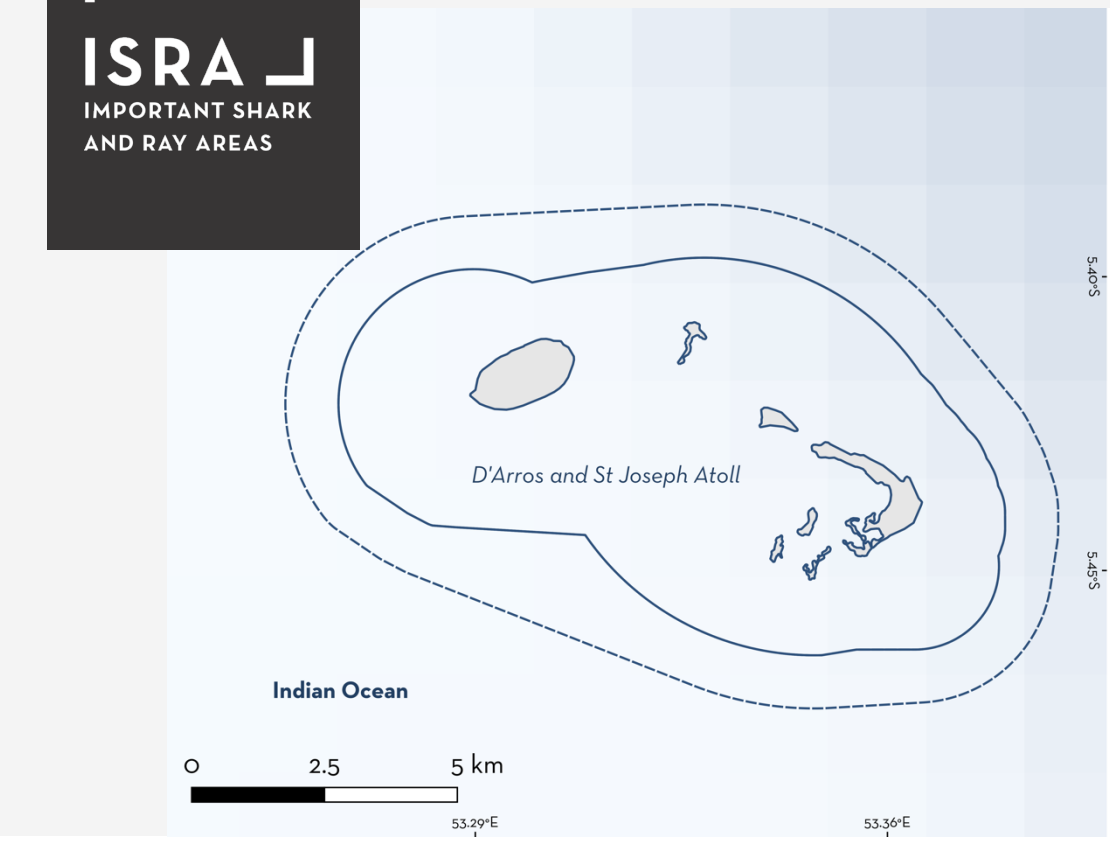
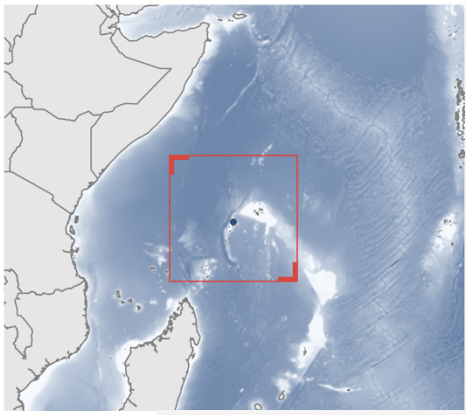
ISRA
IMPORTANT SHARK AND RAY AREAS





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

D'ARROS AND SAINT JOSEPH ATOLL ISRA

Western Indian Ocean Region

SEYCHELLES

0–450 metres

64.08 km²

SUMMARY

D'Arros and Saint Joseph Atoll is situated in the remote Amirantes island group of the Republic of Seychelles. Saint Joseph Atoll is separated from D'Arros Island to the northwest by a shallow narrow channel. Saint Joseph Atoll is unique in Seychelles because its reef flats are only exposed at low tides which isolates the lagoon from the outer reef. This area is characterised by extensive reef and sand flats, seagrass beds, and unconsolidated coral rubble. The area sits within an Ecologically or Biologically Significant Marine Area and a Key Biodiversity Area. Within this area there are: **threatened species** (e.g., Mangrove Whipray *Urogymnus granulatus*); **reproductive areas** (e.g., Blacktip Reef Shark *Carcharhinus melanopterus*); **feeding areas** (Reef Manta Ray *Mobula alfredi*); and **undefined aggregations** (Reef Manta Ray).

CRITERIA

Criterion A – Vulnerability; Sub-criterion C1 – Reproductive Areas; Sub-criterion C2 – Feeding Areas; Sub-criterion C5 – Undefined Aggregations

DESCRIPTION OF HABITAT

D'Arros and Saint Joseph Atoll is located on the northern Amirantes Bank, Republic of Seychelles. The Amirantes Bank is a submerged plateau characterised by relatively shallow depths (mostly <40 m), surrounded by open ocean with depths >1,000 m (Filmalter 2011). This region experiences two major seasons, the southeast monsoon (April to November), which is characterised by strong persistent southeasterly winds, lower rainfall and lower temperatures; and the northwest monsoon (December to March), which is dominated by light northwesterly winds, higher rainfall, and warmer temperatures.

D'Arros Island is an oval-shaped, flat coral sand cay, oriented northeast–southwest, 2 km long and 1 km wide, and nowhere higher than 3 m. The island stands on a detached patch coral reef similarly oriented, with maximum dimensions of 2.6 km and 1.4 km. A shallow sand spit extends 0.2 km northeast from it. The island stands on the northern sector of the reef atoll. There are drying reef flats 200–370 m wide on its south side, but only a narrow fringing reef about 75 m wide on its north side.

Saint Joseph Atoll is separated from D'Arros Island to the northwest by a 1 km wide channel (maximum depth = 70 m). The atoll is ~22.53 km^2 in size and comprises a central lagoon (4.8 km^2), enclosed by a large oval shaped reef flat (17.7 km^2) with 16 small unpopulated islands (1.4 km^2 of land area in total; Stoddart et al. 1979). Saint Joseph Atoll is unique in Seychelles because its large, uninterrupted reef flat (0–2 m depth, 15 km^2) is only exposed at low tides, thereby isolating the lagoon (3–9 m depth, 5 km^2) from the outer reef by preventing movement across the entire perimeter of flats for extended periods (Stoddart et al. 1979). Consequently, access to the flats and movement into or out of the lagoon to the outer reef is controlled entirely by the semidiurnal tidal phase. Reef flats are the dominant feature of the atoll and are characterised by extensive sand flats, seagrass beds (predominantly Turtle Grass *Thalassia hemprichii* and *Thalassodendron ciliatum*), unconsolidated coral rubble, and True Mangrove *Rhizophora mucronata* fringes the islands (Stoddart et al. 1979; von Brandis 2011). There is a mixed semidiurnal tidal cycle and, given the lack of a dominant channel, water enters and exits the atoll over the entire expanse of reef flats with changing tides.

The area sits within the Mahe, Alphonse and Amirantes Plateau Ecologically or Biologically Significant Marine Area (CBD 2023) and the D'Arros Island and Saint Joseph Atoll Key Biodiversity Area (KBA 2023).

This Important Shark and Ray Area is delineated from surface waters (0 m) to a depth of 450 m based on the bathymetry of the area.

ISRA CRITERIA

CRITERION A – VULNERABILITY

Seven Qualifying Species considered threatened with extinction according to the IUCN Red List of Threatened Species™ regularly occur in the area. Threatened sharks comprise one Endangered species and one Vulnerable species; threatened rays comprise two Endangered species, and three Vulnerable species (IUCN 2023).

SUB-CRITERION C1 – REPRODUCTIVE AREAS

D'Arros and Saint Joseph Atoll is an important reproductive area for two shark and four ray species.

A mark–recapture survey was conducted from November 2014 to April 2017. A total of 333 neonate and juvenile Blacktip Reef Sharks were tagged and measured at Saint Joseph Atoll (Weideli et al. 2019). These measured 39.5–104.5 cm total length (TL; average = 57.5 ± 0.5 cm TL). Size-at-birth (based on neonate sharks with open umbilical scars) varied substantially from 39.5–63 cm TL (average = 50.5 ± 0.32 cm TL, n = 142) with significantly smaller pups at the beginning of the pupping season (Weideli et al. 2019). Neonates comprised 30% of captures. Most recaptures were found near the initial tagging location (<500 m) after extended times at liberty (>2.5 years).

Similarly, 302 neonate and juvenile Sharptooth Lemon Sharks were tagged and measured at Saint Joseph Atoll (Weideli et al. 2019). These measured 56.6–110.6 cm TL (average = 66.5 ± 0.45 cm TL) and varied in neonatal sizes from 56.6–69.6 cm TL (average = 63.2 ± 0.24 cm TL; Weideli et al. 2019). Neonates comprised 18% of captures. Most recaptures were found near the initial tagging location (<500 m) after extended times at liberty (>2.5 years). These high abundances of both shark species coupled with long-term recaptures are indicative of a habitat where individuals can reside for their first years of life (Weideli et al. 2019). Based on these data, the Saint Joseph Atoll functions as nursery area for these species (as described by Heupel et al. 2007).

Neonate and young-of-the-year (YOY) Blacktip Reef Sharks and Sharptooth Lemon Sharks are highly restricted to the Saint Joseph Atoll and are not found in the immediately adjacent habitats or across the broader Amirantes Bank area. Extensive stereo-BRUV survey around D'Arros and Saint Joseph Atoll (205 deployments in 2022 and 2023) have not recorded a single neonate or YOY (conservatively defined as <70 cm TL) Blacktip Reef Shark or Sharptooth Lemon Shark in habitats outside of the Saint Joseph Atoll flats and lagoon habitats (N Fassbender et al. unpubl. data 2023). Further, no other islands in the Amirantes region are known to support juvenile populations of these species.

Spotted Eagle Rays use Saint Joseph Atoll year-round and are regularly observed by researchers at the site (R Bullock unpubl. data 2023). Drone footage has captured courtship and mating behaviour consistent with documented evidence of reproduction for this species (Tricas 1980), on 4–6 occasions over 2022–2023 (latest two observed events in May 2023: SOSF-DRC unpubl. data 2023). Numbers of animals ranged from 3–6 individuals per observation and duration of courtship behaviour ranged from <3 min to ~20 min.

A total of 70 Broad Cowtail Rays (size range 28–140 cm disc width [DW]), 50 Mangrove Whipray (size range 27–100 cm DW), and 30 Porcupine Ray (size range 43–110 cm DW) were caught within the lagoon of Saint Joseph Atoll for the collection of stomach content and/or muscle samples (Elston et al. 2020). Some of these individuals were assumed to be neonates and/or YOY based on size-at-birth information for these species: Broad Cowtail Ray: 18 cm DW (n = 6 ranging between 28–37 cm DW captured); Mangrove Whipray: 14–28 cm DW (n = 5 ranging between 27–33 cm DW captured); Porcupine Ray unknown size-at-birth but expected to be similar (n = 28 ranging between 43–75 cm DW captured) (Last et al. 2016).

Further capture and tagging of these species from 2021–2022 included Broad Cowtail Rays (n = 18), Mangrove Whiprays (n = 10), and Porcupine Rays (n = 1) with open or recently closed umbilical scars (SOSF-DRC unpubl. data 2023). Moreover, a study aimed at assessing the nursery role of Saint Joseph Atoll for Porcupine Rays tagged 19 juvenile individuals (53–73 cm DW) with VEMCO transmitters and passively monitored their movements from September 2014 to February 2017 using an array of 88 acoustic receivers (Elston et al. 2019). The majority (71%) of individuals displayed

medium (Residency Index [RI]: 0.34–0.66) to high (RI: 0.67–1) levels of residency and 82% of individuals were detected in the atoll for periods close to or exceeding one year. Only three juveniles were recorded on receivers outside the area (0.02% of detections). Home range size increased with DW indicating dispersal from the atoll over time as individuals grow older. This indicates the birth of the individuals inside the atoll (Elston et al. 2019).

Finally, results from acoustic tagging of Broad Cowtail Rays and Mangrove Whiprays highlighted residency (median RI = 0.75 and 0.57 for Broad Cowtail Ray and Mangrove Whipray, respectively) over periods of months to years for both juveniles and adults. Individuals displayed highly restricted movements; most detections occurred within 1 km of tagging locations, and movement networks were small and fragmented. However, juveniles increased their range of movements with size before dispersing to various locations on the Amirantes Bank (Elston et al. 2021). Combined, these data support the classification of Saint Joseph Atoll as a nursery site for these species (Martins et al. 2018).

SUB-CRITERION C2 – FEEDING AREAS

D'Arros Island and Saint Joseph Atoll is an important feeding area for one ray species.

Reef Manta Rays forages on zooplankton in the waters around both D'Arros Island and Saint Joseph Atoll, with the channel between the two land masses representing a significant foraging site. Regular surveys of surface-feeding Reef Manta Rays have been conducted from March 2021 to August 2023, recording 214 feeding mantas over 111 survey days (SOSF-DRC unpubl. data 2023). Surface-feeding is a well-documented behaviour at aggregation sites for Reef Manta Ray (e.g., Armstrong et al. 2016). Acoustic telemetry, satellite telemetry, and photo-identification techniques have been used to confirm the residency and fidelity of individuals to this area. Additionally, the feeding ecology of Reef Manta Rays has also been investigated at this location using stable isotope analyses. Together, these data streams confirm the significance of the feeding area at D'Arros Island and Saint Joseph Atoll to Reef Manta Rays in Seychelles, and also indicate that these animals may play an important role in nutrient transport at this remote location (Peel et al. 2019a).

SUB-CRITERION C5 – UNDEFINED AGGREGATIONS

D'Arros and Saint Joseph Atoll is an important area for undefined aggregations of one ray species.

The cleaning station located on the northern side of D'Arros Island represents the only site of its kind identified for Reef Manta Rays in Seychelles to-date (L Peel pers. obs. 2023). The repeated and extended presence of individual Reef Manta Rays at this site has been confirmed through acoustic telemetry and photo-identification studies (Peel et al. 2019b, 2020, unpubl. data 2023).

Acoustically tagged Reef Manta Rays were most frequently detected on the northern side of D'Arros Island in proximity to the cleaning station (Potts 1973), where they were observed to visit and clean consistently (29.7% of total detections; Peel et al. 2019b). The strong diel cycle observed in the inshore visitation pattern of Reef Manta Rays was explained by their use of the cleaning station during daylight hours. Weekly boat surveys along the coasts of D'Arros and Saint Joseph Atoll between May 2021 and March 2023 identified aggregations of 2–16 Reef Manta Rays on 37 of 111 surveys (SOSF-DRC unpubl. data 2023).

A remote camera system was deployed at a cleaning station on the north coast of D'Arros Island between 29th September 2017 and 27th November 2017 to continuously monitor visits of Reef Manta

Ray at this site (Peel et al. 2020; Peel et al. submitted). This camera deployment allowed for 341 sightings of 83 individual Reef Manta Rays to be confirmed over 599.5 hours of monitoring, with seven of these being new individuals and 51 being re-sighted on at least one occasion (Peel et al. submitted). Alongside the frequent observations of cleaning behaviour (reported in 90.7% of observations), the remote camera system captured the first records of Reef Manta Ray courtship behaviour at the cleaning station in years of monitoring (Peel et al. submitted). By the end of the deployment, 12 courtship events were added to the existing database of records at D'Arros Island, where only four observations of courtship had previously been reported. The remote camera system also captured images of one pregnant female, who was estimated to be in the fourth trimester of a 12-month pregnancy based on the extent of the ventral stomach bulge (Stevens 2016; Peel et al. submitted); emphasising the significance of this cleaning station to Reef Manta Rays of all life stages. However, further information is required to understand the importance of the area for reproductive purposes.

This remote camera system has continued to be deployed because of the reliability of Reef Manta Ray sightings at this site and the importance of the cleaning station to the long-term monitoring of the D'Arros Island and Saint Joseph Atoll Reef Reef Manta Ray aggregation (SOSF-DRC unpubl. data 2023). Between 12th April 2021 and 7th September 2022, the camera system was deployed near-continuously and 44 new individuals were identified. In total, 1,166 sightings of 163 individuals were added to the existing database of records, with one individual being sighted 36 times (SOSF-DRC unpubl. data 2023).

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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	0–75	X		X						
Negaprion acutidens	Sharptooth Lemon Shark	EN	0–90	X		X						
RAYS												
Aetobatus ocellatus	Spotted Eagle Ray	EN	0–40	X		X						
Mobula alfredi	Reef Manta Ray	VU	0–711	X			X			X		
Pastinachus ater	Broad Cowtail Ray	VU	0–60	X		X						
Urogymnus asperrimus	Porcupine Ray	EN	1–30	X		X						
Urogymnus granulatus	Mangrove Whipray	EN	0–85	X		X						

SUPPORTING SPECIES

Scientific Name	Common Name	IUCN Red List Category
SHARKS		
Carcharhinus albimarginatus	Silvertip Shark	VU
Carcharhinus amblyrhynchos	Grey Reef Shark	EN
Carcharhinus leucas	Bull Shark	VU
Galeocerdo cuvier	Tiger Shark	NT
Loxodon macrorhinus	Sliteye Shark	NT
Nebrius ferrugineus	Tawny Nurse Shark	VU
Rhincodon typus	Whale Shark	EN
Triaenodon obesus	Whitetip Reef Shark	VU
RAYS		
Pateobatis fai	Pink Whipray	VU
Rhynchobatus australiae	Bottlenose Wedgefish	CR
Taeniurops meyeni	Blotched Fantail Ray	VU

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.

There are additional indications that this area may also be important for feeding of four shark species.

Between August 2012 and March 2015, 116 individuals of five different shark species were tracked using an array of 67 acoustic receivers (Lea et al. 2016). Blacktip Reef Sharks, Sharptooth Lemon Sharks, Grey Reef Sharks, and Tawny Nurse Sharks were all found to display long-term, perennial use of the lagoon and coastal reef habitats. Though no direct diet or feeding data are currently available for Grey Reef Sharks and Tawny Nurse Sharks, network analyses have revealed high degrees of residency to D'Arros Island and Saint Joseph Atoll for both species, such that these areas can be inferred to represent important feeding sites. For Grey Reef Sharks, 82.5% of all detections were made around the coastal reefs of D'Arros and Saint Joseph Atoll based on a mean 473 days at liberty, and for Tawny Nurse Sharks, 70% of all detections were made inside the Saint Joseph lagoon with larger individuals being regularly detected around the coastal reefs of the area, based on a mean 559 days at liberty. On average, Grey Reef Sharks were detected one in every five days and Tawny Nurse Sharks every second day (Lea et al. 2016). Given the frequency of detection and the high degrees of near-shore residency shown for these species, they are suspected to forage and feed in these areas.

Stomach content data collected from juvenile Blacktip Reef Sharks (n = 115, 37.3–65.5 cm precaudal length [PCL]) and Sharptooth Lemon Sharks (n = 188, 46.0–76.5 cm PCL) from November 2014 to April 2017 showed that the diet of both species was comprised primarily of prey species restricted to the lagoon and sand flats environments of Saint Joseph Atoll (Weideli et al. 2023). Associated acoustic tracking data and mark-recapture tagging data have also shown that both species remain within the lagoon and flats environments for the first years of life, inhabiting restricted areas (Weideli et al. 2019, 2023). Given the reliance of neonates, YOY, and juveniles on these areas, and the reported diet information, the Saint Joseph Atoll may represent a critical feeding area for these species.

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