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Charlie Dryden, Ahmed Basheer, Gabriel Grimsditch, Steven Newman, Danielle Robinson, Ahmed Shan & Mariyam Shidha





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EXECUTIVE SUMMARY

Marine protected areas are used across the Maldives to help protect the high ecological value of the reefs. The largest of these is the South Ari Marine Protected Area (SAMPA), which covers the outer reef of the southern tip of South Ari Atoll (Alifu Dhaalu Atoll). The main aims of SAMPA are to protect and preserve the whale shark aggregation area, to ensure the long-term conservation of the marine environment and promote sustainable tourism and scientific studies in the area which could generate an income for locals. South Ari Atoll is one of the most heavily used atolls for tourism. Due to year-round whale shark sightings and extensive coral reefs, SAMPA is an important income generating area for resorts and other tourism related fields. The combination of popularity and biological importance means it is essential to carefully manage interactions between humans and the environment in this area. The 2016 coral bleaching event has heightened the fragility of this ecosystem and makes understanding and protecting this resource a priority.

The report presents the most comprehensive ecological survey conducted within the South Ari Marine Protected Area (SAMPA) to date. Literature and quantitative data on reefs within SAMPA was limited, therefore a detailed baseline ecological assessment of the MPA was necessary to understand the biological diversity of the area and take appropriate measures to preserve it. The aim of this report was to describe the ecological status of the South Ari Marine Protected Area as of April 2017 and how this might be used to enhance protection of the area. The reefs around SAMPA were surveyed using Manta tows, rapid roaming surveys and transects over a five-day period. Benthic and fish communities were examined, as well as reef resilience metrics. The presence of IUCN Red Listed animals and corals were recorded and a list of all coral and fish species observed collated.

There was a notable spatial pattern in the condition of coral reefs. Average coral cover of the reefs on the eastern side was 24.4%, which was significantly higher than those on the western side (7.5%). This eastern area appeared to have survived the bleaching event better than many other reefs across the country. This finding is particularly important given the projected future for coral reefs under the impacts of climate change and makes this area a potential refugia from climate change driven degradation. Reefs on the eastern half of the survey area also had higher cover of Acroporid corals, most notably at Maamigili.

The fish communities present within SAMPA reflect the wider diversity of the Maldivian coral reef ecosystem. During this short survey 345 species of reef associated fish were identified. The biomass and richness of butterflyfish species mirrored the cover and diversity of corals, with both greater on the eastern side of SAMPA. Grouper biomass was high across the area indicating a high standing stock of groupers. Reef fishery target species were encountered throughout the area; however, their abundance was highly variable due to the large schools encountered.

The potential resilience of the reefs appeared to be high. Coral recruits were found at all sites; the most dominant recruit family was Acroporidae. Though it is too early for these corals to have recruited since the bleaching event, it does suggest a high juvenile survivorship of this important coral family. The reefs on the eastern side of the atoll were the most structurally complex, however most reefs surveyed were between medium and high complexities. The biomass of functionally important herbivores was high throughout the area and the numbers found are likely to confer a level of resilience through prevention of algal overgrowth.

Surveys found significant numbers of IUCN Red Listed sharks, groupers, turtles and coral species. A key reason

for the protection of the South Ari Atoll area is the year-round presence of whale sharks. Though only a one individual was observed on these surveys, multiple individuals were observed during transit to and from surveys.

This study has further highlighted the ecological value and the potential resilience of the coral reefs in SAMPA. Management efforts should prioritise the area from Maamigili – Dhigurah. This has been identified as the healthiest section of reef, and the high coral survivorship following the bleaching event suggests it will be a hotspot for reef resilience in the future. To aid with this a monitoring program should be setup for this area. Strongly enforced guidelines regarding whale shark interactions are also required to ensure the safety and wellbeing of this endangered species.

"This study has further highlighted the ecological value and the potential resilience of the coral reefs in SAMPA. Management efforts should prioritise the area from Maamigili – Dhigurah. This has been identified as the healthiest section of reef, and the high coral survivorship following the bleaching event suggests it will be a hotspot for reef resilience in the future."

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INTRODUCTION

The Maldives archipelago is a chain of over 2,000 coral reefs and 1,100 islands spread across 21 atolls and 4 oceanic reef platforms (Kench 2011). Its geographic location close to the middle of the Indian Ocean has resulted in a diverse marine system, including species from African reefs and from the coral-triangle in south east Asia. There are approximately 250 species of hard, reef-building corals (Pichon and Benzoni 2007) and more than 1,200 reef associated fish species (Rajasuriya et al. 2002). There have also been 36 species of sponge, 285 species of algae, 5 species of seagrass, 400 species of molluscs, 350 species of crustaceans and 80 species of echinoderms recorded in the Maldives (MEE 2015). The reefs provide essential services to many migratory species including manta

rays and several shark species. Five of the seven species of marine turtle are found in the Maldives, with two species, hawksbill (*Eretmochelys imbricate*) and green (*Chelonia mydas*) turtles often cited living on the reefs and nesting on beaches (Ali and Shimal 2016).

To help protect the high ecological value of Maldivian coral reefs there are currently 37 marine protected areas (MPAs) spread across the country. The largest of these is the South Ari Marine Protected Area (SAMPA). The area at the southern tip of South Ari atoll (Figure 1) was declared an MPA on 5th June 2009. The MPA boundary follows the perimeter of the southern edge of the atoll from Rangali Island in the north-west round to Dhigurah island on the eastern side. Protection extends 1 km seaward from the reef crest. The main aims of this MPA are to protect and

preserve the whale shark aggregation area, to ensure the long-term conservation of the marine environment and promote sustainable tourism and scientific studies in the area which could generate an income for locals (Environment Protection Agency 2014). To improve management of this area the Ministry of Environment and Energy (MEE) has advocated developing a new management plan as well as including it in the country's proposed UNESCO Biosphere Reserve network.

The tourism industry is the largest single contributor to Maldivian GDP (Ministry of Tourism 2016). The southern section of Ari atoll (Alifu Dhaalu Atoll) (Figure 1) is one of the most heavily used atoll areas for tourism and diving activities in the Maldives, it is second only to North Malé in terms of tourist capacity with 17 resorts and 16 guesthouses (Ministry of Tourism 2016). Additionally,

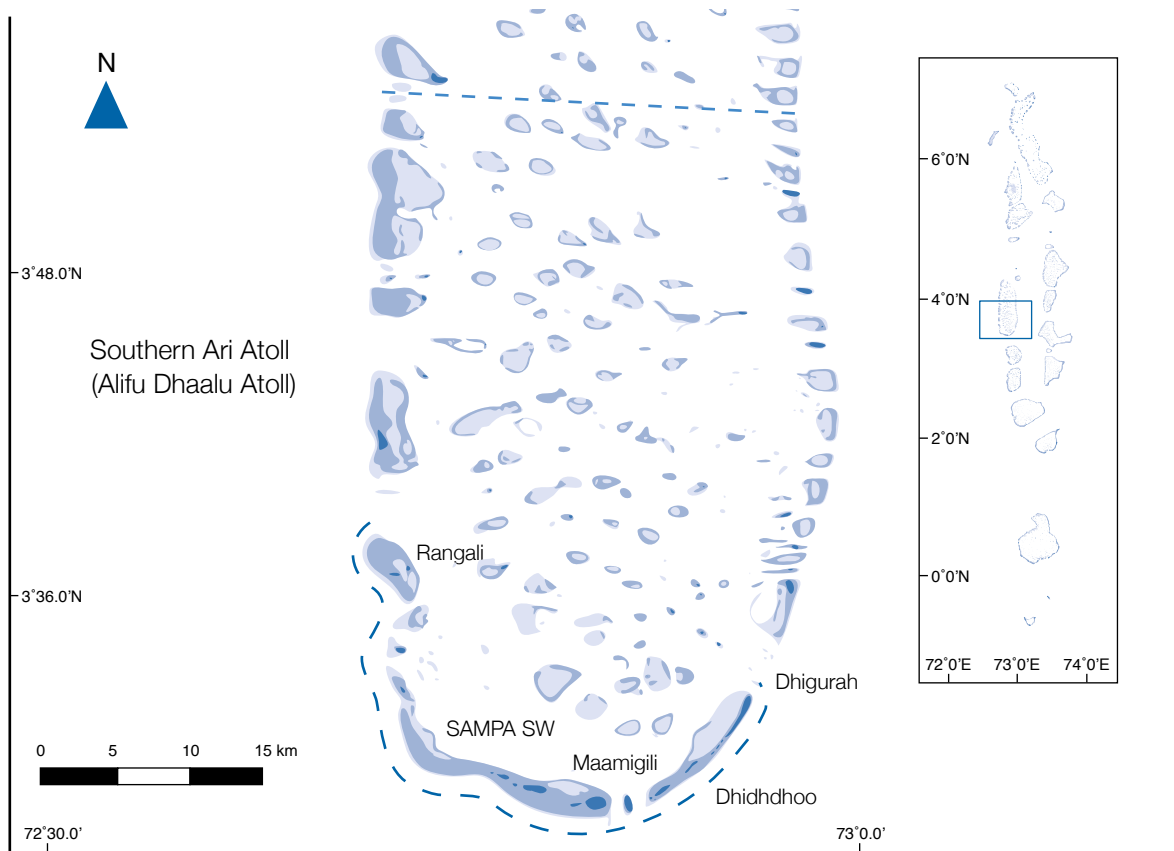


Figure 1. Location of Southern Ari Atoll (Alifu Dhaalu Atoll) in the Maldives Archipelago. Green indicates reef area, blue indicates shallow lagoon area and grey indicates islands. Dashed line marks the extension of the SAMPA boundary from the reef edge.

it is a popular location for dive safari boats with multiple vessels present throughout the year. The area is known globally for its biologically diverse marine life, notably the high probability of whale shark encounters, which make it an important stop-off for many visitors to the country. This combination of popularity and biological importance means it is essential to carefully manage interactions between humans and the environment in this area.

Due to year-round whale shark sightings, SAMPA is an important income generating area for resorts and other tourism. The value of shark diving tourism (including whale sharks) to the Maldives was estimated to be in excess of US\$2.3 million in 1993 (Anderson and Waheed 2001), which likely has increased significantly over the past 14 years. Whale shark eco-tourism is a multi-million US dollar business in a number of countries (Gallagher and Hammerschlag 2011). The estimated number of tourists involved in whale shark excursions to SAMPA in 2013 was 72,000 – 78,000 and their expenditure was estimated to be US \$ 9.4 million (Cagua et al. 2014). The Maldives Whale Shark Research Programme (MWSRP) has recorded sightings of 302 different individuals within the MPA since 2006 (Rees and Hancock 2017), with many re-sightings of the same individuals.

The combination of rising global temperatures and the El Niño climate event in 2015 led to the planet's hottest year on record (Hansen et al. 2016) that resulted in prolonged above average sea surface temperatures (SST) through 2015 – 2016. This led to the third global coral bleaching event (Hughes et al. 2017). Coral reefs in the Maldives were severely impacted by this event with approximately 73% of corals on shallow (<13 m) reefs bleaching (Ibrahim et al. 2017). During a nationwide assessment of bleaching severity, the single site in South Ari (but not within SAMPA) found relatively low bleaching incidence (13.8% bleached coral) (Ibrahim et al. 2017), suggesting reefs in this area may have fared

better than the rest of the country. The impacts of the bleaching event in combination with other threats facing Maldivian coral reefs (Lasagna et al. 2010, Burke et al. 2011, Hoegh-Guldberg 2011, Nepote et al. 2016) makes understanding and managing for coral reef resilience essential. Resilience on coral reefs is the capacity to recover and gravitate towards a coral dominant state following disturbances (Mumby et al. 2014). Resilience-based management focuses on managing resilience explicitly and is now considered a more appropriate approach to protecting coral reef ecosystems (Lam et al. 2017). Indicators of reef resilience include coral recruitment, herbivore communities and coral reef structural complexity (Hughes et al. 2010, Flower et al. 2017).

"The impacts of the bleaching event in combination with other threats facing Maldivian coral reefs makes understanding and managing for coral reef resilience essential."

The area was selected for protection due to the year-round presence of whale sharks and no assessment was performed on the reef habitat at the time of the MPA creation. Literature and quantitative data on reefs within SAMPA is limited and there are only two published reports which discuss the coral reef condition of the area, Reef Check surveys conducted by Biosphere Expedition in 2011 and 2016 (Solandt and Hammer 2012, 2017). Though these surveys provide some information about the reef, only a single site within SAMPA was surveyed on each expedition. Therefore, a detailed baseline ecological study of the MPA was necessary to understand the biological diversity of the area and develop appropriate measures to

preserve it. Consequently, in addition to proposing the area as a UNESCO biosphere site, this study will also aid in understanding the little-studied reefs within SAMPA.

Aims

The aim of this report is to describe the ecological status of the South Ari Marine Protected Area in 2017 and how this might be used to enhance protection of the area, with five key objectives:

1. Describe coral reef benthic habitat and any spatial variability
2. Describe reef associated fish communities
3. Quantify key reef resilience metrics
4. Identify endangered, vulnerable or threatened marine species present
5. Catalogue all species of coral and fish identified

METHODS

The range of habitats, conditions and reef types present within SAMPA and the aims of this project required multiple survey methodologies. Manta tows were used to assess the benthic condition of the reef over a large area. Using this approach, the entire perimeter of SAMPA reef flat was observed (Figure 2). Timed roaming surveys were used to survey the benthic habitat and fish community on all reef types and environmental conditions. Roaming surveys were performed at 32 approximately evenly spaced distances around the reef perimeter and in three channels (Figure 2). These were then grouped into 11 sites for analysis. Transect surveys were used to quantitatively assess fish and benthic communities (Figure 2) at a high taxonomic level. Transect sites were selected using a stratified, haphazard process and a gap of at least 5 m was left between each transect to ensure independence of samples. Surveys were conducted over a five-day period between 10/04/2017 – 14/04/2017. The same team conducted all the surveys, ensuring

consistency in the data. The results of surveys are presented as averages \pm standard error throughout.

Table 1. Name and location of all sites surveyed within SAMPA. Reef type describes the reef formation within the zone. Site number relates to location shown in figures 2 b and c. Yes values indicate whether this type of survey was performed at this zone. Aspect is the compass direction the reef was facing.

Coral reef benthos

Coarse-scale assessments of the SAMPA reef flat were performed using manta tows. Tows were conducted around the perimeter of the outer reef of SAMPA. Tows took place over areas of shallow fringing reef; deeper channels separating stretches of reef were avoided. This approach allowed a large area of reef to be surveyed rapidly, examining broad scale patterns in reef condition. A single observer was towed behind a boat along the perimeter of the outer reef. Tows were performed in 6 – 12 m depth at a speed of 6 – 8 km/h and lasted 2 minutes. The surveyor then estimated percentage cover of the categories live coral, dead coral, sponge, turf algae, macroalgae, rock, rubble, sand and

crustose coralline algae (CCA). The surveyor also recorded the depth, visibility and the identity and number of any Red Listed species or crown-of-thorns starfish observed. At the same time, the assistant on the boat recorded the GPS coordinates of the start and end of each Manta tow.

Roaming surveys were performed either whilst snorkelling or SCUBA diving. Each survey lasted 15 minutes with start and finish times, survey location (GPS of start/finish or entry/exit), reef type (wall, slope, channel), estimated average depth and visibility recorded. The percent cover was visually estimated for eight different substrate categories: live coral, sponge, turf algae, macroalgae, rock, rubble, sand, and CCA. Percent cover of coral, rock and turf algae (the underlying structure) was categorised in eight growth forms: table, branching, massive, foliose, free-living, encrusting, finger and others.

Transect surveys were conducted at five sites along the outer reef. Six transects were conducted at each site. The cover of different substrate categories was collected using a point intercept approach along the 30 m transect tape. Starting at 0.5 m

the substrate type directly under the transect tape every 50 cm along the transect was identified as one of the categories: live coral (identified to genus and growth form), dead coral (growth form), sponge (growth form), algae (turf and underlying growth form or macroalgae), rock, rubble, sand, CCA.

Fish community

Roaming fish surveys were conducted at the same time and over the same area as the roaming benthos surveys. During surveys, the presence and time of first observation for each fish family was recorded. This provides a representation of how common these families were. Fish targeted by coral reef fisheries in the Maldives were counted and identified to species.

Site Name	Site Number	Northing	Easting	Reef Type	Manta Tow	Roaming Survey	Transect Survey	Aspect
Dhigurah	1	3°32'08.3	72°55'17.8	Fringing	Yes	Yes	Yes	East
Lux	2	3°29'45.6	72°54'03.0	Fringing	Yes	Yes	Yes	East
Dhidhdhoo	3	3°28'47.6	72°52'42.6	Fringing	Yes	Yes	-	South east
Maamigili	4	3°28'01.7	72°50'14.6	Fringing	Yes	Yes	Yes	South
Maamigili Channel	5	3°28'16.1	72°50'42.7	Channel	-	Yes	-	South
Fenfushi	6	3°29'02.5	72°46'42.1	Fringing	Yes	Yes	Yes	South west
SAMPA SW	7	3°30'06.6	72°43'26.6	Fringing	Yes	Yes	-	South west
Huruethi	8	3°32'22.3	72°42'56.8	Fringing	Yes	Yes	Yes	West
Hukurudhoo	9	3°34'19.9	72°42'36.5	Channel	-	Yes	-	West
Rangali	10	3°36'47.9	72°42'28.8	Fringing	Yes	Yes	-	West
Rangali Kandu	11	3°35'24.1	72°43'20.8	Channel	-	Yes	-	West

Table 1. Name and location of all sites surveyed within SAMPA. Reef type describes the reef formation within the zone. Site number relates to location shown in figures 2 b and c. Yes values indicate whether this type of survey was performed at this zone. Aspect is the compass direction the reef was facing.

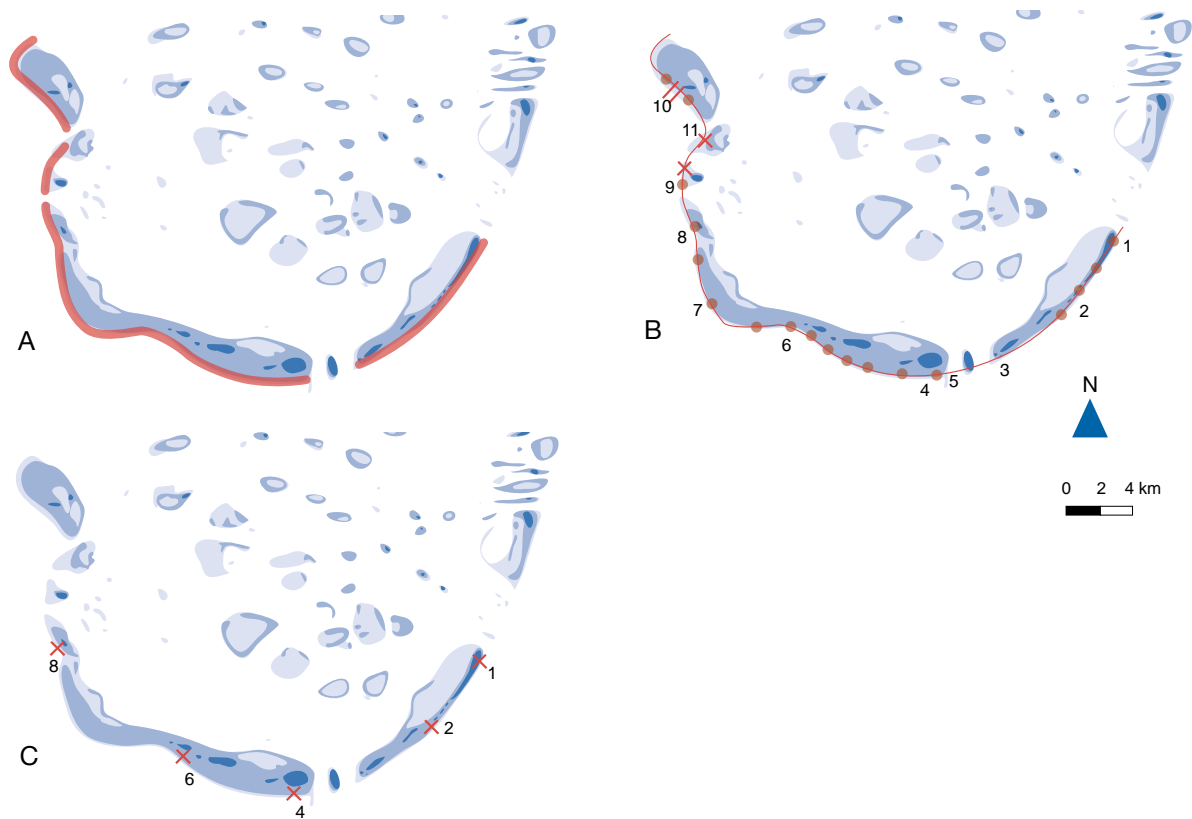


Figure 2 A. Shows the path of the manta tows around the perimeter of outer reef. Gaps in the path are across channels where the reef was too deep to survey. B) shows the sites of roaming surveys. Circles represent snorkel roaming surveys and crosses represent dive roaming surveys. Site numbers relate to table 2 C) shows the transect survey sites. Site numbers relate to table 2.

These included all species of snapper (Lutjanidae), emperor (Lethrinidae) and jacks and trevally (Carangidae) and groupers (Serranidae) of the genera *Aethaloperca*, *Anyperodon*, *Cephalopholis*, *Epinephelus*, *Plectropomus* and *Variola* (Sattar and Adam 2005).

Fish communities were also surveyed on six 4 x 30 m transects using the same transects as the benthos surveys. The presence of all fish families was recorded on each transect. All butterflyfish (Chaetodontidae), parrotfish (Scaridae), groupers, surgeonfish (Acanthuridae), sharks and rays were counted and identified to species and their total length estimated to the nearest 5 cm. Batfish (Ehippidae), rabbitfish (Siganidae), snappers and jacks were counted and identified to family and their total length was estimated in 5 cm size classes. The biomass of fish species was calculated the length-weight conversion: $W = aL^b$, where a

and b are constants, L is total length in cm and W is weight in grams. Constants vary by species and were gathered from FishBase (Froese and Pauly 2017).

Reef resilience

Specific metrics that have been shown to indicate the resilience of coral reef habitats were collected using the different survey methods. Juvenile coral recruitment was quantified on the transect surveys. A 25 x 25 cm quadrat was placed above and below the transect every 5 m at 5 m, 10 m, 15 m, 20 m, 25 m and 30 m. The number of coral recruits (colonies < 5 cm diameter) within each quadrat were counted and identified to genus where possible. Recruit density was then calculated as number of recruits per area. Coral reef structural complexity was visually assessed during roaming surveys, for the duration of the timed swim, and for the length

of the transects. Structural complexity was estimated on a scale from 0 (completely flat) to 5 (highly complex) (following Wilson et al. 2007). Biomass of key herbivorous fish species was calculated on transects following the method described above. Abundance of the corallivorous crown-of-thorns (*Acanthaster planci*) and pin-cushion (*Oulcita schmideliana*) starfish species were quantified during roaming surveys.

Endangered, vulnerable or threatened species

The International Union for the Conservation of Nature (IUCN) Red List classifications, critically endangered (CR) endangered (EN), vulnerable (VU) or near threatened (NT) were used to identify marine species globally at risk that were present in SAMPA. Roaming surveys were used to quantify the presence and abundance of these species as this method covers a large area which increases the likelihood of

Species	Red List category	CITES Appendix
Galaxea astreata	Vulnerable	II
Pachyseris rugosa	Vulnerable	II
Pavona venosa	Vulnerable	II
Physogyra lichtensteini	Vulnerable	II
Turbinaria mesenterina	Vulnerable	II

Table 2. Pre-selected coral species quantified and their IUCN Red List category and CITES Appendix

encounter. Five pre-selected VU coral species were selected as they were easy to identify during the rapid surveys (*Table 2*). All fish and reptile species (CR, EN, VU or NT) were counted and identified to species.

Catalogue of coral and fish species present

Throughout all surveys, all species of coral and fish were identified to species. Where in-situ identification was not possible photographs were used to identify species later. All members of the survey team participated in data collection and photographic identification to ensure maximum area coverage and accuracy. Species lists were updated daily.

Statistical analysis

Spatial interpolation of the manta tow and roaming survey coral cover data was performed using the inverse distance weighted method (IDW) in Quantum GIS version 2.18.14 (Quantum GIS Development Team 2017). To test for significant differences in benthic and fish communities among survey sites a one-way analysis of variance (ANOVA) was used where data were normally distributed and a Kruskal-Wallis test if not. Distribution of the data was tested for normality using the Shapiro-Wilk test. Fish species diversity was calculated using the Simpson's diversity index. All statistical analysis was performed using R version 3.4.0 (R Core Team 2017).

RESULTS

Coral reef benthos

One hundred and forty-one manta tows were required to survey approximately 45 km of reef along the perimeter of reef around SAMPA from Dhigurah to Rangali. Coral cover varied with methodology. However, both revealed coral cover was highest on the eastern side (*Figure 3*). Highest percent live coral cover was observed on reefs near Dhidhdhoo $39.3 \pm 2.5\%$ and Dhigurah $32.5 \pm 2.5\%$ on the eastern side of the atoll. Lowest coral cover was found on the reefs at SAMPA SW $4.7 \pm 1.2\%$ and Huruelhi $5.0 \pm 1.2\%$, both of which were on the western side of the MPA. Coral cover varied across the remaining the reef area, ranging from 7 – 23%. Rock was the dominant substrate across both roaming and transect surveys (*Figure 4* and *Figure 5*). The cover of all algae combined was $21.5 \pm 2.1\%$ with CCA contributing the most to this category ($16.1 \pm 2.2\%$). The three channel areas surveyed, Maamigili Channel, Hukurudhoo and Rangali Kandu had the most varied substrate composition. Mean coral cover on transects was $28 \pm 2.5\%$ (*Figure 5*). Lux was the only site where rock did not have the highest cover. Turf ($5.2 \pm 0.7\%$) and macroalgae cover ($3.0 \pm 0.7\%$) was low across all of the sites surveyed accounting for $5.2 \pm 0.7\%$ and $3.0 \pm 0.7\%$ of the substrate

"Highest percent live coral cover was observed on reefs near Dhidhdhoo $39.3 \pm 2.5\%$ and Dhigurah $32.5 \pm 2.5\%$ on the eastern side of the atoll."

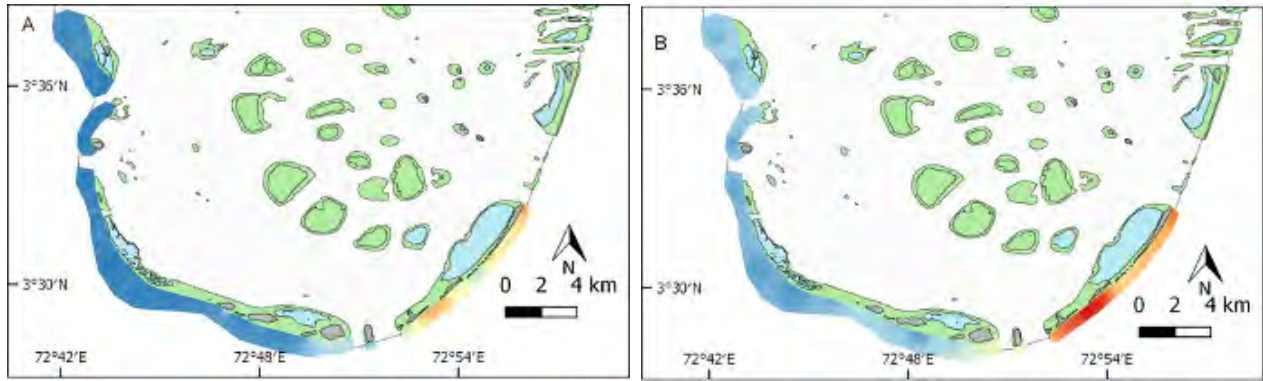


Figure 3. IDW interpolation of live coral cover from (A) manta tows and (B) roaming surveys. Colour scale is 0% (dark blue) to 40% (dark red) coral cover

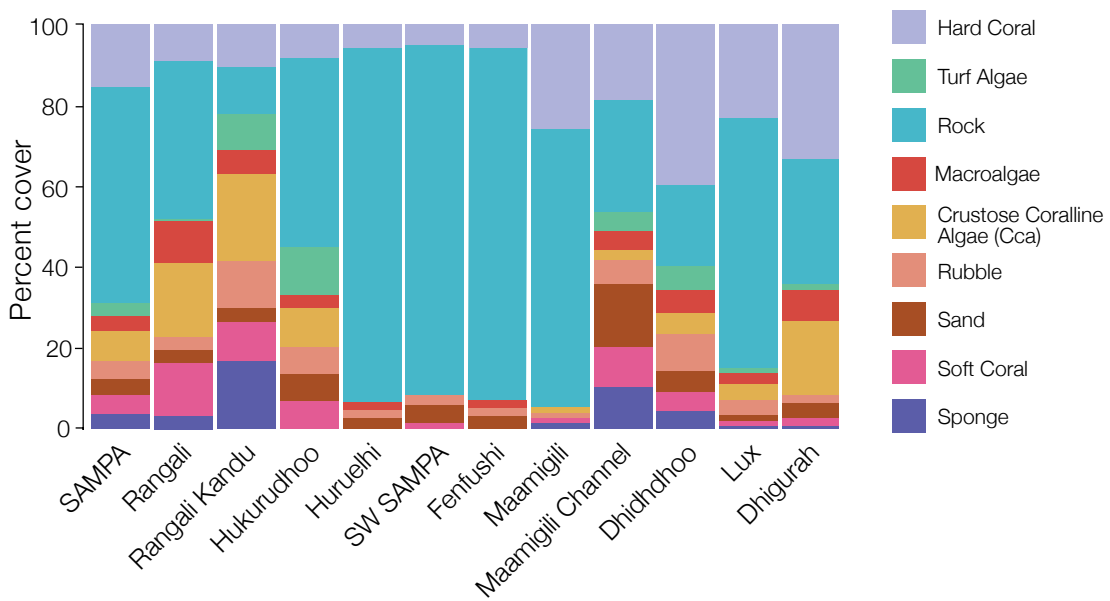


Figure 4. Mean percent cover of nine substrate categories estimated using the roaming survey method. Categories were hard coral (violet), rock (turquoise), turf algae (green), macroalgae (red), crustose coralline algae (CCA) (orange), rubble (cream), sand (brown), soft coral (pink) and sponge (purple).

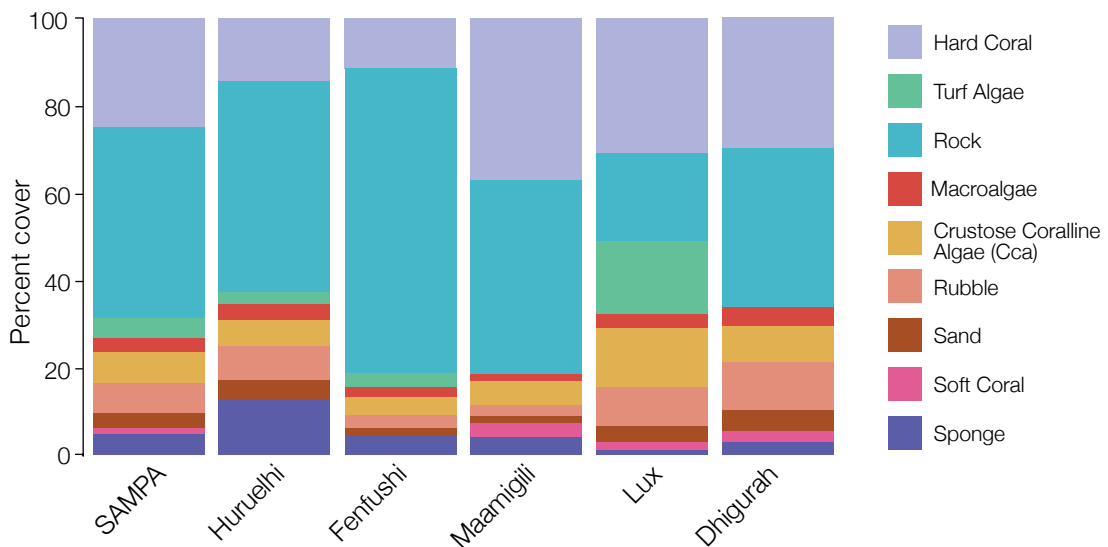


Figure 5. Mean percent cover of nine substrate categories estimated using the transect survey method. Categories were hard coral (violet), rock (turquoise), turf algae (green), macroalgae (red), crustose coralline algae (CCA) (orange), rubble (cream), sand (brown), soft coral (pink) and sponge (purple).

Corals belonging to the families Poritidae, Pocilloporidae and Acroporidae were the most frequently observed. These corals were found on 97%, 90% and 83% of transects respectively, and at all five transect survey sites. Poritidae and Acroporidae had the highest percent cover among coral families (Figure 6). The non-scleractinian blue coral *Heliopora* and fire coral *Millepora* were also recorded.

The reef structure of SAMPA was dominated by massive (57.6%), branching (32.8 %) and encrusting (28.6%) corals (Figure 7). The reef of Lux on the eastern side was dominated by massive ($16.2 \pm 3.4\%$) and branching ($6.7 \pm 2.1\%$) corals. Like Lux, the adjacent reef of Dhigurah was dominated by branching ($12.5 \pm 2.3\%$) and massive ($11.5 \pm 1.6\%$) corals. Reefs on the western side

were dominated by abiotic massive and encrusting rock structure. Free living (0.7%) and finger (2.6%) like growth forms were rarely observed. It is also notable that eastern reef had a significant amount of live tabular coral growth.

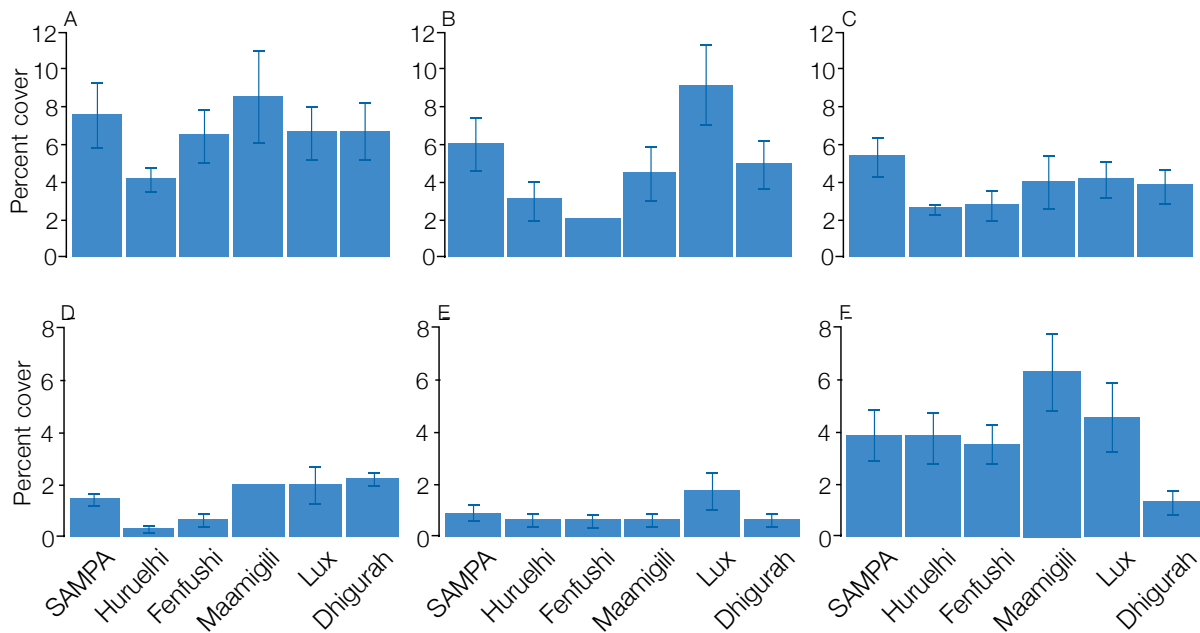


Figure 6. Percent cover of the five most commonly observed coral families: (A) Poritidae, (B) Acroporidae, (C) Pocilloporidae, (D) Agariciidae, (E) Merulidae and all (F) other coral families combined. Values are mean percentage cover on transects across SAMPA and among each survey site. Error bars indicate standard error of the mean. Sites are presented west to east.

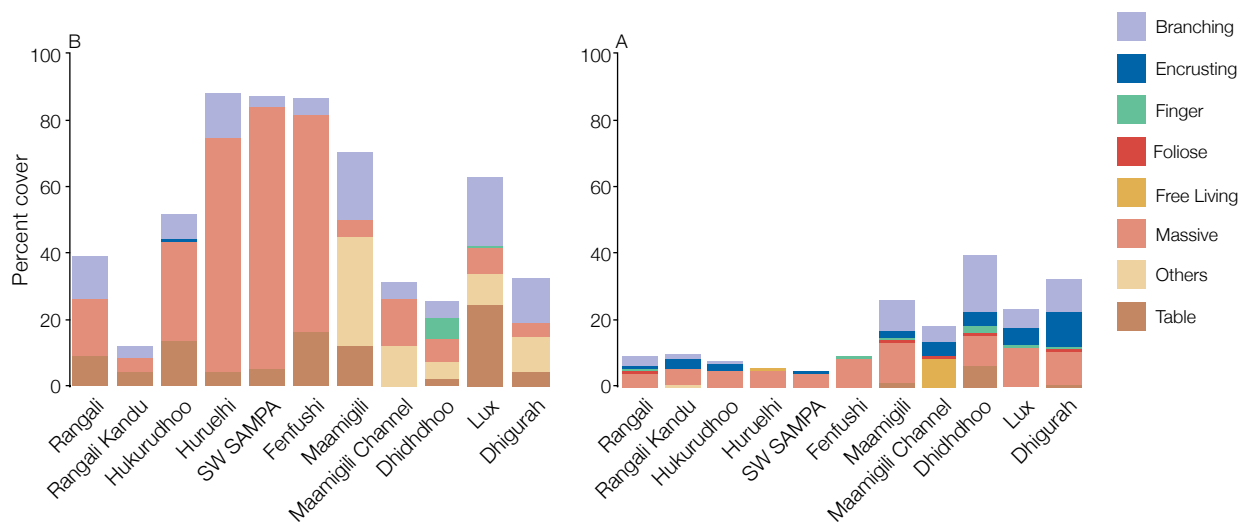


Figure 7. The percentage cover of the (A) living and (B) dead structural growth forms. Values are mean percent cover on roaming surveys across SAMPA and among each survey site. Sites are presented west to east.



Figure 8. Extensive cover of table corals at Maamigili. Coral were present on both the reef flat and reef slope. Photos © Nishan Perera, IUCN Maldives

Fish communities

Fish family richness was high across all sites, with an atoll mean of 20.2 ± 1.5 families and 20.1 ± 0.9 families for roaming and transect surveys respectively (Figure 9). There was no significant difference in the number of fish families found at sites on either roaming (ANOVA, $p > 0.05$) or transect (ANOVA, $p > 0.05$) surveys. However, the roaming results suggest the highest richness was on the eastern most reefs within SAMPA, though this is not apparent in the transect data.

In total 46 different fish families were observed during roaming surveys (Figure 10). Parrotfish, damselfish and wrasse were observed on all 50 roaming surveys. The most common nine families were observed on over 95% of surveys.

Butterflyfish biomass varied significantly by site (Kruskal-Wallis, $p < 0.05$), however, the only significant difference was between Fenfushi and Lux (Figure 12), though butterflyfish biomass was generally higher on the eastern side. Grouper biomass did not vary

significantly among sites (Kruskal-Wallis, $p > 0.05$) (Figure 12). Species richness of both butterflyfish (ANOVA, $p < 0.01$) and groupers (ANOVA, $p < 0.05$) varied significantly across survey sites. Lux had the highest butterflyfish species richness and diversity (Figure 11). Sites on the western side of the area had a lower richness and diversity of butterflyfish species than sites on the eastern side. Huruelhi and Lux had the highest grouper species richness. Grouper diversity was more even between sites; only Lux had a noticeably higher value.

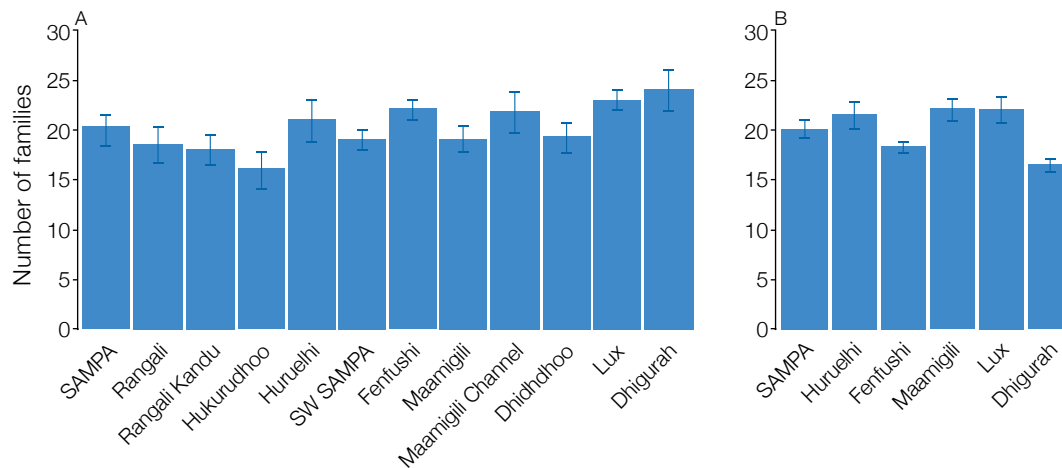


Figure 9. Mean number of fish families observed across all (A) roaming surveys and (B) transect surveys. Error bars show standard error. Plots show data averaged across all surveys (SAMPA) and from the 11 and 5 sites surveyed using roaming and transect survey methods respectively

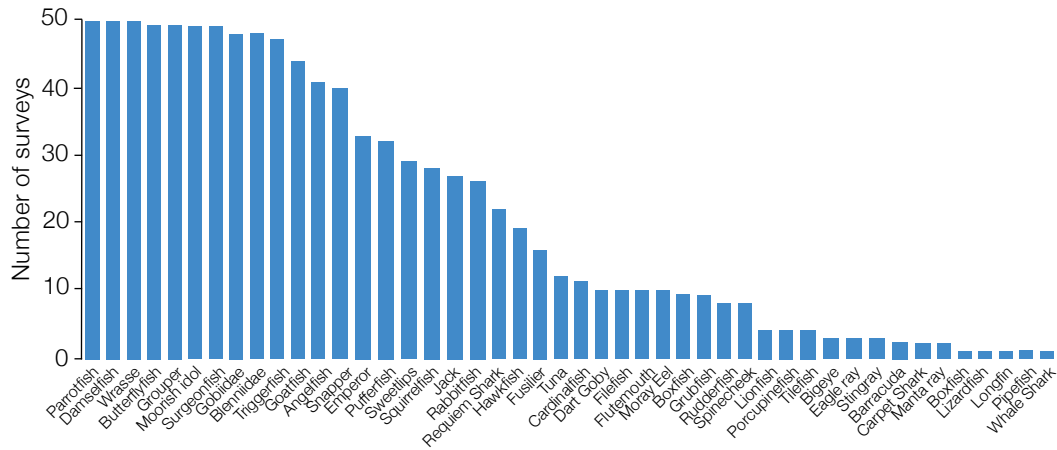


Figure 10. Frequency of occurrence of fish families on roaming surveys (n=50).

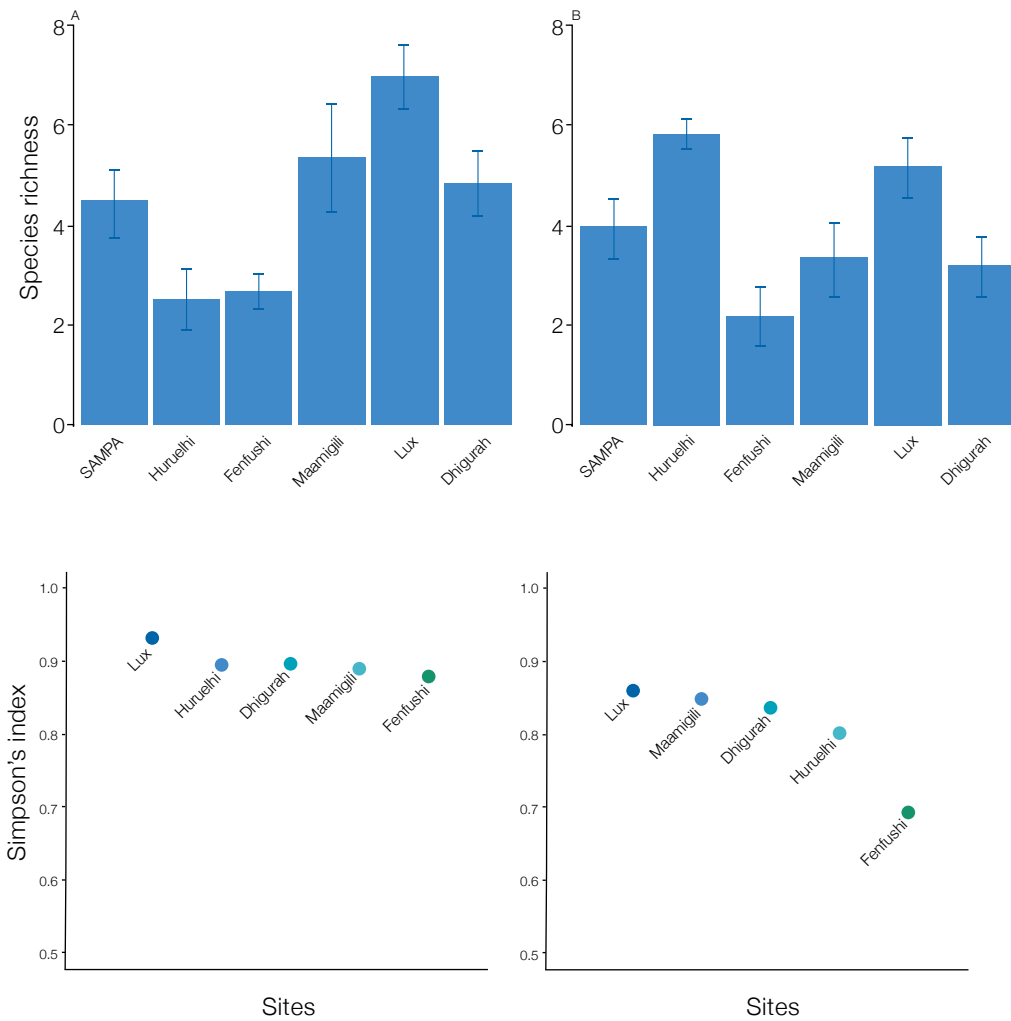


Figure 11. Mean species richness for (A) butterflyfish and (B) groupers and Simpson's diversity index for (C) butterflyfish and (D) groupers observed on transect surveys. Error bars show standard error.

Emperor abundance was highest at Dhidhoo (85.0 ± 14.6) (Figure 13), they were also highly abundant at Lux, however their numbers were relatively low across the rest of SAMPA. Grouper abundance was highest on the eastern and western sections of

SAMPA with southern sites having the lowest numbers. The exception to this was Maamigili Channel, however the numbers here were highly variable. Jacks were observed throughout SAMPA, except at Lux. Their numbers were comparatively low when examined

alongside other reef fishery target families. Snappers were the most abundant reef fishery target family; however, their number was highly variable among surveys.

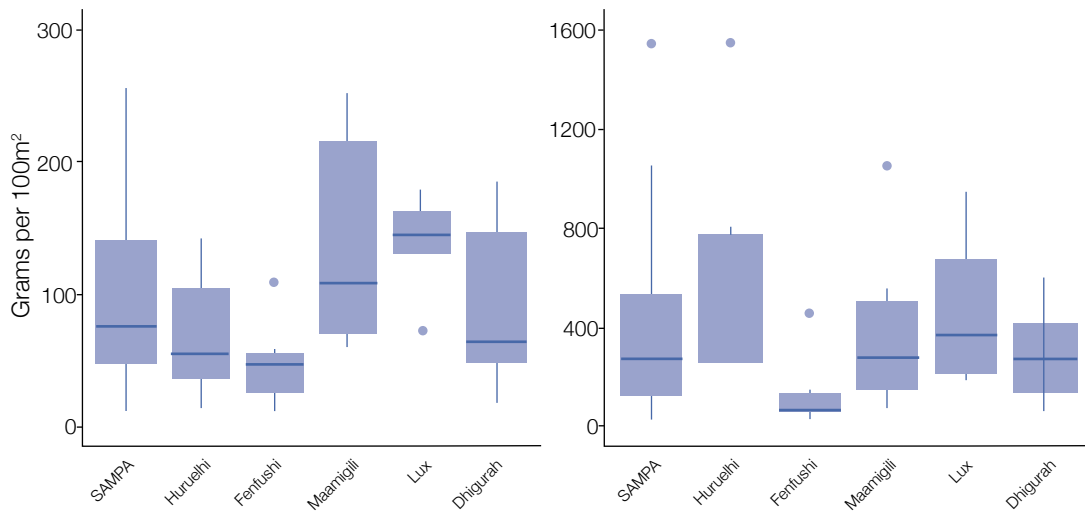


Figure 12. Butterflyfish (A) and grouper (B) biomass from transect surveys. Thick black line represents median value. Note the y axis of graphs are on different scales

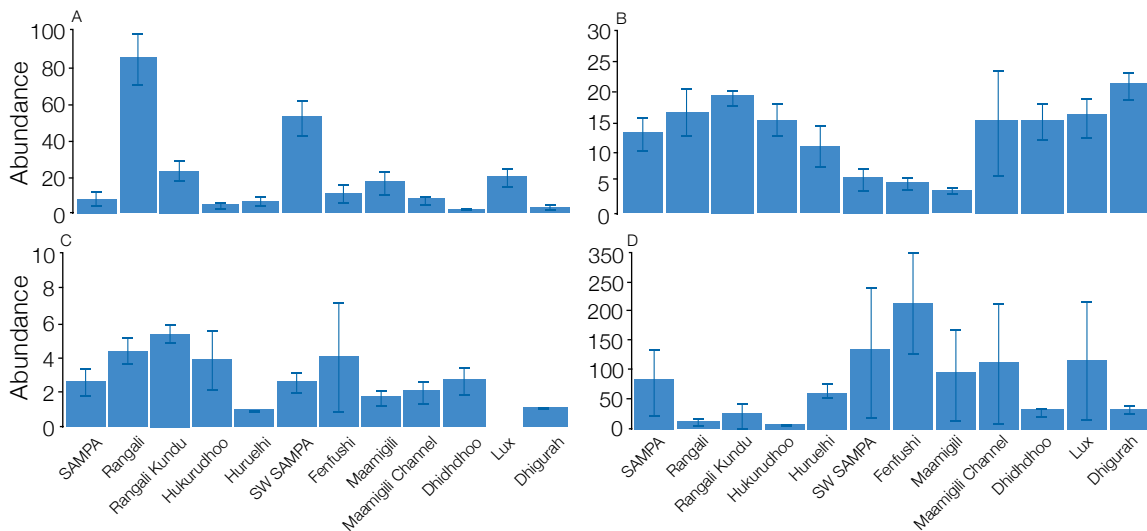


Figure 13. The mean abundance of fisheries reef fisheries target families: (A) emperors, (B) groupers, (C) jacks and trevallies and (D) snappers observed on roaming surveys across SAMPA and at each of the 11 sites. Error bars show standard error. Note y axis of each graph is on a different scale.

Reef resilience

The mean density of coral recruits from the transect surveys was 9.8 ± 1.3 per m^2 . There was no significant difference in recruit density among sites (ANOVA, $p > 0.05$). The density at sites ranged from 5.9 ± 1.4 per m^2 at Maamigili to 11.2 ± 1.4 per m^2 at

Lux (Figure 14). Recruits belonging to 13 different families were recorded. The most common family of recruits across all sites was Acroporidae (Figure 15). Agariciidae Pocilloporidae and Psammocoridae were the only other coral families which averaged recruit densities of greater the 1 per m^2 .

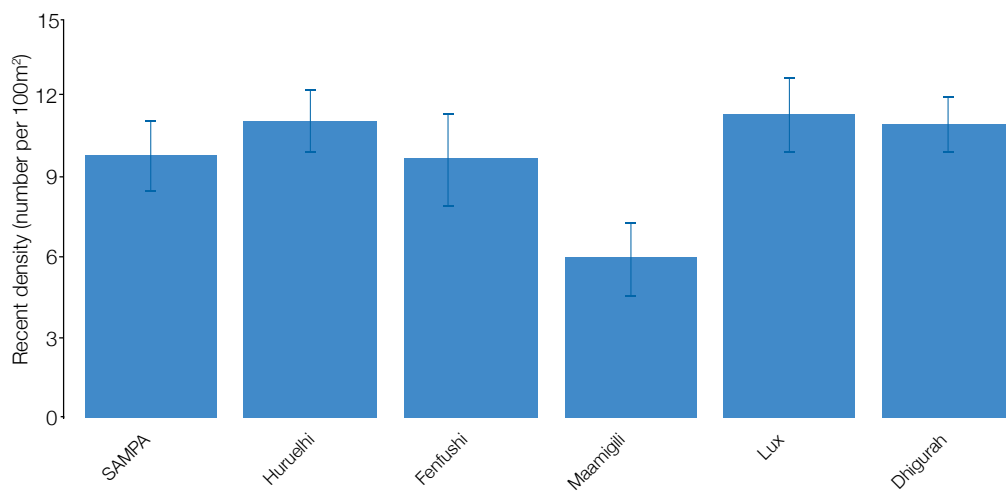


Figure 14. Mean density of coral recruits per m^2 found on transects across SAMPA and at each survey zone. Error bars show standard error.

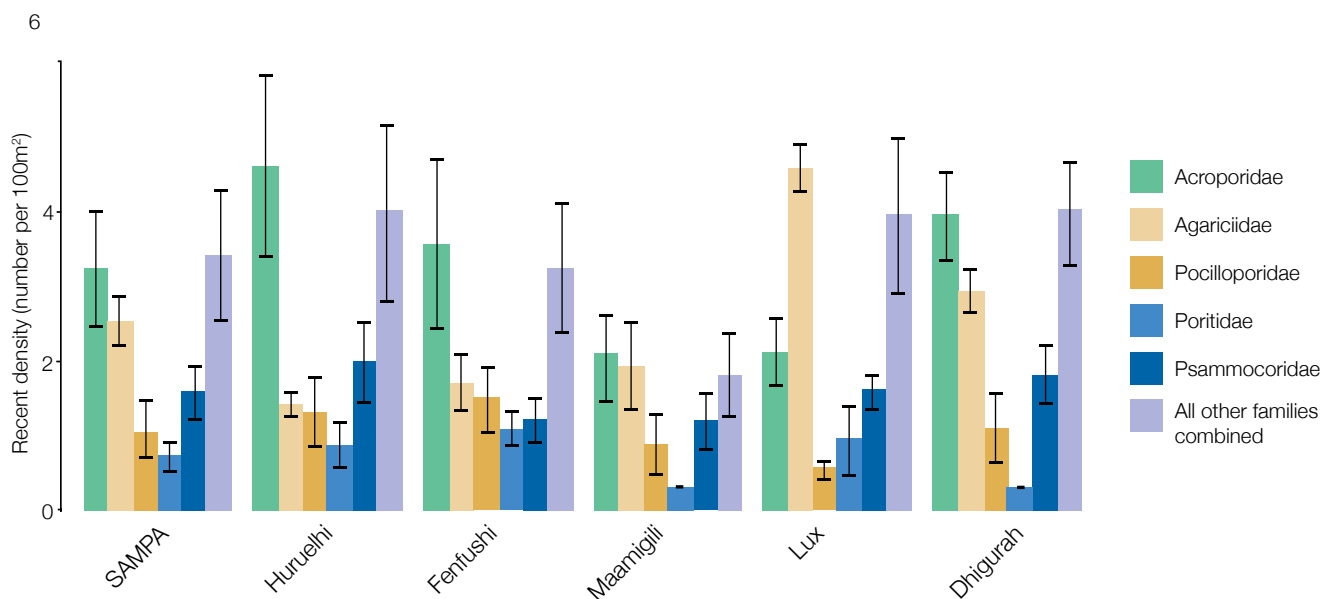


Figure 15. Mean density of the five most commonly observed coral recruit families: Acroporidae (green), Agariciidae (light yellow), Pocilloporidae (dark yellow), Poritidae (light blue), Psammocoridae (dark blue) and all other families combined (violet).

Coral reef structural complexity on roaming surveys ranged from 1 – 4, with no sites completely flat (Figure 16). Sites varied significantly in their structural complexity (ANOVA, $p < 0.01$). Sites on the eastern side of SAMPA tended to have the highest complexities, with Dhigurah (4.0 ± 0) and Dhidhdhoo (3.7 ± 0.2) the highest. Reef structural complexity was lowest in Huruelhi (1.0 ± 0 s.e.) and SW SAMPA reef (1.3 ± 0.3).

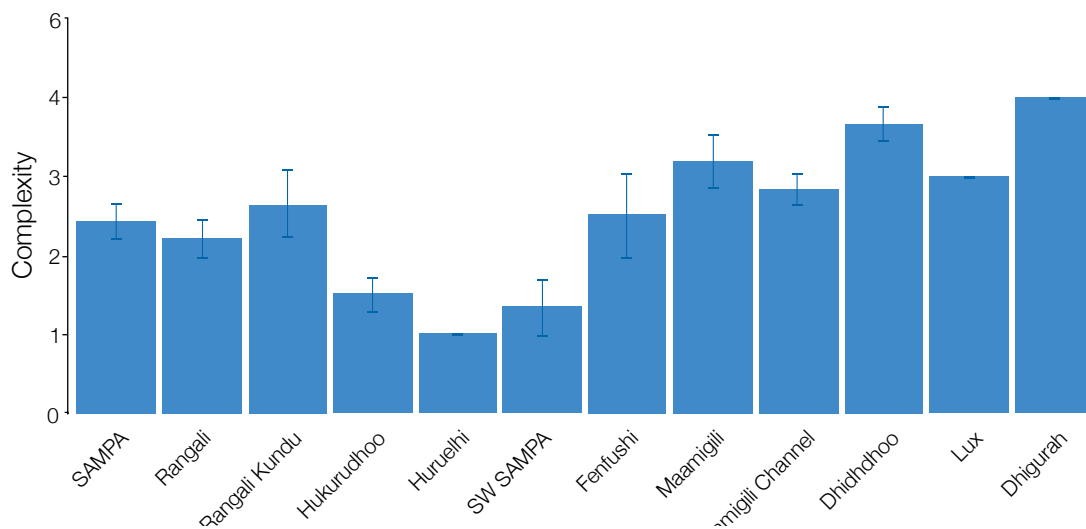


Figure 16. The mean structural complexity level estimates on roaming surveys. Error bars show standard errors. Complexity was estimated on a scale of 0 – 5, where 0 was completely flat and 5 highly complex.

Parrotfish and surgeonfish biomass did not vary significantly among survey sites (Kruskal-Wallis tests $p > 0.05$; Figure 17). There was a high variability in the biomass of both families within sites as indicated by the length of the boxes in Figure 17. Fentushi had the highest median biomass of both parrotfish ($5.46 \text{ kg per } 100 \text{ m}^2$) and

surgeonfish ($2.52 \text{ kg per } 100 \text{ m}^2$). Species richness of both butterflyfish (ANOVA, $p < 0.01$) and groupers (ANOVA, $p < 0.05$) varied significantly across survey sites and species diversity was relatively even across sites (Figure 18). However, in each case only one site differed significantly from the others. Huruelhi (1.8 ± 0.3 per 100

m^2) had a significantly lower parrotfish species richness than all other sites. Maamigili (11.6 ± 2.2 per 100 m^2) had a significantly higher surgeonfish species richness than all other sites. Though not significantly different, Dhigurah had the lowest values for surgeonfish biomass, species richness and diversity.

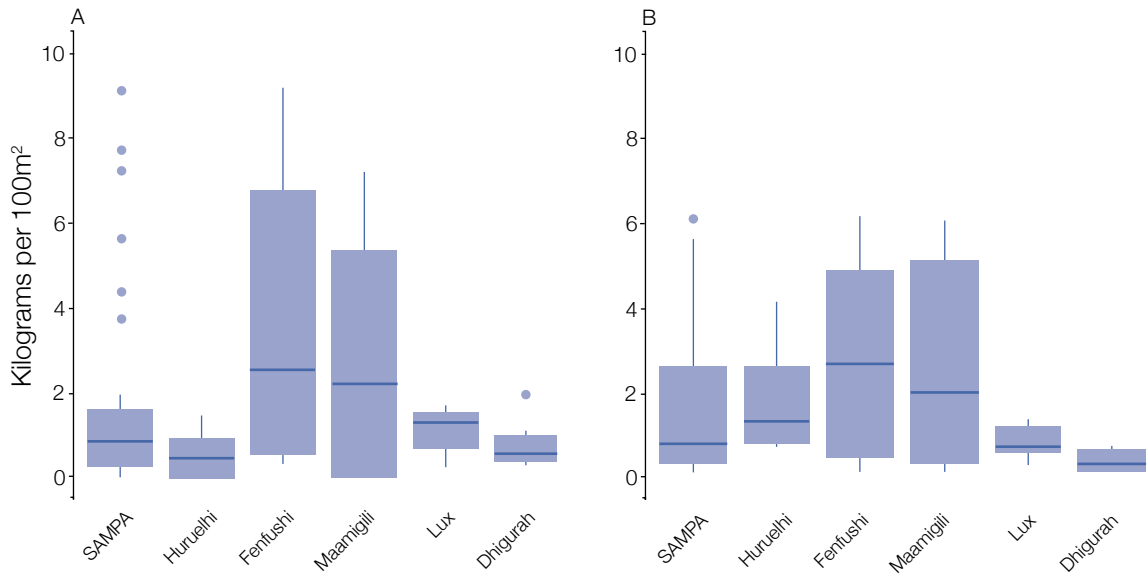


Figure 17. Biomass of (A) parrotfish and (B) surgeonfish on transect surveys. Thick black line represents the median values. Plots show data averaged across all surveys (SAMPA) and from 5 the sites surveyed using the transect survey method.

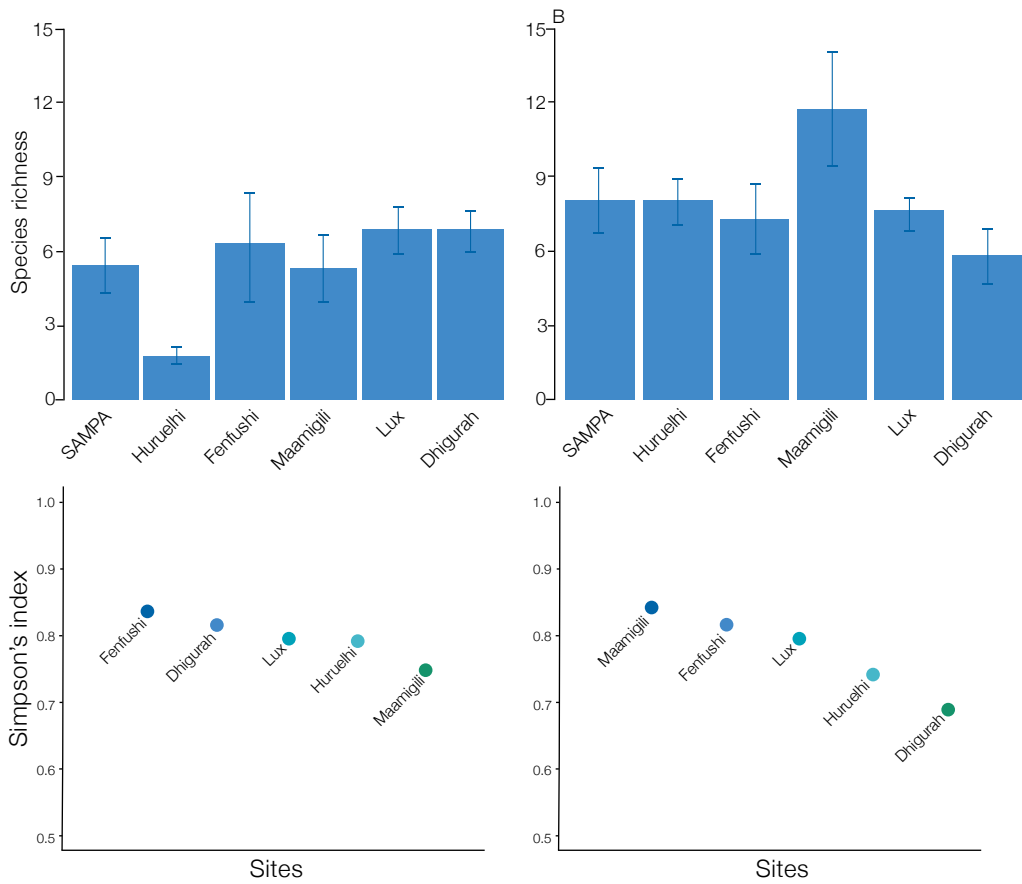


Figure 18. Mean species richness for (A) parrotfish and (B) surgeonfish and Simpson's diversity index for (C) parrotfish and (D) surgeonfish observed on transect surveys. Error bars show standard error.

Endangered species

Twelve species of IUCN Red Listed (CR, EN, VU or NT) teleost fish, elasmobranchs, turtles and invertebrates were observed during surveys. The whitetip reef shark (*Triaenodon obesus*) was observed on the greatest number of surveys and the chevron butterflyfish (*Chaetodon trifascialis*) had the highest abundance (Figure 19). The critically endangered

hawksbill turtle (*Eretmochelys imbricata*) was observed on sites on all sides of SAMPA. High numbers of elasmobranch species were also observed across the area. The most commonly observed Red Listed coral species was *Pachyseris rugosa*, however four of the five selected species were commonly observed throughout the roaming surveys (Figure 20).

"Coral taxonomic surveys identified a 102 species of scleractinian corals belonging to 37 genera. Fish taxonomic surveys identified 237 species of teleost fish and 8 species of elasmobranch fish"

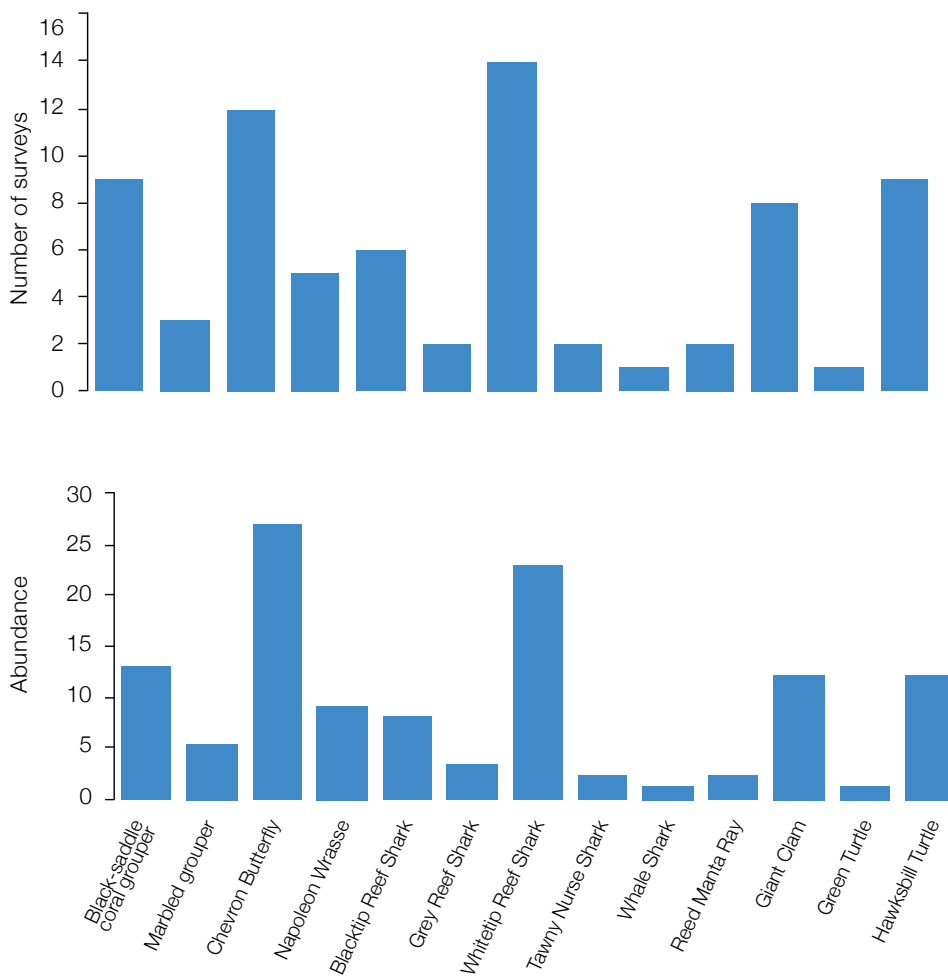


Figure 19 (A). Number of surveys each Red Listed species was recorded on and (B) total abundance of Red Listed species observed on roaming surveys (n=50).

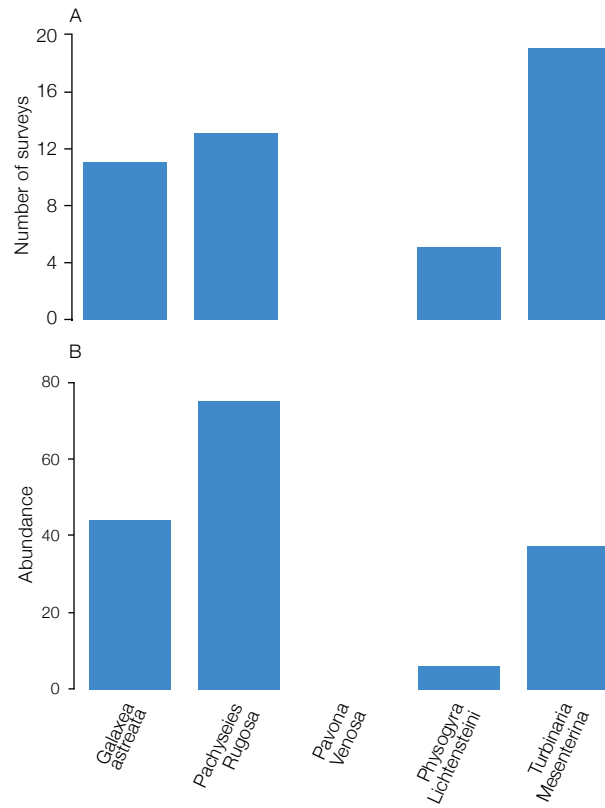


Figure 20. Number of surveys each pre-selected IUCN Red Listed coral species was recorded on and (B) their total abundance observed on roaming surveys (n=50).

Catalogue of coral and fish species

Coral taxonomic surveys identified a 102 species of scleractinian corals belonging to 37 genera (Table A3).

Fish taxonomic surveys identified 237 species of teleost fish and 8 species of elasmobranch fish (Table A4).

DISCUSSION

The report presents the most comprehensive ecological survey conducted within SAMPA. There was a notable spatial pattern in the condition of coral reefs. Reefs on the eastern side of the area had a higher coral cover on both roaming and transect surveys and had a more complex reef structure with greater a proportion of branching and tabular growth forms. Butterflyfish and emperors were present in greater numbers on the eastern section of the area, however there was no significant difference in family diversity among sites and other fish families did not show a significant variation in numbers between sites. The surveys also highlighted SAMPA as an important area for IUCN Red Listed species, which were observed across the whole area.

Coral reef benthos

Live coral cover across the Maldives has been heavily impacted by the 2016 coral bleaching event (Ibrahim et al. 2017, Perry and Morgan 2017). It was apparent from these surveys that reefs in SAMPA have not escaped the widespread loss of coral cover. However, coral cover was generally high when compared to the 2017 country average ($18.7 \pm 2.5\%$) (Dryden et al. In Prep). The manta tow surveys of the reef flat area found a maximum live coral cover of 30% but it was generally below 10% for the whole area. However, the reef slope on the east side appeared to have survived better than many other reefs across the country (Dryden et al. In Prep). This finding is particularly important given the projected future for coral reefs under the impacts of climate change (Hoegh-Guldberg 2011). Areas of reef

which survive climate-induced events have the potential to re-populate reefs locally and regionally and, under the right management, may help areas withstand future degradation (Cinner et al. 2016). Work by the Marine Research Centre (MRC) and others has helped identify "hope spots" across the country (Ibrahim et al. 2017) and it appears that the reefs on the east of SAMPA should be included in this list.

Coral cover was noticeably higher on the eastern side of the MPA. This difference in coral communities could be linked to physical oceanic processes, including wave energy conditions and cooler upwelling water. Reefs surveyed on the western side had a higher percentage of abiotic components such as a rock and rubble. High energy from waves on this more exposed side may have reduced the complexity of these reefs. The three-dimensional reef structure was minimal here resulting in a flattened reef form. Whereas, eastern reefs were more sheltered and may have benefitted from cooler waters created by a localised upwelling. When assessing reef recovery, understanding the structural complexity the reefs is important due its apparent relationship with the diversity and abundance of the reef community including fishes (Graham et al. 2006).

Coral taxonomic surveys identified 102 species of scleractinian corals belonging to 37 genera. This represents 41% of species and 64% of genera known from the Maldives (Pichon and Benzoni 2007). Reefs on the eastern half of the survey area had a high cover of Acroporid corals, most notably at Maamigili. The reef slope in this area had a high number of table and branching corals and many large Acropora colonies. After the bleaching events in 1998 and 2016, it was

observed that the fast growing genera, Acropora, suffered comparatively higher mortality rates than slow growing species in the Maldives (Zahir et al. 2009, Ibrahim et al. 2017). The presence of Acroporid colonies in Dhidhdhoo and Maamigili could indicate this area was less affected by the bleaching events. This may be a result of acclimatisation and adaptation to thermal stress as observed by (Tkachenko 2012) in Ihavandippolhu atoll. Alternatively, it may be a result of lower water temperatures on the reef slopes here. Though water temperature was not recorded it was observed by all surveyors that the temperature of the reef slope on the east and south-east of the area was lower than elsewhere. This may have kept the water temperature below the bleaching threshold for corals in this area. This is an observation which requires further investigation, and if true this reef may be an important source population that may supply other more heavily impacted reefs with coral larvae.

Reefs on west and south-western sections of the area were dominated by less complex reef growth forms. This side of the atoll is exposed to a large stretch of open ocean which can create a high wave energy environment. The result of this was less complex reef development. Though reefs here may be less structurally complex they play a key role in coastal protection for these exposed islands, dissipating a significant amount of wave energy (Ferrario et al. 2014). Corals which able to survive in this environment also experience a significant reduction in corallivory (Lenihan et al. 2015) and may be an important source of coral larvae following corallivore outbreaks.

There was a relatively high cover of CCA on the reefs across SAMPA. CCA plays a number of important roles on coral reefs: it can induce coral larvae settlement on substrate (Tebben et al. 2015); CCA performs much of the binding together of loose debris, such as rubble creating a stable substrate (Littler and Littler 2013); CCA is known to play a major role for the maintenance

"Areas of reef which survive climate-induced events have the potential to re-populate reefs locally and regionally and, under the right management, may help areas withstand future degradation..."

of wave resistant intertidal ridges and for the absorption of high wave energy, that would otherwise result in erosion of shoreward land masses (Littler and Littler 1984). CCA can therefore play a significant role in the development and recovery of coral reef communities and their relative abundance in SAMPA should be considered a positive sign.

Fish community

Fish communities present within SAMPA reflect the wider diversity of the Maldivian coral reef ecosystem. During this short survey, almost 350 species of reef associated fish were identified. This number was achieved with limited searching and while focusing primarily on the reef crest area and as such is a significant underestimate of the area's true richness. Fish family richness for both roaming and transect surveys was greater than 20, and never less than 15 for a site, indicating that the diversity is high throughout the area.

The biomass and richness of butterflyfish species mirrored the cover and diversity of corals, with a greater richness on the east side of SAMPA. Many species of butterflyfish are corallivores and their abundance and diversity can be linked to the availability of their coral food (Cole and Pratchett 2013). They are also among the first species to respond to coral loss following bleaching events (Graham et al. 2007). This apparent east-west decline in the butterflyfish community indicates the difference in reef condition on the area's coral reefs.

Grouper biomass was high across the area, except at Fenfushi. However, the biomass was highly variable within sites. This appears to indicate high standing stock of groupers. Grouper species richness was also high at most sites and there were no spatial differences across the area. That the number of groupers was in line with previous findings from 20 years ago (Sluka and Reichenbach 1995) is a remarkable result and suggests there has been limited exploitation

of groupers in this area. The results appear to indicate a healthy grouper population within SAMPA however the number and richness of groupers at each sites may be dependent on certain reef features or spatial characteristics (Robinson et al. 2008, Kerry and Bellwood 2015).

"The reefs in SAMPA appear to be especially important for endangered marine animals. Significant numbers of IUCN Red Listed sharks, groupers, turtles and corals were observed during the surveys."

Reef resilience

The biomass of functionally important herbivores was high throughout SAMPA. Herbivorous fish, such as parrotfish and surgeonfish are important in preventing coral reefs from becoming overgrown by algae following disturbances (Hughes et al. 2007, Mumby et al. 2007). The numbers found on surveys across SAMPA are likely to confer a level of resilience to the reefs. Though there is no fishery targeting these species it is important that any management measures ensure protection for these key groups, and that monitoring their number is part of any management plan. The high variability of parrotfish biomass is attributed to the presence of large Sheephead parrotfish (*Chlorurus strongylocephalus*). Bigger parrotfish have larger territories (Mumby and Wabnitz 2002) and likely roam over much of SAMPA. As such the high biomass of this important family is beneficial for the whole area.

The high species richness of the herbivores confers additional resilience

to the reefs in SAMPA. Having a range of species which can perform the important function of algae removal from reefs creates an overlap, termed functional redundancy. This means the loss of one species can be mitigated by another (Violle et al. 2007). Therefore, having a high number of different species, especially if they vary in size, can add significantly to the resilience of a reef area (Nash et al. 2016).

The reefs on the east side of the atoll were the most structurally complex, however the majority of reefs surveyed were between medium and high complexity (2 – 4 visual grade). Such levels of complexity are associated with greater fish diversity and abundance (Wilson et al. 2007, Newman et al. 2015). Higher levels of structural complexity have also been identified as a key component of coral reef resilience (McClanahan et al. 2012).

Most recruits in this study belonged to the family Acroporidae, which was severely affected by bleaching of 2016 (Ibrahim et al. 2017). It was observed that during the 1998 bleaching, 98% of the adult population of bleaching susceptible coral species were subjected to mortality (Zahir 2000), however 10 months post bleaching, 67-87% of the recruits on both natural and artificial reefs of North Male Atoll belonged to same susceptible species (Acroporids and Pocilloporids) (Edwards et al. 2001). The high density of Acroporid corals observed in SAMPA resembles these recruitment patterns. Though it is too early for these corals to have recruited since the bleaching event, it does show a high juvenile survivorship post-bleaching of this important coral family.

Endangered species

The reefs in SAMPA appear to be especially important for endangered marine animals. Significant numbers of IUCN Red Listed sharks, groupers, turtles and corals were observed during the surveys. Particularly noticeable

was the high number of chevron butterflyfish. This species is acutely susceptible to declines in coral cover and its abundance here may allow repopulation of areas of Maldivian reefs which were more heavily impacted by the bleaching event.

A key reason for the protection of the South Ari Atoll area is the year-round presence of whale sharks. Though only one individual was observed on these surveys, three additional individuals were observed during transit to and from surveys. All four observations were made in the area between Maamigili and Lux. The whale shark community around SAMPA is monitored by the Maldives Whale Shark Research Project (MWSRP) and their annual reports (e.g. Rees and Hancock 2017) provide significant information about the population. The presence of these sharks is of great importance to the local economy; however, the industry needs strongly enforced guidelines regarding whale shark interactions.

Future management

The ecological management goal for SAMPA is to provide a means to promote and ensure the long-term conservation and protection of the South Ari ecosystem. The findings of this report and the data collected can be used as a baseline against which to measure this goal. The main goal is broken down into two sub-goals: 1) to maintain the resilience of biological communities to stressors associated with climate change and 2) to maintain populations of unharvested marine species for tourism, fishery enhancement and scientific purposes. To best achieve these goals management efforts should prioritise the area from Maamigili – Dhigurah. This has been identified as the healthiest section of reef, and the level of post 2016 bleaching coral survivorship suggests it will be important in the future. The surveys found high structural complexity, recruit density and herbivore biomass and richness, indicating a high potential

for resilience to climate change driven degradation. Future efforts should aim to monitor and manage for resilience (Flower et al. 2017, Lam et al. 2017). Though they do not form part of the reef fishery, any management plan should explicitly prohibit the capture of herbivorous fish species given their importance to reef resilience. Rangali was a second area which had high fishery species abundances and a diverse benthic assemblage. Rangali channel has also been identified locally as an area where manta rays are commonly encountered.

In order to preserve the ecological resilience of the SAMPA and to protect its biodiversity for future generations, it is recommended that a comprehensive management plan is developed for the area. The management plan could consider the following elements:

- The development of a long-term monitoring programme for the protected area in order to track ecological and social changes over time,
- A plan for enforcement of regulations in the area, which is potentially challenging due to the large marine area that needs to be monitored, and a plan for inclusion of local communities in management and enforcement of the SAMPA
- Updated regulations for activities in the area, especially whale shark tourism and interactions with vulnerable or endangered species
- A plan for sustainable financing (e.g. potentially through user fees) of protected area management staff (e.g. park rangers) and infrastructure (e.g. patrol boats or drones) for the area
- A plan for benefit-sharing for the area, so that revenue from SAMPA is used to empower and support the development of local communities who depend on SAMPA for natural resources

CONCLUSION

It is apparent from these surveys that the reefs in SAMPA are of ecological importance both within the country and across the Indian Ocean region. The robust reefs of SAMPA are a good indication that not all Maldivian reefs were subjected extensive coral

mass mortality in 2016 due to the temperature anomaly. The area has the potential to act as a climate change refugia (Kavousi and Keppel 2017) and was buffered against the worst impacts of the 2016 bleaching event. It should be studied to elucidate the underlying reasons for this. The health of this reef provides evidence and hope that some of the species known to be vulnerable to bleaching can survive and exhibit high resilience within Maldivian waters. Since bleaching recovery patterns are variable across atolls in the archipelago, the presence of high percentage of bleaching vulnerable tabulate Acroporidae in SAMPA represents an important finding.

This report has highlighted the eastern side of the atoll as being particularly important. It had the highest coral cover, complexity and fish numbers. Further research should be conducted to examine the cause of high coral survivorship on the reef slopes here. This eastern area is also known to be the most common area for whale shark sightings. However, it is also the most heavily used area of the MPA, with significant tourist traffic and a large local island. Future management plans for SAMPA should focus on this area as it both the most important and the most at risk.

The highly valuable biodiversity and ecological resilience characteristics of the SAMPA mean that it could be considered for nomination as either a stand-alone UNESCO Biosphere Reserve, or a core area within a wider UNESCO Biosphere Reserve. Nominating SAMPA for this status would raise its profile internationally, catalyse the development of a management plan for the area, and potentially help to leverage funding for the management of the MPA.

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APPENDIX

Table A1. The coral and rock growth form categories used in this project.

Growth form	Description
Branching	Corals grow in criss-crossing pattern of needle, blade, club or branch-like shapes. This creates interstitial space between branches
Encrusting	Spread outward, creating a thin layer over existing hard substrates. Can take on a lumpier shape but not typically uniform like massive corals
Finger	Exhibit vertical clusters of digitate, or finger-shaped, structures. These are generally thicker than branching corals and there is less crossing of the structures creating less interstitial space
Foliose	Have a series flattened, overlapping plates radiating out from a central point. Can often appear to spiral outward in a continuous sheet
Free Living	Individual corals that are not attached to the substrate
Massive	Mound or dome shape with similar length, height and width dimensions
Others	All other coral growth forms not described here
Table	Extend from a single point off the substrate creating a thin, often circular, plate-like structure with space underneath

Table A2. IUCN Red List category, CITES appendix and CMS Appendix category of all Red Listed (CR, EN, VU or NT) non-coral fauna observed in this study.

Common name	Scientific name	Red List category	CITES Appendix	CMS Appendix
Grey reef shark	<i>Carcharhinus amblyrhynchos</i>	Near Threatened		
Blacktip reef shark	<i>Carcharhinus melanopterus</i>	Near Threatened		
Chevron butterflyfish	<i>Chaetodon trifascialis</i>	Near Threatened		
Napoleon wrasse	<i>Cheilinus undulatus</i>	Endangered	II	
Green turtle	<i>Chelonia mydas</i>	Endangered	I	I & II
Hawksbill turtle	<i>Eretmochelys imbricata</i>	Critically endangered	I	I & II
Reef manta ray	<i>Manta alfredi</i>	Vulnerable	II	I & II
Tawny nurse shark	<i>Nebrius ferrugineus</i>	Vulnerable		
Blacksaddle coral grouper	<i>Plectropomus laevis</i>	Vulnerable		
Whale shark	<i>Rhincodon typus</i>	Endangered	II	
Whitetip reef shark	<i>Triaenodon obesus</i>	Near Threatened		
Giant clam	<i>Tridacna sp.</i>	Vulnerable	II	

Table A3. Full species list of all coral identified during this research expedition

Family	Genus	Species
Lobophylliidae	Acanthastrea	<i>Acanthastrea echinata</i>
Acroporidae	Acropora	<i>Acropora anthocercis</i>
Acroporidae	Acropora	<i>Acropora aspera</i>
Acroporidae	Acropora	<i>Acropora austera</i>
Acroporidae	Acropora	<i>Acropora clathrata</i>
Acroporidae	Acropora	<i>Acropora cytherea</i>
Acroporidae	Acropora	<i>Acropora digitifera</i>
Acroporidae	Acropora	<i>Acropora formosa</i>
Acroporidae	Acropora	<i>Acropora gemmifera</i>
Acroporidae	Acropora	<i>Acropora humilis</i>
Acroporidae	Acropora	<i>Acropora hyacinthus</i>
Acroporidae	Acropora	<i>Acropora loripes</i>
Acroporidae	Acropora	<i>Acropora monticulosa</i>
Acroporidae	Acropora	<i>Acropora robusta</i>
Acroporidae	Acropora	<i>Acropora spicifera</i>
Acroporidae	Acropora	<i>Acropora tenuis</i>
Acroporidae	Astreopora	<i>Astreopora myriophthalma</i>
Acroporidae	Astreopora	<i>Astreopora ocellata</i>
Coscinareae	Coscinareae	<i>Coscinareae monile</i>
Lobophylliidae	Cynarina	<i>Cynarina lacrymalis</i>
Merulinidae	Cyphastrea	<i>Cyphastrea chalcidicum</i>
Merulinidae	Cyphastrea	<i>Cyphastrea microphthalma</i>
Merulinidae	Cyphastrea	<i>Cyphastrea serailia</i>
Diploastreidae	Diploastrea	<i>Diploastrea heliopora</i>
Lobophylliidae	Echinophyllia	<i>Echinophyllia aspera</i>
Merulinidae	Echinopora	<i>Echinopora horrida</i>
Merulinidae	Echinopora	<i>Echinopora hirsutissima</i>
Merulinidae	Echinopora	<i>Echinopora lamellosa</i>
Euphyllidae	Euphyllia	<i>Euphyllia glabrescens</i>
Merulinidae	Dipsastraea	<i>Dipsastraea favus</i>
Merulinidae	Dipsastraea	<i>Dipsastraea matthaii</i>
Merulinidae	Dipsastraea	<i>Dipsastraea speciosa</i>
Merulinidae	Favites	<i>Favites abdita</i>
Merulinidae	Favites	<i>Favites complanata</i>
Merulinidae	Favites	<i>Favites flexuosa</i>
Merulinidae	Favites	<i>Favites halicora</i>

Family	Genus	Species
Merulinidae	Favites	<i>Favites paraflexuosa</i>
Merulinidae	Favites	<i>Favites pentagona</i>
Merulinidae	Favites	<i>Favites spinosa</i>
Fungiidae	Fungia	<i>Fungia concinna</i>
Fungiidae	Fungia	<i>Fungia corona</i>
Fungiidae	Fungia	<i>Fungia danae</i>
Fungiidae	Fungia	<i>Fungia fungites</i>
Euphylliidae	Galaxea	<i>Galaxea astreata</i>
Euphylliidae	Galaxea	<i>Galaxea fascicularis</i>
Agariciidae	Gardinoseris	<i>Gardinoseris planulata</i>
Merulinidae	Goniastrea	<i>Goniastrea edwardsi</i>
Merulinidae	Goniastrea	<i>Goniastrea retiformis</i>
Merulinidae	Goniopora	<i>Goniopora columna</i>
Merulinidae	Goniopora	<i>Goniopora tenuidens</i>
Merulinidae	Hydophora	<i>Hydophora exesa</i>
Merulinidae	Hydophora	<i>Hydophora microconos</i>
Insertae sedis	Leptastrea	<i>Leptastrea purpurea</i>
Insertae sedis	Leptastrea	<i>Leptastrea transversa</i>
Merulinidae	Leptoria	<i>Leptoria phrygia</i>
Agariciidae	Leptoseris	<i>Leptoseris explanata</i>
Agariciidae	Leptoseris	<i>Leptoseris incrustans</i>
Agariciidae	Leptoseris	<i>Leptoseris mycetoseroides</i>
Agariciidae	Leptoseris	<i>Leptoseris scabra</i>
Lobophylliidae	Lobophyllia	<i>Lobophyllia corymbosa</i>
Lobophylliidae	Lobophyllia	<i>Lobophyllia robusta</i>
Merulinidae	Merulina	<i>Merulina ampliata</i>
Merulinidae	Merulina	<i>Merulina scabricula</i>
Paramonastreae	Montastrea	<i>Montastrea magnistellata</i>
Paramonastreae	Montastrea	<i>Montastrea valenciennesi</i>
Acroporidae	Montipora	<i>Montipora corbettensis</i>
Acroporidae	Montipora	<i>Montipora danae</i>
Acroporidae	Montipora	<i>Montipora stilosa</i>
Acroporidae	Montipora	<i>Montipora tuberculosa</i>
Acroporidae	Montipora	<i>Montipora turgescens</i>
Acroporidae	Montipora	<i>Montipora undata</i>
Acroporidae	Montipora	<i>Montipora verrucosa</i>
Merulinidae	Mycedium	<i>Mycedium elephantotus</i>

Family	Genus	Species
Lobophylliidae	Oxypora	<i>Oxypora lacera</i>
Agariciidae	Pachyseris	<i>Pachyseris rugosa</i>
Agariciidae	Pachyseris	<i>Pachyseris speciosa</i>
Agariciidae	Pavona	<i>Pavona clavus</i>
Agariciidae	Pavona	<i>Pavona explanulata</i>
Agariciidae	Pavona	<i>Pavona maldivensis</i>
Agariciidae	Pavona	<i>Pavona varians</i>
Agariciidae	Pavona	<i>Pavona venosa</i>
Insertae sedis	Physogyra	<i>Physogyra lichtensteini</i>
Merulinidae	Platygyra	<i>Platygyra lamellina</i>
Merulinidae	Platygyra	<i>Platygyra daedalea</i>
Merulinidae	Platygyra	<i>Platygyra pini</i>
Merulinidae	Platygyra	<i>Platygyra verweyi</i>
Insertae sedis	Plesiastrea	<i>Plesiastrea versipora</i>
Pocilloporidae	Pocillopora	<i>Pocillopora eydouxi</i>
Pocilloporidae	Pocillopora	<i>Pocillopora meandrina</i>
Pocilloporidae	Pocillopora	<i>Pocillopora verrucosa</i>
Poritidae	Porites	<i>Porites lobata</i>
Poritidae	Porites	<i>Porites lutea</i>
Poritidae	Porites	<i>Porites rus</i>
Poritidae	Porites	<i>Porites solida</i>
Psammocoridae	Psammocora	<i>Psammocora contigua</i>
Psammocoridae	Psammocora	<i>Psammocora haimeana</i>
Psammocoridae	Psammocora	<i>Psammocora profundacella</i>
Fungiidae	Sandalolitha	<i>Sandalolitha robusta</i>
Lobophylliidae	Symphillia	<i>Symphillia radians</i>
Lobophylliidae	Symphillia	<i>Symphillia recta</i>
Dendrophyllidae	Turbinaria	<i>Turbinaria mesenterina</i>
Dendrophyllidae	Turbinaria	<i>Turbinaria peltata</i>

TableA4. Full species list of all fish identified during this research expedition

Family	Latin Name	Common Name
Acanthuridae	<i>Acanthurus auranticavus</i>	Ring-tail surgeonfish
Acanthuridae	<i>Acanthurus leucocheilus</i>	White-spine surgeonfish
Acanthuridae	<i>Acanthurus leucostemon</i>	Powder blue surgeonfish
Acanthuridae	<i>Acanthurus lineatus</i>	Lined surgeonfish
Acanthuridae	<i>Acanthurus mata</i>	Pale surgeonfish
Acanthuridae	<i>Acanthurus nigricauda</i>	Eye-line surgeonfish
Acanthuridae	<i>Acanthurus nigrofuscus</i>	Dusky surgeonfish
Acanthuridae	<i>Acanthurus tennentii</i>	Lieutenant surgeonfish
Acanthuridae	<i>Acanthurus thompsoni</i>	Night surgeonfish
Acanthuridae	<i>Acanthurus triostegus</i>	Convict surgeonfish
Acanthuridae	<i>Acanthurus tristis</i>	Mimic surgeonfish
Acanthuridae	<i>Acanthurus xanthopterus</i>	Yellow-fin surgeonfish
Acanthuridae	<i>Ctenochaetus binotatus</i>	Two spot bristletooth
Acanthuridae	<i>Ctenochaetus striatus</i>	Fine-lined bristletooth
Acanthuridae	<i>Ctenochaetus trigosus</i>	
Acanthuridae	<i>Ctenochaetus truncatus</i>	Gold-ring bristletooth
Acanthuridae	<i>Naso brachycentron</i>	Humpback unicornfish
Acanthuridae	<i>Naso brevirostris</i>	Spotted unicornfish
Acanthuridae	<i>Naso elegans</i>	Orange spine surgeonfish
Acanthuridae	<i>Naso hexacanthus</i>	Sleek hexacanthus
Acanthuridae	<i>Naso thynnoides</i>	One-spine unicornfish
Acanthuridae	<i>Naso unicornis</i>	Blue-spine unicornfish
Acanthuridae	<i>Naso vlamingii</i>	Bignose unicornfish
Acanthuridae	<i>Zebrasoma desjardini</i>	Sailfin surgeonfish
Acanthuridae	<i>Zebrasoma scopas</i>	Brown tang
Apogonidae	<i>Apogon angustatus</i>	Narrow striped cardinalfish
Apogonidae	<i>Apogon apogonides</i>	Plain cardinalfish
Apogonidae	<i>Apogon fraenatus</i>	Tapered-lined cardinalfish
Apogonidae	<i>Apogon nigrofasciatus</i>	Black-striped cardinalfish
Apogonidae	<i>Apogon urostigma</i>	Spiny-head cardinalfish
Apogonidae	<i>Cheilodipterus lineatus</i>	Tiger cardinalfish
Apogonidae	<i>Cheilodipterus quinquelineatus</i>	Five-line cardinalfish
Aulostomidae	<i>Aulostomus chinensis</i>	Trumpetfish
Balistidae	<i>Balistapus undulatus</i>	Striped triggerfish
Balistidae	<i>Balistoides conspicillum</i>	Clown triggerfish
Balistidae	<i>Balistoides viridescens</i>	Titan triggerfish

Family	Latin Name	Common Name
Balistidae	<i>Melichthys indicus</i>	Indian triggerfish
Balistidae	<i>Melichthys niger</i>	Black triggerfish
Balistidae	<i>Odonus niger</i>	Blue triggerfish
Balistidae	<i>Pseudobalistese flavimarginatus</i>	Yellow-margin triggerfish
Balistidae	<i>Rhinecanthus aculeatus</i>	Picasso triggerfish
Balistidae	<i>Sufflamen bursa</i>	Bommerang triggerfish
Balistidae	<i>Sufflamen chrysopterum</i>	Halfmoon triggerfish
Balistidae	<i>Sufflamen fraenatum</i>	Bridled triggerfish
Belonidae	<i>Tylosaurus crocodilus</i>	Houndfish
Blennidae	<i>Aspidontus taeniatus</i>	False cleanerfish
Blennidae	<i>Blenniella chrysospilos</i>	Orange-spotted blenny
Blennidae	<i>Ecsenius bicolor</i>	Two-colour combtooth blenny
Blennidae	<i>Ecsenius lineatus</i>	Lined combtooth blenny
Blennidae	<i>Ecsenius minutus</i>	Little combtooth blenny
Blennidae	<i>Meiacanthus smithii</i>	Smith's venomous blenny
Blennidae	<i>Plagiotremus phenax</i>	Imposter fanyblenny
Blennidae	<i>Plagiotremus rhinorhynchos</i>	Tube-worm blenny
Blennidae	<i>Plagiotremus tapeinosoma</i>	Piano fangblenny
Bothidae	<i>Bothus pantherines</i>	Leopard flounder
Caesionidae	<i>Caesio caeruleaurea</i>	Gold band fusilier
Caesionidae	<i>Caesio lunaris</i>	Moon fusilier
Caesionidae	<i>Caesio varilineata</i>	Thin-lined fusilier
Caesionidae	<i>Caesio xanthonota</i>	Yellow-back fusilier
Caesionidae	<i>Pterocaesio pisang</i>	Banana fusilier
Caesionidae	<i>Pterocaesio tile</i>	Blue dash fusilier
Caesionidae	<i>Pterocaesio trilineata</i>	Striped fusilier
Callionymidae	<i>Synchiropus stellatus</i>	Starry dragonet
Carangidae	<i>Carangoides ferdau</i>	Banded trevally
Carangidae	<i>Carangoides plagiotaenia</i>	Bar-cheek trevally
Carangidae	<i>Caranx ignobilis</i>	Giant trevally
Carangidae	<i>Caranx lugubris</i>	Black jack
Carangidae	<i>Caranx melampygus</i>	Blue-fin jack
Carangidae	<i>Caranx sexfasciatus</i>	Big-eye trevally
Carangidae	<i>Elegatis bipinnulata</i>	Rainbow runner
Carangidae	<i>Trachinotus bailloni</i>	Black-spotted pompano
Carangidae	<i>Trachinotus blochii</i>	Shub-nose pompano
Carcharhinidae	<i>Carcharhinus melanopterus</i>	Blacktip reef shark

Family	Latin Name	Common Name
Carcharhinidae	<i>Charcharhinus amblyrhyncos</i>	Grey reef shark
Carcharhinidae	<i>Triaenodon obesus</i>	Whitetip reef shark
Chaetodontidae	<i>Chaetodon andamanensis</i>	Yellow butterflyfish
Chaetodontidae	<i>Chaetodon auriga</i>	Threadfin butterflyfish
Chaetodontidae	<i>Chaetodon bennetti</i>	Eclipse butterflyfish
Chaetodontidae	<i>Chaetodon citrinellus</i>	Citron butterflyfish
Chaetodontidae	<i>Chaetodon collare</i>	Head-band butterflyfish
Chaetodontidae	<i>Chaetodon falcula</i>	Double saddle butterflyfish
Chaetodontidae	<i>Chaetodon guttattissimus</i>	Spotted butterflyfish
Chaetodontidae	<i>Chaetodon interruptus</i>	Yellow teardrop butterflyfish
Chaetodontidae	<i>Chaetodon kleinii</i>	Brown butterflyfish
Chaetodontidae	<i>Chaetodon lineolatus</i>	Lined butterflyfish
Chaetodontidae	<i>Chaetodon lunula</i>	Raccoon butterflyfish
Chaetodontidae	<i>Chaetodon madagaskariensis</i>	Madagascar butterflyfish
Chaetodontidae	<i>Chaetodon melannotus</i>	Black-back butterflyfish
Chaetodontidae	<i>Chaetodon meyeri</i>	Meyer's butterflyfish
Chaetodontidae	<i>Chaetodon mitratus</i>	Indian butterflyfish
Chaetodontidae	<i>Chaetodon ornatissimus</i>	Omate butterflyfish
Chaetodontidae	<i>Chaetodon oxycephalus</i>	Pig-face butterflyfish
Chaetodontidae	<i>Chaetodon triangulum</i>	Triangular butterflyfish
Chaetodontidae	<i>Chaetodon trifascialis</i>	Chevroned butterflyfish
Chaetodontidae	<i>Chaetodon trifasciatus</i>	Pinstriped butterflyfish
Chaetodontidae	<i>Chaetodon vagabundus</i>	Vagabond butterflyfish
Chaetodontidae	<i>Chaetodon xanthocephalus</i>	Yellow-head butterflyfish
Chaetodontidae	<i>Forcipiger flavissimus</i>	Longnose butterflyfish
Chaetodontidae	<i>Forcipiger longirostris</i>	Very long nose butterflyfish
Chaetodontidae	<i>Hemitaurichthys zoster</i>	Black pyramid butterflyfish
Chaetodontidae	<i>Heniochus acuminatus</i>	Reef bannerfish
Chaetodontidae	<i>Heniochus diphreutes</i>	Schooling bannerfish
Chaetodontidae	<i>Heniochus monoceros</i>	Masked bannerfish
Chaetodontidae	<i>Heniochus pleurotaenia</i>	Phantom bannerfish
Cirrhitidae	<i>Cirrhichthys oxycephalus</i>	Spotted hawkfish
Cirrhitidae	<i>Cyprinocirrhites polyactis</i>	Lyre-tail hawkfish
Cirrhitidae	<i>Paracirrhites arcatus</i>	Ring eye hawkfish
Cirrhitidae	<i>Paracirrhites forsteri</i>	Forster's hawkfish
Congridae	<i>Heteroconger hassi</i>	Spotted garden eel
Dasyatidae	<i>Himantura granulata</i>	White-spotted whipray

Family	Latin Name	Common Name
Dasyatidae	<i>Taeniura meyeni</i>	Blotched fantail ray
Diodontidae	<i>Diodon hystrix</i>	Black-spotted porcupinefish
Diodontidae	<i>Diodon liturosus</i>	Blotched porcupinefish
Echeneidae	<i>Echeneis naucrates</i>	Remora
Ephippidae	<i>Platax orbicularis</i>	Rounded batfish
Ephippidae	<i>Platax teira</i>	Tail-fin batfish
Fistulariidae	<i>Fistularia commersonii</i>	Smooth flutemouth
Ginglymostomatidae	<i>Nebrius ferrugineus</i>	Tawny nurse shark
Gobiidae	<i>Amblyeleotris steinitz</i>	Steinitz's shrimp goby
Gobiidae	<i>Bryaninops loki</i>	Loki whip-goby
Gobiidae	<i>Bryaninops yongei</i>	Seawhip goby
Gobiidae	<i>Eviota albolineata</i>	Green pygmy goby
Gobiidae	<i>Eviota mikiae</i>	White line pygmy goby
Gobiidae	<i>Eviota mikiae</i>	Yellow and whitestriped pygmy goby
Gobiidae	<i>Eviota sebreei</i>	Sebree's pygmy goby
Gobiidae	<i>Fusigobius duospilus</i>	Double-spot sand goby
Gobiidae	<i>Fusigobius inframaculatus</i>	Inner-spotted sand-goby
Gobiidae	<i>Fusigobius sp.</i>	Orange-spotted sand-goby
Gobiidae	<i>Gnatholepis anjerensis</i>	Eyebar goby
Gobiidae	<i>Gnatholepis cauerensis</i>	Shoulderbar goby
Gobiidae	<i>Istigobius decoratus</i>	Decorated sand-goby
Gobiidae	<i>Pleurosicya micheli</i>	Cling goby
Gobiidae	<i>Priolepis cincta</i>	Banded reef goby
Gobiidae	<i>Priolepis inhaca</i>	Orange-tail reef-goby
Gobiidae	<i>Stonogobiops dracula</i>	Dracula shrimp goby
Gobiidae	<i>Trimma flammeum</i>	Orange spotted pygmy goby
Gobiidae	<i>Valenciennea strigata</i>	Golden-head sleeper goby
Haemulidae	<i>Plectorhinchus chaetodonoides</i>	Harlequin sweetlips
Haemulidae	<i>Plectorhinchus gibbosus</i>	Brown sweetlips
Haemulidae	<i>Plectorhinchus vittatus</i>	Oriental sweetlips
Hemiramphidae	<i>Hyporhamphus sp.</i>	Unid halfbeak
Holocentridae	<i>Myripristis adusta</i>	Shadowfin soldierfish
Holocentridae	<i>Myripristis kuntee</i>	Epaulette soldierfish
Holocentridae	<i>Myripristis murdjan</i>	Crimson soldierfish
Holocentridae	<i>Myripristis pralinia</i>	Big-eyed soldierfish
Holocentridae	<i>Myripristis violacea</i>	Violet soldierfish
Holocentridae	<i>Myripristis vittata</i>	Immaculate soldierfish

Family	Latin Name	Common Name
Holocentridae	<i>Neoniphon opercularis</i>	Mouthfin squirrelfish
Holocentridae	<i>Sargocentron caudimaculatum</i>	White-tail squirrelfish
Holocentridae	<i>Sargocentron microstoma</i>	Fine-lined squirrelfish
Holocentridae	<i>Sargocentron spiniferum</i>	Sabre squirrelfish
Holocentridae	<i>Sargocentron tiere</i>	Blue-lined squirrelfish
Kyphosidae	<i>Kyphosus cinerascens</i>	Snubnose rudderfish
Kyphosidae	<i>Kyphosus vaigiensis</i>	Brassy rudderfish
Labridae	<i>Allocoris cuvieri</i>	African rainbow wrasse
Labridae	<i>Allocoris formosa</i>	Queen rainbow wrasse
Labridae	<i>Anampses meleagrides</i>	Speckled wrasse
Labridae	<i>Biochoeres cosmetus</i>	Adorned wrasse
Labridae	<i>Biochoeres leucoxanthus</i>	Lemon meringue wrasse
Labridae	<i>Bodianus axillaris</i>	Coral hogfish
Labridae	<i>Bodianus diana</i>	Diana hogfish
Labridae	<i>Cheilinus chlorourus</i>	White-dotted maori wrasse
Labridae	<i>Cheilinus fasciatus</i>	Banded maori wrasse
Labridae	<i>Cheilinus trilobatus</i>	Triple-tail maori wrasse
Labridae	<i>Cheilinus undulatus</i>	Napoleon wrasse
Labridae	<i>Cirrhilabrus rubrisquamis</i>	Rosy-scaled wrasse
Labridae	<i>Epibulus insidiator</i>	Sling-jaw wrasse
Labridae	<i>Gomphosus caeruleus</i>	Bird wrasse
Labridae	<i>Halichoeres zeylonicus</i>	Sri Lankan wrasse
Labridae	<i>Hemicoris batuensis</i>	Batu rainbow wrasse
Labridae	<i>Hemigymnus fasciatus</i>	Banded thicklip wrasse
Labridae	<i>Hemigymnus melapterus</i>	Half and half wrasse
Labridae	<i>Hemitautoga hortulanus</i>	Checkerboard wrasse
Labridae	<i>Hemitautoga scapularis</i>	Zigzag wrasse
Labridae	<i>Labrichthys unilineatus</i>	Tube mouth wrasse
Labridae	<i>Labroides bicolor</i>	Two-colour cleaner wrasse
Labridae	<i>Labroides dimidiatus</i>	Blue-streak cleaner wrasse
Labridae	<i>Labropsis xanthonota</i>	V-tail tubelip wrasse
Labridae	<i>Macropharyngodon bipartitus</i>	Splendid leopard wrasse
Labridae	<i>Novaculichthys taeniourus</i>	Rockmover wrasse
Labridae	<i>Paracheilinus mccoskeri</i>	McCosker's wrasse
Labridae	<i>PlatyGLOSSUS annularis</i>	Dusky wrasse
Labridae	<i>PlatyGLOSSUS chrysotaenia</i>	Vrolik's wrasse
Labridae	<i>Pseudocheilinus evanidus</i>	Pin-striped wrasse

Family	Latin Name	Common Name
Labridae	<i>Pseudocheilinus hexataenia</i>	Six-line wrasse
Labridae	<i>Pseudocoris yamashiroi</i>	Pink wrasse
Labridae	<i>Pseudodax mollucanus</i>	Chiseltooth wrasse
Labridae	<i>Stethojulis albobittata</i>	Blue-lined wrasse
Labridae	<i>Stethojulis trilineata</i>	Blue ribbon wrasse
Labridae	<i>Thalassoma amblycephalum</i>	Two-tone wrasse
Labridae	<i>Thalassoma hardwicke</i>	Six bar wrasse
Labridae	<i>Thalassoma janseni</i>	Jansen's wrasse
Labridae	<i>Thalassoma lunare</i>	Moon wrasse
Labridae	<i>Thalassoma quinquevittatum</i>	Fivestripe wrasse
Labridae	<i>Thalassoma schwanenfeldii</i>	Ribbon wrasse
Labridae	<i>Wetmorella albofasciata</i>	White-banded possum wrasse
Lethrinidae	<i>Gnathodentex aurolineatus</i>	Gold-spot emperor
Lethrinidae	<i>Gymnocranium grandoculis</i>	Blue-line large-eye emperor
Lethrinidae	<i>Lethrinus erythracanthus</i>	Orange-finned emperor
Lethrinidae	<i>Lethrinus harak</i>	Black-blotch emperor
Lethrinidae	<i>Lethrinus microdon</i>	Small-tooth emperor
Lethrinidae	<i>Lethrinus obsoletus</i>	Orange-stripe emperor
Lethrinidae	<i>Lethrinus olivaceus</i>	Long-nose emperor
Lethrinidae	<i>Lethrinus ornatus</i>	Ornate emperor
Lethrinidae	<i>Lethrinus xanthochilus</i>	Yellow-lip emperor
Lethrinidae	<i>Monotaxis grandoculis</i>	Large-eye bream
Lutjanidae	<i>Aphareus furca</i>	Small-tooth jobfish
Lutjanidae	<i>Aprion virescens</i>	Green jobfish
Lutjanidae	<i>Lutjanus biguttatus</i>	Two-spot snapper
Lutjanidae	<i>Lutjanus bohar</i>	Red bass
Lutjanidae	<i>Lutjanus gibbus</i>	Humpback snapper
Lutjanidae	<i>Lutjanus kasmira</i>	Blue-striped snapper
Lutjanidae	<i>Lutjanus monostigma</i>	One spot snapper
Lutjanidae	<i>Macolor macularis</i>	Midnight snapper
Lutjanidae	<i>Macolor niger</i>	Black snapper
Malacanthidae	<i>Malacanthus latovittatus</i>	Blue blunquillo
Microdesmidae	<i>Nemateleotris evides</i>	Arrow goby
Microdesmidae	<i>Nemateleotris magnifica</i>	Red fire goby
Mobulidae	<i>Mobula kuhni</i>	Short-fin pygmy devil ray
Monacanthidae	<i>Aluterus scriptus</i>	Scribbled leatherjacket
Monacanthidae	<i>Cantherhines dumerilii</i>	Barred filefish

Family	Latin Name	Common Name
Monacanthidae	<i>Cantherhines pardalis</i>	Honeycomb filefish
Monacanthidae	<i>Paraluteres prionurus</i>	Mimic filefish
Mugilidae	<i>Crenimugil crenilabis</i>	Warty lip mullet
Mullidae	<i>Mulloidichthys vanicolensis</i>	Yellow-stripe goatfish
Mullidae	<i>Parupeneus barberinus</i>	Dash and dot
Mullidae	<i>Parupeneus cyclostomus</i>	Yellow saddle goatfish
Mullidae	<i>Parupeneus macronema</i>	Long-barbel goatfish
Mullidae	<i>Parupeneus trifasciatus</i>	Double-bar goatfish
Muraenidae	<i>Echidna nebulosa</i>	Clouded moray
Muraenidae	<i>Echidna polyzona</i>	Barred moray
Muraenidae	<i>Gymnomuraena zebra</i>	Zebra moray
Muraenidae	<i>Gymnothorax breedeni</i>	Black cheek moray
Muraenidae	<i>Gymnothorax favagineus</i>	Honeycomb moray
Muraenidae	<i>Gymnothorax flavimarginatus</i>	Yellow-margin moray
Muraenidae	<i>Gymnothorax meleagris</i>	White-mouth moray
Muraenidae	<i>Gymnothorax richardsoni</i>	Little moray
Muraenidae	<i>Gymnothorax javanicus</i>	Giant moray
Muraenidae	<i>Gymnothorax undulatus</i>	Undulate moray
Muraenidae	<i>Siderea grisea</i>	
Myliobatidae	<i>Aetobatus narinari</i>	White spotted eagle ray
Myliobatidae	<i>Manta alfredi</i>	Reef manta ray
Nemipteridae	<i>Scolopsis bilineata</i>	Monocle bream
Ostraciidae	<i>Ostracion cubicus</i>	Yellow boxfish
Ostraciidae	<i>Ostracion meleagris</i>	Black boxfish
Pempheridae	<i>Parapriacanthus ransonneti</i>	Yellow sweeper
Pempheridae	<i>Pempheris vanicolensis</i>	Greenback bullseye
Pinguipedidae	<i>Parapercis hexophthalma</i>	Black-tail grubfish
Pinguipedidae	<i>Parapercis millipunctata</i>	Thousand spot grubfish
Pinguipedidae	<i>Parapercis signata</i>	Maldivian grubfish
Plesiopidae	<i>Callopleysiops altivelis</i>	Comet
Pomacanthidae	<i>Apolemichthys trimaculatus</i>	Three spot angelfish
Pomacanthidae	<i>Centropyge multispinis</i>	Many spined angelfish
Pomacanthidae	<i>Pomacanthus imperator</i>	Emperor angelfish
Pomacanthidae	<i>Pomacanthus xanthometopon</i>	Blue face angelfish
Pomacanthidae	<i>Pygoplites diacanthus</i>	Regal angelfish
Pomacentridae	<i>Abudefduf vaigiensis</i>	Sergeant major
Pomacentridae	<i>Amblyglyphidodon batunai</i>	Green sergeant

Family	Latin Name	Common Name
Pomacentridae	<i>Amphiprion clarkii</i>	Clark's anemonefish
Pomacentridae	<i>Amphiprion nigripes</i>	Blackfoot anemonefish
Pomacentridae	<i>Chromis atripectoralis</i>	Blue-green puller
Pomacentridae	<i>Chromis dimidiata</i>	Two-tone puller
Pomacentridae	<i>Chromis elerae</i>	Twin-spot puller
Pomacentridae	<i>Chromis flavipectoralis</i>	White-finned puller
Pomacentridae	<i>Chromis nigroanalis</i>	Black-fin puller
Pomacentridae	<i>Chromis opercularis</i>	Double-bar puller
Pomacentridae	<i>Chromis tematensis</i>	Swallow-tail puller
Pomacentridae	<i>Chromis viridis</i>	Green puller
Pomacentridae	<i>Chromis weberi</i>	Weber's puller
Pomacentridae	<i>Chrysiptera unimaculata</i>	One-spot damsel
Pomacentridae	<i>Dascyllus carneus</i>	Indian humbug
Pomacentridae	<i>Dascyllus trimaculatus</i>	Three spot humbug
Pomacentridae	<i>Dascyllus aruanus</i>	Humbug damsel
Pomacentridae	<i>Plectroglyphidodon lacrymatus</i>	Jewel damsel
Pomacentridae	<i>Plectroglyphidodon dickii</i>	Narrowbar damsel
Pomacentridae	<i>Plectroglyphidodon leucozonus</i>	White-band damsel
Pomacentridae	<i>Pomacentrus caeruleus</i>	Blue-yellow damsel
Pomacentridae	<i>Pomacentrus indicus</i>	Indian damselfish
Pomacentridae	<i>Pomacentrus nagasakiensis</i>	Scribbled damsel
Pomacentridae	<i>Pomacentrus philippinus</i>	Philippine damsel
Priacanthidae	<i>Heteropriacanthus cruentatus</i>	Blotched bigeye
Priacanthidae	<i>Priacanthus blochii</i>	Glasseye
Priacanthidae	<i>Priacanthus hamrur</i>	Crescent-tail bigeye
Pseudochromidae	<i>Chlidichthys inornatus</i>	Yellow dottyback
Rhincodontidae	<i>Rhincodon typus</i>	Whale shark
Scarinae	<i>Cetoscarus bicolor</i>	Two-colour parrotfish
Scarinae	<i>Chlorurus sordidus</i>	Shabby parrotfish
Scarinae	<i>Chlorurus strongylocephalus</i>	Sheephead parrotfish
Scarinae	<i>Hipposcarus harid</i>	Longnose parrotfish
Scarinae	<i>Scarus caudofasciatus</i>	Bartail parrotfish
Scarinae	<i>Scarus frenatus</i>	Bridled parrotfish
Scarinae	<i>Scarus niger</i>	Dusky parrotfish
Scarinae	<i>Scarus prasiognathos</i>	Green-face parrotfish
Scarinae	<i>Scarus psittacus</i>	Rosy cheek parrotfish
Scarinae	<i>Scarus quoyi</i>	Green-blotched parrotfish

Family	Latin Name	Common Name
Scarinae	<i>Scarus rubroviolaceus</i>	Ember parrotfish
Scarinae	<i>Scarus scaber</i>	Five saddle parrotfish
Scarinae	<i>Scarus tricolor</i>	Three-colour parrotfish
Scarinae	<i>Scarus viridifucatus</i>	Green-snout parrotfish
Scombridae	<i>Gymnosarda unicolor</i>	Dogtooth tuna
Scombridae	<i>Rastrelliger kanagurta</i>	Mouth mackerel
Scorpaenidae	<i>Pterois antennata</i>	Spotfin lionfish
Scorpaenidae	<i>Pterois radiata</i>	White-lined lionfish
Scorpaenidae	<i>Pterois volitans</i>	Common lionfish
Scorpaenidae	<i>Scorpaenopsis oxycephala</i>	Smallscale scorpionfish
Serranidae	<i>Aethaloperca rogaa</i>	Ref-flushed grouper
Serranidae	<i>Anyperodon leucogrammicus</i>	White-lined grouper
Serranidae	<i>Cephalopholis argus</i>	Peacock rock cod
Serranidae	<i>Cephalopholis leopardus</i>	Leopard rock cod
Serranidae	<i>Cephalopholis miniata</i>	Vermillion rock cod
Serranidae	<i>Cephalopholis nigripinnis</i>	Blackfin rock cod
Serranidae	<i>Ephinephelus tukula</i>	Potato grouper
Serranidae	<i>Epinephelus caeruleopunctatus</i>	Small-spotted grouper
Serranidae	<i>Epinephelus fasciatus</i>	Blacktip grouper
Serranidae	<i>Epinephelus fuscoguttatus</i>	Marbled grouper
Serranidae	<i>Epinephelus macrospilos</i>	Snubnose grouper
Serranidae	<i>Epinephelus ongus</i>	White-speckled grouper
Serranidae	<i>Epinephelus polyphekadian</i>	Snout-spots grouper
Serranidae	<i>Epinephelus spilotoceps</i>	Foursaddle grouper
Serranidae	<i>Gracila albomarginata</i>	White-square grouper
Serranidae	<i>Nemanthias carberryi</i>	Threadfin basslet
Serranidae	<i>Plectropomus areolatus</i>	Squaretail coral grouper
Serranidae	<i>Plectropomus laevis</i>	Black-saddle coral grouper
Serranidae	<i>Pseudanthias evansi</i>	Yellow-tail basslet
Serranidae	<i>Pseudanthias ignitis</i>	Flame basslet
Serranidae	<i>Pseudanthias squamipinnis</i>	Orange basslet
Serranidae	<i>Variola albimarginata</i>	White-edged lyretail
Serranidae	<i>Variola louti</i>	Lunar tailed grouper
Siganidae	<i>Siganus argenteus</i>	Schooling rabbitfish
Siganidae	<i>Siganus corallinus</i>	Coral rabbitfish
Siganidae	<i>Siganus laques</i>	Starry rabbitfish
Siganidae	<i>Siganus puelloides</i>	Chin-strap rabbitfish

Family	Latin Name	Common Name
Sphyracidae	<i>Sphyracidae barracuda</i>	Great barracuda
Sphyracidae	<i>Sphyracidae flavicauda</i>	Yellowtail barracuda
Sphyracidae	<i>Sphyracidae genie</i>	Blackfin barracuda
Syngnathidae	<i>Dunckerocampus multiannulatus</i>	Many-bands pipefish
Synodontidae	<i>Synodus variegatus</i>	Variegated lizardfish
Tetraodontidae	<i>Arothron melagris</i>	Guineafowl pufferfish
Tetraodontidae	<i>Arothron nigropunctatus</i>	Black-spotted pufferfish
Tetraodontidae	<i>Arothron stellatus</i>	Stary pufferfish
Tetraodontidae	<i>Canthigaster janthinoptera</i>	White-spotted pufferfish
Tetraodontidae	<i>Canthigaster valentini</i>	Saddled pufferfish
Tripterygiidae	<i>Helcogramma maldivensis</i>	Maldives triplefin
Tripterygiidae	<i>Helcogramma sp.</i>	Green-head triplefin
Zanclidae	<i>Zanclus cornutus</i>	Moorish idol



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