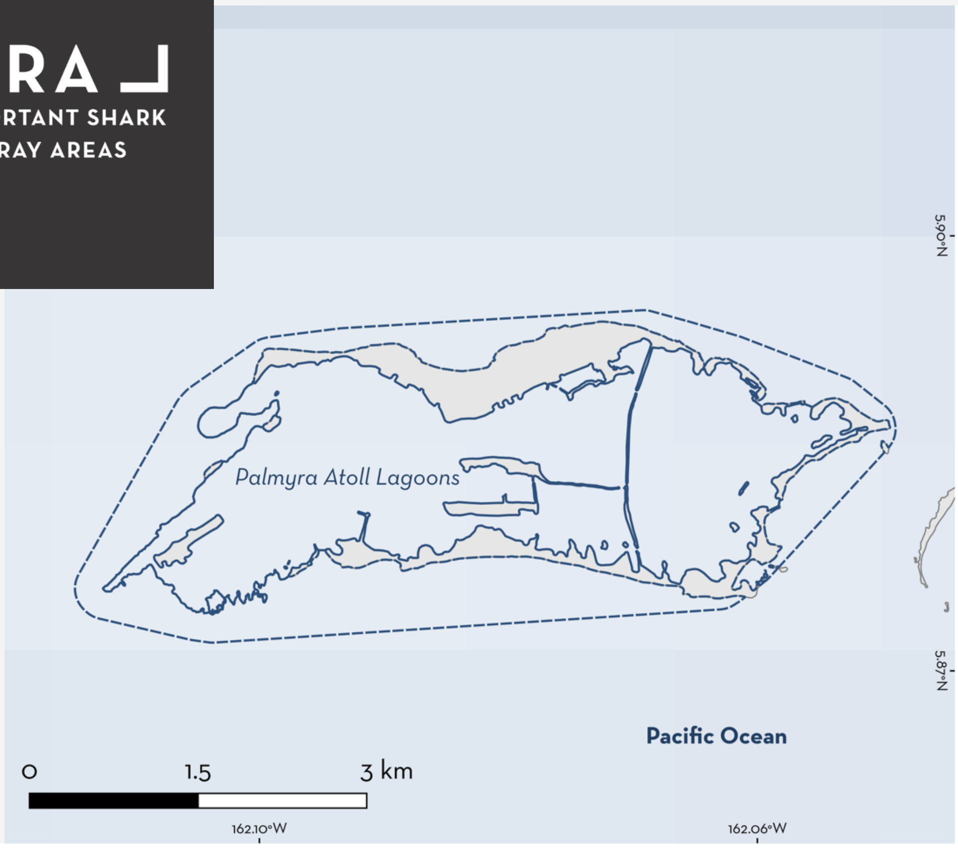
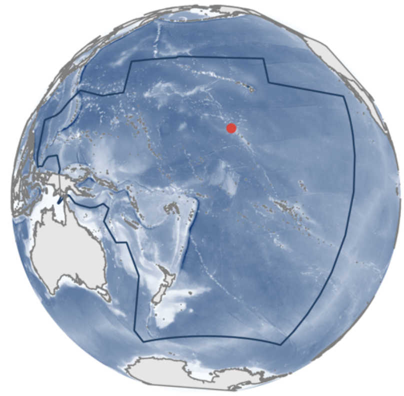
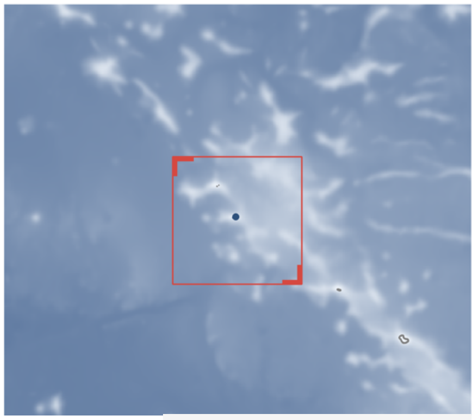
ISRA
IMPORTANT SHARK AND RAY AREAS







Blue lines indicate the area meeting the ISRA Criteria; dashed lines indicate the suggested buffer for use in the development of appropriate place-based conservation measures

PALMYRA ATOLL LAGOONS ISRA

New Zealand & Pacific Islands Region

SUMMARY

Palmyra Atoll Lagoons is located in the northernmost of the Line Islands in the northern-central Pacific Ocean. This area is remote and uninhabited, situated ~1,700 km south of Hawaii. It is characterised by two lagoons (east and west) which are surrounded by sandflats, native forests, and one main channel connecting them with the open ocean. The lagoons are influenced by nutrient runoff rich native forest islets fertilised by seabirds, which increases productivity. This area overlaps with an Ecologically or Biologically Significant Marine Area, and two Key Biodiversity Areas. It is part of the Pacific Remote Islands Marine National Monument of the United States of America. Within this area there are: **threatened species** (e.g., Reef Manta Ray *Mobula alfredi*); **reproductive areas** (Blacktip Reef Shark *Carcharhinus melanopterus*); and **feeding areas** (Reef Manta Ray).

CRITERIA

Criterion A – Vulnerability; Sub-criterion C1 – Reproductive Areas; Sub-criterion C2 – Feeding Areas

PALMYRA ATOLL

0–35 metres

8.33 km²

sharkrayareas.org

DESCRIPTION OF HABITAT

Palmyra Atoll Lagoons is located in the northern end of the Line Island chain, ~1,700 km south of Hawaii in the central Pacific Ocean. The area is a remote historically uninhabited location. The atoll has three main lagoon basins: West, Center, and East lagoons. West and Center lagoons are functionally similar with negligible physical separation between basins. West-Center and East lagoon are largely separated from each other by a man-made causeway 1.7 km long (Collen et al. 2009). West-Center lagoon is directly connected to the open ocean by a ~1.5 km long channel that is ~80 m wide and 8 m deep. This channel is characterised by a sandy substratum of relatively uniform depth that is flanked by near-vertical walls of coral rubble (McCauley et al. 2016). East lagoon is only connected to the outer reefs via shallow sandflats (Papastamatiou et al. 2010). Other much shallower and smaller reef passages provide additional, albeit less significant, open ocean connections in both lagoon basins. Depths in West-Center and East lagoons do not exceed 60 m and 50 m, respectively (NOAA 2006). These lagoons have been characterised as having a well-mixed surface layer that is dynamically influenced by the wind and tides which overlays a relatively static and stable deepwater pool (Gardner et al. 2011). The deeper lagoon waters (10–50 m) become rapidly depleted in oxygen with dysoxic/anoxic conditions occurring at >35 m depth (Gardner et al. 2011).

Lagoons are generally more contained, and their surface waters can be less mobile and more productive than often oligotrophic, dynamic offshore surface waters (Delesalle & Sournia 1992). Palmyra's lagoons are surrounded by forests which are fractured into discrete patches of well conserved native forest (*Pisonia grandis* and *Tournefortia argentea*) surrounded by dense stands of coconut palm (*Cocos nucifera*) (Young et al. 2010; McCauley et al. 2012a). Seabird colonies roosting on native trees fertilize soils, increasing coastal nutrients. Many of the nutrients concentrated in these native forests are returned to the adjacent oligotrophic ocean waters via rain and tidal vectoring (McCauley et al. 2012a).

Due to Palmyra's location in the Inter-tropical Convergence Zone, the atoll receives up to 500 cm of rainfall per year (Papastamatiou et al. 2009b). This area is located in the Central Pacific high productivity zone, a large-scale oceanographic feature, comprising the western extent of flow from the Pacific south equatorial current. This westerly flowing cool upwelling tongue of water brings high nutrients to the surface waters of the central Pacific Ocean supporting high primary production (CBD 2024).

This area partly overlaps with the Equatorial High-Productivity Zone Ecologically or Biologically Significant Marine Areas (EBSA; CBD 2024). It also overlaps with two Key Biodiversity Areas (KBA): Palmyra Atoll Marine (KBA 2024a) and Proposed Central Pacific World Heritage Site (KBA 2024b). The area is part of the Pacific Remote Islands Marine National Monument of the United States of America (NOAA 2024).

This Important Shark and Ray Area is benthopelagic and is delineated from inshore and surface waters (0 m) to 35 m based on the depth range of Qualifying Species in the area.

ISRA CRITERIA

CRITERION A – VULNERABILITY

Two Qualifying Species considered threatened with extinction according to the IUCN Red List of Threatened Species regularly occur in the area. These are the Vulnerable Blacktip Reef Shark (Simpfendorfer et al. 2020) and Reef Manta Ray (Marshall et al. 2022).

SUB-CRITERION C1 – REPRODUCTIVE AREAS

Palmyra Atoll Lagoons is an important reproductive area for one shark species.

Between March 2004 and November 2007, 254 Blacktip Reef Sharks were caught on handlines with barbless hooks in both the west and east lagoons of this area (Papastamatiou et al. 2009a). Males measured between 34–119 cm total length (TL) and females measured between 37–137 cm TL. There were two size classes: one for neonates, young-of-the-year (YOY), and juveniles with a mode of 50 cm TL, and another for sub-adults and adults with a mode at 110 cm TL (Papastamatiou et al. 2009a). The size-at-birth for the Blacktip Reef Shark is 30–52 cm TL (Ebert et al. 2021). Most of the individuals sampled within the smallest size class were neonates, followed by YOYs and juveniles (Papastamatiou et al. 2009a).

Between 2004–2007, acoustic (n = 49 sharks) and satellite telemetry (n = 3 sharks), and stable isotopes (n = 63 sharks with sizes between 75–130 cm TL) were used to understand movement patterns, macroscale habitat use, and trophic ecology of Blacktip Reef Sharks between two lagoons (eastern and western) in this area (Papastamatiou et al. 2010). Active, passive, and satellite telemetry all suggest that Blacktip Reef Sharks in the lagoons have relatively small core home ranges, and show high levels of site fidelity to core areas. According to stable isotope analysis, sharks obtain most of their energy from this lagoon ecosystem (Papastamatiou et al. 2010).

Between February 2005 and September 2007, acoustic telemetry was used in this area to quantify the movement patterns of 14 Blacktip Reef Sharks (mean body size ± SD: 100 ± 17 cm TL) with four individuals measuring between 65–80 cm TL (Papastamatiou et al. 2009b). Blacktip Reef Sharks had relatively small home ranges over a timescale of days to weeks and showed strong residency to sand-flat ledges within the west lagoon over a three-year period. Blacktip Reef Sharks showed evidence of diel and tidal movements, and they utilised certain regions of the west lagoon disproportionately. There were ontogenetic shifts in habitat selection, with neonate and YOY sharks (35–61 cm TL) showing greater selection for very shallow sand-flat habitats inside the lagoon (Papastamatiou et al. 2009b). Neonate and YOY Blacktip Reef Sharks are only observed in very shallow sand-flat habitats, close to shore in the lagoons (Papastamatiou et al. 2009b).

Between 2–29 July 2009, high-resolution acoustic cameras were used in the main channel of this area to study the ecology and behaviour of the most common reef sharks (i.e., Grey Reef Shark and Blacktip Reef Shark; McCauley et al. 2016). A total of 1,196 shark observations were recorded during 443 hours of acoustic camera recording. The maximum number of sharks observed in a single frame was 10 individuals. It was suggested that most of the sharks recorded were Blacktip Reef Sharks as these are the most common shark observed in Palmyra's lagoons (Papastamatiou et al. 2015). During this study period, the majority of sharks observed were Blacktip Reef Sharks (McCauley et al. 2016). Measurements of shark sizes ranged from 50–340 cm TL, with ~200 counts belonging to sharks measuring 50–80 cm TL (McCauley et al. 2016). Therefore, among this size class (50–80 cm TL) most of them were neonate, YOY, or juvenile Blacktip Reef Sharks.

Between 2004–2014, telemetry data (n = 56 sharks; mean ± SD = 95 ± 25 cm TL) and fishing surveys showed that Blacktip Reef Sharks in the lagoons showed a 49% chance of remaining there and <0.1% probability of moving to the backreefs (Papastamatiou et al. 2018). Also, baited remote underwater video station (BRUVS) surveys (n = 47) were used to determine the MaxN (maximum number of individuals of a species observed in a single frame) (Papastamatiou et al. 2018). Among forereef, backreef, and lagoon environments sampled, lagoons presented the highest MaxN (range = 4–5).

SUB-CRITERION C2 – FEEDING AREAS

Palmyra Atoll Lagoons is an important feeding area for one ray species.

From September 2007 to August 2011, stable isotope analysis (SIA) was used to assay the energetic importance of lagoons to Reef Manta Rays; high-resolution tracking data provided information about how Reef Manta Rays utilised lagoonal habitats over long and short time periods; acoustic cameras logged patterns of animal entrances and departures from lagoons; and photo identification/laser photogrammetry provided insights into why they may be using this habitat (McCauley et al. 2014).

These methods demonstrated that Reef Manta Rays showed strong evidence of energetic dependence on lagoon resources during the study and spent long periods of residence within lagoons or frequently transited into them from elsewhere (McCauley et al. 2014). Also, Reef Manta Rays were regularly observed feeding (e.g., surface swimming with mouth open and somersaulting) during the tracking and observation periods inside the lagoons (McCauley et al. 2014). A total of 333 Reef Manta Rays sightings were recorded in Palmyra's main channel during one month of data collection (McCauley et al. 2014).

A total of 107 Reef Manta Rays photographs were collected; 69 were identified to be distinct individuals. Of these, 24 individuals were resighted on multiple occasions. In total, 12 individuals were resighted more than two months after their initial sighting. Forty-five Reef Manta Rays were measured, and body size ranged from 188–339 cm disc width (DW), with a mean size of 282 cm DW. Size-at-birth is between 130–150 cm DW (Last et al. 2016). Therefore, some of these individuals were YOY. Reef Manta Rays that were measured offshore and in the main channel (n = 34) were nearly 1.5 times larger than those sized within the lagoons (n = 11) (McCauley et al. 2014). This area may provide a refuge for Reef Manta Rays from large offshore predators (e.g., large sharks). Surveys of sharks conducted inside the lagoons and on the outer forereef indicate that certain species of larger sharks that have been observed to attack manta rays (Marshall & Bennett 2010) are rarer inside the lagoons (McCauley et al. 2012b; Papastamatiou et al. 2009a). This area might also be functioning as a reproductive area, however, further information is needed to confirm this.

Another study utilised correlated random walk, fractal, and first passage time analysis to quantify the response of Reef Manta Rays to spatial scale and identify locations of area-restricted searching (ARS) in this area (Papastamatiou et al. 2012). Once resources are located, the animal may utilise a movement strategy that allows it to remain within a small area and maximize resource acquisition known as ARS. For this, 10 Reef Manta Rays were actively tracked for periods of 5–46 hours (Papastamatiou et al. 2012). Overall, 88% of Reef Manta Rays demonstrated some degree of ARS. The locations of ARS were principally detected in regions where their plankton forage was determined to be the highest.

Using biogeochemical assays, animal tracking, and field surveys, another study between 2009–2010, showed that Reef Manta Rays are attracted to native forest coastlines as waters adjacent to native forests present greater biomass in zooplankton and key zooplankton taxa (Copepoda) achieve larger sizes (McCauley et al. 2012a).

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Yannis Papastamatiou (Florida International University) and Adriana Gonzalez Pestana (IUCN SSC Shark Specialist Group – ISRA Project) contributed and consolidated information included in this factsheet. We thank all participants of the 2024 ISRA Region 10 – New Zealand and Pacific Islands workshop for their contributions to this process.

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QUALIFYING SPECIES

Scientific Name	Common Name	IUCN Red List Category	Global Depth Range (m)	ISRA Criteria/Sub-criteria Met								
				A	**B**	**C1**	**C2**	**C3**	**C4**	**C5**	**D1**	**D2**
SHARKS												
Carcharhinus melanopterus	Blacktip Reef Shark	VU	0–100	X		X						
RAYS												
Mobula alfredi	Reef Manta Ray	VU	0–711	X			X					

SUPPORTING SPECIES

Scientific Name	Common Name	IUCN Red List Category
SHARKS		
Negaprion acutidens	Sharptooth Lemon Shark	EN
Sphyrna lewini	Scalloped Hammerhead	CR
Triaenodon obesus	Whitetip Reef Shark	VU
RAYS		
Aetobatus ocellatus	Spotted Eagle Ray	EN

IUCN Red List of Threatened Species Categories are available by searching species names at www.iucnredlist.org Abbreviations refer to: CR, Critically Endangered; EN, Endangered; VU, Vulnerable; NT, Near Threatened; LC, Least Concern; DD, Data Deficient.

SUPPORTING INFORMATION

There are additional indications that Palmyra Atoll Lagoons is an important for reproductive purposes of one ray species. Spotted Eagle Rays are regularly seen in this area and pre-copulation behaviour has been recorded in the lagoons. Further information is needed to understand the use of this area by this species.

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