go to the Café, and then to understand the stressors that sharks face when they are present in the area. The Café falls outside the EEZ of any country, complicating the ability to create an MPA in the area. Nevertheless, it is a key area to explore, and could potentially have a substantial positive impact on the protection and conservation status of white sharks.

5.6. Conclusion

The creation of MPAs has never been more necessary. The current network of MPAs covers just 2.53% of the world’s oceans, and 0.65% is designated no-take. The use of MPAs in the conservation of migratory species is challenging, and the current level of protection provided to a number of shark species is minimal. While new MPAs need to be created, it is vital that researchers focus on identifying areas that will provide the most effective protection to species, habitats, and ecosystems, while also being sensitive to economic and political factors. MPAs should be developed using the current data, and altered as new information arises. Governments need to be cognizant of the issues facing marine habitats and species, and understand the detrimental impact of human activities. It is also critical that current and new MPAs be effectively managed, to provide the best possible protection to habitats and species.

The creation of MPAs should extend beyond the coastline to create a network of protected areas that encompass and fully represent all ecosystems, thus providing stepping-stones for biodiversity throughout the oceans. The more research that is conducted to help understand movement patterns and critical habitats, the more effective the MPA network can become. There is still a significant amount of work to be done to meet global targets. However, when combined with other marine management and conservation efforts, an effective network of MPAs may help reduce population declines, assist in population recovery, and improve the status and health of marine species, habitats, and ecosystems.

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APPENDICES

APPENDIX I: LIST OF ALL AND PART NO-TAKE MPAS

No-take MPAs used in this analysis. Shaded lines are the MPAs that were added during this study. More information on country codes can be found at https://www.iso.org/.

Country	Name	Designation	No-take Category	No-Take Area (km^2)	Marine Area (km^2)	Total Area (km^2)
ABNJ	South Orkney Islands Southern Shelf Marine Protected Area	Marine Protected Area	All	93818.88	93818.88	93818.88
ASM	Rose Atoll Marine National Monument	Marine National Monument	All	34837.9	34837.9	34837.9
AUS	Heard and McDonald Islands	World Heritage Site	All	6219.03	6219.03	6589.03
AUS	Coral Sea Reserves (Coringa-Herald and Lihou Reefs and Cays)	Wetland of International Importance (Ramsar Convention)	All	17289.2	17289.2	17289.2
AUS	Sinclair Island	Conservation Park	All	0.0046	0.0046	0.0046
AUS	Seal Rocks	Nature Reserve	All	0.02	0.02	0.02
AUS	Bushrangers Bay	Aquatic Reserve	All	0.04	0.04	0.04
AUS	Lancelin Island Lagoon	Fish Habitat Protection Area	All	0.082	0.082	0.082
AUS	Rocky Island (North)	Conservation Park	All	0.13	0.13	0.17
AUS	Eagle Rock	Marine Sanctuary	All	0.17	0.17	0.17
AUS	Barwon Bluff	Marine Sanctuary	All	0.17	0.17	0.17
AUS	Cabbage Tree Bay	Aquatic Reserve	All	0.2	0.2	0.2
AUS	Rocky Island (South)	Conservation Park	All	0.22	0.22	0.22
AUS	Point Danger	Marine Sanctuary	All	0.25	0.25	0.25
AUS	Merri	Marine Sanctuary	All	0.25	0.25	0.25
AUS	The Arches	Marine Sanctuary	All	0.45	0.45	0.45
AUS	Mushroom Reef	Marine Sanctuary	All	0.8	0.8	0.8
AUS	Ricketts Point	Marine Sanctuary	All	1.15	1.15	1.15
AUS	Point Cooke	Marine Sanctuary	All	2.9	2.9	2.9
AUS	Aldinga Reef	Aquatic Reserve	All	6.23	6.23	6.23
AUS	Churchill Island	Marine National Park	All	6.7	6.7	6.7
AUS	Bales Beach	Aquatic Reserve	All	7.21	7.21	10.11
AUS	Ballina	Nature Reserve	All	7.21	7.21	7.21
AUS	Yaringa	Marine National Park	All	9.8	9.8	9.8
AUS	American River	Aquatic Reserve	All	15.49	15.49	15.49
AUS	Corner Inlet	Marine National Park	All	15.5	15.5	15.5
AUS	Bunurong	Marine National Park	All	21	21	21
AUS	Discovery Bay	Marine National Park	All	27.7	27.7	27.7
AUS	Port Phillip Heads	Marine National Park	All	35.8	35.8	35.8
AUS	Cape Howe	Marine National Park	All	40.5	40.5	40.5
AUS	Barrow Island	Marine Park	All	41.69	41.69	41.69
AUS	Twelve Apostles	Marine National Park	All	75	75	75
AUS	Mermaid Reef	Marine National Nature Reserve	All	539.87	539.87	539.87
AUS	Shark Bay	Marine Park	All	7118.63	7118.63	7118.63
AUS	Lihou Reef	National Nature Reserve	All	8436.7	8436.7	8436.7
AUS	Coringa-Herald	National Nature Reserve	All	8852.61	8852.61	8852.61
AUS	Goose Island	Aquatic Reserve	All	0.69	0.69	0.69
AUS, HMD	Heard Island and McDonald Islands	Marine Reserve	All	64598.48	64598.48	64598.48

BHS	Exuma Cays Land and Sea Park	National Park	All	364.512	364.67	455.84
BLZ	Caye Bokel	Spawning Aggregation Site Reserve	All	5.5794	5.5794	5.568450156
BLZ	Halfmoon Caye	Natural Monument	All	39.541382	39.541382	39.2545073
BLZ	Laughing Bird Caye	National Park	All	40.952222	40.952222	40.95014014
BLZ	Blue Hole	Natural Monument	All	4.139937	4.139937	4.139937
BLZ	Sandbore	Spawning Aggregation Site Reserve	All	4.471577	4.471577	5.179955986
BLZ	South Point	Spawning Aggregation Site Reserve	All	5.28882	5.28882	5.438954797
BLZ	Emily or Caye Glory	Spawning Aggregation Site Reserve	All	5.467052	5.467052	5.467052
BLZ	Bacalar Chico	National Park	All	22.55	22.55	113.9109146
BLZ	Caye Caulker	Marine Reserve	All	39.13	39.13	39.13
BMU	Vixen	Protected Area	All	0.031	0.031	0.031
BMU	Commissioner's Point Area	Protected Area	All	0.126	0.126	0.126
BMU	Xing Da Area	Protected Area	All	0.126	0.126	0.126
BMU	Walsingham	Marine Reserve	All	0.2491	0.2491	0.2491
BMU	Cristobal Colon	Protected Area	All	0.283	0.283	0.283
BMU	North East Breaker	Protected Area	All	0.283	0.283	0.283
BMU	Taunton	Protected Area	All	0.283	0.283	0.283
BMU	Aristo	Protected Area	All	0.283	0.283	0.283
BMU	Mills Breaker	Protected Area	All	0.283	0.283	0.283
BMU	The Cathedral	Protected Area	All	0.283	0.283	0.283
BMU	Kate	Protected Area	All	0.283	0.283	0.283
BMU	Tarpon Hole	Protected Area	All	0.283	0.283	0.283
BMU	Marie Celeste	Protected Area	All	0.283	0.283	0.283
BMU	North Carolina	Protected Area	All	0.283	0.283	0.283
BMU	Airplane	Protected Area	All	0.283	0.283	0.283
BMU	Darlington	Protected Area	All	0.283	0.283	0.283
BMU	L'Herminie	Protected Area	All	0.283	0.283	0.283
BMU	Lartington	Protected Area	All	0.283	0.283	0.283
BMU	Montana	Protected Area	All	0.283	0.283	0.283
BMU	Snake Pit	Protected Area	All	0.283	0.283	0.283
BMU	Hog Breaker	Protected Area	All	0.283	0.283	0.283
BMU	Caraquet	Protected Area	All	0.283	0.283	0.283
BMU	Madiana	Protected Area	All	0.283	0.283	0.283
BMU	Pelinaion and Rita Zovetto	Protected Area	All	0.785	0.785	0.785
BMU	Hermes and Minnie Breslauer	Protected Area	All	0.785	0.785	0.785
BMU	Constellation Area	Protected Area	All	0.785	0.785	0.785
BMU	Blanche King	Protected Area	All	1	1	1
BMU	Eastern Blue Cut	Protected Area	All	1.13	1.13	1.13
BMU	South West Breaker Area	Protected Area	All	1.131	1.131	1.131
BMU	North Rock	Protected Area	All	3.142	3.142	3.142
BRA	Comboios	Reserva Biologica	All	8.33	8.33	8.33
BRA	Atol das Rocas	Reserva Biologica	All	362.49	362.49	362.49
BRB	Folkestone	Marine Reserve	All	2.277	2.277	2.3
CAN	Wapusk	Parc national	All	803.25	803.25	11475
CHL	Las Cruces	Area Marina Costera Protegida	All	0.144	0.144	0.144
COK	Maina Lagoon	Ra'ui	All	0.021	0.021	0.021
COK	Ootu Reserve	Ra'ui	All	0.022	0.022	0.022
COK	Pouara	Ra'ui	All	0.05	0.05	0.05
COK	Aroa	Ra'ui	All	0.23	0.23	0.23
COK	Tikioki	Marine Sanctuary	All	0.4	0.4	0.4
COK	Titikaveka	Ra'ui	All	0.5	0.5	0.5
COK	Maina Reserve	Reserve	All	0.8	0.8	0.8
COK	Aroko/Muri	Ra'ui	All	0.87	0.87	0.87
COK	Takutea	Other Area	All	1.2	1.2	1.2
COK	Motukitiu Reserve	Ra'ui	All	4.07	4.07	4.07
COL	Malpelo Fauna and Flora Sanctuary	World Heritage Site	All	8571.5	8571.5	8575
COL	Malpelo	Santuario De Fauna Y Flora	All	9741.24	9741.24	9744.74

CYM	Little Sound (Grand Cayman)	Environmental Zone	All	10.28	10.28	17.31
CYP	Lara-Toxeftra	Marine Reserve	All	5.5	5.5	6.5
ESP	Ses Negres	Marine Reserve	All	0.42	0.42	0.42
FRA	Carry-le-Rouet	Marine Protected Zone: aquaculture concession	All	0.85	0.85	0.85
FRA	Cap Couronne	Marine Protected Zone: aquaculture concession	All	2.1	2.1	2.1
FSM	Nahtik Marine Sanctuary	Marine Protected Area	All	0.1905	0.1905	0.1905
IOT	Cow Island	Strict Nature Reserve	All	112.93	112.93	112.93
IOT	Nelson Island	Strict Nature Reserve	All	118.16	118.16	118.92
IOT	Danger Island	Strict Nature Reserve	All	131.99	131.99	133.04
IOT	Three Brothers and Resurgent Islands	Strict Nature Reserve	All	187.36	187.36	187.36
IOT	Eastern Peros Banhos Atoll	Strict Nature Reserve	All	624.22	624.22	822.9
IOT	British Indian Ocean Territory Marine Protected Area (Chagos)	Marine Protected Area	All	640000	640000	640000
ITA	Oasi blu di Gianola	Public Maritime Domain	All	0.05	0.05	0.05
ITA	Oasi blu di Scogli di Isca	Public Maritime Domain	All	0.06	0.06	0.06
ITA	Oasi blu di Villa di Tiberio	Public Maritime Domain	All	0.104	0.104	0.104
ITA	Oasi blu di Monte Orlando	Public Maritime Domain	All	0.3	0.3	0.3
ITA	TegnÌ_e of Chioggia	No-take Zone	All	26.5	26.5	26.5
KEN	Malindi	Marine National Park	All	6.3	6.3	6.3
KEN	Mombasa	Marine National Park	All	10	10	10
KEN	Watamu	Marine National Park	All	10	10	10
KEN	Kisite	Marine National Park	All	28	28	28
MNP	Sasanhaya Bay Fish Reserve	Marine Conservation Area	All	0.844	0.844	0.844
MNP	Managaha Marine Conservation Area	Marine Conservation Area	All	4.9899	4.9899	5.0435
NCL	SÌ¬che-Croissant	Reserve Speciale de Faune	All	0.1	0.1	0.1
NCL	Aiguille (RÌ©serve spÌ©ciale marine de la baie de Prony)	Special Marine Reserve	All	0.125	0.125	0.125
NCL	Parc du lagon de Bourail: Ile Verte	Special Marine Reserve	All	0.84	0.84	0.84
NCL	L'Ilot Casy (RÌ©serve spÌ©ciale marine de la baie de Prony)	Special Marine Reserve	All	1.45	1.45	1.45
NCL	Parc du lagon sud: Ile aux Canards	Special Marine Reserve	All	1.76	1.76	1.76
NCL	Parc du lagon sud: Ilot Bailly	Special Marine Reserve	All	2.15	2.15	2.15
NCL	Parc du lagon sud: Ilot Signal	Special Marine Reserve	All	2.43	2.43	2.43
NCL	Parc du lagon sud: Ilot Maitre	Special Marine Reserve	All	7.65	7.65	7.65
NCL	Parc du lagon de Bourail: PoÌ©	Special Marine Reserve	All	28	28	28
NIU	Anono (Namoui)	Marine Reserve	All	0.2767	0.2767	0.2767
NZL	Whangarei Harbour	Marine Reserve	All	2.537	2.537	2.537
NZL	Te Awaatu Channel (The Gut)	Marine Reserve	All	0.93	0.93	0.93
NZL	Pohatu (Flea Bay)	Marine Reserve	All	2.15	2.15	2.15
NZL	Te Paepae o Aotea (Volkner Rocks)	Marine Reserve	All	2.6724	2.6724	2.6724

NZL	Hawea (Clio Rocks)	Marine Reserve	All	4.11	4.11	4.11
NZL	Kutu Parera (Gaer Arm)	Marine Reserve	All	4.33	4.33	4.33
NZL	Te Angiangi	Marine Reserve	All	4.46	4.46	4.46
NZL	Te Hapua (Sutherland Sound)	Marine Reserve	All	4.54	4.54	4.54
NZL	Kahukura (Gold Arm)	Marine Reserve	All	4.64	4.64	4.64
NZL	Motu Manawa - Pollen Island	Marine Reserve	All	5	5	5
NZL	Cape Rodney ‰ÛÒ Okakari Point Marine Reserve	Marine Reserve	All	5.18	5.18	5.18
NZL	Westhaven - Te Taitapu	Marine Reserve	All	5.36	5.36	5.36
NZL	Taipari Roa (Elizabeth Island)	Marine Reserve	All	6.13	6.13	6.13
NZL	Long Island-Kokomohua	Marine Reserve	All	6.19	6.19	6.19
NZL	Piopiotahi (Milford Sound)	Marine Reserve	All	6.9	6.9	6.9
NZL	Te Matuku (Waiheke Island)	Marine Reserve	All	6.9	6.9	6.9
NZL	Te Wanganui-a-Hei (Cathedral Cove)	Marine Reserve	All	8.4	8.4	8.4
NZL	Horoirangi	Marine Reserve	All	9.037	9.037	9.037
NZL	Long Bay - Okura	Marine Reserve	All	9.8	9.8	9.8
NZL	Mayor Island (Tuhua)	Marine Reserve	All	10.6	10.6	10.6
NZL	Ulva Island-Te Wharawhara	Marine Reserve	All	10.75	10.75	10.75
NZL	Taumoana (Five Finger Peninsula)	Marine Reserve	All	14.66	14.66	14.66
NZL	Tonga Island	Marine Reserve	All	18.35	18.35	18.35
NZL	Parininihi	Marine Reserve	All	18.44	18.44	18.44
NZL	Poor Knights Islands	Marine Reserve	All	18.9	18.9	18.9
NZL	Moana Uta (Wet Jacket Arm)	Marine Reserve	All	20.07	20.07	20.07
NZL	Kapiti	Marine Reserve	All	21.67	21.67	21.67
NZL	Te Tapuwae O Rongokako	Marine Reserve	All	24.52	24.52	24.52
NZL	Te Tapuwae o Hua (Long Sound)	Marine Reserve	All	36.72	36.72	36.72
NZL	Auckland Islands / Motu Maha	Marine Reserve	All	4980	4980	4980
NZL	Kermadec Islands	Marine Reserve	All	7480	7480	7480
PHL	Nalayag Point	Fishery Refuge and Sanctuary	All	0.01	0.01	0.01
PHL	Binalan	Restricted Area	All	0.0137	0.0137	0.0137
PHL	Looc	Marine Sanctuary	All	0.0251	0.0251	0.0251
PHL	Balicasag Island	Fish Sanctuary	All	0.0344	0.0344	0.0344
PHL	Basdiot	Fish Sanctuary	All	0.0417	0.0417	0.0417
PHL	Jandayan Sur	Marine Sanctuary	All	0.0465	0.0465	0.0465
PHL	Catarman	Marine Sanctuary	All	0.0474	0.0474	0.0474
PHL	Camboang	Marine Sanctuary	All	0.0482	0.0482	0.0482
PHL	Botigues	Marine Sanctuary	All	0.05	0.05	0.05
PHL	Nagolon Island	Fish Sanctuary	All	0.05	0.05	0.05
PHL	Bolod	Fish Sanctuary	All	0.0542	0.0542	0.0542
PHL	Sta. Filomena	Marine Sanctuary	All	0.0562	0.0562	0.0562
PHL	Magkalagom	Restricted Area	All	0.0568	0.0568	0.0568
PHL	Agan-an	Marine Reserve	All	0.06	0.06	0.06
PHL	Sibulan	Marine Reserve	All	0.06	0.06	0.06
PHL	Masaplod Norte	Marine Reserve	All	0.06	0.06	0.06
PHL	Poblacion	Marine Sanctuary	All	0.0638	0.0638	0.0638
PHL	Santo Nino	Marine Sanctuary	All	0.071	0.071	0.071
PHL	Tubod	Marine Sanctuary	All	0.075	0.075	0.075
PHL	Doljo	Fish Sanctuary	All	0.0771	0.0771	0.0771
PHL	Bil-isan	Fish Sanctuary	All	0.0776	0.0776	0.081624
PHL	Maslog	Marine Sanctuary	All	0.08	0.08	0.08
PHL	Danao	Fish Sanctuary	All	0.0807	0.0807	0.0807
PHL	Saavedra	Fish Sanctuary	All	0.0813	0.0813	0.0813
PHL	Hilantagaan	Fish Sanctuary	All	0.089	0.089	0.089
PHL	Arbor	Marine Sanctuary	All	0.0899	0.0899	0.0899
PHL	Poblacion District 1	Marine Reserve	All	0.09	0.09	0.09
PHL	Banban	Fishery Refuge and Sanctuary	All	0.0903	0.0903	0.0903
PHL	North Granada	Marine Sanctuary	All	0.0935	0.0935	0.0935

PHL	Lawis	Seagrass Sanctuary	All	0.099	0.099	0.099
PHL	Biasong	Marine Fish Sanctuary	All	0.1	0.1	0.1
PHL	Doong	Marine Sanctuary	All	0.1	0.1	0.1
PHL	Luyong-baybay	Marine Sanctuary	All	0.1	0.1	0.1
PHL	Pantudlan	Fish Sanctuary	All	0.1	0.1	0.1
PHL	Patao	Marine Sanctuary	All	0.1	0.1	0.1
PHL	Sto. NiÌ±o	Seagrass Sanctuary	All	0.1	0.1	0.1
PHL	Tugas	Marine Sanctuary	All	0.1	0.1	0.1
PHL	Tuka	Marine Sanctuary	All	0.1	0.1	0.1
PHL	Alang-alang	Marine Sanctuary	All	0.1	0.1	0.1
PHL	Kaong-Kod	Marine Sanctuary	All	0.1	0.1	0.1
PHL	Legaspi	Marine Sanctuary	All	0.1035	0.1035	0.1035
PHL	Madangog	Fish Sanctuary	All	0.1045	0.1045	0.1045
PHL	Pasil	Marine Sanctuary	All	0.1045	0.1045	0.1045
PHL	Madredijos	Marine Sanctuary	All	0.1078	0.1078	0.1078
PHL	Tulic	Marine Sanctuary	All	0.1099	0.1099	0.1099
PHL	Pamilacan Island	Fish Sanctuary	All	0.119	0.119	0.119
PHL	Lajog	Marine Sanctuary	All	0.1196	0.1196	0.1196
PHL	Balud-Consolacion	Marine Sanctuary	All	0.12	0.12	0.12
PHL	Binlod	Marine Sanctuary	All	0.12	0.12	0.12
PHL	Bogo	Marine Sanctuary	All	0.12	0.12	0.12
PHL	Langtad	Marine Sanctuary	All	0.12	0.12	0.12
PHL	Talo-ot	Marine Sanctuary	All	0.12	0.12	0.12
PHL	Sta. Cruz	Marine Sanctuary	All	0.1201	0.1201	0.1201
PHL	Macaas	Marine Sanctuary	All	0.127	0.127	0.127
PHL	Caticugan	Fish Sanctuary	All	0.1351	0.1351	0.1351
PHL	Guinacot	Marine Sanctuary	All	0.137	0.137	0.137
PHL	Talima	Fish Sanctuary	All	0.141	0.141	0.141
PHL	Lawis	Marine Sanctuary	All	0.1451	0.1451	0.1451
PHL	Gilutongan Island	Marine Sanctuary	All	0.1489	0.1489	0.1489
PHL	Matutinao	Marine Sanctuary	All	0.15	0.15	0.15
PHL	Tarong	Fish Sanctuary, Marine Park and Fishery Reserve	All	0.15	0.15	0.15
PHL	Anas	Fish Sanctuary	All	0.1562	0.1562	0.1562
PHL	Nahawan	Seagrass Sanctuary	All	0.1583	0.1583	0.1583
PHL	Barili	Marine Sanctuary	All	0.159	0.159	0.159
PHL	Colase	Marine Sanctuary	All	0.16	0.16	0.16
PHL	Jagoliao	Marine Refuge and Sanctuary	All	0.16	0.16	0.16
PHL	Poblacion	Marine Sanctuary	All	0.1681	0.1681	0.1681
PHL	Talisay	Fish Sanctuary	All	0.1745	0.1745	0.1745
PHL	Tayong Oriental	Marine Sanctuary	All	0.18	0.18	0.18
PHL	Pulang Yuta	Fishery Refuge and Sanctuary	All	0.1843	0.1843	0.1843
PHL	Pandanon	Marine Sanctuary	All	0.2	0.2	0.2
PHL	Sulangan	Marine Sanctuary	All	0.2	0.2	0.2
PHL	Banacon Island	Marine Sanctuary	All	0.2	0.2	0.2
PHL	Batasan	Marine Sanctuary	All	0.21	0.21	0.21
PHL	Liboron	Seagrass Sanctuary	All	0.222	0.222	0.222
PHL	Masigpit Island	Sanctuary	All	0.2261	0.2261	0.2261
PHL	Daang Lungsod-Guiwang	Marine Sanctuary	All	0.2271	0.2271	0.2271
PHL	Luyang	Fish Sanctuary	All	0.23	0.23	0.23
PHL	Pasil Reef	Fishery Refuge and Sanctuary	All	0.24	0.24	0.24
PHL	Tayong Occidental	Marine Sanctuary	All	0.24	0.24	0.24
PHL	Bato	Seagrass and Fish Sanctuary	All	0.25	0.25	0.25
PHL	Lambog	Seagrass and Fish Sanctuary	All	0.25	0.25	0.25
PHL	Bato	Fish Sanctuary	All	0.25	0.25	0.25
PHL	Kinawahan	Fish Sanctuary	All	0.27	0.27	0.27
PHL	Tulapos	Marine Sanctuary	All	0.2722	0.2722	0.2722
PHL	Bitoon	Marine Sanctuary	All	0.2785	0.2785	0.2785
PHL	Jandayan Norte	Marine Sanctuary	All	0.3	0.3	0.3
PHL	Mantatao	Marine Sanctuary	All	0.3169	0.3169	0.3169
PHL	Busogon	Fish Sanctuary	All	0.32	0.32	0.32
PHL	Tambongon	Fish Sanctuary	All	0.32	0.32	0.32
PHL	Magtongtong	Fish Sanctuary	All	0.3285	0.3285	0.3285
PHL	Victoria	Marine Sanctuary	All	0.36	0.36	0.36
PHL	Sumilon Island	Fish Sanctuary	All	0.3975	0.3975	0.3975

PHL	Pinamgo	Marine Sanctuary	All	0.4	0.4	0.4
PHL	Sto. NiÌ±o-Basiawan	Fish Sanctuary	All	0.4	0.4	0.4
PHL	Balasinon	Fish Sanctuary	All	0.5	0.5	0.5
PHL	Handumon	Marine Sanctuary	All	0.5	0.5	0.5
PHL	Padada	Fish Sanctuary	All	0.5	0.5	0.5
PHL	San Isidro	Marine Sanctuary	All	0.5156	0.5156	0.5156
PHL	Sta. Cruz	Seagrass Sanctuary	All	0.6772	0.6772	0.6772
PHL	Nalusuan	Marine Sanctuary	All	0.83	0.83	0.83
PHL	Poblacion,Alcoy	Marine Sanctuary	All	0.12	0.12	0.12
PHL	Sta. Filomena	Marine Sanctuary	All	0.115	0.115	0.115
PHL	Manyukos Island	Marine Sanctuary	All	2.3249	2.3249	2.3249
PHL	Port Barton	Marine Park	All	744.83	744.83	744.83
PLW	Ngkisaol Sardines	Sanctuary	All	0.008	0.008	0.008
PLW	Tululeu Seagrass	Conservation Area	All	0.8	0.8	0.8
PLW	Ngemai	State Conservation Area	All	1	1	1
PLW	Ngerumekoal Spawning Area	Conservation Area	All	3.5	3.5	3.5
PLW	Ngederrak Reef	Conservation Area	All	6	6	6
PLW	Ngermasech	Conservation Area	All	7	7	7
PLW	Ngerukuid (Ngerukewid) Islands Preserve	National Preserve	All	12	12	12
PLW	Ebiil	Conservation Area	All	15	15	15
PNG	Sinub	Wildlife Management Area	All	0.06	0.06	0.06
PNG	Tab Island	Wildlife Management Area	All	0.0492	0.0492	0.049
PNG	Simbine Coast	Wildlife Management Area	All	0.362	0.362	0.362
PNG	Laugum Island	Wildlife Management Area	All	0.729	0.729	0.729
PNG	Silom	Locally Managed Marine Area	All	0.92	0.92	0.92
PNG	Ungakum	Locally Managed Marine Area	All	0.96	0.96	0.96
PNG	M'Buke	Locally Managed Marine Area	All	1.022	1.022	1.022
PYF	Taiaro	Strict Nature Reserve	All	9.23	9.23	9.23
PYF	Bellinghausen (Motu One)	Territorial Reserve	All	9.6	9.6	9.6
PYF	Eiao Island	Natural Reserve	All	43.8	43.8	43.8
RUS	Dzhugdzhursky	Zapovednik	All	537	537	8599.56
RUS	Kronotsky	Zapovednik	All	1350	1350	11476.1937
RUS	Bolshoy Arktichesky / Great Arctic	Zapovednik	All	9809.34	9809.34	41692.22
RUS	Ostrov Vrangelya / Wrangel Island	Zapovednik	All	14635.7	14635.7	22256.5
RUS	Magadansky	Zapovednik	All	381	381	8838.17
SLB	Nusa Hope/Heloro	Marine Protected Area	All	1.138424	1.138424	1.138424
SLB	Kere hira	Marine Protected Area/Tabu	All	0.0009	0.0009	0.0009
SLB	Loreto, Lalana, Su‰Ûªu,	Marine Protected Area/Tabu	All	0.018	0.018	0.018
SLB	Wahere	Marine Protected Area/Tabu	All	0.03	0.03	0.03
SLB	Waimamauru	Marine Protected Area/Tabu	All	0.051	0.051	0.051
SLB	Hot Spot Reef	Marine Protected Area	All	0.051	0.051	0.051
SLB	Karikasi Reef	Marine Protected Area	All	0.06	0.06	0.06
SLB	Sisili	Marine Protected Area/Tabu	All	0.068	0.068	0.068
SLB	Taburu	Marine Protected Area/Tabu	All	0.07	0.07	0.07
SLB	Niuhoa	Marine Protected Area/Tabu	All	0.075	0.075	0.075
SLB	Tulagi Island	Marine Protected Area/Tabu	All	0.107	0.107	0.107
SLB	Pusinau Reef	Marine Protected Area	All	0.11	0.11	0.11

SLB	Nusa Roviana	Marine Protected Area	All	0.15	0.15	2.6677
SLB	Leva Point	Marine Protected Area	All	0.15	0.15	0.15
SLB	Penjapenja Reef	Marine Protected Area	All	0.15	0.15	0.15
SLB	Renjo Reef MPA	Marine Protected Area	All	0.15	0.15	0.15
SLB	Maravaghi	Marine Protected Area/Tabu	All	0.154	0.154	0.154
SLB	Nu'u Marere	Marine Protected Area/Tabu	All	0.158	0.158	0.158
SLB	Roderic bay	Marine Protected Area/Tabu	All	0.198	0.198	0.198
SLB	Niami Reef	Marine Protected Area	All	0.2	0.2	0.2
SLB	Hatare (Tariairaro)	Marine Protected Area/Tabu	All	0.219	0.219	0.219
SLB	Rabakela	Marine Conservation Area	All	0.22	0.22	0.22
SLB	Varu North Reef	Marine Protected Area	All	0.23	0.23	0.23
SLB	Suvania Reef	Marine Protected Area	All	0.25	0.25	0.25
SLB	Inuzaru Island	Marine Protected Area	All	0.25	0.25	0.25
SLB	Jericho Reef	Marine Protected Area	All	0.3	0.3	0.3
SLB	Kogulavata Reef	Marine Protected Area	All	0.32	2.91	2.91
SLB	Bakiha Reef	Marine Protected Area	All	0.32	0.32	0.32
SLB	Tebono	Marine Protected Area	All	0.33	0.33	0.33
SLB	Duduli Rereghana	Marine Protected Area/Tabu	All	0.3568	0.3568	0.3568
SLB	Salavo	Marine Protected Area/Tabu	All	0.365	0.365	0.365
SLB	Kekehe	Marine Protected Area	All	0.41	0.41	0.41
SLB	Nusatupe Reef	Marine Protected Area	All	0.48	0.48	0.48
SLB	Simeruka	Marine Protected Area/Tabu	All	0.481	0.481	0.481
SLB	Alite	Marine Protected Area/Tabu	All	0.59	0.59	0.59
SLB	Kibelifolu	Marine Protected Area/Tabu	All	0.729	0.729	0.729
SLB	Chivoko	Marine Conservation Area	All	0.84	0.84	0.84
SLB	Olive	Marine Protected Area	All	0.99	0.99	1.5668
SLB	Abalolo, Gwaedalo, Ailau (AGA)	Marine Protected Area/Tabu	All	1	1	1
SLB	Dunde Shark Point	Marine Protected Area/Tabu	All	1	1	1
SLB	Paipai	Marine Protected Area/Tabu	All	1.044	1.044	1.044
SLB	Njari Island	Marine Protected Area	All	1.07	1.07	1.07
SLB	Redman	Marine Conservation Area	All	1.09	1.09	1.09
SLB	Petu Island	Marine Protected Area	All	1.2	1.2	1.2
SLB	Ha'apai	Marine Protected Area	All	1.261	1.261	1.261
SLB	Opele	Marine Protected Area/Tabu	All	1.5	1.5	1.5
SLB	Tobo	Marine Protected Area/Tabu	All	1.5	1.5	1.5
SLB	Vaininoturu Island	Marine Protected Area	All	1.5	1.5	1.5
SLB	Zinoa	Marine	All	1.5	1.5	1.5

		Conservation Area				
SLB	Variparui Island	Marine Protected Area	All	1.6	1.6	1.6
SLB	Babanga Reef	Marine Protected Area	All	1.82	1.82	1.82
SLB	Vena Island	Marine Protected Area	All	2.6	2.6	2.6
SLB	Marapa-Niu	Marine Protected Area/Tabu	All	2.63	2.63	2.63
SLB	Alale, Grant Island	Marine Protected Area	All	2.78	2.78	2.78
SLB	Sasavele/NB	Marine Protected Area/Tabu	All	3	3	3
SLB	Ladosama Reef	Marine Protected Area	All	3.13	3.13	3.13
SLB	Parama	Marine Conservation Area	All	3.47	3.47	3.47
SLB	Naru Reef	Marine Protected Area	All	3.5	3.5	3.5
SLB	Rendova Harbor	Marine Protected Area/Tabu	All	4	4	4
SLB	Pipa/Kororo (Marovo)	Marine Protected Area/Tabu	All	5	5	5
SLB	Tetepare	Marine Protected Area	All	11	11	17
SLB	Grant Island, Patuparoana	Marine Protected Area	All	14.84	14.84	14.84
SLB	Saeraghi Reef	Marine Protected Area	All	24.57	24.57	24.57
SLB	Arnavon Islands	Marine Conservation Area	All	157.8	157.8	157.8
SLB	Baraulu/Bule Lavata	Marine Protected Area	All	1.032	1.032	1.032
SLB	Tetepare	Marine Protected Area	All	11	11	17
SYC	Cousin Island	Special Reserve	All	0.012	0.012	0.015
SYC	Aride Island	Special Reserve	All	0.7	0.7	0.7
SYC	Baie Ternay	Marine National Park	All	0.8628	0.8628	0.8727
SYC	Port Launay	Marine National Park	All	1.5426	1.5426	1.5426
SYC	Ile Cocos, Ile La Fouche, Ilot Platte	Marine National Park	All	1.6548	1.6548	1.7053
SYC	Ste. Anne	Marine National Park	All	9.9604	9.9604	13.8475
SYC	Curieuse	Marine National Park	All	12.8369	12.8369	15.7815
SYC	Silhouette Marine	Marine National Park	All	16.55	16.55	30.45
SYC	Aldabra	Special Reserve	All	142	142	350
THA	Mu Ko Surin	Marine National Park	All	102.5	102.5	141.25
TKL	Atafu Marine Conservation Area	Marine Reserve	All	0.2	0.2	0.2
TKL	Nukunonu Marine Conservation Area	Marine Reserve	All	0.25	0.25	0.25
TKL	Fakaofo Conservation Area	Reserve	All	5	5	10
TUR	Kekova	Specially Protected Area	All	115	115	260
TUV	Momea Tapu	Marine Managed Area	All	2.52	2.52	2.52
TUV	Nukufetau	Marine Managed Area	All	11.746	11.746	11.746
TUV	Funafuti	Conservation Area	All	35.95	35.95	35.95
TZA	Chumbe Island Coral Park (CHICOP)	Marine Sanctuary and Forest Reserve	All	0.3	0.3	0.3
TZA	Maziwe Island	Marine Reserve	All	2.6	2.6	2.6
TZA	Dar es Salaam	Marine Reserve	All	26	26	26
UMI	Pacific Remote Islands	Marine National Monument	All	225038.9	225038.9	225038.9
USA	North Shore Alvar	State Nature Preserve	All	0.020234313	0.020234313	0.020234313

USA	Sund Rock	Conservation Area	All	0.28732725	0.28732725	0.28732725
USA	Orchard Rocks	Conservation Area	All	0.420873718	0.420873718	0.420873718
USA	Del Mar Landing	State Marine Reserve	All	0.554420186	0.554420186	0.554420186
USA	Skunk Point (Santa Rosa Island)	State Marine Reserve	All	3.605754639	3.605754639	3.605754639
USA	Punta Gorda	State Marine Reserve	All	5.362093037	5.362093037	5.362093037
USA	Big Sycamore Canyon	State Marine Reserve	All	5.738451266	5.738451266	5.738451266
USA	Judith Rock (San Miguel Island)	State Marine Reserve	All	11.77637037	11.77637037	11.77637037
USA	Scorpion (Santa Cruz Island)	State Marine Reserve	All	24.86392424	24.86392424	24.86392424
USA	Anacapa Island	State Marine Reserve	All	29.7687218	29.7687218	29.7687218
USA	Santa Barbara Island	State Marine Reserve	All	32.97383703	32.97383703	32.97383703
USA	Carrington Point (Santa Rosa Island)	State Marine Reserve	All	33.00216507	33.00216507	33.00216507
USA	South Point (Santa Rosa Island)	State Marine Reserve	All	33.7791627	33.7791627	33.7791627
USA	Big Creek	State Marine Reserve	All	37.49418263	37.49418263	37.49418263
USA	Gull Island (Santa Cruz Island)	State Marine Reserve	All	51.50846806	51.50846806	51.50846806
USA	Harris Point (San Miguel Island)	State Marine Reserve	All	65.16662957	65.16662957	65.16662957
USA	Vandenberg	State Marine Reserve	All	85.03672528	85.03672528	85.03672528
USA	Richardson Rock (San Miguel Island)	State Marine Reserve	All	106.1532547	106.1532547	106.1532547
USA	Tortuga	Marine Reserve	All	230.0479553	230.0479553	230.0479553
USA	Rose Atoll	National Wildlife Refuge	All	158.8	158.8	157.6860039
USA	Point Resistance	Special Closure	All	0.036421764	0.036421764	0.036421764
USA	Double Point/Stormy Stack	Special Closure	All	0.052609215	0.052609215	0.052609215
USA	Southeast Farallon	Special Closure B	All	0.052609215	0.052609215	0.052609215
USA	Zella M. Schultz/Protection Island	Seabird Sanctuary	All	0.12140588	0.12140588	0.12140588
USA	Egg (Devil's Slide) Rock to Devil's Slide	Special Closure	All	0.129499605	0.129499605	0.129499605
USA	Manele-Hulopoe	Marine Life Conservation District	All	0.18	0.18	1.25
USA	Brackett's Landing	Shoreline Sanctuary Conservation Area	All	0.190202546	0.190202546	0.190202546
USA	Wai'opae Tidepools	Marine Life Conservation District	All	0.198296271	0.198296271	0.198296271
USA	Hanauma Bay	Marine Life Conservation District	All	0.4087	0.4087	0.4087
USA	Southeast Farallon	Special Closure A	All	0.42492058	0.42492058	0.42492058
USA	Moro Cojo Slough	State Marine Reserve	All	0.453248619	0.453248619	0.453248619
USA	North Farallon Islands & Isle of St. James	Special Closure	All	0.550373323	0.550373323	0.550373323
USA	Natural Bridges	State Marine Reserve	All	0.639404302	0.639404302	0.639404302
USA	Lovers Point	State Marine Reserve	All	0.764857045	0.764857045	0.764857045
USA	Morro Bay	State Marine Reserve	All	0.801278809	0.801278809	0.801278809
USA	Russian River	Marine Recreational Management Area	All	0.914590963	0.914590963	0.914590963
USA	Carmel Pinnacles	State Marine Reserve	All	1.367839582	1.367839582	1.367839582
USA	Bird Island	Marine Sanctuary	All	1.4146	1.4146	1.464964286
USA	Point Reyes	Special Closure	All	1.671354283	1.671354283	1.671354283
USA	San Pedro	Underwater Archaeological	All	2.606179559	2.606179559	2.606179559

		Preserve State Park				
USA	Ahihi-Kinau	Natural Area Reserve	All	3.27	3.27	8.28
USA	Elkhorn Slough	State Marine Reserve	All	3.905222476	3.905222476	3.905222476
USA	Asilomar	State Marine Reserve	All	3.92545679	3.92545679	3.92545679
USA	Grays Harbor	National Wildlife Refuge	All	5.58	5.58	7.494789664
USA	Canal Luis PeÌ±a	Natural Reserve	All	6.329293215	6.329293215	6.329293215
USA	Mutton Snapper	Red Hind Spawning Aggregation Area	All	8.810020032	8.810020032	8.810020032
USA	Point Arena	State Marine Reserve	All	11.32312175	11.32312175	11.32312175
USA	East of St. Croix	Red Hind Spawning Aggregation Area	All	11.63473018	11.63473018	11.63473018
USA	Southeast Farallon Island	State Marine Reserve	All	13.86859837	13.86859837	13.86859837
USA	Point Lobos	State Marine Reserve	All	14.00214484	14.00214484	14.00214484
USA	Point Buchon	State Marine Reserve	All	17.27200987	17.27200987	17.27200987
USA	Footprint	State Marine Reserve	All	17.86285182	17.86285182	17.86285182
USA	Bodega Head	State Marine Reserve	All	24.13953582	24.13953582	24.13953582
USA	Point Reyes	State Marine Reserve	All	24.44709739	24.44709739	24.44709739
USA	Point Sur	State Marine Reserve	All	25.24432933	25.24432933	25.24432933
USA	Piedras Blancas	State Marine Reserve	All	27.00066773	27.00066773	27.00066773
USA	Abrir La Sierra Bank	Red Hind Spawning Aggregation Area	All	29.291192	29.291192	29.291192
USA	Bajo de Cico	Red Hind Spawning Aggregation Area	All	30.24220473	30.24220473	30.24220473
USA	Montara	State Marine Reserve	All	30.48906335	30.48906335	30.48906335
USA	Tourmaline Bank	Red Hind Spawning Aggregation Area	All	31.22963922	31.22963922	31.22963922
USA	Hind Bank	Marine Conservation District	All	44.39408349	44.39408349	44.39408349
USA	North Farallon Islands	State Marine Reserve	All	46.79791991	46.79791991	46.79791991
USA	Stewarts Point	State Marine Reserve	All	62.28931021	62.28931021	62.28931021
USA	Lydonia Canyon	Closed Area	All	169.0900629	169.0900629	169.0900629
USA	Oceanographer Canyon	Closed Area	All	257.3683252	257.3683252	257.3683252
USA	Papahanaumokuakea	Marine National Monument	All	341362	341362	362023.9331
USA	Waikiki	Marine Life Conservation District	All	0.3	0.3	0.3
USA	Papahanaumokuakea	World Heritage Site	All	362075	362075	362075
VIR	Buck Island Reef	National Monument	All	75.3	75.3	76.84182837
ZAF	Marcus Island	Marine Protected Area	All	0.255079	0.255079	0.255079
ZAF	Helderberg	Marine Protected Area	All	2.398248	2.398248	2.398248
ZAF	Sardinia Bay	Marine Protected Area	All	12.912689	12.912689	12.912689
ZAF	Hluleka	Marine Protected Area	All	40.8923988	40.8923988	40.8923988
ZAF	Bird Island Group	Marine Protected Area	All	70.381937	70.381937	70.381937
ZAF	Dwesa - Cwebe	Marine Protected Area	All	192.9360235	192.9360235	192.9360235
ZAF	Tsitsikamma	Marine Protected Area	All	264.280382	264.280382	264.280382
ZAF	De Hoop	Marine Protected Area	All	288.9248	288.9248	288.9248
AUS	Macquarie Island	Nature Reserve	All^	815.38	815.38	873.0646

GUM	Guam	National Wildlife Refuge	All^	1.5	1.5	94
PHL	Batalang-Bato	Fish Sanctuary	All^	0.025	0.025	0.025
PHL	Bonbon	Seagrass Sanctuary	All^	0.0945	0.0945	0.0945
PHL	Casay Shoal	Marine Sanctuary	All^	0.1138	0.1138	0.12
PHL	Bulasa	Marine Sanctuary	All^	0.1198	0.1198	0.1198
PHL	Cagawasan	Seagrass Sanctuary	All^	0.21	0.21	0.21
PHL	Cabantian	Marine Sanctuary	All^	0.2222	0.2222	0.2222
PHL	Arthur's Rock	Fish Sanctuary	All^	0.25	0.25	0.25
PHL	Canhabaga	Marine Park	All^	0.28	0.28	0.28
PHL	Cathedral Rock	Fish Sanctuary	All^	0.44	0.44	0.44
PNG	Whal Island	Locally Managed Marine Area	All^	0.022	0.022	0.07
PNG	Sawasawaga	Locally Managed Marine Area	All^	0.1	0.1	0.1
PYF	IlÌ«t de Sable	Natural Reserve	All^	0.005	0.005	0.01
PYF	Mohotani Reserve Integrale	Natural Reserve	All^	7.75	7.75	15.5
PYF	Hatutu Island Reserve Integrale	Strict Nature Reserve	All^	9.05	9.05	18.1
CAN	Sirmilik	Parc national	All*	222	222	22200
CAN	Ukkusiksalik	Parc national	All*	3228	3228	20558
CAN	Quttinirpaaq	Parc national	All*	3275	3275	37775
AUS	Great Barrier Reef	World Heritage Site	Part	115000	331265	348700
AUS	Solitary Islands (Commonwealth Waters)	Marine Reserve	Part	0.79	152.3234	160
AUS	Towra Point	Aquatic Reserve	Part	5	14	14
AUS	Jervis Bay	Marine Park	Part	43.04	215	215
AUS	Solitary Islands	Marine Park	Part	86.5	715.3	715.3
AUS	Rowley Shoals	Marine Park	Part	211.29434	876.74	876.74
AUS	Montebello Islands	Marine Park	Part	286.6	583.75	583.75
AUS	Lord Howe Island	Marine Park	Part	962.08	3005	3005
AUS	Macquarie Island	Commonwealth Marine Reserve	Part	58000	161894.6566	161894.6566
AUS	Great Barrier Reef	Marine Park	Part	115395	343904.36	344003.54
AUS	Southwest	National Park	Part	99.43	177.53	6190.3229
AUS	Tasman Fracture	Commonwealth Marine Reserve	Part	692	42500.5575	42500.5575
AUS	Shark Bay, Western Australia	World Heritage Site	Part	1731.52	21973	15600
AUS	Murray	Commonwealth Marine Reserve	Part	12749	25803.1173	25803.1173
AUS	Flinders	Commonwealth Marine Reserve	Part	25812	27043.0568	27043.0568
AUS	Freycinet	Commonwealth Marine Reserve	Part	56793	57942.48	57942.48
BES	Saba	National Marine Park	Part	4.29	13	21.2
BES	St. Eustatius (Statia)	Marine Park	Part	4.9	27.5	27.5
BLZ	Hol Chan	Marine Reserve	Part	4.005	13.89	53.96966234
BLZ	Glover's Reef	Marine Reserve	Part	8.918	326.548624	350.6685953
BLZ	Port Honduras	Marine Reserve	Part	13.233	404.69	409.1371843
BLZ	Sapodilla Cayes	Marine Reserve	Part	30.417	156.18344	156.1843768
COL	Seaflower	Marine Protected Area	Part	2330	65000	65066.49
ESP	Illes Medes	Marine Reserve	Part	0.393	4.63	5.1278
FJI	Yavusa Nakaukilagi	Locally Managed Marine Area	Part	0.7	1.04	1.04
FJI	Yadua Taba Island	Locally Managed Marine Area	Part	1	1975.05	1975.05
FJI	Tikina Levuka (Ovalau)-Vuna	Locally Managed Marine Area	Part	1	9.88	9.88
FJI	Yavusa Cibaciba	Locally Managed Marine Area	Part	1	1.11	1.11
FJI	Vanua Navatu-Leya	Locally Managed Marine Area	Part	1.3	86.78	86.78
FJI	Yavusa Nabuna	Locally Managed Marine Area	Part	2	20.77	20.77
FJI	Rakiraki District	Locally Managed Marine Area	Part	15	584	584
FJI	Vanua Nasavusavu-Nagigi/Waivunia/Vivili/Nukubalavu/Yaroi	Locally Managed Marine Area	Part	20.6	56.6	56.6

FJI	Naigani	Locally Managed Marine Area	Part	0.03	662.24	662.24
FJI	Yavusa Natusara (Bulia, Dravuni village)	Locally Managed Marine Area	Part	0.07	20.6	20.6
FJI	Rakiraki	Locally Managed Marine Area	Part	0.13	2.09	2.09
FJI	Tavuki village/Natumua village/Baidamudamu/Solodamu village	Locally Managed Marine Area	Part	0.14	18.59	18.59
FJI	Solovola	Locally Managed Marine Area	Part	0.14	3.46	3.46
FJI	Mokoisa	Locally Managed Marine Area	Part	0.15	6.92	6.92
FJI	Matanuku village	Locally Managed Marine Area	Part	0.15	4.63	4.63
FJI	Uluiloli	Locally Managed Marine Area	Part	0.16	13.5714	13.5714
FJI	Namalata/Namuana	Locally Managed Marine Area	Part	0.19	3.18	3.18
FJI	Yauwe	Locally Managed Marine Area	Part	0.26	8.19	8.19
FJI	Muani	Locally Managed Marine Area	Part	0.28	6.9	6.9
FJI	Wailevu/Galoa/Soso villages	Locally Managed Marine Area	Part	0.29	44.82	44.82
FJI	Nakorotubu	Locally Managed Marine Area	Part	0.41	539.5	539.5
FJI	Tawake district	Locally Managed Marine Area	Part	0.43	57.77	57.77
FJI	Levuka	Locally Managed Marine Area	Part	0.44	2.39	2.39
FJI	Cevai village	Locally Managed Marine Area	Part	0.45	2.83	2.83
FJI	Muainuku	Locally Managed Marine Area	Part	0.45	2.39	2.39
FJI	Vanua Conua	Locally Managed Marine Area	Part	0.48	7.05	7.05
FJI	Nuku	Locally Managed Marine Area	Part	0.49	1.07	1.07
FJI	Navutulevu village	Locally Managed Marine Area	Part	0.54	2.18	2.18
FJI	Vanua Balavu-Namuana	Locally Managed Marine Area	Part	0.58	2.61	2.61
FJI	Naboutini village (Saqani district)	Locally Managed Marine Area	Part	0.6	67.19	67.19
FJI	Vanua Vaturova	Locally Managed Marine Area	Part	0.69	81.83	81.83
FJI	Yavusa Cawalevu	Locally Managed Marine Area	Part	0.75	0.91	0.91
FJI	Biaugunu/Lakeba/Natuvu/Vuniwai	Locally Managed Marine Area	Part	0.79	65.441	65.441
FJI	Ravitaki	Locally Managed Marine Area	Part	0.83	7.84	7.84
FJI	Yavusa Ulunivuaka	Locally Managed Marine Area	Part	0.83	1.7	1.7
FJI	Waitabu village	Locally Managed Marine Area	Part	0.95	148.15	148.18
FJI	Vanua Naboutini	Locally Managed Marine Area	Part	0.98	2.21	2.21
FJI	Gunu village	Locally Managed Marine Area	Part	1	173.299	173.299
FJI	Dawato-Malake/Navetau/Yasawa	Locally Managed Marine Area	Part	1	34.41	34.41
FJI	Naioconivonu	Locally Managed Marine Area	Part	1	4.05	4.05
FJI	Batiki-Manuku	Locally Managed Marine Area	Part	1	2.77	2.77
FJI	Namaqumaqua village	Locally Managed Marine Area	Part	1	2.2	2.2
FJI	Gasele	Locally Managed Marine Area	Part	1	1.65	1.65
FJI	Naivakarauniniu village	Locally Managed Marine Area	Part	1.09	6.81	6.81

FJI	Nasegai village	Locally Managed Marine Area	Part	1.09	4.08	4.08
FJI	Dawasamu/Nasinu/Natacileka/Natale-i-ra/Silana	Locally Managed Marine Area	Part	1.11	150.1	150.1
FJI	Batiki-Mua/Naigani/Yavu	Locally Managed Marine Area	Part	1.2	8.26	8.26
FJI	Malomalo	Locally Managed Marine Area	Part	1.29	2.19	2.19
FJI	Kumi/Naivuruvuru/Naloto/Navunimono/Sawa/Ucunivanua	Locally Managed Marine Area	Part	1.3	81.4284	81.4284
FJI	Joma village	Locally Managed Marine Area	Part	1.39	8.49	8.49
FJI	Nacomoto village	Locally Managed Marine Area	Part	1.48	7.66	7.66
FJI	Naikorokoro	Locally Managed Marine Area	Part	1.56	4.73	4.73
FJI	Saqani	Locally Managed Marine Area	Part	1.72	33.6	33.6
FJI	Yavusa Bucabuca	Locally Managed Marine Area	Part	1.8	2.21	2.21
FJI	Yavusa Kade	Locally Managed Marine Area	Part	1.87	3.72	3.72
FJI	Kadavu village	Locally Managed Marine Area	Part	2	22.14	22.14
FJI	Tikina Wai	Locally Managed Marine Area	Part	2.32	11	11
FJI	Namada/Votua/Vatuolalai/Tagaqe	Locally Managed Marine Area	Part	2.32	9	9
FJI	Yavusa Nakodu/Qalitu/Wailevu	Locally Managed Marine Area	Part	2.41	4.77	4.77
FJI	Vanua Balavu-Muamua	Locally Managed Marine Area	Part	2.47	17.43	17.43
FJI	Biausevu/Navola/Vanua Komave-Komave/Namatakula	Locally Managed Marine Area	Part	2.55	3.92	3.92
FJI	Daku village	Locally Managed Marine Area	Part	2.87	5.92	5.92
FJI	Vueti Navakavu	Locally Managed Marine Area	Part	2.94	18.71	18.71
FJI	Serua	Locally Managed Marine Area	Part	2.97	11.3	11.3
FJI	Raviravi District	Locally Managed Marine Area	Part	3	63.3	63.3
FJI	Sawau District	Locally Managed Marine Area	Part	3	29.41	29.41
FJI	Yavusa Matanimudu	Locally Managed Marine Area	Part	3	10.65	10.65
FJI	Yavusa Werelevu and Nagusu	Locally Managed Marine Area	Part	3.02	7.929	7.929
FJI	Yavusa Loto	Locally Managed Marine Area	Part	3.16	5.48	5.48
FJI	Tikina Nasinu (Ovalau)-Nabobo/Levuka/Natokalau/Naikorokoro/Nasinu/Tokou/Visoto/Draiba	Locally Managed Marine Area	Part	3.18	21.38	21.38
FJI	Vanua Naweni-Dromoninuku/Naweni-Naweni/Naweni-Tacilevu	Locally Managed Marine Area	Part	3.5	16.56	16.56
FJI	Vanua Vanuavou	Locally Managed Marine Area	Part	4	17.13	17.13
FJI	Nairai-Lawaki/Natoloa/Tovulailai/Vutuna/Waitoga	Locally Managed Marine Area	Part	4.1	136.2	136.2
FJI	Kiuva	Locally Managed Marine Area	Part	4.21	115.749	115.749
FJI	Soso	Locally Managed Marine Area	Part	4.56	7.48	7.48
FJI	Vanua Balavu-Daliconi	Locally Managed Marine Area	Part	4.66	64.15	64.15
FJI	Tikina Ovalau/Nasinu	Locally Managed Marine Area	Part	4.84	5.84	5.84
FJI	Navukailagi	Locally Managed	Part	4.89	14.4	14.4

	village/Qarani (Gau Is.)/Vione	Marine Area				
FJI	Daviqele village/Nabukelevu/Qaliira/Kabariki	Locally Managed Marine Area	Part	5.09	21.9	21.9
FJI	Mositi Vanuaso-Lamiti-Malawai/Lekanai/Nacavanadi/Naovuka/Vanuaso	Locally Managed Marine Area	Part	5.15	15.01	15.01
FJI	Namuana village	Locally Managed Marine Area	Part	5.39	9.25	9.25
FJI	Yavusa Nasau	Locally Managed Marine Area	Part	5.47	5.92	5.92
FJI	Vanua Navatu-Navakaka	Locally Managed Marine Area	Part	5.58	39.09	39.09
FJI	Rukurukulevu/Cuvu/Sila/Tore/Naevuevu/Yadua	Locally Managed Marine Area	Part	6.72	9.72	9.72
FJI	Vanua Balavu-Dakuilomaloma	Locally Managed Marine Area	Part	8.17	115.02	115.02
FJI	Tikina Levuka (Ovalau)-Arovudi/Levuka Vakaviti/ Naqaliduna/ Nauouo/Nukutocia/Rukuruku/Taviya/Vagadaci/Vatukalo/Waitovu	Locally Managed Marine Area	Part	8.4	98.8	98.8
FJI	Drue village	Locally Managed Marine Area	Part	8.76	22.44	22.44
FJI	Sawaieke district-Vadravadra/Somosomo/Sawaieke/Nukuloa	Locally Managed Marine Area	Part	9.14	149.72	149.72
FJI	Moturiki-Daku/Niubasaga/Uluibau	Locally Managed Marine Area	Part	9.54	82.7	82.7
FJI	Vanua Yanuca	Locally Managed Marine Area	Part	9.74	61.34	61.34
FJI	Vanua Balavu-Boitaci	Locally Managed Marine Area	Part	9.99	21.61	21.61
FJI	Votua village	Locally Managed Marine Area	Part	10.53	1526.93	1526.93
FJI	Vacalea village/Lawaki village/Nukuvou village/Matasawalevu village/Tiliva village	Locally Managed Marine Area	Part	10.87	88.032	88.032
FJI	Vanua Tabanivonolevu	Locally Managed Marine Area	Part	13.5	52.35	52.35
FJI	Tavua District	Locally Managed Marine Area	Part	13.61	690.77	690.77
FJI	Ulunikoro Marine Reserve/Narikoso Village/Vabea Village	Locally Managed Marine Area	Part	19.22	272.96	272.96
FJI	Namuka/ Dogotuki districts-Visoqo, Ravuka, Cawadevo/Rauriko/Qelewara, Naur/Naduru/Nabubu, Lakeba, Nasovivi/Kedra, Lagi/Gevo Island/Druadrua Island	Locally Managed Marine Area	Part	20.84	142.56	142.56
FJI	Yanuca (Malolo (Mamanuca Group)-Solevu/Yaro)	Locally Managed Marine Area	Part	46.4	68	68
FJI	Vanua Kubulau	Locally Managed Marine Area	Part	50.72	259.61	259.61
FJI	Macuata/Dreketi/Sasa/Mali Districts	Locally Managed Marine Area	Part	56.05	1344.3	1344.3
FJI	Bulia Village	Locally Managed Marine Area	Part	5	20.53	20.53
FRA	Port Cros	Parc National - C□Òur	Part	0.03	18	24.75
FRA	Scandola	RÌ©serve Naturelle de la collectivitÌ© territoriale de Corse	Part	0.72	6.5	16.69
FRA	Cote Bleue	Marine Park	Part	2.95	101.68	101.68
FRA	Bouches de Bonifacio	Nature Reserve	Part	12	800	800
FSM	Lenger Island	Marine Protected Area	Part	0.0024	0.006	0.006

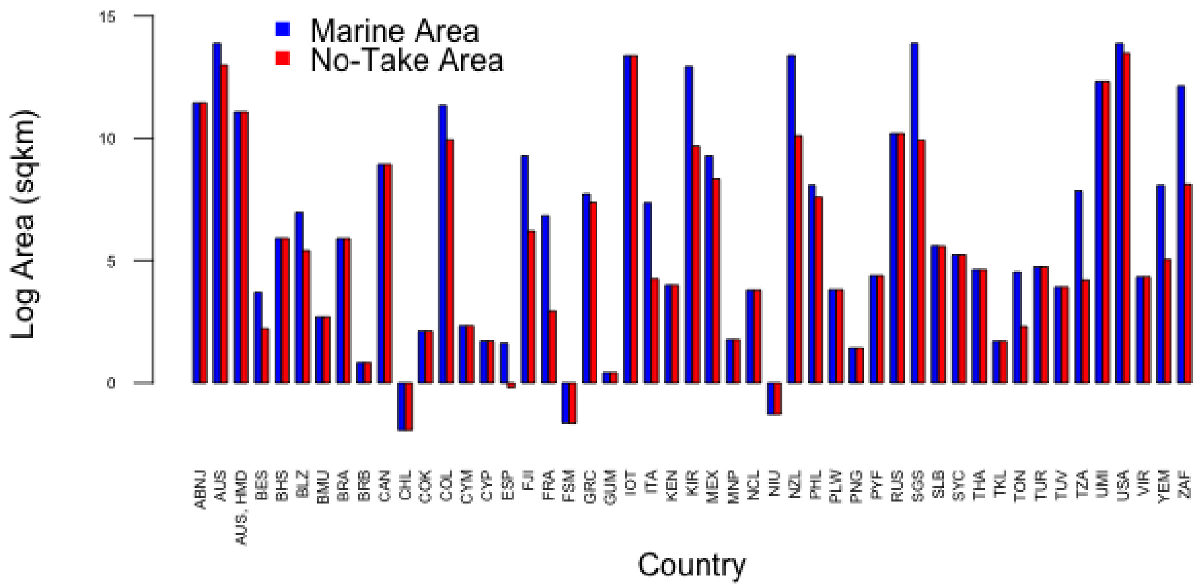
GRC	Ethniko Thalassio Parko Alonnisou Voreion Sporadon	Ethniko Thalassio Parko	Part	1587	2265	2301.398816
ITA	Marine Protected Area of Portofino	Specially Protected Area of Marine Importance (Barcelona Convention)	Part	0.18	3.46	3.85
ITA	Capo Rizzuto	Riserva Naturale Marina e Aree Naturali Marine Protette	Part	0.3	147.21	147.21
ITA	Riserva naturale marina Isole Ciclopi	Riserva Naturale Marina e Aree Naturali Marine Protette	Part	0.35	6.23	6.23
ITA	Marine Protected Area Capo Caccia-Isola Piana	Specially Protected Area of Marine Importance (Barcelona Convention)	Part	0.38	26.31	26.31
ITA	Riserva naturale marina Isola di Ustica	Riserva Naturale Marina e Aree Naturali Marine Protette	Part	0.65	159.51	159.51
ITA	Marine Protected Area Punta Campanella	Specially Protected Area of Marine Importance (Barcelona Convention)	Part	1.73	15.39	15.49
ITA	Isole Tremiti	Riserva Naturale Marina e Aree Naturali Marine Protette	Part	1.8	14.66	14.66
ITA	Capo Carbonara	Riserva Naturale Marina e Aree Naturali Marine Protette	Part	3.32	85.98	85.98
ITA	Torre Guaceto	Riserva Naturale Marina e Aree Naturali Marine Protette	Part	3.42	22.27	22.27
ITA	Marine Protected Area and Natural Reserve of Torre Guaceto	Specially Protected Area of Marine Importance (Barcelona Convention)	Part	3.42	22.27	22.27
ITA	Isole di Ventotene e Santo Stefano	Riserva Naturale Marina e Aree Naturali Marine Protette	Part	4.1	27.99	27.99
ITA	Tavolara - Punta Coda Cavallo	Riserva Naturale Marina e Aree Naturali Marine Protette	Part	5.29	153.57	153.57
ITA	Asinara	Parco Nazionale	Part	5.77	51.7	51.7
ITA	Mouths of Bonifacio - Bonifacio Straits	International Marine Park	Part	12	800	800
KIR	Phoenix Islands	Protected Area	Part	15798.19	408222.08	408250
MEX	Alto Golfo de California y Delta del RÌ_o Colorado	Reserva de la Biosfera	Part	3068	5416.36	9347.56
MEX	Cabo Pulmo	Parque Nacional	Part	24.95961	71.11	71.11
MEX	Arrecifes de Cozumel	Parque Nacional	Part	50.10984	119.88	119.88
MEX	Arrecife Alacranes	Parque Nacional	Part	316.61	3337.69	3337.69
MEX	BahÌ_a de Loreto	Parque Nacional	Part	687.91473	1837.11	1837.11
NZL	New Zealand Sub-Antarctic Islands	World Heritage Site	Part	4215	14000	14764.58
NZL	Kermadec	Benthic Protection Area	Part	7446.7	620433.7	620467
PHL	Casay	Marine Park and Sanctuary	Part	0.05	0.07	0.07
PHL	Bilangbilangan	Marine Sanctuary	Part	0.06	0.105	0.105
PHL	Taongon Can-andam	Fish Sanctuary	Part	0.1	0.267	0.267

	Fishery Refuge and Sanctuary/ 3T					
PHL	Tubod Mar	Marine Sanctuary	Part	0.1	0.2622	0.2622
PHL	Bacon	Marine Reserve	Part	0.48	1.68	1.68
PHL	Hayaan, Inanuran and Budlaan	Fish Sanctuary	Part	0.9	2	2
PHL	Turtle Islands	Wilderness Sanctuary	Part	1213.245	2426.49	2429.67
SGS	South Georgia and South Sandwich Islands Marine Protected Area	Marine Protected Area	Part	20431	1070000	1070000
SLB	Kozou	Marine Protected Area	Part	0.002292	0.4518	0.4518
SLB	Kindu	Marine Protected Area	Part	0.00492	0.7642	0.7642
SLB	Kindu	Marine Protected Area	Part	0.492	0.76424	0.76424
TON	Eueiki	Multi/Multiple Use Conservation Area	Part	0.8764	2.178	2.178
TON	Atata	Multi/Multiple Use Conservation Area	Part	1.15	6.179	6.179
TON	Ha'afeva	Multi/Multiple Use Conservation Area	Part	1.5132	11.28	11.28
TON	Felemea	Multi/Multiple Use Conservation Area	Part	1.5274	16.27	16.27
TON	O'ua	Multi/Multiple Use Conservation Area	Part	2.043	47.41	48.75
TON	Ovaka	Multi/Multiple Use Conservation Area	Part	2.949	9.562	9.562
TZA	Misali Island	Area de Conservacion	Part	0.7	21.6	23
TZA	Mafia Island	Marine Park	Part	7.995	615	822
TZA	Tanga	Not Reported	Part	28.71	1914	1914
USA	Florida Keys	National Marine Sanctuary	Part	566.554	9844.54	9844.54
USA	Channel Islands	UNESCO-MAB Biosphere Reserve	Part	823.616	4288.011	4796.52
USA	Honolua-Mokuleia Bay	Marine Life Conservation District	Part	0.109265112	0.1821	0.1821
USA	Lapakahi	Marine Life Conservation District	Part	0.147710244	0.5908	0.5908
USA	Kealakakua Bay	Marine Life Conservation District	Part	0.63737982	1.2747	1.2747
USA	Hawaiian Islands National Wildlife Refuge (8 sites)	National Wildlife Refuge	Part	2469.181095	2476.3281	2476.3281
USA	Northwestern Hawaiian Islands Coral Reef Ecosystem	Reserve	Part	682.72	341362	341362
YEM	Socotra Archipelago	UNESCO-MAB Biosphere Reserve	Part	154	3178.4	26816.4
ZAF	Prince Edward Islands	Marine Protected Area	Part	1551.65	180000	180000
ZAF	Aliwal Shoal	Marine Protected Area	Part	2.128291	124.743558	124.743558
ZAF	Langebaan Lagoon	Marine Protected Area	Part	10.638312	47.157107	47.157107
ZAF	Table Mountain National Park	Marine Protected Area	Part	17.18741	953.249941	953.249941
ZAF	Maputaland	Marine Protected Area	Part	130.075194	385.191382	385.191382
ZAF	St. Lucia	Marine Protected Area	Part	134.161523	442.698653	442.698653
ZAF	Pondoland	Marine Protected Area	Part	592.288298	1238.170922	1238.170922

*MPAs that are no-take but allow native extraction
^MPAs that were recorded as part no-take in the WDPA but changed to all no-take because the no-take area reported equalled the marine area reported.

APPENDIX II: MARINE AND NO-TAKE AREA BY COUNTRY

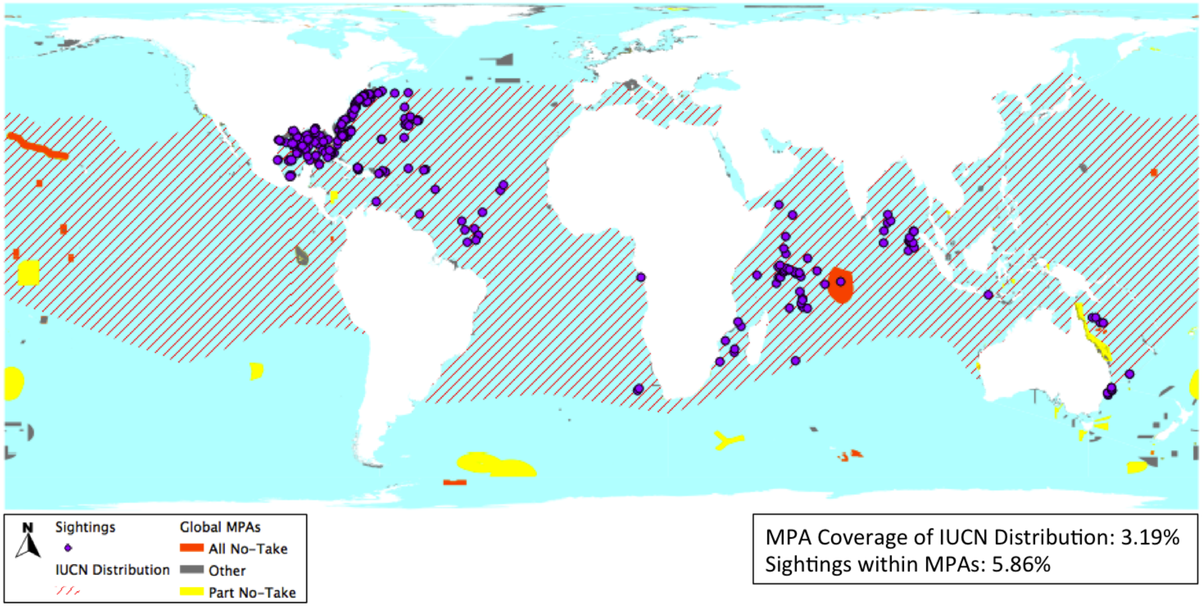
Marine and no-take area (km^2) by country for MPAs that have a no-take component. Areas are log transformed. More information on country codes can be found at https://www.iso.org/.



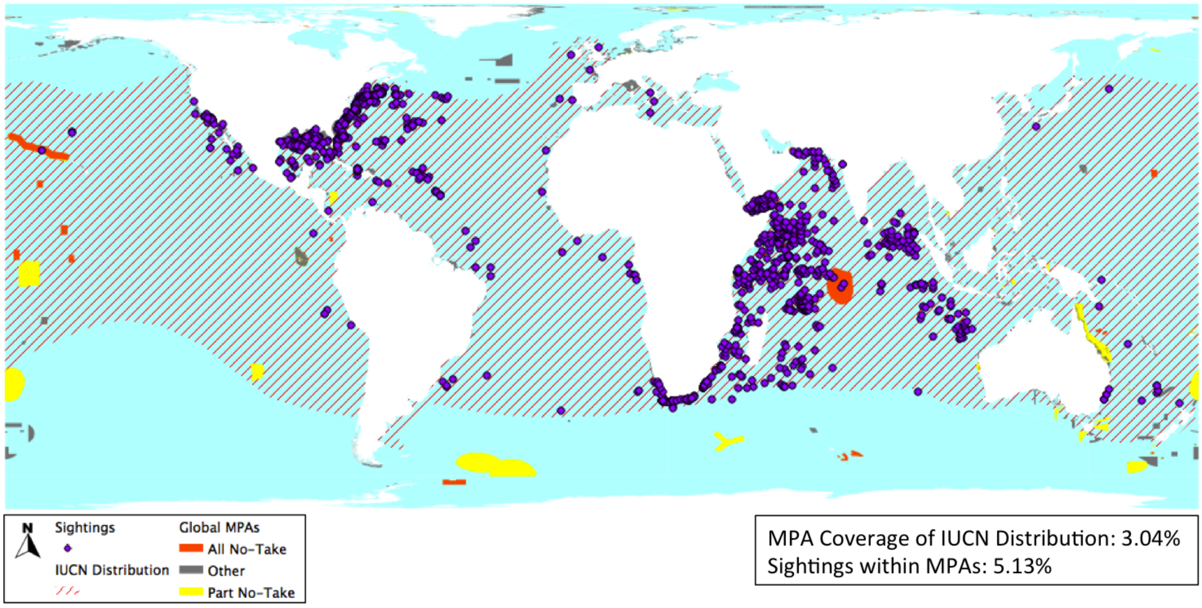
Appendix III: Sightings and Distribution of Shark Species

The IUCN distribution and GBIF/OBIS sighting data for nine of the ten shark species assessed in this study. MPAs are highlighted as all no-take and part no-take. MPAs classified as “other” are either no no-take or do not have a reported no-take status.

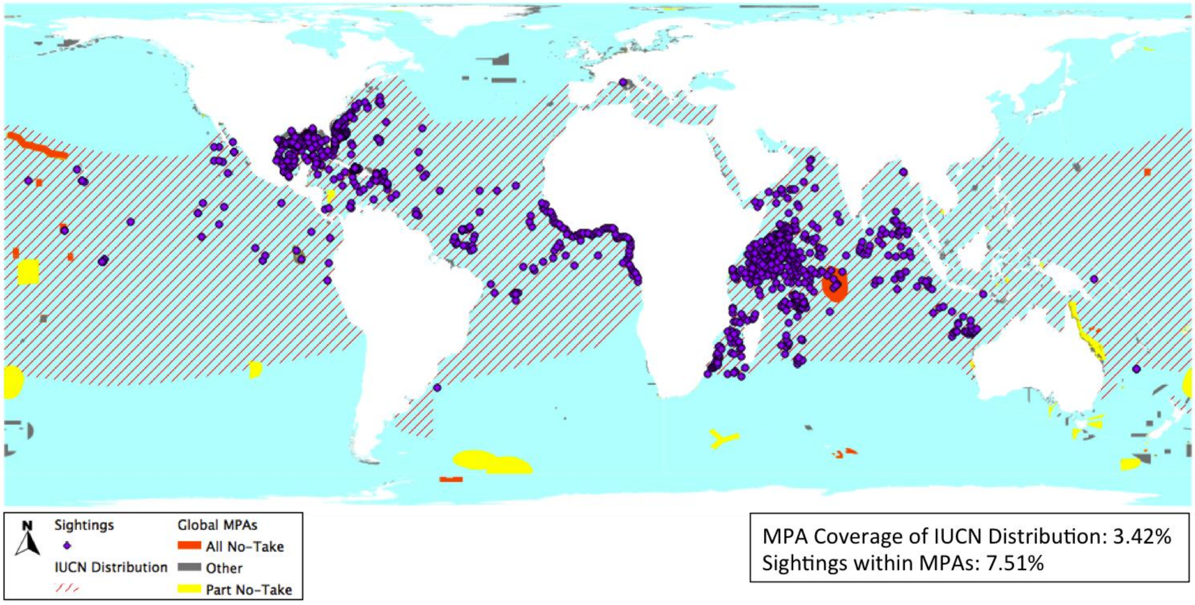
Longfin Mako Shark



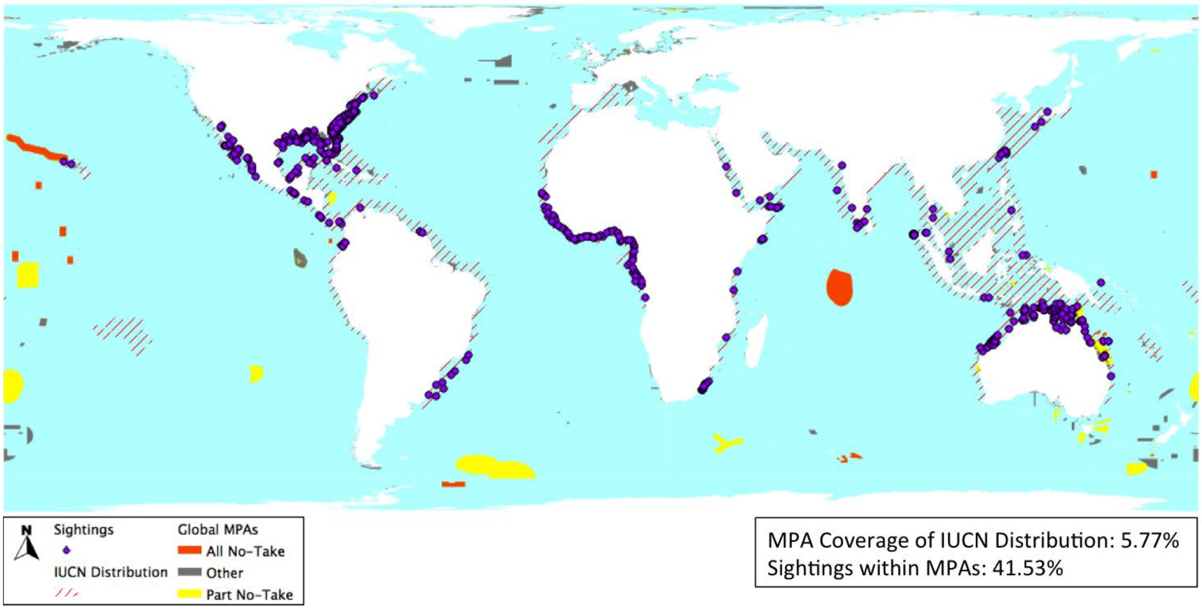
Shortfin Mako Shark



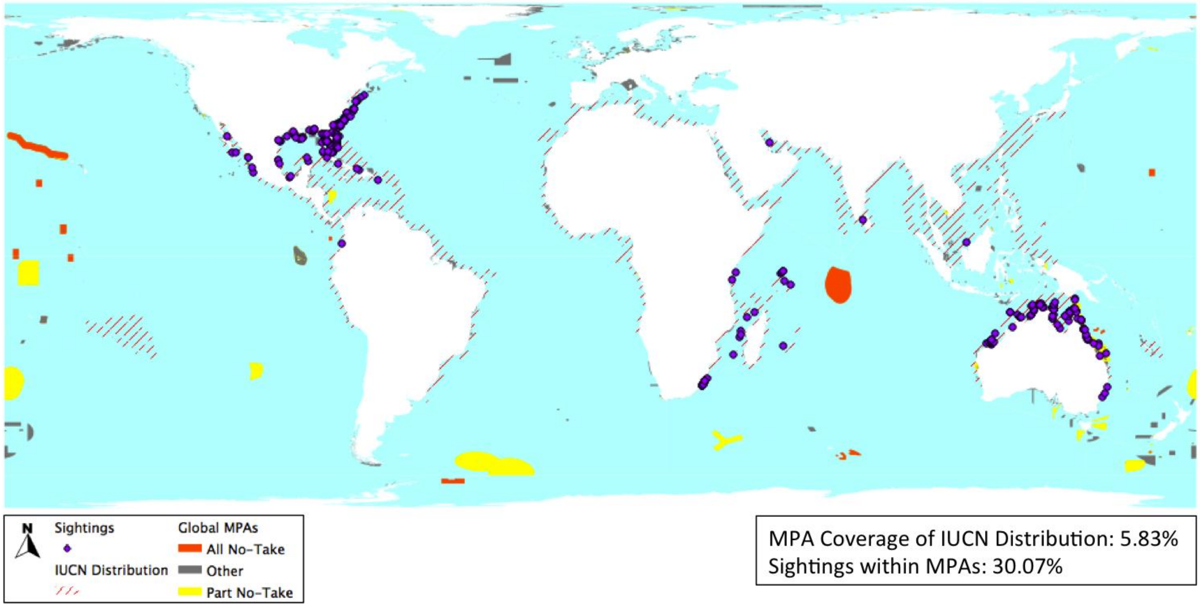
Oceanic Whitetip Shark



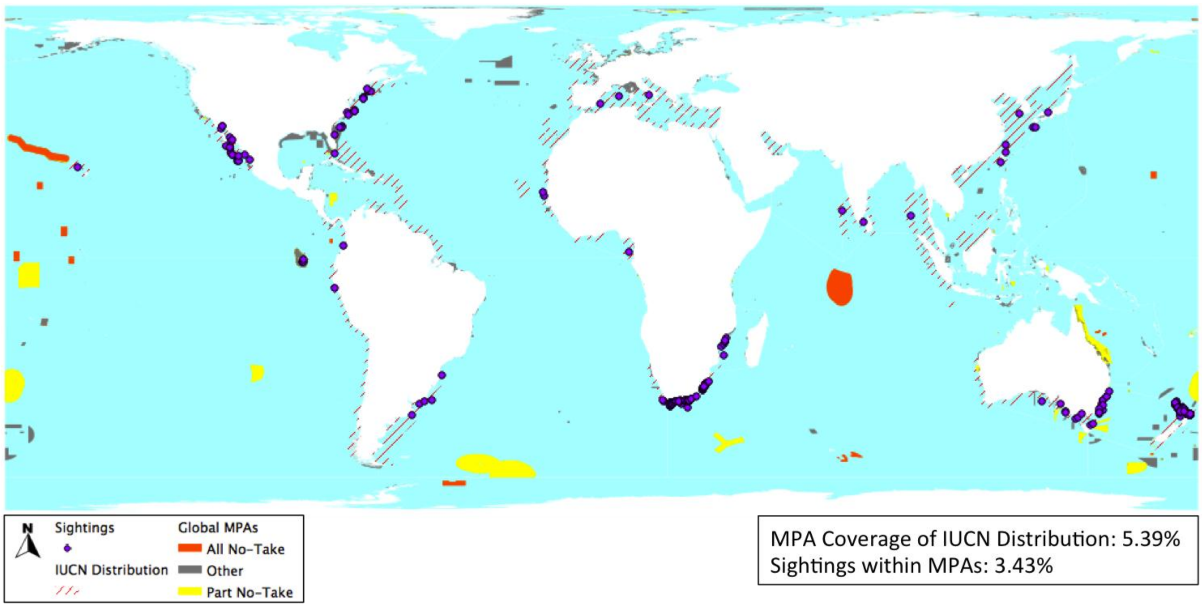
Scalloped Hammerhead Shark



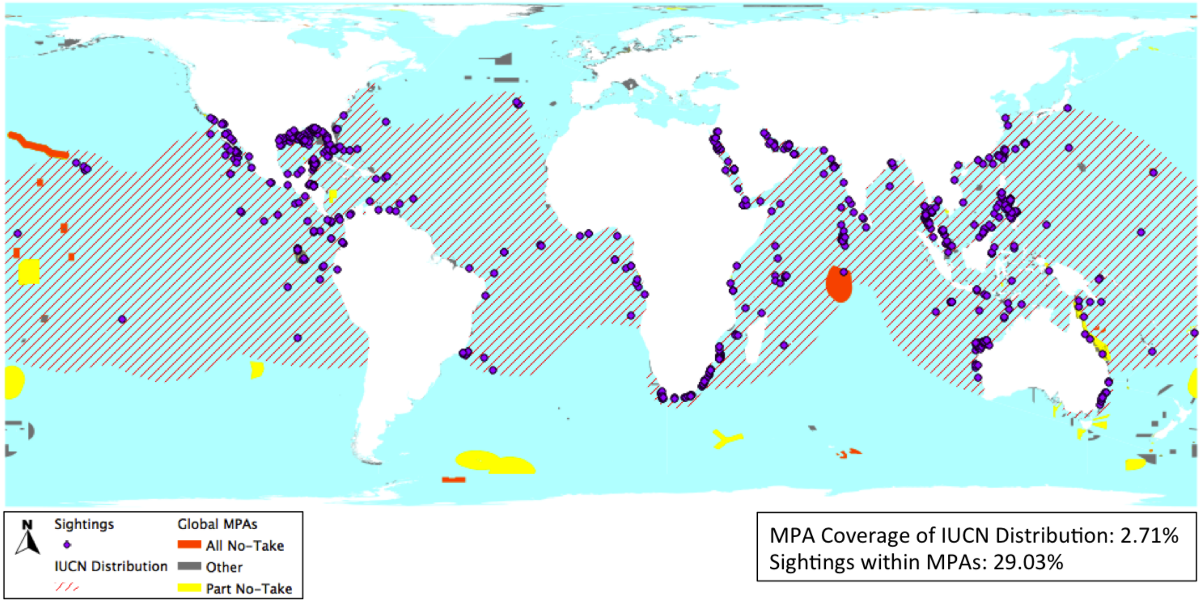
Great Hammerhead Shark



Smooth Hammerhead Shark

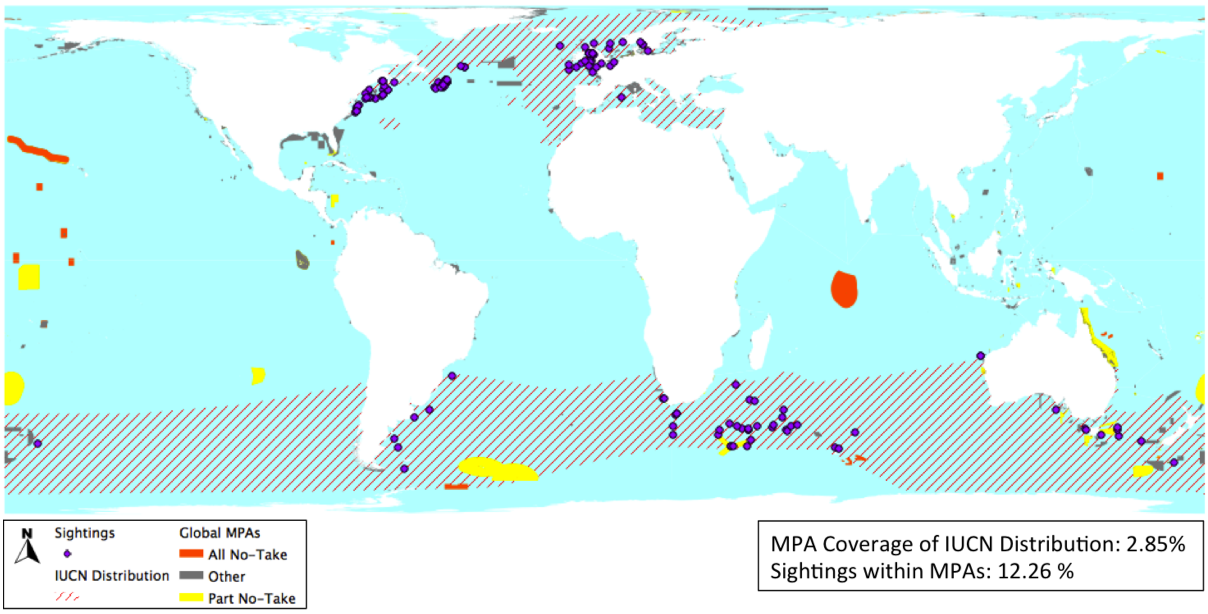


Whale Shark



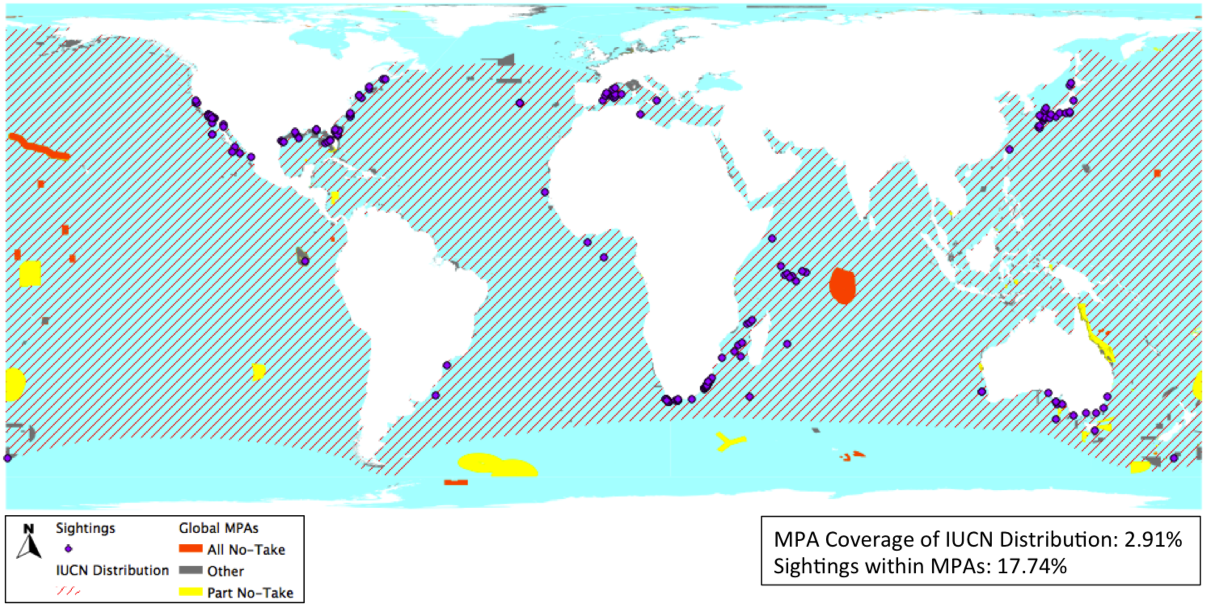
MPA Coverage of IUCN Distribution: 2.71%
Sightings within MPAs: 29.03%

Porbeagle Shark



MPA Coverage of IUCN Distribution: 2.85%
Sightings within MPAs: 12.26 %

White Shark


N
Sightings
IUCN Distribution
Global MPAs
All No-Take
Other
Part No-Take
MPA Coverage of IUCN Distribution: 2.91%
Sightings within MPAs: 17.74%

APPENDIX IV: MPA COVERAGE AND NORMALIZED CATCH BY FAO MAJOR FISHING AREA

The normalized catch (tonnes per 1,000 km^2) and percent MPA cover for each of the FAO major fishing areas. Line represents the result of the linear model. Abbreviations: E=Eastern, EC=East-central, Med and Black = Mediterranean and Black Seas, NE=Northeast, NW=Northwest, SE=Southeast, SW=Southwest, W=Western, WC=West-central