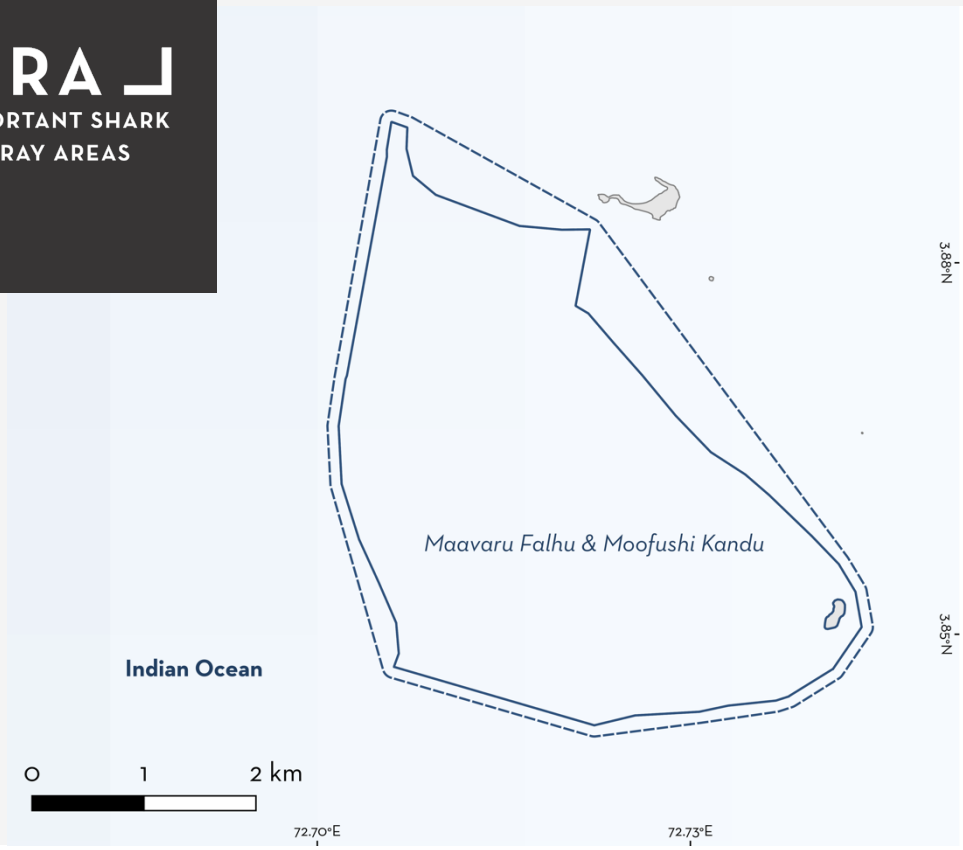
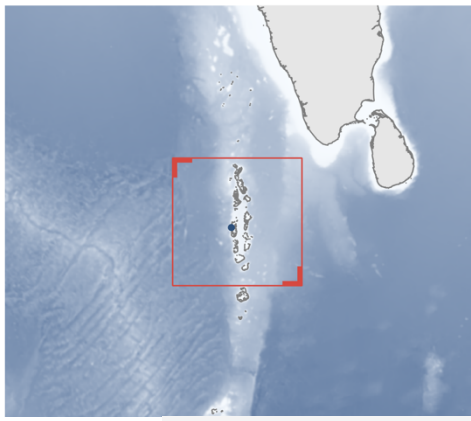
ISRA
IMPORTANT SHARK AND RAY AREAS





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

MAAVARU FALHU & MOOFUSHI KANDU ISRA

Western Indian Ocean Region

MALDIVES

0–80 metres

14.10 km²

SUMMARY

Maavaru Falhu & Moofushi Kandu is located along the southwestern side of Ari Atoll in the Maldives. The area comprises a large lagoon situated along the inner-atoll margin that is connected to the open ocean via a channel. The bathymetry of the area in combination with tidal currents and Langmuir Circulation leads to a concentration of zooplankton in the lagoon. Within the area there are: **threatened species**, **reproductive areas**, and **feeding areas** (Reef Manta Ray *Mobula alfredi*).

CRITERIA

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

DESCRIPTION OF HABITAT

Maavaru Falhu & Moofushi Kandu is located along the southwestern side of Ari Atoll in the Maldives. Maavaru Falhu is a large lagoon situated along the inner-atoll margin of Maavaru Reef located north of Innafushi Island and south of Moofushi Island, whilst Moofushi Kandu is the channel that borders the northern inlet of this lagoon and opens to the ocean on the west. The lagoon is ~4 km in length and ~2.5 km wide, and the channel is ~0.9 km wide inside the atoll with the channel opening ~1.2 km. The lagoon reaches a maximum depth of ~15 m with a benthic cover of fine sand and scattered coral blocks. It is enclosed by a shallow barrier reef of depths between 2–10 m with a primary northern access point along the channel inlet which has a maximum depth of ~20 m inside the atoll, dropping beyond 1,000 m outside the atoll.

The Maldives has two monsoon seasons: the southwest monsoon (May–November), and the northeast monsoon (December–May) (Anderson et al. 2011). Sea surface temperatures fluctuate little between 28–30°C. The location and geomorphology of the shallow lagoon, coupled with the tidal movements and Langmuir Circulation, acts as a zooplankton trap, especially during the northeast monsoon season (Hedley et al. 2018; Moloney et al. 2019; Harris et al. 2020; Harris & Stevens 2021).

This Important Shark and Ray Area is benthopelagic and is delineated from the inshore and surface waters (0 m) to 80 m based on the bathymetry of the area.

ISRA CRITERIA

CRITERION A – VULNERABILITY

The one Qualifying Species within the area is considered threatened with extinction according to the IUCN Red List of Threatened Species™. The Reef Manta Ray is assessed as Vulnerable (Marshall et al. 2022).

SUB-CRITERION C1 – REPRODUCTIVE AREAS

Maavaru Falhu & Moofushi Kandu is an important reproductive area for one ray species.

Between 2007–2022, 458 in-water surveys were conducted in this area with neonates, young-of-the-year (YOY), pregnant females, and courtship recorded (IDtheManta unpubl. data 2022). During these surveys, 232 individual Reef Manta Rays were identified, representing 16% of the total identified throughout Ari Atoll (n = 1,418).

Of all neonate and YOY individuals identified in Ari Atoll (n = 74), 20% were first recorded in the area, making it the primary YOY site in South Ari Atoll (Hedley et al. 2018; Moloney et al. 2019). Maturity estimates were based on individual size between 150–190 cm disc width (DW); length of tail; light ventral/spot pattern pigmentation; creases along pectorals; and often a light pink skin pigmentation on first sighting (Kashiwagi 2014; Stevens 2016). Reef Manta Ray size-at-birth is 130–150 cm DW (Last et al. 2016). In addition, 15 of the YOY sighted in Maavaru Falhu & Moofushi Kandu were observed over consecutive years returning to the area. It is theorised that sheltered, shallow reef lagoons (like Maavaru Falhu) are typically used as nursery sites by devil rays, as they provide calm conditions, safety from large predators, reliable food source, and opportunities for interaction with conspecifics (McCauley et al. 2014; Heupel et al. 2019; Setyawan et al. 2022).

Seventeen individual Reef Manta Rays have been recorded as pregnant at this location since 2014, with all recorded individuals exhibiting cleaning behaviour. Females were determined as pregnant

by trained research staff based on the presence of extended abdomens (Stevens 2016). Pregnant Reef Manta Rays typically use cleaning stations during outgoing tides (Hedley et al. 2018; Moloney et al. 2019), and these consistent observations suggest that this site is important to maintaining the health of pregnant rays.

Reef Manta Ray courtship behaviour was observed on 14 separate occasions during the study period and involved 44 individual rays. Observations included shadowing behaviour and mating chains.

SUB-CRITERION C2 – FEEDING AREAS

Maavaru Falhu is an important feeding area for one ray species.

Reef Manta Rays aggregate in the area in a regular and predictable way when tidal movements and Langmuir Circulation concentrate zooplankton in the shallow lagoon, providing an ideal environment for planktivorous megafauna in the area (Harris et al. 2020; Harris & Stevens 2021). There were 302 in-water surveys conducted in the area between 2012–2022. During 50 of these surveys, photo identification revealed feeding aggregations with an average of eight individuals (standard deviation = 3.77; minimum = 5; maximum = 27 individuals) (IDtheManta unpubl. data 2022). During the northeast monsoon, aggregations are more abundant due to an accumulation of zooplankton in the area resulting from the combination of wind and tidal forcings (Harris et al. 2020). Of the 1,418 Reef Manta Rays recorded throughout Ari Atoll, 18% have been observed feeding in Maavaru Falhu (IDtheManta unpubl. data 2022), making this area one of the most important and regular feeding locations for Reef Manta Rays in Ari Atoll.

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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
RAYS												
Mobula alfredi	Reef Manta Ray	VU	0–711	X		X	X					

SUPPORTING SPECIES

Scientific Name	Common Name	IUCN Red List Category
SHARKS		
Carcharhinus amblyrhynchos	Grey Reef Shark	EN
Carcharhinus melanopterus	Blacktip Reef Shark	VU
Nebrius ferrugineus	Tawny Nurse Shark	VU
Rhincodon typus	Whale Shak	EN
Stegostoma tigrinum	Indo-Pacific Leopard Shark	EN
Triaenodon obesus	Whitetip Reef Shark	VU
RAYS		
Aetobatus ocellatus	Spotted Eagle Ray	EN
Urogymnus asperrimus	Porcupine Ray	EN
Urogymnus granulatus	Mangrove Whipray	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 Maavaru Falhu & Moofushi Kandu is an important area for the reproductive, resting, and aggregative behaviour of four shark and one ray species. The area is also used by Blacktip Reef Sharks (L. Saponari pers. comm. 2023), Grey Reef Shark, Whitetip Reef Shark, and Spotted Eagle Ray likely to rest and save energy. The tidal currents at the channel corner and the nearby drop off to deeper waters creates upwelling of current in which the negatively buoyant sharks and rays are able to rest and reduce energy expenditure (Papastamatiou et al. 2021). Spotted Eagle Rays have been observed in large undefined aggregations or in assemblages with Grey Reef Sharks. Whitetip Reef Sharks have also been recorded mating in the area. Whale Sharks are observed cruising by, it is assumed that after deep dives they return to surface waters to thermoregulate (G Stevens pers. comm. 2023). Aggregations of these sharks and ray are common, however more data are required on the regular and predictable occurrence of these behaviours.

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