Reef Life Survey Assessment of Coral Reef Biodiversity in the North-west Marine Parks Network

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Report to Parks Australia, Department of the Environment

2020

Citation

Edgar GJ, Mellin C, Turak E, Stuart-Smith RD, Cooper AT, Ceccarelli DM (2020) Reef Life Survey Assessment of Coral Reef Biodiversity in the North-west Marine Parks Network. Reef Life Survey Foundation Incorporated.

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Images

Cover: RLS diver and *Tridacna gigas* at Imperieuse Reef by Andrew Green
Remaining images: Page ii: Graham Edgar, Western Australia; Page iv: Graham Edgar, *Pomacentrus pavo* Ashmore Reef; Page viii: Graham Edgar Drone image Clerke Reef, Rowley Shoals; Page 2: Graham Edgar, *Ecsenius lividinalis*, Ashmore Reef; Page 33: Graham Edgar, *Amphiprion ocellaris*, Kimberley; Page 35: Graham Edgar, *Tridacna gigas*, Imperieuse Reef; Page 39 Graham Edgar, Hermit crab, Kimberley; Rear cover: Andrew Green, RLS diver at Mermaid Reef

1 Contents

Figures

Tables

List of acronyms

ACRONYM	EXPANDED
AMP/CMR	Australian Marine Park/ Commonwealth Marine Reserve
RLSF	The Reef Life Survey Foundation
MPA	Marine Protected Area
IUCN	International Union for Conservation of Nature
RLS	Reef Life Survey
EEZ	Exclusive Economic Zone
CTI	Community Temperature Index

Executive summary

The North-west Marine Parks Network extends from the northern Kimberley to Shark Bay, off Western Australia, and includes shallow, turbid marine habitats with deeper areas and oceanic reefs further offshore. The major offshore coral reefs in the North-west region include Ashmore, Hibernia, Scott, Cartier, Seringapatam, and the Rowley Shoals, and coastal reefs have formed at Ningaloo Reef and in the Kimberley Region. Two isolated reefs in the North-west region are currently protected as Sanctuary Zones, equivalent to the IUCN's category Ia: Ashmore Reef and Cartier Island. A further reef, Mermaid Reef, is IUCN Category II. This report presents the findings of a repeat survey conducted by Reef Life Survey across the North-west Marine Parks Network's reefs, with a focus on comparing coral reef communities from this survey with results of the 2013 baseline survey, and comparing protected with reference reefs.

Results revealed that IUCN Ia sites at Ashmore Reef had increased in fish biomass, fish species richness, biomass of grazing and larger (>20 cm TL) fishes, benthic diversity and density of macroinvertebrates; many of these changes were not recorded at fished references sites and therefore suggest a positive effect of more strict no-take protection in the last five years. With continued adequate protection, the coral reef assemblage at Ashmore Reef is likely to shift further towards what is considered normal for "pristine" oceanic reefs. Distinctions were clearly evident in the fish, benthic and invertebrate communities between the inshore (Kimberley) and offshore reefs, but there was also a separation between the northern offshore reefs (Ashmore, Scott and Hibernia) and the Rowley Shoals (Mermaid, Clerke and Imperieuse). Additionally, Ashmore, Hibernia and Scott Reefs had "warmer" fish assemblages (i.e. higher community temperature index, CTI) than Mermaid Reef, which is to be expected given the latitudinal differences. However, an increase in CTI was evident through time at Mermaid Reef, indicating a potential shift towards fishes that prefer warmer waters. The higher biomass of large fishes was retained at Mermaid Reef from 2013 to 2018, but the state-managed Rowley Shoals Marine Park sites experienced a decline, potentially due to illegal fishing, changes in fish production unrelated to fishing, or attainment of the carrying capacity for the fish community. Functional richness of reef communities was highest at Ashmore Reef, implying a degree of functional redundancy and potentially greater resilience to climatic disruptions.

The clearest changes in the mobile invertebrate and cryptic fish faunas between the 2013 and 2018 surveys were increases in abundance and richness of echinoderms and cryptic fishes. While higher cryptic fish numbers could reflect an increasing focus on cryptic fishes in the surveys by divers, the same trend has occurred along the GBR and in Elizabeth and Middleton Reefs in recent years, and it is more likely that recent warmer years and/or habitat change have fuelled increased production of small fishes.

The ecological success of management protection is emerging at Ashmore Reef Marine Park after a history of disturbance and illegal fishing, and a failure to detect an effect of protection in earlier surveys. The continued absence of sea snakes at Ashmore Reef suggests that this has not been a temporary variation in numbers, so local extirpation is likely if it persists. Pronounced losses of habitat-forming Acropora coral between surveys at the main reference reef (Scott Reef) do not extend to Ashmore Reef, perhaps because the MPA is more resilient to stress or, more likely, recent cyclone impacts did not extend to Ashmore.

Mermaid Reef also appears to have retained stability in the face of change at nearby reefs, but needs to be closely monitored. The ‘warming’ of the fish community in the Rowley Shoals may be contributing to the regional signal of biotic homogenization. This is of interest in the context of declines in sensitive species with heatwaves, habitat loss and fishing, and shifting distributions, which may all be leading to increasing similarity of reef community structure. More research is clearly needed on this topic, and detailed time-series monitoring data will be critical for detecting such change.

MANAGEMENT AND RESEARCH RECOMMENDATIONS

We recommend that:

- ongoing monitoring of North-west Marine Parks Network reefs takes place on a regular basis (5 years or less), using the methods and sites described here;

- data presented in recent RLS surveys be combined with previous surveys to guide efforts to select sites for long-term monitoring;

- research priorities include development of indicators that track changes in reef condition and biodiversity;

- detailed habitat mapping and categorisation of reef types, exposure and aspect is undertaken for inclusion in analyses of ecological patterns;

- causes for species population declines at the State managed Rowley Shoals Marine Park are investigated;

- detailed spatial and temporal mapping of the distribution and impact of natural disturbances is carried out; and

- greater collaboration between agencies collecting data on reefs for the North-west Marine Parks Network is encouraged.

2 Introduction

The North-west Marine Parks Network extends from the northern Kimberley to Shark Bay, off Western Australia (WA). The marine environment is generally shallow (almost half of the seafloor is less than 200 m deep) and tropical, with a wide continental shelf, a large number of banks and shoals, a highly variable tidal regime, a high incidence of tropical cyclones, and a complex system of ocean currents (Baker et al. 2008). The primary oceanographic features in the North-west Marine Parks Network are the Leeuwin Current and the Indonesian Throughflow, which contribute warm, low-nutrient (oligotrophic) water from the Pacific through the Indonesian island group to areas south of Shark Bay. The large tidal range affects the movements of sediments and turbidity plumes (Commonwealth of Australia 2012). The major offshore coral reefs in the North-west region include Ashmore, Hibernia, Scott, Cartier, Seringapatam, and the Rowley Shoals, all of which host high coral and fish diversity (Commonwealth of Australia 2012). Extensive coral reefs have also formed along the coastline, especially at Ningaloo Reef and the Kimberley Region (Gilmour et al. 2019).

The North-west Marine Parks Network shares most species with either the Indian Ocean or the central Indo-Pacific and has relatively low endemicity when compared with other Australian marine regions. The North-west Marine Parks Network's high species richness is thought to be a product of the close proximity to the Coral Triangle biodiversity hotspot, the high diversity of available habitats, including hard limestone seafloor, submerged cliffs, sandy and muddy areas, the deep waters of the Cuvier and the Argo Abyssal Plains, and coral reefs along a gradient from the nearshore Kimberley and Ningaloo to the outer edge of the continental shelf (Falkner et al. 2009). The emergent reefs represent patches of high productivity and diversity in the otherwise oligotrophic waters of the North-west Marine Parks Network. They also attract breeding and feeding aggregations of regionally important populations of marine species, such as seabirds and marine mammals. The steep slope of the Rowley Shoals and other offshore reefs create an upwelling of nutrients that attracts migratory pelagic species such as dolphins, tuna, billfish and sharks.

Two isolated reefs in the North-west region are currently managed by Parks Australia as Sanctuary Zones, equivalent to the IUCN's category Ia: Ashmore Reef and Cartier Island. Mermaid Reef is also highly protected as a National Park Zone (IUCN II). The Ashmore Reef Marine Park is situated on Australia's north-west shelf in the Timor Sea, covers 583 km^2, and encompasses a coral reef with wide reef flats, gently sloping outer reef slopes, two extensive lagoons, shifting sand flats and cays (including three permanent islands known as East, Middle and West Islands) and seagrass meadows. Within the Ashmore Reef Marine Park, 550 km^2 is strictly protected within a IUCN Ia Sanctuary Zone, and 33 km^2 is a IUCN IV Recreational Use Zone, where some fishing is permitted. Ashmore Reef Marine Park historically had the highest diversity of sea snakes in the world (Lukoschek et al. 2013), a genetically distinct population of dugongs (Whiting 1999), WA's highest diversity of reef-building corals (Richards et al. 2009) and reef fishes (Allen 1993), and a regionally significant population of marine turtles (Whiting and Guinea 2001). Ashmore's West Island is a recognized seabird breeding and roosting ground of international significance, as well as an annual migratory stop-over for birds traveling between eastern Asia and Australia, resulting in its listing as a Ramsar site (Ferguson 2002). A detailed habitat map exists of the reef, which has guided site selection for ecological surveys (Skewes et al. 1999). Previous monitoring surveys have focused on populations of commercially important macroinvertebrates, such as holothurians, trochus and tridacnid clams, which have been heavily targeted by Indonesian fishers in the past, and more recently continue to be harvested illegally (Ceccarelli et al. 2011a, Ceccarelli et al. 2013).

Mermaid Reef Marine Park encompasses the northernmost of the three Indian Ocean reefs collectively known as the Rowley Shoals. The three reefs are similar in size and shape, with enclosed lagoons, small sand cays and steep outer reef edges. Clerke and Imperieuse Reefs are managed within the Western Australian Rowley Shoals Marine Park, but not all reef areas are protected as no-take marine reserves, and are subject to some recreational and charter fishing. Mermaid Reef Marine Park is entirely protected as a IUCN II National Park Zone. Compared to the partially-fished Rowley Shoals reefs, Mermaid was previously found to support higher densities of commercially-exploited species of invertebrate and fish (Meekan et al. 2005, Edgar et al. 2017). The coral communities at Mermaid Reef were unique even when compared with Clerke and Imperieuse Reefs, with relatively high overall coral cover, and proportionally higher cover of soft, massive, and encrusting corals (Gilmour et al. 2007). In fact, compared with other reef systems in the region (Scott, Seringapatam, Ashmore, Cartier and Hibernia), the Rowley Shoals, and Mermaid Reef in particular, are thought to represent the most 'pristine' state amongst WA's offshore reefs (Gilmour et al. 2019).

Despite their distance from chronic human pressures that typically affect coral reefs, offshore reefs in the North-west Marine Parks Network have experienced a series of cyclones, heat stress and coral bleaching events in recent decades (Gilmour et al. 2019). Substantial coral bleaching and subsequent mortality occurred as a result of abnormally high SST in 1998, 2002, 2010 and most recently in 2016 (Gilmour et al. 2019). Bleaching and consequent coral mortality were worst at Scott and Seringapatam Reefs, Christmas Island and some sites at Ashmore Reef; the Rowley Shoals experienced minor coral bleaching at most sites (Gilmour et al. 2019). Recovery of coral cover was rapid during years of little or no disturbance, suggesting high resilience in the past (Ceccarelli et al. 2011b).

So far, few surveys of coral reefs in the North-west Marine Parks Network have included all comparable reefs with the same methodology, making it difficult to assess differences between reefs, and between different levels of protection. This report presents the findings of a repeat survey across the North-west Marine Parks Network's reefs, with a focus on comparing coral reef communities from this survey with results of the 2013 baseline survey (Edgar et al. 2017), and comparing protected with reference reefs

3 Methods

In 2018/19 survey expeditions, Reef Life Survey (RLS) dive teams surveyed 23 transects at 12 sites within the Ashmore Reef Marine Park, 52 transects at 26 Ashmore reference sites (Hibernia and Scott Reefs), 35 transects at 18 sites in the Mermaid Marine Park and 64 transects at 32 Mermaid Reference sites (Clerke and Imperieuse Reefs; Figure 3, Appendix 1). All surveys were conducted using the standardised underwater visual census methods applied globally by Reef Life Survey. Reef Life Survey (RLS) involves recreational divers trained to a scientific level of data-gathering to make it possible to conduct ecological surveys across broad geographic areas in a cost-effective manner. RLS divers partner with management agencies and university researchers to undertake detailed assessment of biodiversity on coral and rocky reefs, but all divers and boat crew do so in a voluntary capacity. A summary of these methods is provided here. Full details can be downloaded at: http://reeflifesurvey.com/files/2008/09/NEW-Methods-Manual_15042013.pdf.

Each RLS survey involves three distinct searches undertaken along a 50 m transect line, for: (i) fishes, (ii) invertebrates and cryptic fishes, and (iii) sessile organisms such as corals and macroalgae (described individually below). Two transects were usually surveyed at each site for this study, on predominantly coral reef habitat, and generally parallel at different depths. Depth contours were restricted by depth variations in individual reefs, but where possible were selected to encompass a wide depth range (e.g. 2 – 20 m). Constraints associated with diving bottom time and air consumption generally limited depths to above 20 m. Underwater visibility and depth were recorded at the time of each survey, with visibility measured as the furthest distance at which large objects could be seen along the transect line, and depth as the depth (m) contour followed by the diver when setting the transect line.

FISH SURVEYS (METHOD 1)

All fish species sighted within 5 m x 50 m blocks either side of the transect line were recorded on waterproof paper as divers swam slowly along the line. The number and estimated size-category of each species were also recorded. Size categories used were 25, 50, 75, 100, 125, 150, 200, 250, 300, 350, 400, 500, 625 mm, and 125 mm categories above, which represent total fish length (from snout to tip of tail). All species sighted within the blocks were recorded, including those with unknown identity. Photographs were used to later confirm identities with appropriate taxonomic experts, as necessary. In occasional circumstances when no photograph was available, taxa were recorded to the highest taxonomic resolution for which there was confidence (e.g. genus or family, if not species). Other large pelagic animals such as mammals, sea snakes, turtles and cephalopods were also recorded during the Method 1 fish survey, but were excluded for analyses focusing on fishes. Species observed outside the boundaries of the survey blocks or after the fish survey had been completed were recorded as ‘Method 0’. Such records are a presence record for the time and location but were not used in quantitative analyses at the site level. ‘Method 0’ sightings were also made of invertebrates and any other notable taxonomic groups.

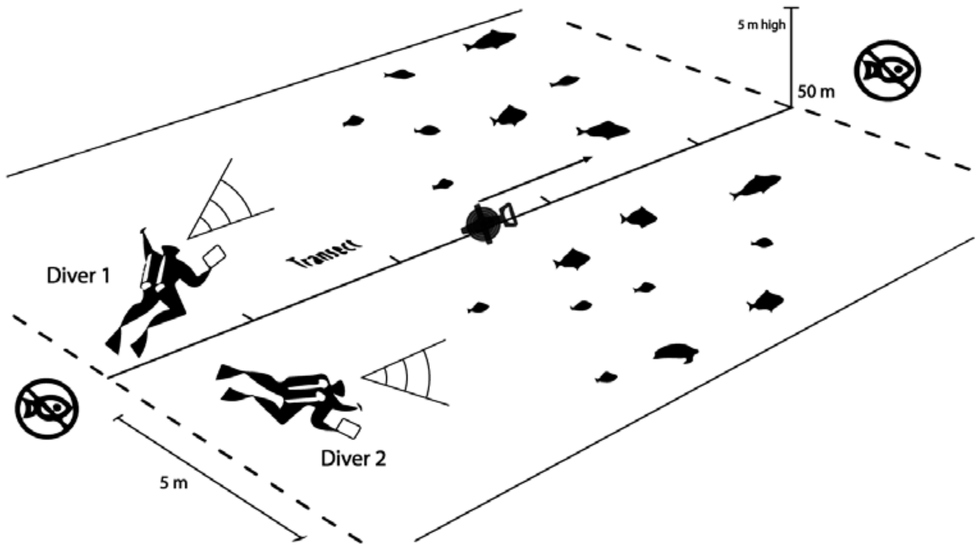

Figure 1. Stylised representation of method 1 survey technique

MACROINVERTEBRATE AND CRYPTIC FISH SURVEYS (METHOD 2)

Large macroinvertebrates (echinoderms, and molluscs and crustaceans > 2.5 cm) and cryptic fishes were surveyed along the same transect lines set for fish surveys. Divers swam near the seabed, up each side of the transect line, recording all mobile macroinvertebrates and cryptic fishes on the reef surface within 1 m of the line. This required searching along crevices and undercuts, but without moving rocks or disturbing corals. Cryptic fishes include those from particular pre-defined families that are inconspicuous and closely associated with the seabed (and are thus disproportionately overlooked during general Method 1 fish surveys). The global list of families defined as cryptic for the purpose of RLS surveys can be found in the online methods manual. As data from Method 2 were collected in blocks of a different width to that used for Method 1 and were analysed separately from those data, individuals of cryptic fishes known to already be recorded on Method 1 were still recorded as part of Method 2. Sizes were estimated for cryptic fishes using the same size classes as for Method 1.

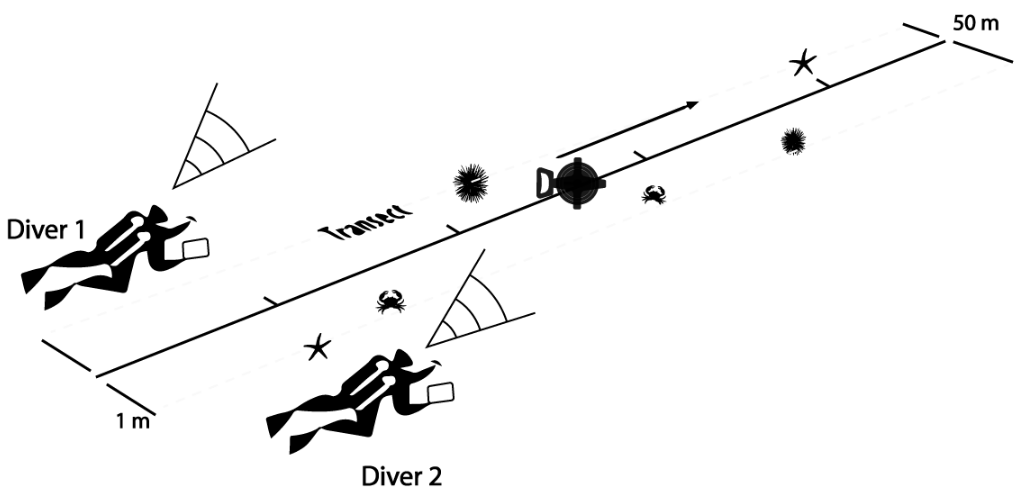

Figure 2. Stylised representation of method 2 survey technique

PHOTO-QUADRATS OF BENTHIC COVER (METHOD 3)

Information on the percentage cover of sessile animals and macroalgae along the transect lines set for fish and invertebrate surveys were recorded using photo-quadrats taken every 2.5 m along the 50 m transect. Digital photo-quadrats were taken vertically-downward from a height sufficient to encompass an area of approximately 0.3 m x 0.3 m.

The percentage cover of different macroalgal, coral, sponge and other attached invertebrate species was obtained from photo-quadrats by recording the coral species or functional group observed under each of five points overlaid on each image, such that 100 points were usually counted for each transect (thus percentage cover was calculated as the number of points each group was scored under).

Functional groups for photo-quadrat processing comprised the standard 50 categories applied in broad-scale analysis of RLS data, which are aligned with the CATAMI benthic imagery classification system (Althaus et al. 2015). For this report, a coral specialist, Dr Emre Turak, was engaged to provide the highest possible taxonomic resolution for corals. Images have been archived and are available for processing at any resolution through the future.

Mean and maximum rugosity values were also estimated for each transect from photo-quadrats, on a scale of 1 to 4, as follows: 1) flat smoothly-curved seabed, occasional projecting rocks when present, not rising more than 5 cm; 2) smoothly-curved seabed with cracks and ridges (with rounded edges) rising vertically 5-20 cm but not undercut; 3) dissected reef surface with cracks and ridges (with some angular edges) rising vertically 20-50 cm and with small undercuts; and 4) highly-dissected reef with extensive (>0.5 m) undercuts.

STATISTICAL ANALYSES

Collection of detailed data on fishes, including species-level identities, length classes and abundance information, allow the calculation of species-specific biomass estimates. The RLS database includes coefficients for length–weight relationships obtained for each species from Fishbase (www.fishbase.org) (in cases of missing length-weight coefficients, these are taken from similar-shaped species). When length–weight relationships were described in Fishbase in terms of standard length or fork length rather than total length, additional length-length relationships provided in Fishbase allowed conversion to total length, as estimated by divers. For improved accuracy in biomass estimates, the bias in divers' perception of fish size underwater was additionally corrected using the mean relationship provided in Edgar et al. (2004), where a consistent bias was found amongst divers that led to underestimation of small fish sizes and overestimation of large fish sizes. Note that estimates of fish abundance made by divers can be greatly affected by fish behaviour for many species (Edgar et al. 2004); consequently, biomass determinations, like abundance estimates, can reliably be compared only in a relative sense (i.e. for comparisons with data collected using the same methods) rather than providing an accurate absolute estimate of fish biomass for a patch of reef.

UNIVARIATE ANALYSES

A range of univariate metrics were calculated from survey data: total fish biomass, fish species richness, biomass of fish trophic groups, abundance and species richness of macroinvertebrates and cryptic fishes, and percent cover of corals and other key benthic organisms. Three additional indicators of reef condition were calculated: the biomass of large reef fishes (B20), the community temperature index (CTI), and an estimate of functional richness. The biomass of large fishes (B20) is an indicator of fishing impacts, with previous analyses revealing lower values in regions of higher fishing impact around Australia, including from previous RLS surveys at Ashmore Reef. B20 is calculated as the sum of biomass for all individuals on any survey that are in the 20 cm size class or larger, regardless of identity. CTI is an indicator of the thermal affinities of the species, and responds to sea temperature changes (Stuart-Smith et al. 2015). For its calculation, the midpoint of each species' thermal distribution (i.e. the temperature range experienced across its geographic distribution) is used as a value of thermal affinity. The mean thermal affinity of species recorded on a survey is then taken, weighted by the log of their abundance on the survey. Functional richness is calculated as the number of unique combinations of categorical traits represented by species on each survey. It includes fishes and mobile invertebrates and is based on three traits: trophic group (corallivores, scraping herbivores, benthic invertivores, algal farmers, browsing herbivores, omnivores, planktivores, higher carnivores, excavators, detritivores, suspension feeders and cleaners), maximum body size (included as 10-cm bins up to 50 cm, and all species which grow to >50 cm binned together), and water column position (benthic, demersal, pelagic site-attached and pelagic non-site-attached). All metrics represent mean values per 500 m^2 transect area for Method 1 fishes, per 100 m^2 transect area for Method 2 fishes and invertebrates, and percent cover of benthic organisms from photo-quadrats.

Analysis of Variance (ANOVA) with appropriate transformations were conducted on the above metrics, with Year, Reef System (ie. Mermaid vs. Ashmore) and IUCN Status as fixed factors. While Reef would normally be considered a random factor in biogeographical studies with a subset of reefs sampled, we considered it fixed for this application because we surveyed the full set of shallow reefs present in the North-west Marine Parks network, and each reef is of specific interest in its own right. Because the comparison of interest was the one between Ashmore and Mermaid Reefs, for which reserve sites were also compared with reference sites, the "Ashmore Reef" reference group includes Scott, Seringapatam and Hibernia Reefs (all encompassed within the broader "Ashmore" Reef System), and the "Mermaid Reef" reference group includes Clerke and Imperieuse Reefs (all encompassed within the "Mermaid" Reef System).

MULTIVARIATE ANALYSES

Relationships between North-west Marine Parks Network sites in percent cover of sessile biota, reef fish and invertebrate communities were initially analysed using non-metric Multi-Dimensional Scaling (MDS). These were run using the software program R (R Development Core Team 2019) using the 'metaMDS' function in the R package 'vegan' for community analysis. This analysis reduces multidimensional patterns (e.g. with multiple species or functional groups) to two dimensions, showing patterns of similarity between sites. MDS was used to investigate differences in community structure between reefs.

Multivariate data (biomass for fishes, abundance for invertebrates) were converted to a Bray-Curtis distance matrix relating each pair of sites after square root transformation. This transformation was applied to down-weight the relative importance of the dominant species at a site, and so allow less abundant species to also contribute to the plots. MDS was followed up with Permutational Multivariate Analysis of Variance (PERMANOVA) (function 'adonis' in R package 'vegan') to test the significance of differences between years, reefs and IUCN status.

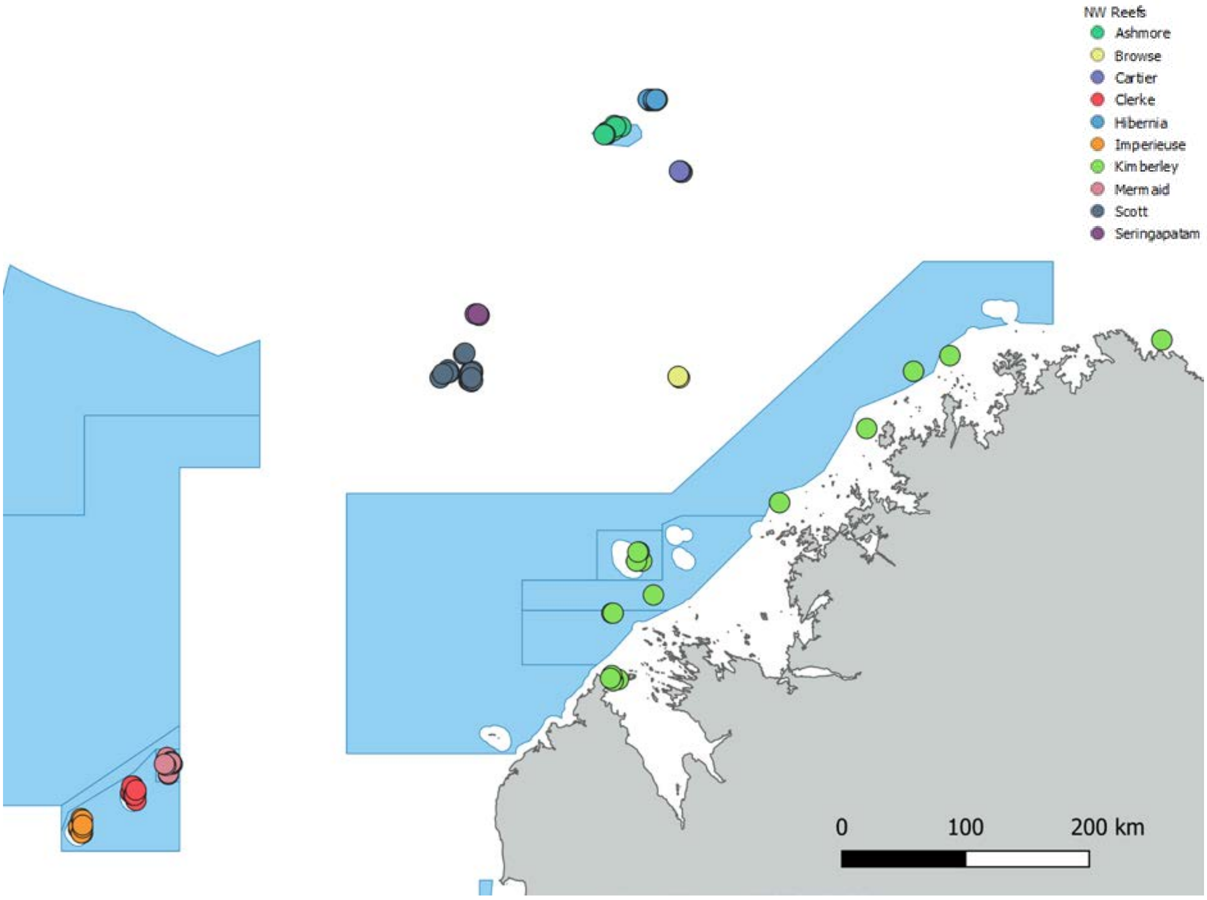

Figure 3. Map of the Northwest sites surveyed from 2009-2019. Most dots have multiple overlapping sites.

4 Results

4.1 Fish Community

4.1.1 COMMUNITY STRUCTURE

The surveys of offshore reefs of the North-west Marine Parks Network in 2018 yielded a total of 507 species of bony fish and elasmobranchs (sharks and rays) recorded along the 500 m^2 transects (Appendix 2). The fish community structure was clearly different between Kimberley reefs and all other reefs, which were offshore (Figure 4, Table 1). Inshore Kimberley reefs appeared to have a more depauperate fish assemblage, dominated by the grazing surgeonfish *Acanthurus grammoptilus*. Offshore reefs had a broader complement of species, dominated by the grazing surgeonfishes *Acanthurus nigricans*, *A. nigrofuscus* and *Ctenochaetus striatus*, the excavating parrotfish *Chlorurus microrhinos* and the predatory grouper *Cephalopholis argus*.

Despite some overlap between groups, offshore reefs also had characteristics that set them apart from each other. Two of the three Browse Island sites appear unique; Hibernia, Ashmore, Cartier, Scott and Seringapatam Reefs are set apart from the three reefs that make up the Rowley Shoals: Mermaid, Clerke and Imperieuse.

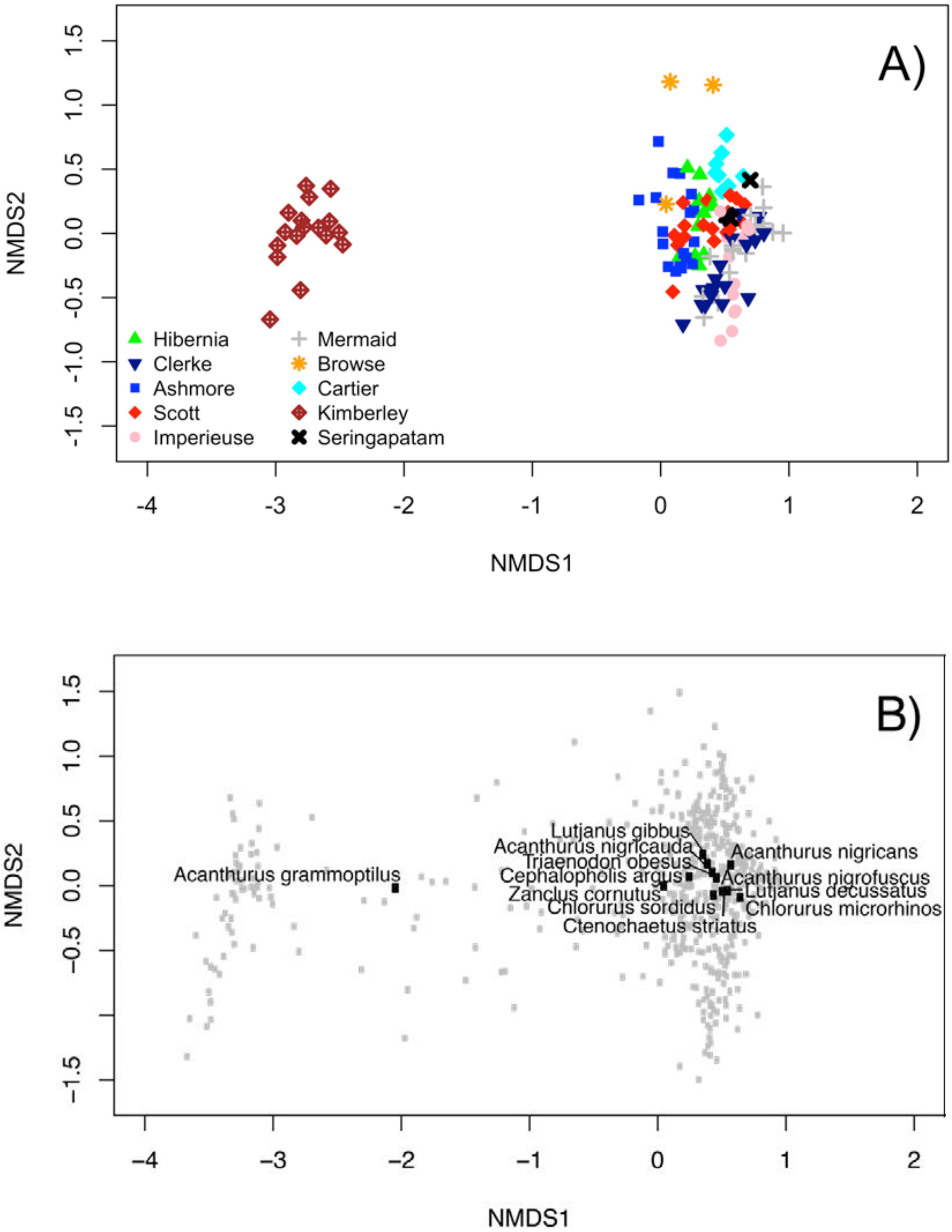

Figure 4. Multidimensional Scaling (MDS) plot of reef fish biomass across all sites surveyed in 2018-2019, performed on the Bray-Curtis similarity matrix of the square-root transformed data, showing (A) site scores and (B) species scores (stress = 0.14). For clarity, species labels are shown for the most abundant species only.

Changes in community structure between years were evident in a general trend for sites to move towards the centre of the MDS space (Figure 5). This increasing similarity of fish communities at sites from different reefs and zones represents a form of regional homogenization. Such changes were greatest at Ashmore IV and Ia sites, whilst Ashmore reference and Rowley Shoals sites showed smaller changes (Table 1).

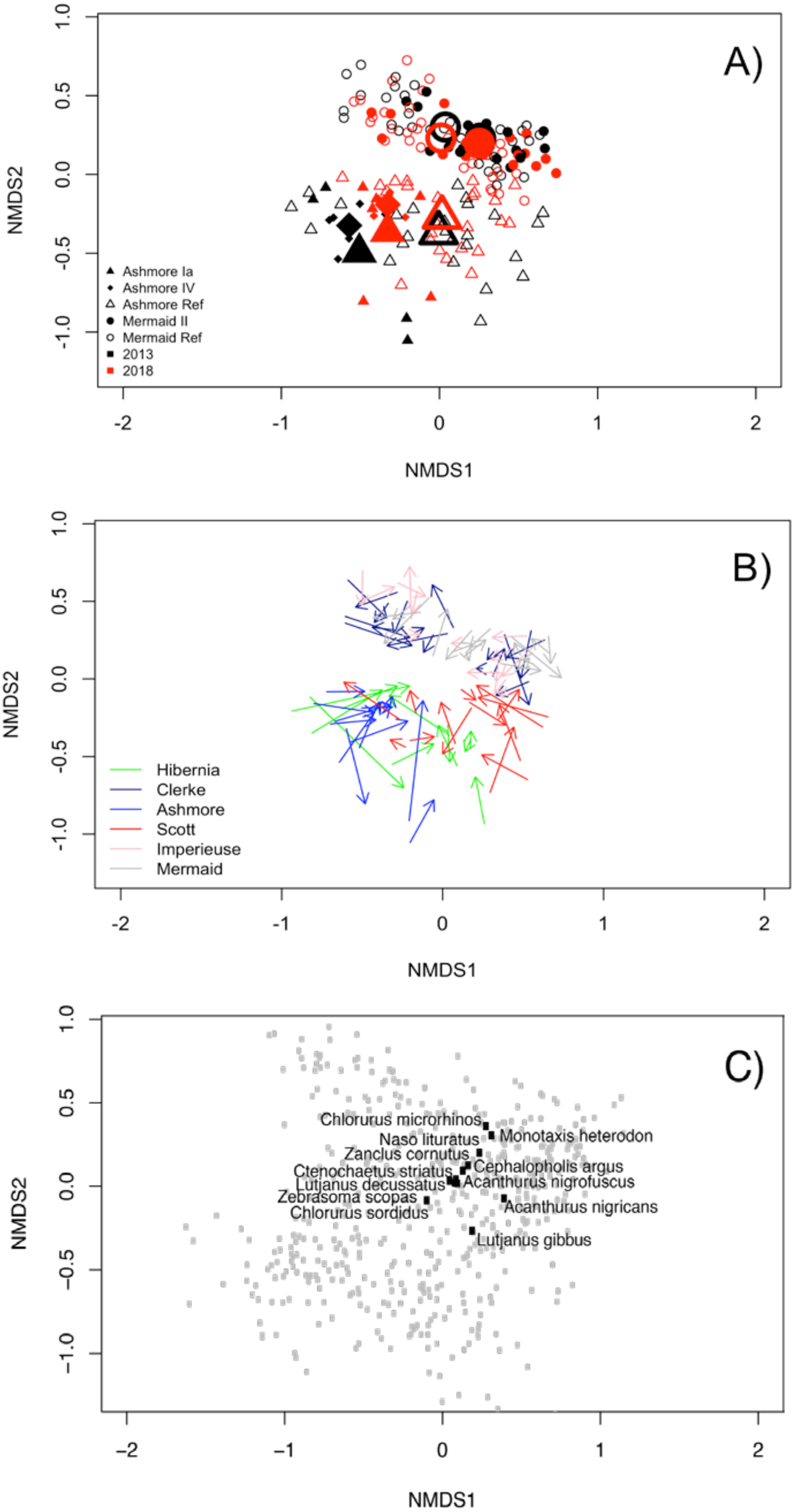

Figure 5. Multidimensional Scaling (MDS) plot of reef fish biomass across all sites surveyed in 2013 vs 2018, either coded by AMP status (A) or reefs (B), and performed on the Bray-Curtis similarity matrix of the square-root transformed data (stress = 0.21). Species scores are shown in C). For clarity, labels are shown for the most abundant taxa only.

Table 1. Permanova test of fish community changes between 2013 and 2018, between reef systems (Mermaid vs. Ashmore), and "IUCN Status" (compares IUCN I-II vs. IUCN IV vs. Reference: Hibernia and Scott Reefs for Ashmore, Clerke and Imperieuse for Mermaid).

	Df	SumsOfSqs	MeanSqs	F.Model	R2	Pr(>F)
Year	1	0.594	0.594	4.384	0.019	**0.001**
Reef System	1	1.363	1.363	10.064	0.045	**0.001**
IUCN Status	2	0.477	0.238	1.761	0.016	**0.052**
Year x Reef System	1	0.749	0.749	5.534	0.025	**0.001**
Year x IUCN Status	2	0.307	0.153	1.133	0.010	**0.335**
Residuals	200	27.077	0.135	NA	0.886	**NA**
Total	**207**	**30.566**	**NA**	**NA**	**1.000**	**NA**

4.2 Fish biomass and species richness

The highest biomass of reef fishes was recorded at Mermaid II sites, while the highest species richness occurred at Ashmore IV sites (Figure 6). Biomass increased from 2013 to 2018 at Ashmore Ia and Ashmore IV, but declined at Ashmore and Mermaid reference sites and remained stable at Mermaid II sites. Species richness increased at Ashmore Ia sites, and all Mermaid sites; changes in species richness were consistent between reef systems and IUCN status (Table 2).

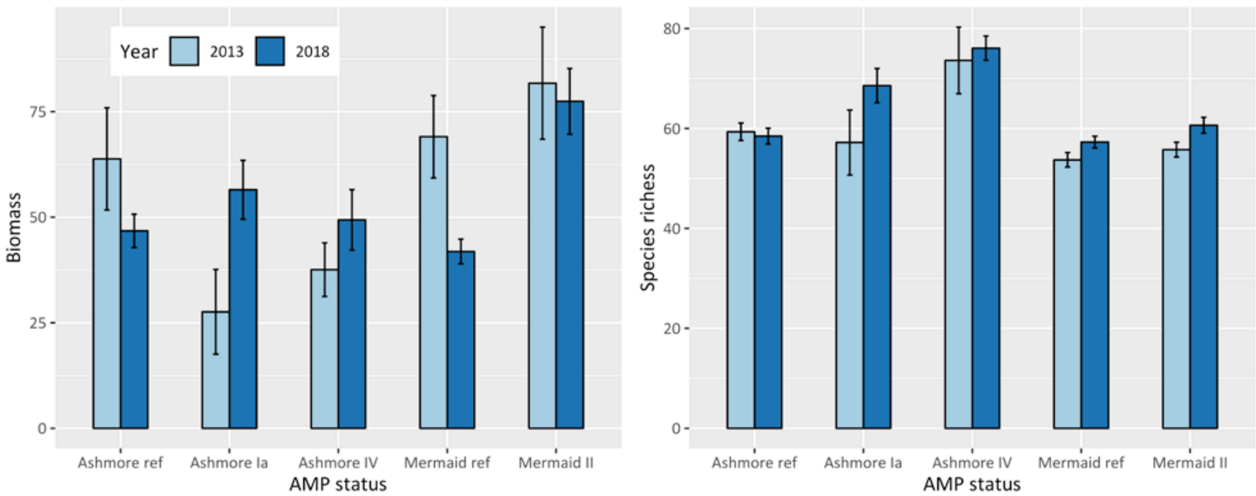

Figure 6. Biomass in kg and species richness of reef fishes per 500 m2 transect at Ashmore Reef Marine Park, Mermaid Reef Marine Park and reference sites in the North-west bioregion. Error Bars = 1 SE.

Table 2. ANOVA testing differences in the degree of change in fish biomass and species richness from 2013 to 2018 between reef systems (Mermaid vs. Ashmore), and "IUCN Status" (compares IUCN I-II vs. IUCN IV vs. Reference: Hibernia and Scott Reefs for Ashmore, Clerke and Imperieuse for Mermaid).

		Df	Sum Sq	Mean Sq	F value	Pr(>F)
Biomass	Reef System	1	43.857	43.857	5.780	**0.018**
	IUCN Status	2	62.666	31.333	4.129	**0.020**
	Reef System x IUCN Status	1	7.451	7.451	0.982	**0.325**
	Residuals	81	614.602	7.588	NA	**NA**
Species richness	Reef System	1	153.123	153.123	1.014	**0.317**
	IUCN Status	2	327.007	163.503	1.082	**0.344**
	Reef System x IUCN Status	1	144.895	144.895	0.959	**0.330**
	Residuals	**81**	**12236.332**	**151.066**	**NA**	**NA**

In 2013, herbivores dominated the biomass of fish communities at Ashmore IV, Clerke and Imperieuse Reefs. Greater biomass of benthic invertivores was recorded at Hibernia and Imperieuse, whilst biomass of higher carnivores was greater at Scott Reef and Mermaid II. In 2018, most groups increased in biomass at Ashmore Ia and Ashmore IV, and declined at Scott, Clerke and Imperieuse (Figure 7). Herbivores increased at Hibernia, Ashmore Ia, Ashmore IV and Imperieuse, and declined at Scott, Clerke and Mermaid. The increase in herbivores at Ashmore Reef Ia sites was mostly due to *Naso brachycentron* (not recorded in 2013, but high biomass in 2018) followed by *Acanthurus olivaceus* and *A. nigrofuscus.* Higher carnivores increased at Ashmore Ia, IV and Mermaid II, and declined at reference sites. There were also large increases in planktivores at Hibernia, Ashmore Ia and Ashmore IV. Corallivores and benthic invertivores generally declined across the region, with the Ashmore protected sites the main exceptions.

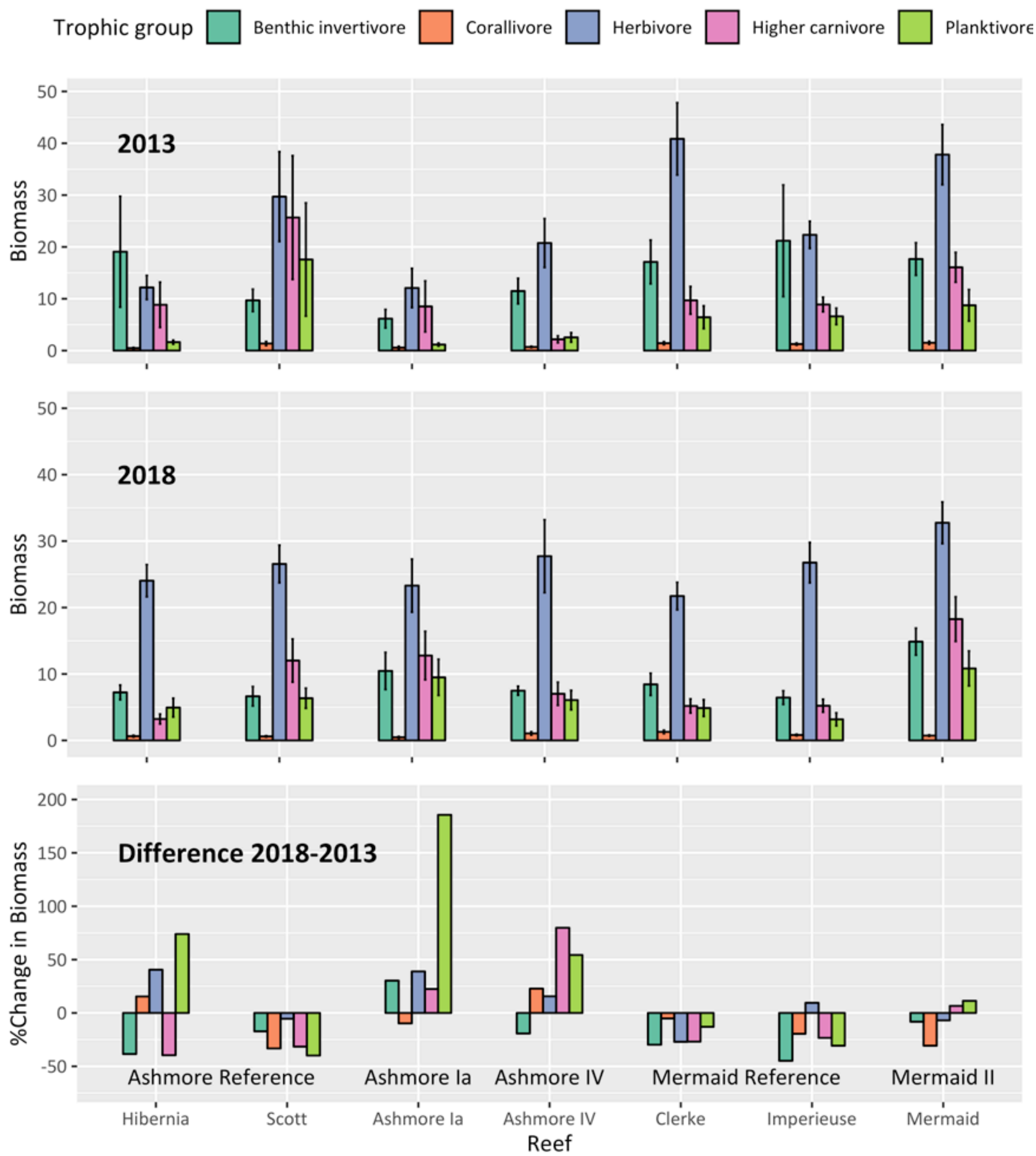

Figure 7. Biomass in kg of functional group of reef fishes per 500 m^2 transect at Ashmore Reef Marine Park, Mermaid Reef Marine Park and reference sites in the North-west bioregion. Error Bars = 1 SE.

The biomass of large fishes (>20cm TL) at Ashmore Ia sites was low in the 2013 surveys by national standards (Stuart-Smith et al. 2017), but increased significantly to 2018 (Figure 8). At all other sites, the biomass of large fishes declined or remained stable; the largest declines were recorded at reference sites for both Ashmore and Mermaid, the latter representing the WA state managed Marine Park (Table 3). The highest large fish biomass in 2018 was recorded in the Kimberley Marine National Park zone (IUCN II), but no sites were surveyed here in previous years to allow a temporal comparison. Ashmore, Kimberley RZ, Scott and Seringapatam were approximately similar to each other (25 kg per 500m^2). Browse, Cartier (NT), Mermaid (NT) and Kimberley fished sites had slightly higher large fish biomass (30-50 kg per 500m^2); the lowest biomass of large fishes was recorded at Hibernia, Imperieuse and Clerke Reefs (Table 3).

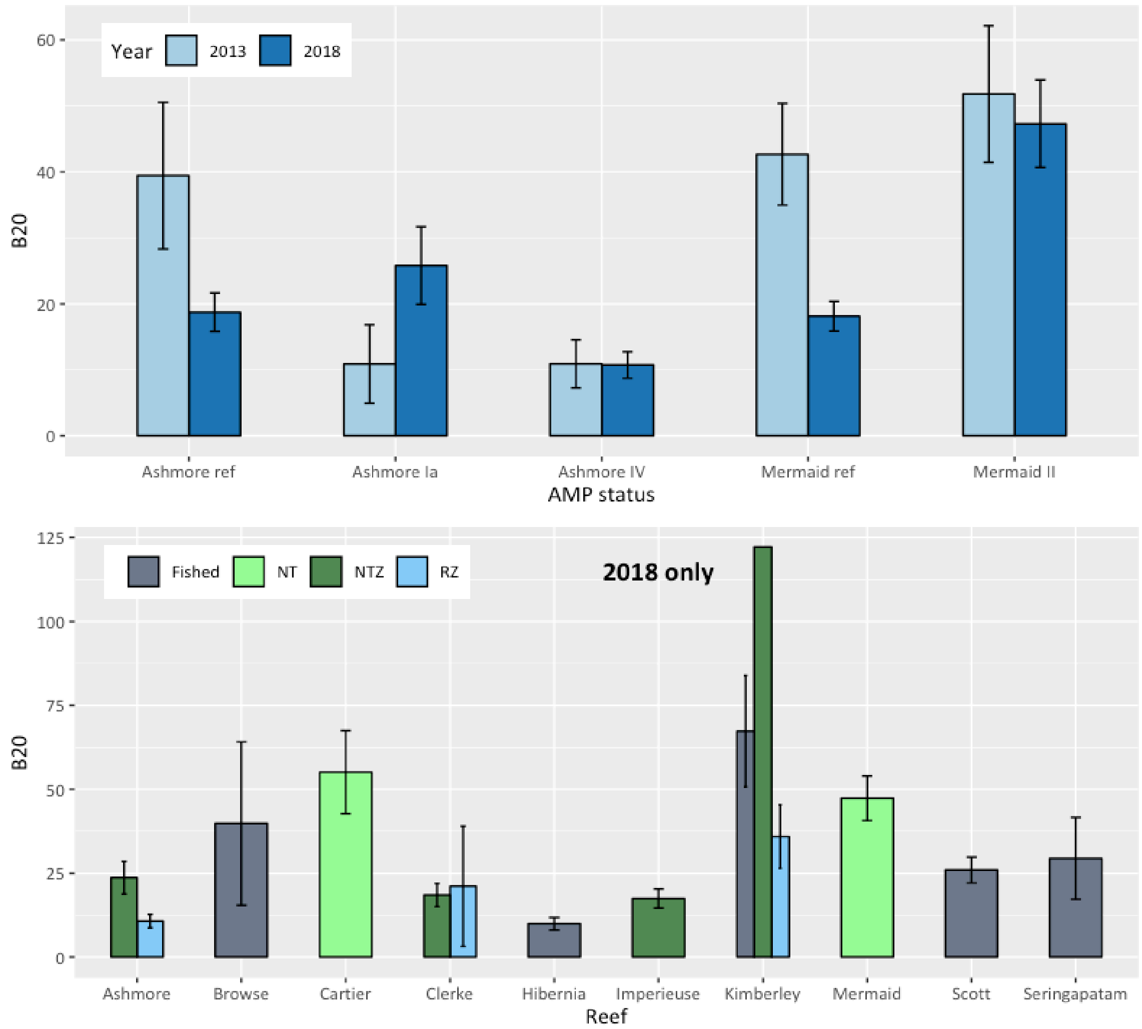

Figure 8. Biomass in kg per 500 m^2 transect of large (>20cm TL) reef fishes at Ashmore Reef Marine Parks, Mermaid Reef Marine Parks and reference sites in the North-west bioregion for 2013 and 2018 (top) and all sites surveyed in 2018 (bottom). Error Bars = 1 SE. NTZs are no take zones within multi-zoned parks (distinct from NT, which are stand-alone no-take zones).

Table 3. ANOVA testing differences in the biomass of large fishes (>20cm) between 2013 and 2018, between reef systems (Mermaid vs. Ashmore), and "IUCN Status" (compares IUCN I-II vs. IUCN IV vs. Reference: Hibernia and Scott Reefs for Ashmore, Clerke and Imperieuse for Mermaid).

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Year	1	63.390	63.390	7.595	**0.006**
Reef System	1	146.947	146.947	17.606	**0.000**
IUCN Status	2	94.654	47.327	5.670	**0.004**
Year x Reef System	1	21.291	21.291	2.551	**0.111**
Year x IUCN Status	2	56.677	28.338	3.395	**0.035**
Residuals	**319**	**2662.492**	**8.346**	**NA**	**NA**

Functional richness of reef fishes was highest at Ashmore IV sites, and has increased or remained stable between 2013 and 2018 at all sites (Figure 9). The change was greatest at Ashmore Ia and Mermaid II, and was significantly different between sites of different IUCN Status, but changes between years were not significant (Table 4). CTI was significantly higher at Ashmore Reef, except in 2018 at Ashmore Ia sites, which were similar to Mermaid Reef (Table 4) despite Ashmore reef being further north and closer to the Coral Triangle (and thus expected to have more warmer affinity species). No significant differences in CTI existed between sites of different IUCN Status. CTI declined at Ashmore Reference sites and Ia, but increased at Ashmore IV, Mermaid Reference and Mermaid II (Figure 9).

The 10 most frequently encountered fish species included numerous small species, which each changed in different ways on different reefs (Appendix 3). Only *Ctenochaetus striatus*, the bristletooth surgeonfish, increased consistently across all reefs and IUCN zones, and *Chaetodon lunulatus* a corallivorous butterflyfish, declined at all sites.

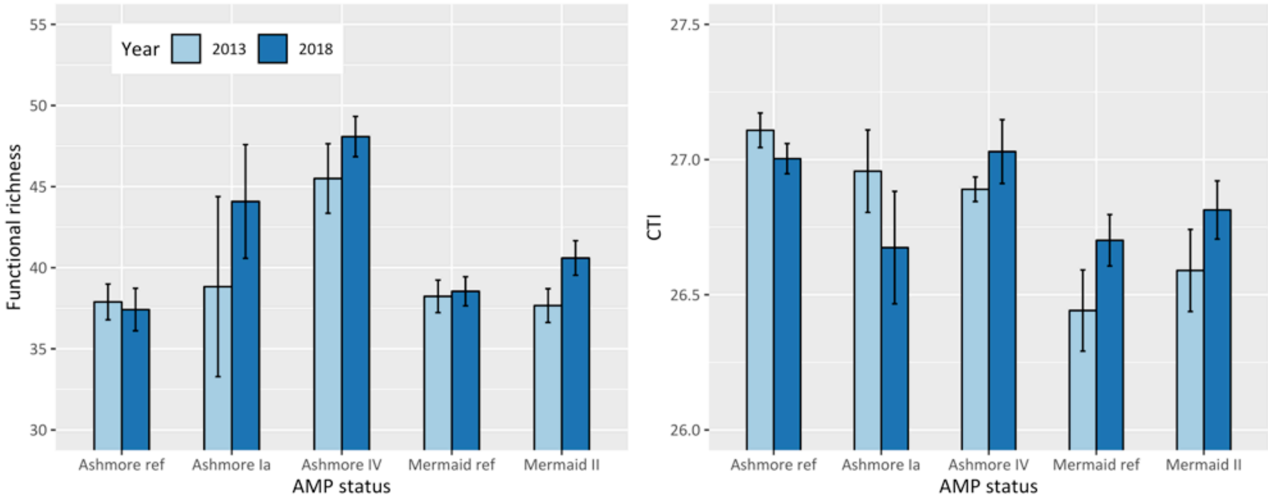

Figure 9. Functional richness of reef fishes and CTI at Ashmore Reef Marine Parks, Mermaid Reef Marine Parks and reference sites in the North-west bioregion. Error Bars = 1 SE.

Table 4. ANOVA testing differences in the functional richness and Community Temperature Index (CTI) between 2013 and 2018, between reef systems (Mermaid vs. Ashmore), and "IUCN Status" (compares IUCN I-II vs. IUCN IV vs. Reference: Hibernia and Scott Reefs for Ashmore, Clerke and Imperieuse for Mermaid).

		Df	Sum Sq	Mean Sq	F value	Pr(>F)
Functional richness	Year	1	56.597	56.597	1.724	0.191
	Reef System	1	46.333	46.333	1.411	0.236
	IUCN Status	2	778.216	389.108	11.852	0.000
	Year x Reef System	1	0.247	0.247	0.008	0.931
	Year x IUCN Status	2	108.591	54.296	1.654	0.194
	Residuals	**200**	**6566.300**	**32.831**	**NA**	**NA**
CTI	Year	1	1.244	1.244	3.786	**0.053**
	Reef System	1	7.403	7.403	22.535	**0.000**
	IUCN Status	2	0.047	0.024	0.072	**0.931**
	Year x Reef System	1	1.779	1.779	5.416	**0.021**
	Year x IUCN Status	2	0.312	0.156	0.474	**0.623**
	Residuals	**200**	**65.699**	**0.328**	**NA**	**NA**

No sea snakes were recorded in surveys at Ashmore Reef, but the olive sea snake *Aipysurus laevis* and turtle-headed sea snake *Emydocephalus annulatus* were recorded at Hibernia Reef, and three species (*A. laevis*, *E. annulatus* and *A. duboisii*) were present at Scott Reef (Appendix 2). Reef sharks (*Carcharhinus melanopterus*, *C. amblyrhynchos* and *Triaenodon obesus*) were present in low numbers across the region, with slightly higher densities at Mermaid Reef (Appendix 2).

4.3 Benthic Community

Benthic photo-quadrats were scored at 100 sites (165 transects in 2013, 187 in 2018) across the NW Marine Parks Network reefs. Across the whole Network, coral cover was 27.6% +/- 15.3% in 2013, and increased to 36.5% +/-13.1% in 2018 (36.9% +/-18.1% in 2013, and 47.2% +/-31.5% in 2018 at reference sites). Benthic community structure separated the sites into a number of groups; both IUCN Status and reefs had significantly different benthic assemblages, which changed significantly from 2013 to 2018 (Table 5). Ashmore Ia and IV sites were similar to each other but distinct from all other sites; these two IUCN categories also experienced the greatest change between 2013 and 2018 (Figure 10). Mermaid II sites and all reference sites formed a tight cluster in both years, with a smaller change between years than for protected Ashmore sites.

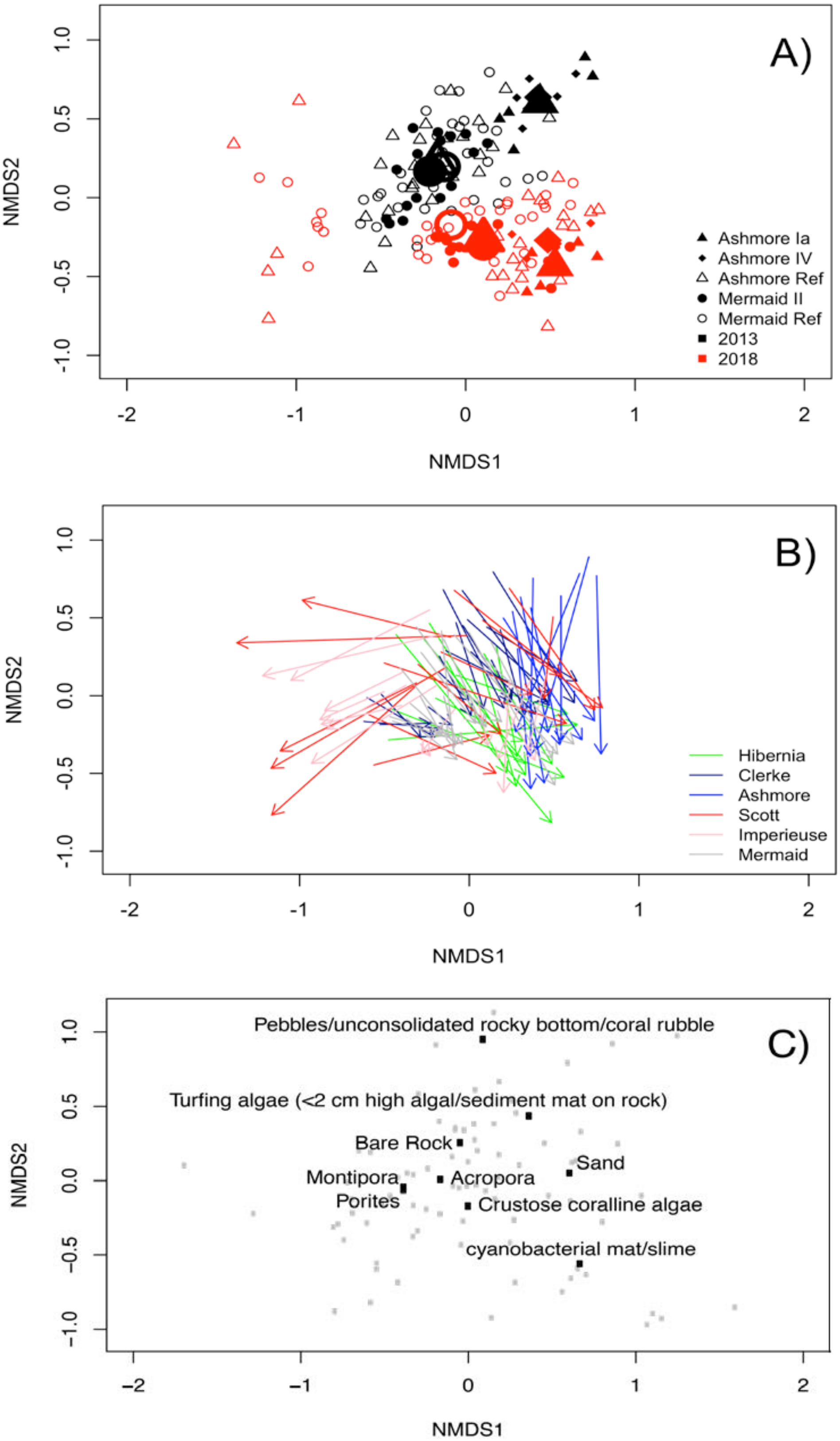

Figure 10. Multidimensional Scaling (MDS) plot of major benthic categories across Ashmore and Mermaid Reef AMPs and their reference sites, performed on the Bray-Curtis similarity matrix of the square-root transformed data (stress = 0.20). Sites are shown by A) AMP categories and B) individual reefs. Species scores are shown in C). For clarity, labels are shown for the most abundant benthic categories only.

Table 5. Permanova test of benthic community differences between years, reef systems (Mermaid vs. Ashmore), and “IUCN Status” (compares IUCN I-II vs. IUCN IV vs. Reference: Hibernia and Scott Reefs for Ashmore, Clerke and Imperieuse for Mermaid).

	Df	Sums Sq	Mean Sq	F	R^2	Pr(>F)
Year	1	4.729	4.729	24.672	0.119	**0.001**
Reef System	1	2.033	2.033	10.605	0.051	**0.001**
IUCN Status	2	1.513	0.756	3.946	0.038	**0.001**
Year x Reef System	1	0.382	0.382	1.995	0.010	**0.041**
Year x IUCN Status	2	0.793	0.397	2.070	0.020	**0.009**
Residuals	158	30.284	0.192	NA	0.762	**NA**
Total	**165**	**39.734**	**NA**	**NA**	**1.000**	**NA**

Total live cover and the number of benthic categories were significantly different between protection levels (Table 6). Total live cover, which ranged between 60 and 90%, was higher at Ashmore and Mermaid reference sites than protected sites in both years, and increased significantly between 2013 and 2018. In contrast, the number of benthic categories was similar across sites in 2013, and increased only at protected sites in 2018 (Figure 9). At Ashmore Ia and IV sites, coral and CCA cover increased, while turf and macroalgae declined; these changes were less evident at all other sites (Figure 11).

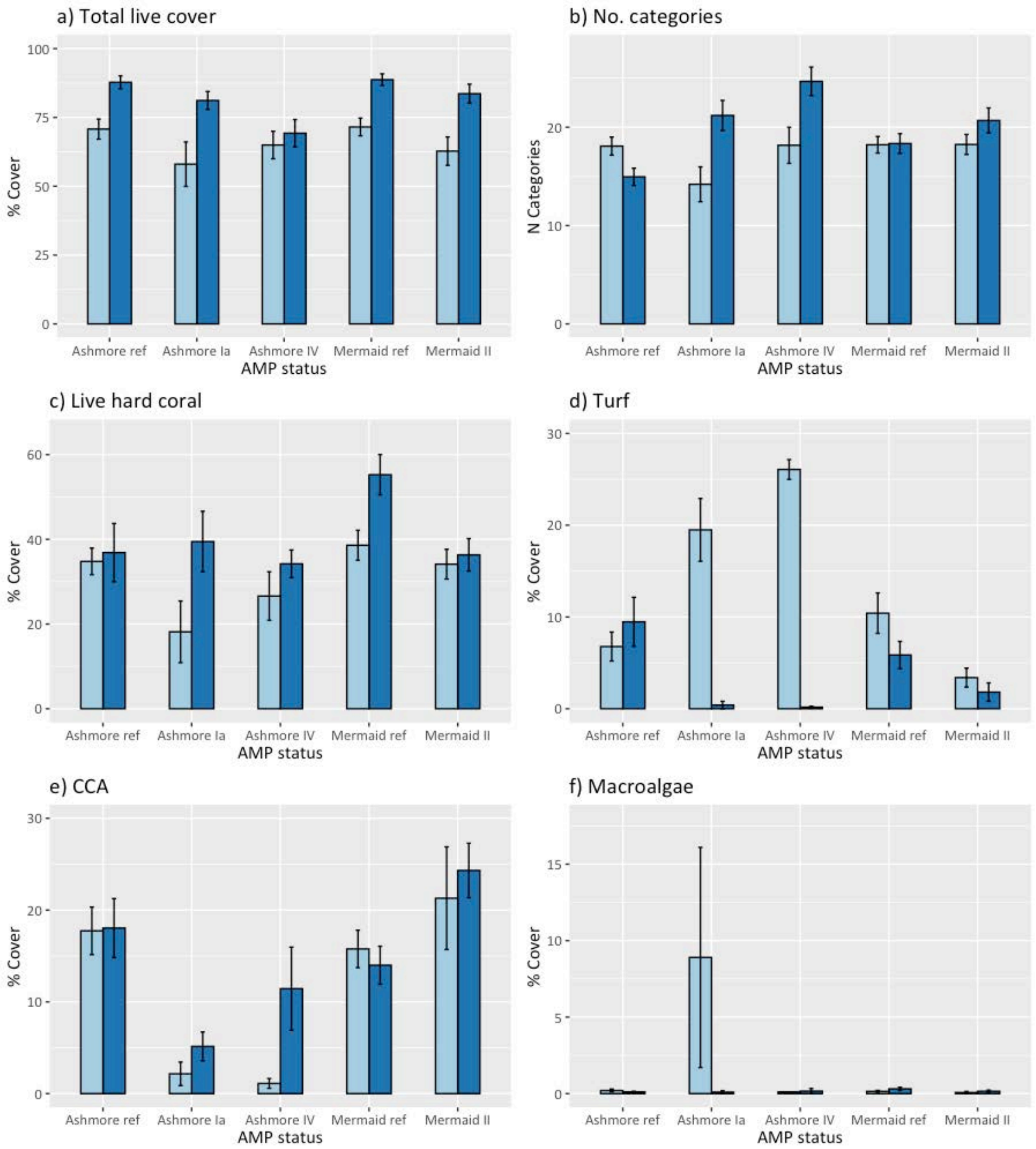

Figure 11. Percent cover of key benthic categories at Ashmore Reef Marine Parks, Mermaid Reef Marine Parks and reference sites in the North-west bioregion. a) Total live cover, b) number of benthic categories, c) live hard coral cover, d) turf cover, e) crustose coralline algae, and f) macroalgae. Error Bars = 1 SE.

Table 6. ANOVA testing differences in the cover of key benthic categories between years, reef systems (Mermaid vs. Ashmore), and "IUCN Status" (compares IUCN I-II vs. IUCN IV vs. Reference: Hibernia and Scott Reefs for Ashmore, Clerke and Imperieuse for Mermaid).

Variable	Factor	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Total live cover	Year	1	0.535	0.535	52.511	**0.000**
	Reef System	1	0.017	0.017	1.672	**0.198**
	IUCN Status	2	0.130	0.065	6.391	**0.002**
	Year x Reef System	1	0.004	0.004	0.410	**0.523**
	Year x IUCN Status	2	0.002	0.001	0.119	**0.888**
	Residuals	182	1.856	0.010	NA	**NA**

Variable	Factor	Df	Sum Sq	Mean Sq	F value	Pr(>F)
N. benthic categories	Year	1	0.018	0.018	1.263	**0.262**
	Reef System	1	0.017	0.017	1.143	**0.286**
	IUCN Status	2	0.140	0.070	4.769	**0.010**
	Year x Reef System	1	0.002	0.002	0.105	**0.747**
	Year x IUCN Status	2	0.268	0.134	9.169	**0.000**
	Residuals	182	2.663	0.015	NA	**NA**
Live coral	Year	1	0.537	0.537	7.256	**0.008**
	Reef System	1	1.022	1.022	13.808	**0.000**
	IUCN Status	2	0.298	0.149	2.012	**0.137**
	Year x Reef System	1	0.002	0.002	0.029	**0.866**
	Year x IUCN Status	2	0.322	0.161	2.176	**0.116**
	Residuals	182	13.475	0.074	NA	**NA**
Turf	Year	1	9.391	9.391	38.908	**0.000**
	Reef System	1	0.988	0.988	4.093	**0.045**
	IUCN Status	2	0.617	0.308	1.278	**0.281**
	Year x Reef System	1	2.090	2.090	8.659	**0.004**
	Year x IUCN Status	2	4.795	2.398	9.934	**0.000**
	Residuals	182	43.927	0.241	NA	**NA**
CCA	Year	1	0.215	0.215	0.982	**0.323**
	Reef System	1	3.343	3.343	15.303	**0.000**
	IUCN Status	2	2.178	1.089	4.984	**0.008**
	Year x Reef System	1	0.750	0.750	3.435	**0.065**
	Year x IUCN Status	2	2.746	1.373	6.285	**0.002**
	Residuals	182	39.764	0.218	NA	**NA**
Macroalgae	Year	1	0.052	0.052	1.242	**0.267**
	Reef System	1	0.068	0.068	1.623	**0.204**
	IUCN Status	2	0.092	0.046	1.092	**0.338**
	Year x Reef System	1	0.250	0.250	5.955	**0.016**
	Year x IUCN Status	2	0.134	0.067	1.601	**0.204**
	Residuals	**182**	**7.633**	**0.042**	**NA**	**NA**

The six most abundant coral genera showed variable abundances and trends across the survey sites (Figure 12). Noteworthy patterns included a relatively high, and increasing, cover of *Acropora* spp. at Mermaid reference sites, and a large decline in *Acropora* spp. at Ashmore reference sites, which had the highest cover of *Porites* spp. The dominant genus at Ashmore Ia sites was *Isopora*, and there was a large relative increase (but only to ~10% cover) in *Pachyseris* spp. at these sites. *Montipora* and *Pocillopora* spp. both had very low % cover throughout the region.

Highly protected Ashmore Ia sites had relatively high cover of *Acropora muricata* and *Isopora brueggemanni*, and very little of the other common species (Figure 13). The other sites with high protection, Mermaid II, had low cover of most species except *Acropora hyacinthus*. *Porites cylindrica* declined at Ashmore reference and IV sites, whilst *Pavona varians* and *Pocillopora verrucosa* increased at Ashmore reference sites. Mermaid reference sites had a moderate cover of most species, and an increase in *Acropora hyacinthus* between 2013 and 2018.

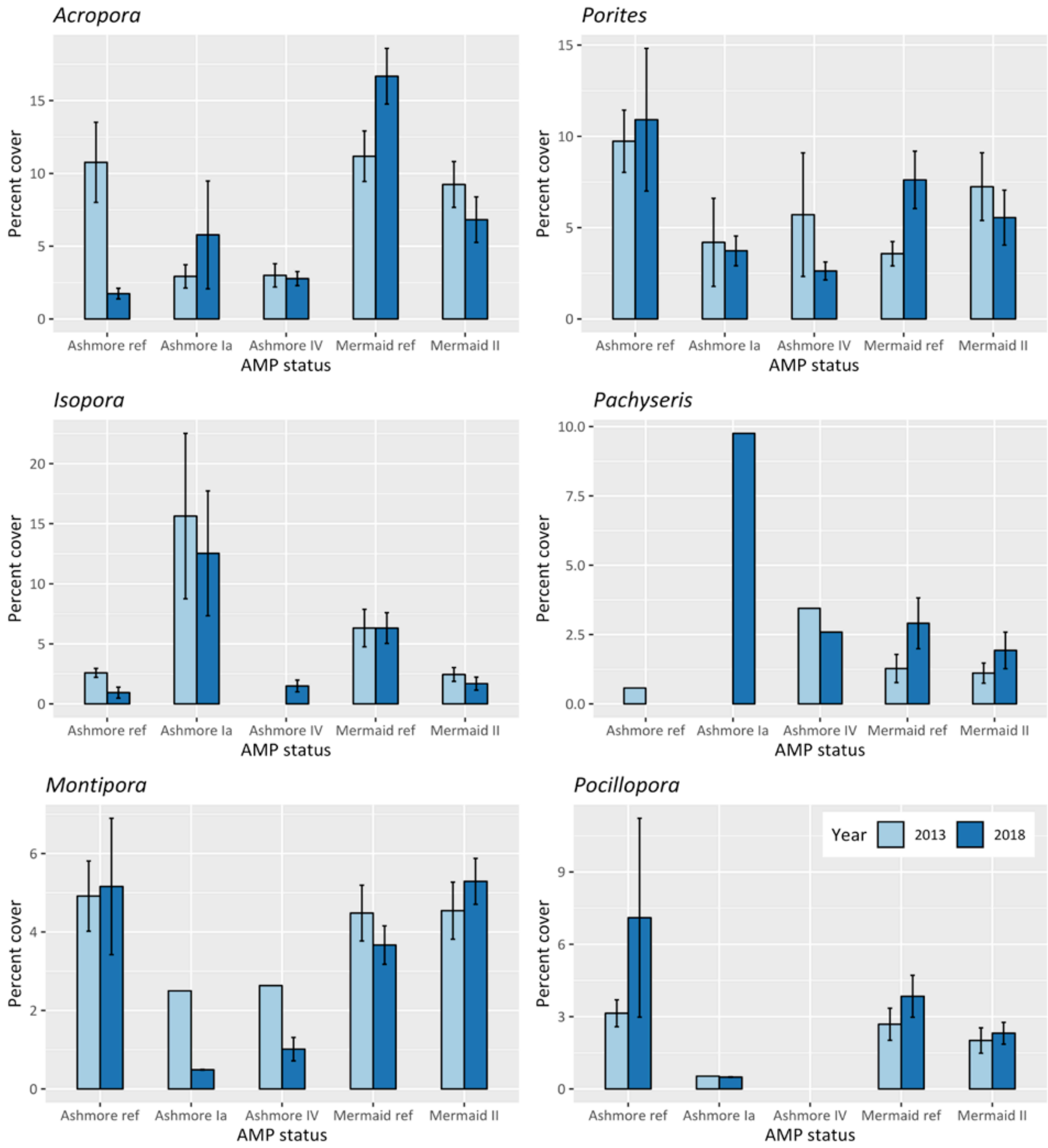

Figure 12. Percent cover of most abundant coral genera at Ashmore Reef CMR, Mermaid Reef CMR and reference sites in the North-west bioregion. Error Bars = 1 SE.

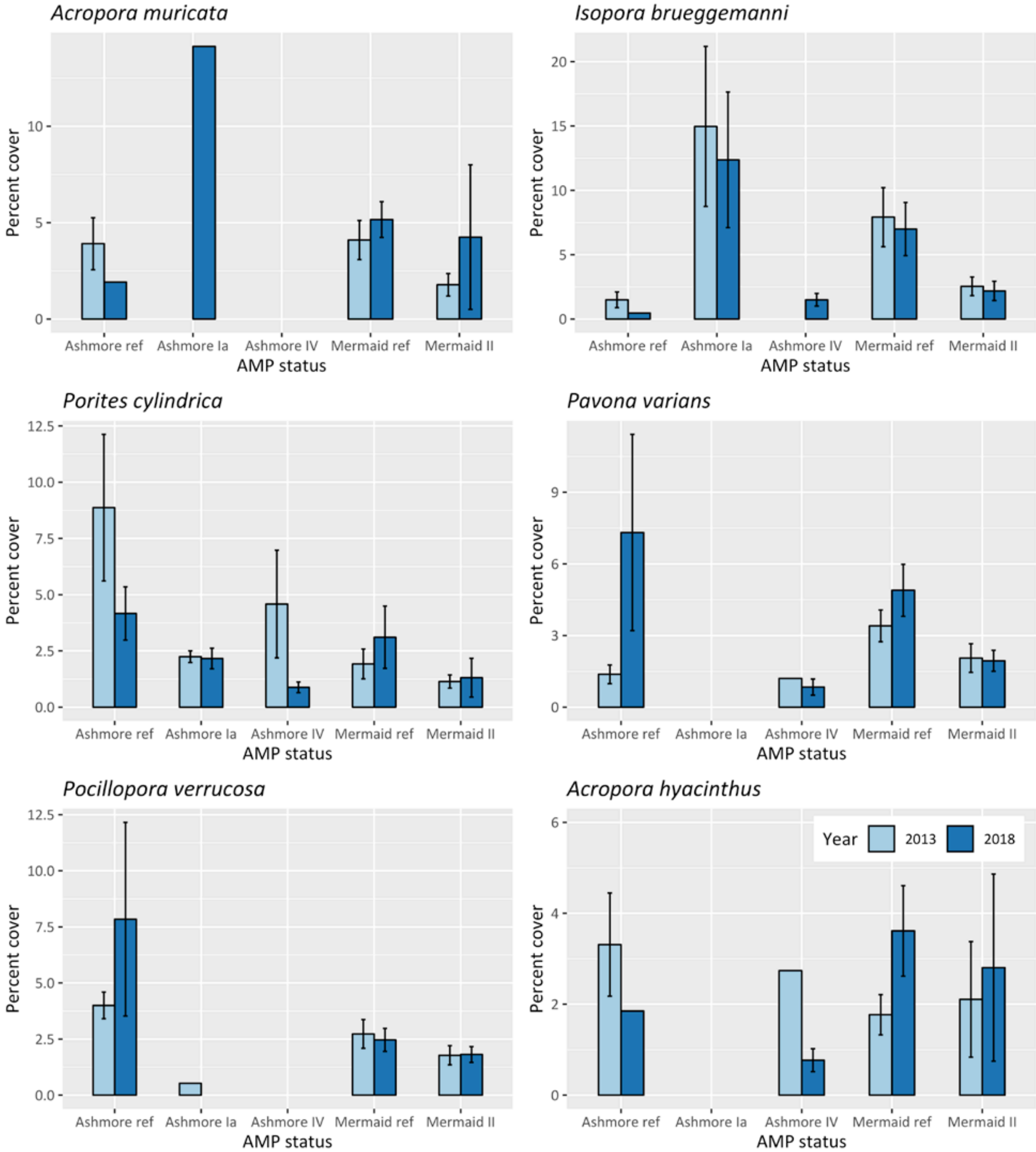

Figure 13. Percent cover of most abundant coral taxa at Ashmore Reef CMR, Mermaid Reef CMR and reference sites in the North-west bioregion. Error Bars = 1 SE.

4.4 Mobile macroinvertebrates

4.4.1 COMMUNITY STRUCTURE

The surveys of offshore reefs of the North-west Marine Parks Network in 2018 yielded a total of 137 species of macroinvertebrate recorded along the 100 m^2 transects (Appendix 4). The separation between reefs was much less clear than for the fish community, suggesting greater similarities in the invertebrate community (Figure 12).

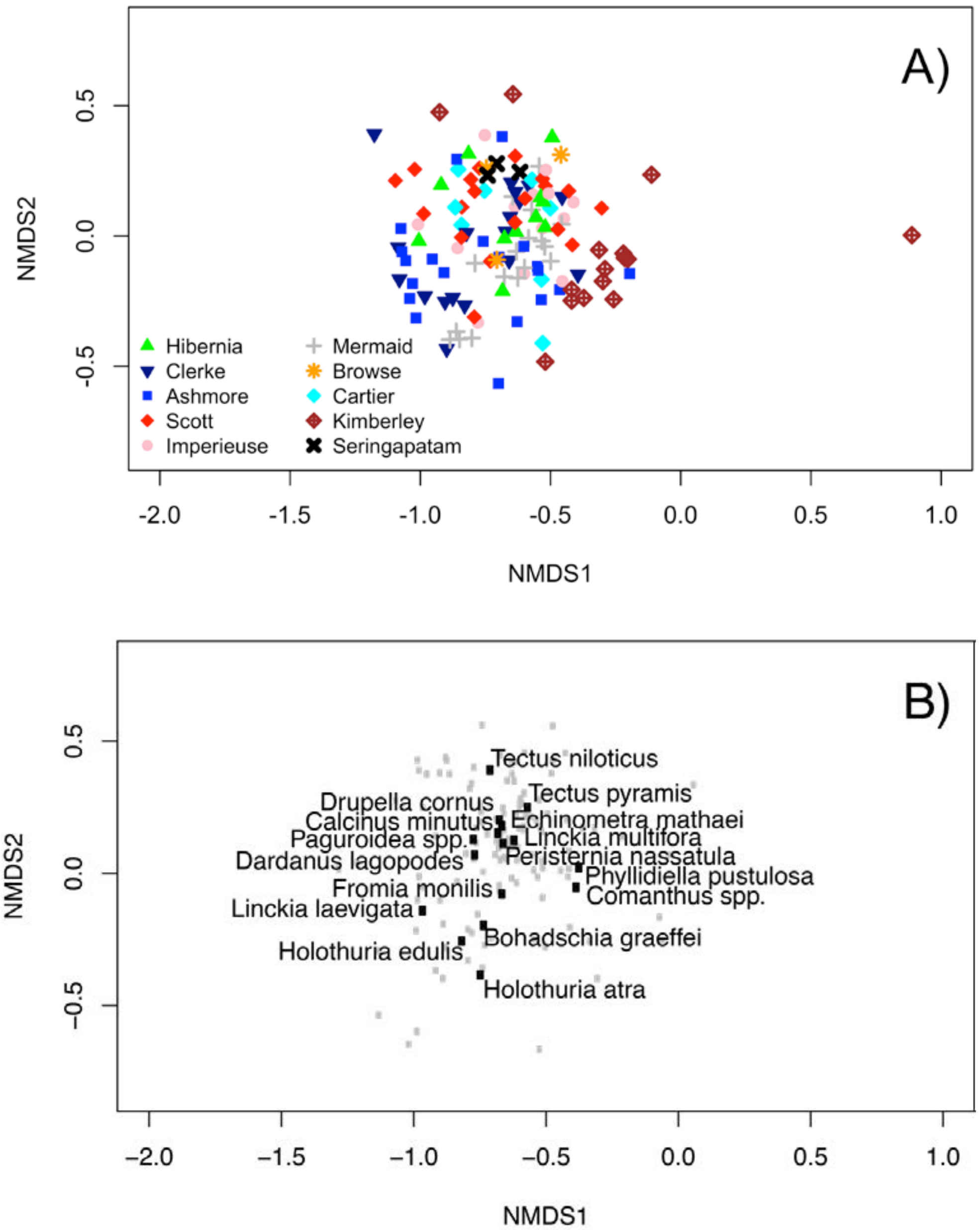

Figure 14. Multidimensional Scaling (MDS) plot of invertebrate abundance across all sites surveyed in 2018, coded by reefs (A), and performed on the Bray-Curtis similarity matrix of the square-root transformed data (stress = 0.10). Species scores are shown in C). For clarity, labels are shown for the most abundant taxa only.

Although less clear separation of reefs was evident in the invertebrate community structure than the fishes, the same trend for increasing similarity of sites occurred from 2013 to 2018. In 2018, reef sites across the region had more similar mobile invertebrate composition and abundance than in 2013 (Figure 13). IUCN zone differences were sustained between 2013 and 2018, but the changes were significantly different at different reefs (Table 7). Mermaid Reef and reference sites remained the most stable between 2013 and 2018; Ashmore reference sites experienced the greatest change. Ashmore Reef changed towards higher abundances of Paguroidea (hermit crabs) and *Echinometra mathaei* (Figure 13).

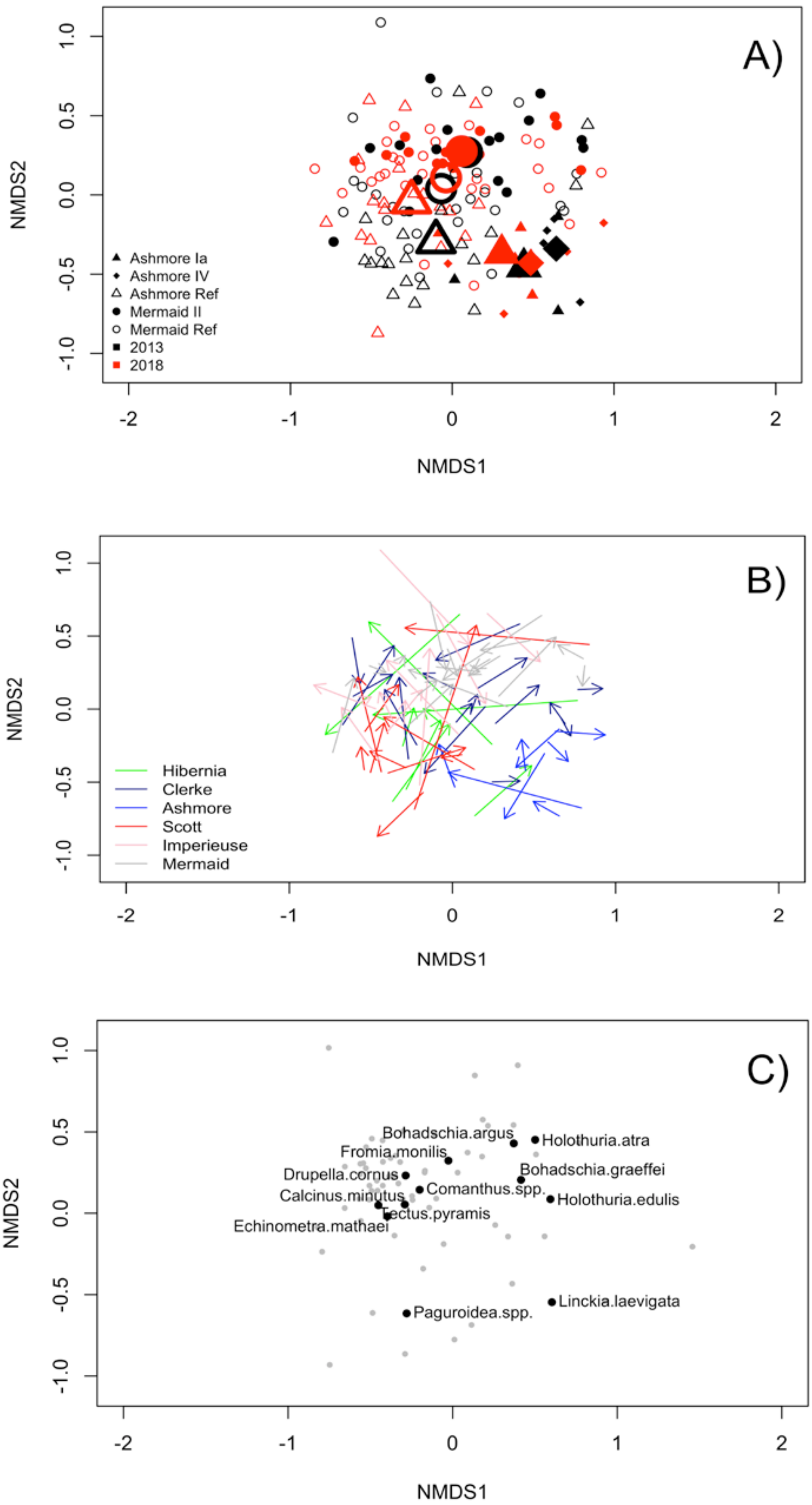

Figure 15. Multidimensional Scaling (MDS) plot of mobile invertebrate abundance across all sites surveyed in 2013 vs 2018, either coded by AMP status (A) or reefs (B), and performed on the Bray-Curtis similarity matrix of the square-root transformed data (stress = 0.21). Species scores are shown in C). For clarity, labels are shown for the most abundant taxa only.

Table 7. Permanova test of macroinvertebrate community changes between 2013 and 2018, between reef systems (Mermaid vs. Ashmore), and "IUCN Status" (compares IUCN I-II vs. IUCN IV vs. Reference: Hibernia and Scott Reefs for Ashmore, Clerke and Imperieuse for Mermaid).

	Df	SumsOfSqs	MeanSqs	F.Model	R2	Pr(>F)
Year	1	1.654	1.654	4.976	0.026	**0.001**
Reef System	1	2.505	2.505	7.537	0.040	**0.001**
IUCN Status	2	2.438	1.219	3.668	0.039	**0.001**
Year x Reef System	1	0.669	0.669	2.014	0.011	**0.019**
Year x IUCN Status	2	0.499	0.250	0.751	0.008	**0.875**
Residuals	166	55.166	0.332	NA	0.877	**NA**
Total	**173**	**62.931**	**NA**	**NA**	**1.000**	**NA**

4.4.2 INVERTEBRATE SPECIES RICHNESS AND ABUNDANCE

The abundance and species richness of macroinvertebrates increased significantly across almost all sites (Figure 13, Table 8). The only exception was the relative stability in abundance and a small decline in species richness at Ashmore IV sites. Elsewhere, abundance almost doubled, although both abundance and species richness were significantly lower at Ashmore Reef than Mermaid Reef (Figure 13).

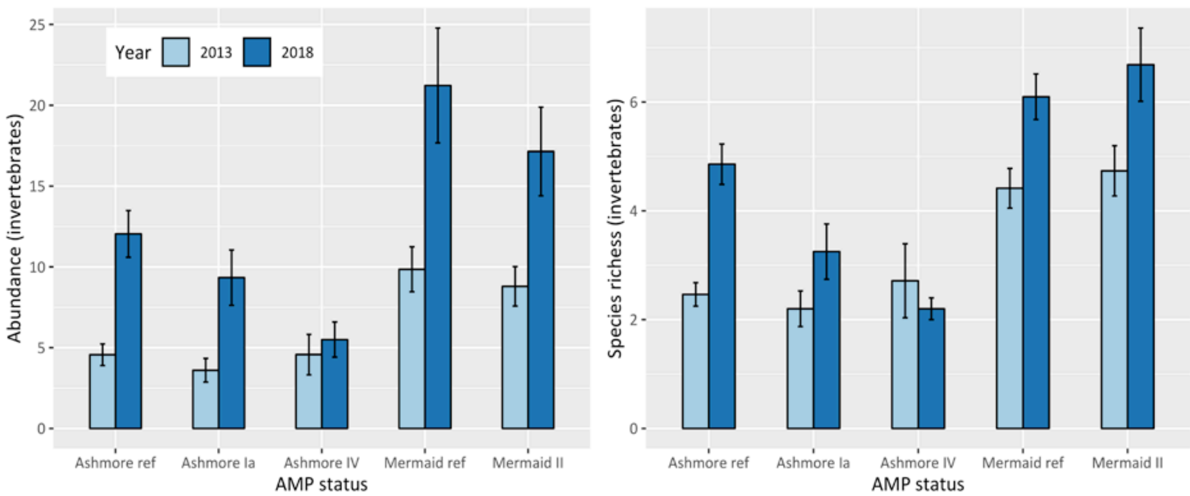

Figure 16. Abundance and species richness of mobile macroinvertebrates per 500 m^2 transect at Ashmore Reef Marine Parks, Mermaid Reef Marine Parks and reference sites in the North-west bioregion. Error Bars = 1 SE.

Table 8. ANOVA testing differences in the abundance and species richness of macroinvertebrates between 2013 and 2018, between reef systems (Mermaid vs. Ashmore), and "IUCN Status" (compares IUCN I-II vs. IUCN IV vs. Reference: Hibernia and Scott Reefs for Ashmore, Clerke and Imperieuse for Mermaid).

Variable	Factor	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Abundance	Year	1	3070.761	3070.761	17.846	**0.000**
	Reef System	1	2077.417	2077.417	12.073	**0.001**
	IUCN Status	2	250.320	125.160	0.727	**0.485**
	Year x Reef System	1	224.176	224.176	1.303	**0.255**
	Year x IUCN Status	2	123.374	61.687	0.358	**0.699**
	Residuals	160	27531.621	172.073	NA	**NA**
Species richness	Year	1	132.139	132.139	23.441	**0.000**
	Reef System	1	184.184	184.184	32.673	**0.000**
	IUCN Status	2	10.254	5.127	0.910	**0.405**
	Year x Reef System	1	0.124	0.124	0.022	**0.882**
	Year x IUCN Status	2	16.389	8.195	1.454	**0.237**
	Residuals	**160**	**901.954**	**5.637**	**NA**	**NA**

Abundance was relatively even across the three major phyla (Arthropoda, Echinodermata and Mollusca) in 2013, but was dominated by echinoderms in 2018, especially at Mermaid Reef (Figure 15). Arthropods increased in abundance at Ashmore Reef and declined at Mermaid; there was a significant year x reef interaction (Figure 15, Table 9). Echinoderms increased significantly across all sites. The largest increase occurred at Imperieuse Reef (one of the Mermaid reference reefs) and the smallest at Ashmore IV sites (Figure 15, Table 9). Mollusc abundance increased everywhere except at Mermaid reference reefs, where abundance appeared to remain stable (Figure 15). Protection level had no significant influence on the abundance of the major phyla or the differences between years (Table 9).

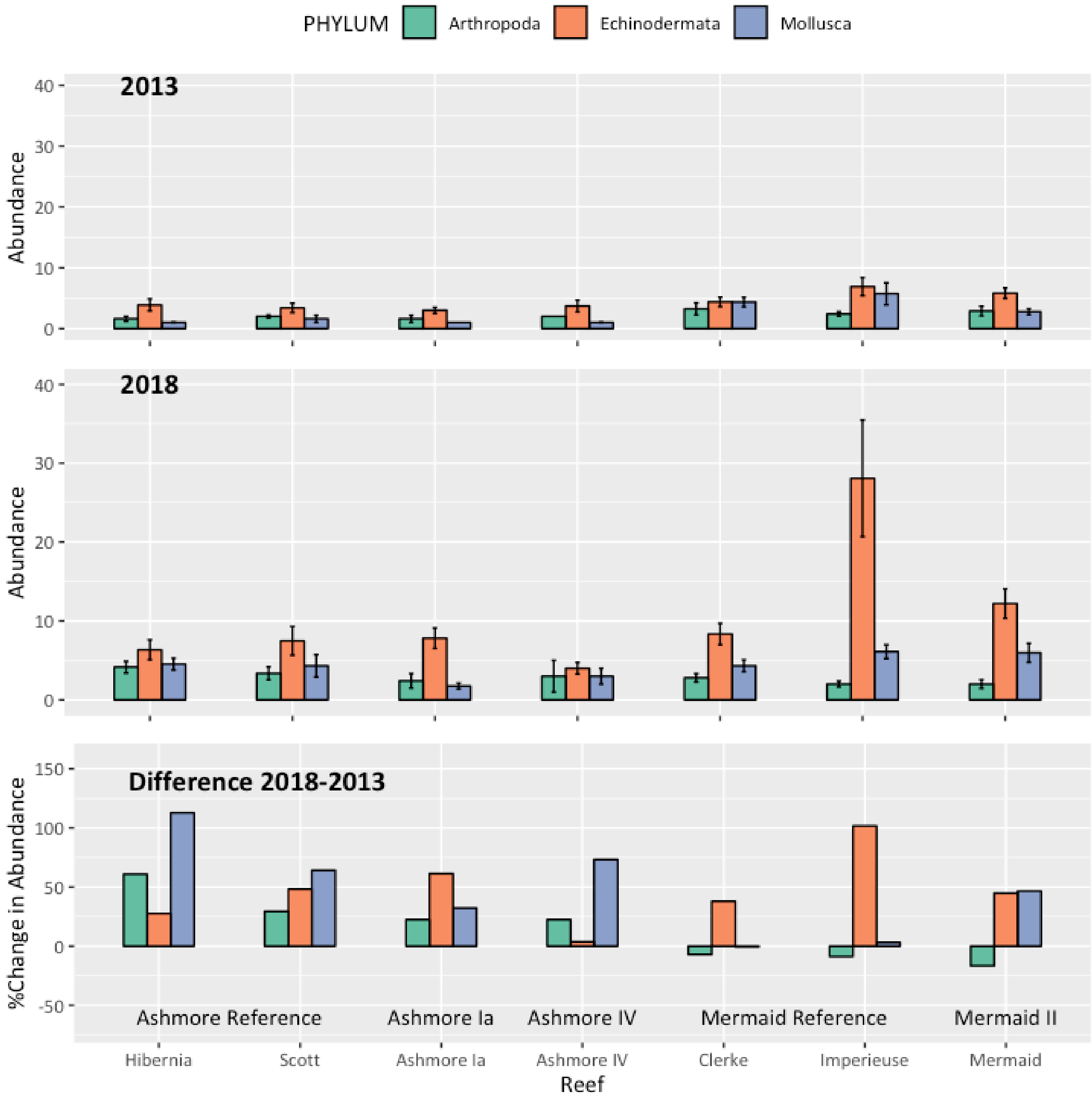

Figure 17. Abundance of each phylum of mobile macroinvertebrates per 500 m^2 transect at Ashmore Reef Marine Parks, Mermaid Reef Marine Parks and reference sites in the North-west bioregion. Error Bars = 1 SE.

Table 9. ANOVA testing the effect of reef and protection on the changes in abundance of Arthropoda, Echinodermata and Mollusca between 2013 and 2018, between reef systems (Mermaid vs. Ashmore), and "IUCN Status" (compares IUCN I-II vs. IUCN IV vs. Reference: Hibernia and Scott Reefs for Ashmore, Clerke and Imperieuse for Mermaid).

Phylum	Factor	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Arthropoda	Year	1	0.388	0.388	1.048	**0.308**
	Reef System	1	0.202	0.202	0.546	**0.461**
	IUCN Status	2	0.632	0.316	0.854	**0.428**
	Year x Reef System	1	2.755	2.755	7.439	**0.007**
	Year x IUCN Status	2	0.190	0.095	0.257	**0.774**
	Residuals	139	51.475	0.370	NA	**NA**
Echinodermata	Year	1	63.034	63.034	32.884	**0.000**
	Reef System	1	38.279	38.279	19.970	**0.000**
	IUCN Status	2	1.051	0.526	0.274	**0.760**
	Year x Reef System	1	5.150	5.150	2.686	**0.102**
	Year x IUCN Status	2	1.559	0.780	0.407	**0.666**
	Residuals	291	557.810	1.917	NA	**NA**
Mollusca	Year	1	4.972	4.972	6.524	**0.011**
	Reef System	1	8.266	8.266	10.847	**0.001**
	IUCN Status	2	1.780	0.890	1.168	**0.313**
	Year x Reef System	1	1.418	1.418	1.861	**0.174**
	Year x IUCN Status	2	0.840	0.420	0.551	**0.577**
	Residuals	**187**	**142.503**	**0.762**	**NA**	**NA**

4.5 Cryptic fishes

The surveys of offshore reefs of the North-west Marine Parks Network in 2018 yielded a total of 145 species of cryptic fishes recorded along the 100 m^2 transects (Appendix 5). The abundance of cryptic fishes was highest and most variable among Ashmore Ia sites, and also high at Mermaid sites (Figure 16). There were significant increases in cryptic fish abundance between 2013 and 2018 (Table 10). The difference between reefs was significant, but not between protection levels (Figure 16, Table 10). The increase in species richness of cryptic fish to 2018 was also significant, and was greatest at all Mermaid sites. Ashmore reference sites had the lowest species richness, and also the smallest change (Figure 16, Table 10).

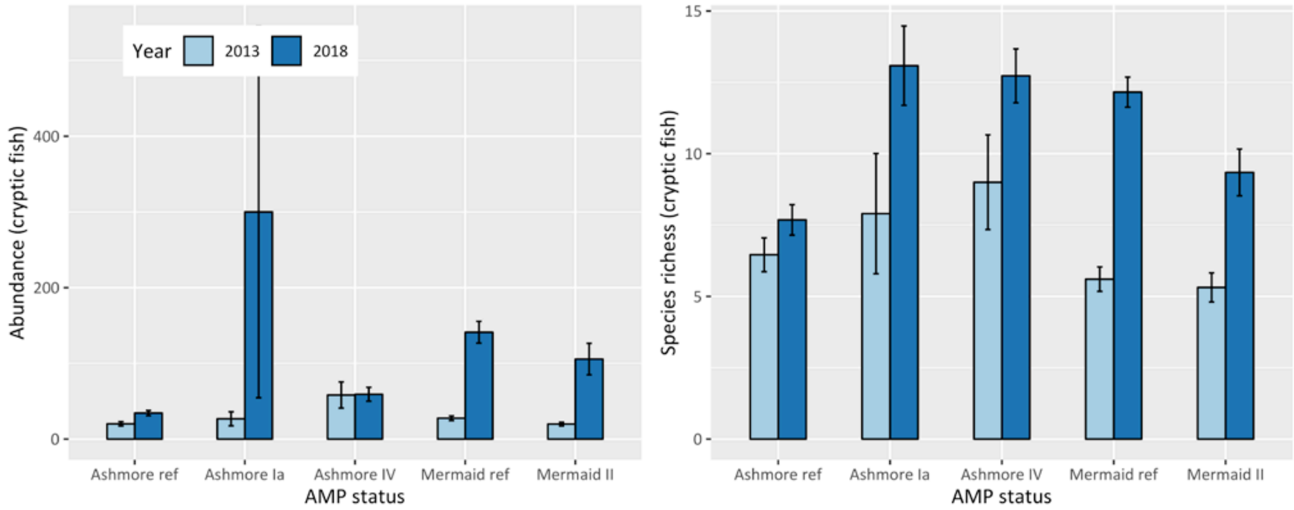

Figure 18. Abundance and species richness of cryptic fishes per 500 m^2 transect at Ashmore Reef Marine Parks, Mermaid Reef Marine Parks and reference sites in the North-west bioregion. Error Bars = 1 SE.

Table 10. ANOVA testing the effect of reef and protection on the changes in cryptic fish abundance and species richness between 2013 and 2018, between reef systems (Mermaid vs. Ashmore), and "IUCN Status" (compares IUCN I-II vs. IUCN IV vs. Reference: Hibernia and Scott Reefs for Ashmore, Clerke and Imperieuse for Mermaid).

CRYPTIC FISH ABUNDANCE						
Variable	**Factor**	**Df**	**Sum Sq**	**Mean Sq**	**F value**	**Pr(>F)**
Abundance	Year	1	756.184	756.184	50.900	**0.000**
	Reef System	1	97.755	97.755	6.580	**0.011**
	IUCN Status	2	33.065	16.533	1.113	**0.331**
	Year x Reef System	1	140.842	140.842	9.480	**0.002**
	Year x IUCN Status	2	17.430	8.715	0.587	**0.557**
	Residuals	164	2436.415	14.856	NA	**NA**
Species richness	Year	1	731.328	731.328	52.796	**0.000**
	Reef System	1	1.707	1.707	0.123	**0.726**
	IUCN Status	2	115.293	57.646	4.162	**0.017**
	Year x Reef System	1	157.883	157.883	11.398	**0.001**
	Year x IUCN Status	2	14.927	7.464	0.539	**0.584**
	Residuals	**164**	**2271.716**	**13.852**	**NA**	**NA**

5 Discussion

Surveys across the North-west Marine Parks Network in 2018 revealed that highly protected sites at Ashmore Reef (IUCN Ia) had increased fish biomass, fish species richness, the biomass of grazing and larger (>20 cm TL) fishes, and the density of macroinvertebrates; many of these changes were not recorded at fished references sites and therefore suggest a positive effect of no-take protection in the last five years. A previous analysis that included the 2013 RLS data (Stuart-Smith et al. 2017) from the North-west region indicated that Ashmore Reef had some of the clearest evidence of fishing impacts on reefs in Australian waters. Despite protected status and the Memorandum of Understanding with the Indonesian Government that had rules prohibiting the take of reef fishes, Ashmore sites clearly had reduced large fish biomass compared with other reefs in the region and more broadly. Illegal fishing has historically plagued this reserve, so that that recovery of target populations appeared negligible in previous surveys (Field et al. 2009, Ceccarelli et al. 2013, Edgar et al. 2017). More strict protection in recent years (Edgar et al. 2014, Green et al. 2014), together with a time lag common on isolated reefs (Graham et al. 2006), are likely facilitating the increases recorded in this most recent survey. With continued adequate protection, the coral reef assemblage at Ashmore Reef is likely to shift further towards what is considered normal for “pristine” oceanic reefs (Sandin et al. 2008, Speed et al. 2019).

Speed et al. (2019) also found that between 2004 and 2016, fish communities at Ashmore Reef were becoming more different from those at Scott Reef, which is open to fishing, and more similar to Mermaid Reef in the Rowley Shoals, where compliance with the no-take reserve has traditionally been high. Thus, the evidence of two independent datasets (Speed et al, and RLS here) suggests recovery is occurring in the fish communities within the Ashmore Marine Park. It is well-known that no-take reserves will only yield real benefits when compliance is adequate (Edgar et al. 2014, Speed et al. 2018). Although it is never clear where and when benefits may spill over into unprotected areas and enhance populations of exploited species, subsidize sustainable fisheries, and increase biodiversity (Russ and Alcala 1996, Harrison et al. 2012), this cannot be achieved when compliance is not sufficient to generate ecological change within reserve boundaries first.

The higher biomass of large fishes was retained at Mermaid Reef from 2013 to 2018, but the state-managed Rowley Shoals Marine Park sites experienced a decline (Edgar et al. 2017). Such trends could arise for a number of reasons, including differences in levels of compliance, differences in the specific regulations relating to catch of reef fishes, an increase in fishing pressure in the State managed reefs over that last five years, or changes in fish communities and reef production unrelated to fishing. The lack of an increase at Mermaid Reef may similarly reflect any number of causes, including illegal fishing, changes in fish production unrelated to fishing, or that the fish community is at carrying capacity.

Functional richness of reef fishes was highest at Ashmore Reef, both at highly protected IUCN Ia sites and at less protected sites. High functional richness implies a greater likelihood of functional redundancy and is thought to impart greater resilience to coral reef assemblages as they face increasing climatic disruptions (Tilman et al. 1997, Hoey and Bellwood 2009). Our measure of functional richness is simply a measure of the number of unique trait combinations covered by the species of fish and mobile invertebrates present. It is related to species richness and so spatial comparisons between reefs are less informative than changes through time at one reef, especially when investigated alongside changes in species richness. In our results, functional richness changes closely matched changes in fish species richness and largely agree with changes in invertebrate species richness. Thus, despite the disturbance associated with the 2016 bleaching event, there are no clear indications that the communities may have become more vulnerable to change as a result (which would be more likely had functional richness declined disproportionately to species richness). Benthic communities also changed towards higher richness and live cover, and changes in benthic categories were not indicative of degradation. Functional richness is not necessarily a strong indicator of resilience, however (D'Agata et al. 2016), and is reported here mostly for comprehensiveness.

Distinctions were clearly evident in the fish, benthic and invertebrate communities between the inshore (Kimberley) and offshore reefs, but there was also a separation between the northern offshore reefs (Ashmore, Scott and Hibernia) and the Rowley Shoals (Mermaid, Clerke and Imperieuse). Additionally, Ashmore, Hibernia and Scott Reefs had "warmer" fish assemblages than Mermaid Reef, which is to be expected given the latitudinal differences, but there was an increase in CTI at Mermaid Reef, indicating a potential shift towards fishes typical of warmer waters. Recent research suggests that the Rowley Shoals are subject to large temperature variations (Zinke et al. 2018), and despite being subject to recent heat stress, corals there suffered relatively little mortality (Gilmour et al. 2019). However, these studies did not include the effects of heat stress on the fish assemblage, which may be responding more strongly than benthic communities (Stuart-Smith et al. 2018). The 'warming' of the fish community in the Rowley Shoals may be contributing to the regional signal of biotic homogenisation, with species from the northern reefs becoming more prevalent in the Rowley Shoals. This signal of biotic homogenization is of broad interest, given that declines in sensitive species with heatwaves, habitat loss and fishing, and shifting distributions spreading species from the Coral Triangle into northern Australian waters, may all be leading to increasing similarity of reef community structure. More research is clearly needed on this topic, and detailed time-series monitoring data will be critical for detecting such change.

Benthic communities showed signs of continued recovery, in that total live cover and the richness of benthic categories increased across the survey sites. These changes were greatest at the highly protected Ashmore Reef sites, in keeping with past trends of rapid recovery after disturbance at Ashmore Reef (Ceccarelli et al. 2011b) and other reefs in the region (Smith et al. 2008). These are encouraging trends, given the recent disturbance events, especially heat stress, experienced across the region (Gilmour et al. 2019). Disturbance events apparently most affected coral communities at Scott Reef, where *Acropora* cover precipitously declined between surveys (change in cover from 11% to 2% for Ashmore reference sites in Fig. 10).

There appeared to be a wider variety of benthic organisms at Ashmore Reef and its reference sites; the number of benthic categories was, in fact, highest at Ashmore Reef. The relatively high cover of fast-growing *Acropora* spp. may in part explain the overall high coral cover in the Rowley Shoals. However, *Acropora* spp. tend to be more vulnerable to storms, bleaching and predation than other taxa (Zinke et al. 2018); this may make the Rowley Shoals more vulnerable to coral loss than the other offshore reefs in the network (Gilmour et al. 2019). As bleaching events and cyclones are predicted to become more frequent and intense, reefs with a higher functional diversity of corals with different levels of vulnerability may be more able to adapt (Hughes et al. 2019).

The Rowley Shoals appear to have maintained their historically high cover of branching corals, despite also being affected by bleaching within the past two years (Gilmour et al. 2019). Their orientation and deep lagoonal habitats may provide enough shelter for coral communities to thrive, and there may be local hydrodynamic conditions (e.g. upwelling) that buffer temperature stress (Riegl et al. 2019). Fish and invertebrate communities seemed more closely aligned to live coral cover, with richer assemblages at reefs with higher coral cover.

Changes in the mobile invertebrate and cryptic fish faunas were also evident between the 2013 and 2018 surveys. Amongst the clearest of these were increases in abundance and richness of invertebrates (particularly echinoderms) and cryptic fishes. While such starkly different cryptic fish numbers could reflect an increasing focus on cryptic fishes in the surveys by divers, and should be interpreted with caution, the same trend has occurred along the GBR, Coral Sea and at Elizabeth and Middleton Reefs in recent years, and it is more likely that recent warmer years and/or habitat change have fueled increased production of small fishes. Short life cycles and varied feeding strategies (although largely unknown on a species level), means that this group can respond quickly to change (Brandl et al. 2019).

The success of management is emerging at Ashmore Reef Marine Park. Numerous surveys conducted at Ashmore Reef in the past did not detect recovery in exploited populations; there was a history of disturbance and illegal fishing, a much wider variety of distinct habitats, and the reference sites tended to have different geomorphology (Edgar et al. 2017). The continued absence of sea snakes at Ashmore Reef suggests that this was not a temporary variation in numbers, and with repeated follow-up surveys, may be confirmed as probable local extinctions. However, the value of repeated surveys in the same locations is evident here, where a recent timeline suggests the beginning of recovery. Likewise, Mermaid Reef appears to have retained stability in the face of change at nearby reefs, but needs to be closely monitored.

6 Recommendations

- ongoing monitoring of North-west Marine Parks Network reefs takes place on a regular basis (5 years or less), using the methods and sites described here;

- data presented in recent RLS surveys be combined with previous surveys to guide efforts to select sites for long-term monitoring;

- research priorities include development of indicators that track changes in reef condition and biodiversity;

- detailed habitat mapping and categorisation of reef types, exposure and aspect is undertaken for inclusion in analyses of ecological patterns;

- causes for declines at the State managed Rowley Shoals Marine Park are investigated;

- detailed spatial and temporal mapping of distribution and impact of natural disturbances is carried out; and

- greater collaboration between agencies collecting data on reef for the North-west Marine Parks Network is encouraged.

7 Acknowledgements

This report used the NCRIS-en abled Integrated Marine Observing System (IMOS) infrastructure for database support and storage. The skilled field assistance of Ian Donaldson, Andrew Green, Sam Griffiths, Ben Jones, Ian Shaw, Mike Sugden, Joe Shields, Tanja Ponudic, Derek Shields, Nestor Echedey Bosch Guerra, Russell Thomson, Beth Strain, Sue Baker, and Bob Edgar is gratefully acknowledged, and data, photoquadrat and logistical support of Just Berkhout, Elizabeth Oh and Ella Clausius.

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Appendices

APPENDIX 1. SURVEY SITES

List of sites surveyed in 2013 and 2018 to be included in year, reef system and zone comparisons, with the number of transects surveyed in each year at each site.

Reef	Reef System	IUCN Status	SiteCode	Site Name	Longitute	Latitude	2013	2018
Ashmore	Ashmore	Ashmore Ia	NWS14	Surge Crest East	123.00392	-12.217	2	2
Ashmore	Ashmore	Ashmore Ia	NWS15	Surge Crest West	123.00575	-12.2159	2	2
Ashmore	Ashmore	Ashmore Ia	NWS20	Flats Edge	123.00182	-12.24414	1	2
Ashmore	Ashmore	Ashmore Ia	NWS21	Hemiplage Bommie	122.99881	-12.24405	1	2
Ashmore	Ashmore	Ashmore Ia	NWS23	Kuhlii Bommie	122.99001	-12.23384	2	2
Ashmore	Ashmore	Ashmore Ia	NWS24	Reel Lost Bommie	122.985307	-12.242641	2	2
Ashmore	Ashmore	Ashmore IV	NWS16	Guardian Reef	122.98389	-12.23963	2	2
Ashmore	Ashmore	Ashmore IV	NWS17	Turtle Patch	122.99063	-12.24179	1	2
Ashmore	Ashmore	Ashmore IV	NWS18	Busy Bommie	122.984927	-12.241222	1	2
Ashmore	Ashmore	Ashmore IV	NWS19	Grand Oculis Bommie	122.983286	-12.240542	1	2
Ashmore	Ashmore	Ashmore IV	NWS22	Dotty Reef	122.986398	-12.241092	2	2
Ashmore	Ashmore	Ashmore IV	NWS25	Eviota Bommie	122.986433	-12.239894	1	1
Hibernia	Ashmore	Ashmore Reference	NWS10	Rogaa Bommie	123.32136	-11.97452	2	2
Hibernia	Ashmore	Ashmore Reference	NWS11	Hibernia Lagoon SW	123.33523	-11.98059	2	2
Hibernia	Ashmore	Ashmore Reference	NWS12	Hibernia Lagoon NW	123.33757	-11.97626	2	2
Hibernia	Ashmore	Ashmore Reference	NWS13	Golden Sleeper Corner	123.3271	-11.9834	3	2
Hibernia	Ashmore	Ashmore Reference	NWS3	Cardinal Shoal	123.3878	-11.9719	2	2
Hibernia	Ashmore	Ashmore Reference	NWS4	Titan Reef	123.3794	-11.969	2	2
Hibernia	Ashmore	Ashmore Reference	NWS5	Hibernia Lagoon SE	123.38074	-11.97961	2	2
Hibernia	Ashmore	Ashmore Reference	NWS6	Hibernia Lagoon SE2	123.38116	-11.97448	2	2

Reef	Reef System	IUCN Status	SiteCode	Site Name	Longitute	Latitude	2013	2018
Hibernia	Ashmore	Ashmore Reference	NWS7	Big Fish Gulch	123.3586	-11.9671	2	2
Hibernia	Ashmore	Ashmore Reference	NWS8	Hibernia Lagoon South	123.36079	-11.97908	1	2
Hibernia	Ashmore	Ashmore Reference	NWS9	Spur and Groove Reef	123.33694	-11.9706	2	2
Scott	Ashmore	Ashmore Reference	NWS27	Election Day Reef	121.961272	-14.070388	2	2
Scott	Ashmore	Ashmore Reference	NWS28	Consolation Bommie	121.94218	-14.1327	1	2
Scott	Ashmore	Ashmore Reference	NWS29	Moray Bommie	121.94546	-14.12668	1	2
Scott	Ashmore	Ashmore Reference	NWS30	Longnose Spur	121.9589	-14.14184	1	2
Scott	Ashmore	Ashmore Reference	NWS31	Napoleon Reef	121.95693	-14.14383	1	2
Scott	Ashmore	Ashmore Reference	NWS32	Goby Heaven	121.96473	-14.10934	2	2
Scott	Ashmore	Ashmore Reference	NWS33	NE Passage	121.95847	-14.05597	2	2
Scott	Ashmore	Ashmore Reference	NWS34	Table Tip	121.9653	-14.06257	2	2
Scott	Ashmore	Ashmore Reference	NWS35	Ians Anchorage	121.95083	-14.0717	2	2
Scott	Ashmore	Ashmore Reference	NWS36	Fungiid Fields	121.78767	-14.0747	2	2
Scott	Ashmore	Ashmore Reference	NWS37	Stake Edge	121.78072	-14.0453	2	2
Scott	Ashmore	Ashmore Reference	NWS38	Chaetodontoides	121.77651	-14.06866	2	2
Scott	Ashmore	Ashmore Reference	NWS39	Odonus Dropoff	121.74816	-14.0828	2	2
Scott	Ashmore	Ashmore Reference	NWS40	Stern Trawler Reef	121.742	-14.0785	3	2
Scott	Ashmore	Ashmore Reference	NWS41	Dead West	121.72068	-14.10823	2	2
Mermaid	Mermaid	Mermaid II	NWS66	Mermaid anchorage dropoff 1.3	119.6539	-17.0764	3	3
Mermaid	Mermaid	Mermaid II	NWS67	Mermaid anchorage bommie	119.6455	-17.07374	2	2
Mermaid	Mermaid	Mermaid II	NWS68	Mermaid S channel entrance	119.64696	-17.06263	2	2
Mermaid	Mermaid	Mermaid II	NWS69	Mermaid anchorage dropoff 1.1	119.6494	-17.0658	2	2
Mermaid	Mermaid	Mermaid II	NWS70	Mermaid SW bommie M11	119.6339	-17.13371	2	2
Mermaid	Mermaid	Mermaid II	NWS71	Mermaid S bommie	119.6311	-17.15365	2	2
Mermaid	Mermaid	Mermaid II	NWS72	Mermaid Reef Lagoon Dragon	119.64617	-17.0754	2	2

Reef	Reef System	IUCN Status	SiteCode	Site Name	Longitute	Latitude	2013	2018
Mermaid	Mermaid	Mermaid II	NWS73	Mermaid channel mid bank	119.64167	-17.06644	2	2
Mermaid	Mermaid	Mermaid II	NWS74	Mermaid Lagoon Reef Dragon Escape	119.643667	-17.06983	2	2
Mermaid	Mermaid	Mermaid II	NWS75	Mermaid west lagoon	119.6148	-17.08687	2	2
Mermaid	Mermaid	Mermaid II	NWS76	Mermaid central bommie	119.63474	-17.11469	2	2
Mermaid	Mermaid	Mermaid II	NWS77	Mermaid Reef Cod Hole	119.64815	-17.06202	2	2
Mermaid	Mermaid	Mermaid II	NWS78	Mermaid channel bommies	119.64027	-17.0666	2	2
Mermaid	Mermaid	Mermaid II	NWS79	Mermaid dropoff 1.2	119.6533	-17.0721	2	2
Mermaid	Mermaid	Mermaid II	NWS80	Mermaid Reef No Pygmy	119.65518	-17.08181	2	2
Mermaid	Mermaid	Mermaid II	NWS81	Mermaid North M1	119.61792	-17.02767	2	2
Mermaid	Mermaid	Mermaid II	NWS82	Mermaid west dropoff M4	119.5962	-17.0762	2	2
Clerke	Mermaid	Mermaid Reference	NWS100	Clerke east reef top C28	119.37575	-17.29965	2	2
Clerke	Mermaid	Mermaid Reference	NWS101	Clerke Reef - BnB	119.38393	-17.35516	2	2
Clerke	Mermaid	Mermaid Reference	NWS83	Clerke North C1B	119.35201	-17.24607	2	2
Clerke	Mermaid	Mermaid Reference	NWS84	Clerke North Point	119.34713	-17.24612	2	2
Clerke	Mermaid	Mermaid Reference	NWS86	Clerke anchorage dropoff 2.1	119.3781	-17.2927	2	2
Clerke	Mermaid	Mermaid Reference	NWS87	Clerke Anchorage Dropoff 2.2	119.3769	-17.2843	2	2
Clerke	Mermaid	Mermaid Reference	NWS88	Clerke anchorage dropoff 2.3	119.3775	-17.288	2	2
Clerke	Mermaid	Mermaid Reference	NWS89	Blue lagoon	119.36037	-17.25302	1	2
Clerke	Mermaid	Mermaid Reference	NWS90	Clerke Reef Snorkelling Paradise	119.3724	-17.28632	2	2
Clerke	Mermaid	Mermaid Reference	NWS91	Clerke NE C14	119.37301	-17.28312	2	2
Clerke	Mermaid	Mermaid Reference	NWS92	Clerke Reef Aquarium	119.37053	-17.28321	1	2
Clerke	Mermaid	Mermaid Reference	NWS93	Clerke west lagoon C26	119.3423	-17.29772	2	2
Clerke	Mermaid	Mermaid Reference	NWS94	Clerke west C12	119.33673	-17.30364	2	2
Clerke	Mermaid	Mermaid Reference	NWS95	Clerke lagoon bommie C13	119.3675	-17.31065	2	2
Clerke	Mermaid	Mermaid Reference	NWS96	South Lagoon bommie C21	119.3605	-17.31882	2	2

Reef	Reef System	IUCN Status	SiteCode	Site Name	Longitute	Latitude	2013	2018
Clerke	Mermaid	Mermaid Reference	NWS97	Clerke south lagoon C25	119.3675	-17.3155	2	2
Clerke	Mermaid	Mermaid Reference	NWS98	Clerke lagoon east C20	119.37064	-17.30694	2	2
Clerke	Mermaid	Mermaid Reference	NWS99	Clerke lagoon NW bommie C29	119.35929	-17.2909	2	2
Imperieuse	Mermaid	Mermaid Reference	NWS50	Imperieuse SE lagoon	118.97	-17.6101	2	2
Imperieuse	Mermaid	Mermaid Reference	NWS51	Imperieuse West Lagoon	118.96364	-17.6089	2	2
Imperieuse	Mermaid	Mermaid Reference	NWS53	Imperieuse SE reef top	118.96872	-17.579	2	2
Imperieuse	Mermaid	Mermaid Reference	NWS54	Imperieuse east lagoon	118.9369	-17.5804	2	2
Imperieuse	Mermaid	Mermaid Reference	NWS55	Imperieuse East	118.97193	-17.56991	2	2
Imperieuse	Mermaid	Mermaid Reference	NWS56	Imperieuse Reef Rage	118.9747	-17.6102	2	2
Imperieuse	Mermaid	Mermaid Reference	NWS57	Imperieuse edge	118.9737	-17.548	1	2
Imperieuse	Mermaid	Mermaid Reference	NWS58	Rowley Shoals 3	118.9738	-17.5531	1	2
Imperieuse	Mermaid	Mermaid Reference	NWS59	Imperieuse lagoon bommie	118.9668	-17.54732	2	2
Imperieuse	Mermaid	Mermaid Reference	NWS60	Imperieuse 14	118.96884	-17.54749	2	2
Imperieuse	Mermaid	Mermaid Reference	NWS61	Imperieuse edge RS3-3	118.9724	-17.5582	2	2
Imperieuse	Mermaid	Mermaid Reference	NWS62	Imperieuse anchorage	118.96635	-17.50713	1	2
Imperieuse	Mermaid	Mermaid Reference	NWS63	Imperieuse north	118.96276	-17.50218	2	2
Imperieuse	Mermaid	Mermaid Reference	NWS64	Imperieuse north lagoon	118.94214	-17.56045	2	2

APPENDIX 2. FISH SPECIES LIST

Average abundance of each fish species recorded along 500 m^2 transects with method 1, in 2013 and 2018.

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Acanthuridae	Acanthurid spp.	0	0	0	0	0	0	0	0	0.4	0.3	0	0	0	0	0	0
Acanthuridae	*Acanthurus blochii*	0	0.3	0	0	2	4.1	16.5	0	0	0	2.1	3.8	1.3	3.5	2.7	7.7
Acanthuridae	*Acanthurus dussumieri*	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0.2	0.2	0
Acanthuridae	*Acanthurus fowleri*	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0
Acanthuridae	*Acanthurus grammoptilus*	0.8	4.4	1.2	2.3	0	0.2	0	0	0.1	0	0.3	0	0	0	0.8	1.4
Acanthuridae	*Acanthurus leucocheilus*	0.3	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Acanthuridae	*Acanthurus lineatus*	9.2	4.6	0	0	0.5	0.1	0	0	0.8	8.9	1	0.2	1.9	1.3	1.5	0.6
Acanthuridae	*Acanthurus mata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.1	0
Acanthuridae	*Acanthurus nigricans*	0.2	0.8	1.1	0.8	7.8	5.3	0	0	7.2	16.3	4.7	4.5	14.2	9.6	18.4	15
Acanthuridae	*Acanthurus nigricauda*	0.7	5.5	0.4	5.5	2.1	0.9	0	0	2.4	1	1.6	0.6	0.7	0.7	5.7	3.8
Acanthuridae	*Acanthurus nigrofuscus*	2.3	29.6	0.6	43.2	24.1	14.8	24	0	6.5	47.7	13.4	25.8	35.8	15.3	3.5	26
Acanthuridae	*Acanthurus olivaceus*	1.1	5.2	0.5	0	0.4	0	0	0	0.5	0.1	1.2	0	0	0	7	0.2
Acanthuridae	*Acanthurus pyroferus*	1.1	2.2	1.2	3.1	0	0	0	0	2.4	4.1	0	0	0.2	0	0.4	0.4
Acanthuridae	*Acanthurus* spp.	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0
Acanthuridae	*Acanthurus thompsoni*	0	0	0	0	0.4	0.2	0	0	0	0	0.2	0	1.8	3.5	0	0
Acanthuridae	*Acanthurus triostegus*	0	0	0	0	0	0	0	0	0	0.4	0.2	0.7	0	0	12.7	3.8
Acanthuridae	*Acanthurus xanthopterus*	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Acanthuridae	*Ctenochaetus binotatus*	5.6	0.7	5.4	11.5	0	0	0	0	3.7	18	0.1	0	0.1	0	8.7	10.1
Acanthuridae	*Ctenochaetus cyanocheilus*	3.9	12.3	0	1.9	0	0.6	0	0	4	10.6	0.1	0.1	0	0.6	4.3	0.4
Acanthuridae	*Ctenochaetus* sp. [white tail]	0	0	0	0	0	0.1	0	0	0	0	0	1.7	0	0	0	0
Acanthuridae	*Ctenochaetus striatus*	22.3	48.7	41.8	86.7	97	73.5	50	95.5	70.9	114.3	58.4	93	103.3	128	68.7	125.8
Acanthuridae	*Naso annulatus*	0	0.1	0	0.2	0	0	0	0	0	0	0	0	0	0	0.1	0.1

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Acanthuridae	*Naso brachycentron*	0	2.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acanthuridae	*Naso brevirostris*	0	1.9	0	0	2	0.5	0	0	0	0.1	0	0	1.1	0.2	0.4	0.4
Acanthuridae	*Naso caesius*	0	0	0	0	0.6	0.1	0	0	0	0	0	0	0.6	1.7	0.5	0.2
Acanthuridae	*Naso hexacanthus*	0	0	0	0	0	1.1	0	0	0	0	0	0.1	0	0.4	0.2	0
Acanthuridae	*Naso lituratus*	0.3	0.6	1	0.6	6.6	0.8	0	0	0.4	0.8	2.5	2.4	6.2	3.2	0.7	1.9
Acanthuridae	*Naso* spp.	0.1	0	0.4	0	0	0	0	0	1.1	0	0	0	0	0	0.3	0
Acanthuridae	*Naso tonganus*	0	0.2	0	0.1	0	0	0	0	0	0	0	0	0	0	0.1	0
Acanthuridae	*Naso unicornis*	0.2	0.1	0	0	0.2	0.2	0	0.5	0.1	0	3	0.2	0.4	0.9	0	0.2
Acanthuridae	*Naso vlamingii*	0	0.1	0.1	0	0.3	0.2	0	0	0.2	0.3	0.5	0	1.2	2	0.1	0.5
Acanthuridae	*Paracanthurus hepatus*	0.2	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acanthuridae	*Zebrasoma scopas*	9	17.4	17.6	15	12.8	12.6	0	0	3.4	2.7	11.2	14.1	15.4	21.7	7.6	2.2
Acanthuridae	*Zebrasoma velifer*	0.1	0.6	0.5	1.1	4.5	1.1	5.5	2	0.2	0.2	3	3.4	3.6	2.9	0.1	0.4
Apogonidae	*Apogon doederleini*	0	0	0	1.8	0	0	0	0	0	0	0	0	0	0	0	0
Apogonidae	Apogonid spp.	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apogonidae	*Archamia bleekeri*	0	3.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apogonidae	*Cheilodipterus artus*	0	0	2.5	0	0	0.1	0	0	1.1	0	0	0	0	0	0	0
Apogonidae	*Cheilodipterus isostigmus*	0	0.2	0	0	0	3.2	0	0	0	0.2	0	3.2	0	0.4	0	0
Apogonidae	*Cheilodipterus macrodon*	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0
Apogonidae	*Cheilodipterus quinquelineatus*	2	0.8	12.9	3.2	1.8	0	2.5	0	0.5	0	0.5	0	0.7	0	0.7	1.9
Apogonidae	*Nectamia bandanensis*	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0
Apogonidae	*Ostorhinchus angustatus*	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Apogonidae	*Ostorhinchus compressus*	0	0	0	1.5	0	0	0	0	0	0	0	0	0	0	0	0
Apogonidae	*Ostorhinchus cyanosoma*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.7	0
Apogonidae	*Ostorhinchus nigrofasciatus*	0	0	0	0	0	0.1	0	0	0	0	0	0.9	0	0.3	0	0
Apogonidae	*Ostorhinchus properuptus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Apogonidae	*Ostorhinchus sealei*	0	10.8	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Apogonidae	*Ostorhinchus wassinki*	0	0	0	0	0	0	0	0	3.2	1.4	0	0	0	0	0	0
Apogonidae	*Pristiapogon exostigma*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0
Apogonidae	*Pristiapogon kallopterus*	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0
Apogonidae	*Rhabdamia gracilis*	0	291.7	0	9.1	0	0	0	0	3636.4	0	0	0	0	0	0	0
Apogonidae	*Taeniamia biguttata*	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apogonidae	*Taeniamia zosterophora*	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0
Apogonidae	*Zoramia fragilis*	0	0	0	0	0	0	0	0	0	10.1	0	0	0	0	0	0
Apogonidae	*Zoramia viridiventer*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25.2
Atherinidae	Atherinid spp.	0	0	0	0	0	0	0	0	0	1.8	0	0	0	0	0	0
Aulostomidae	*Aulostomus chinensis*	0	0	0	0	0.1	0.1	0.5	0	0	0.1	0	0	0	0.1	0	0
Balistidae	*Balistapus undulatus*	0.2	0.5	0	0.3	0.9	0.6	0	0	0.4	1.5	1	1.5	1.3	0.7	0.7	1.3
Balistidae	*Balistoides conspicillum*	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0
Balistidae	*Balistoides viridescens*	0	0.2	0	0.1	0	0.1	0	0	0.1	0.1	0.1	0	0	0.1	0	0
Balistidae	*Melichthys niger*	0	0	0	0	1.4	0.6	0	0	0	0	0.8	1.7	0.8	0.9	0	0
Balistidae	*Melichthys vidua*	0	0	0	0	5.9	0.3	0	0	0	0	2.3	0.9	4	1.7	0	0
Balistidae	*Odonus niger*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16.3	6
Balistidae	*Pseudobalistes flavimarginatus*	0.4	0	0.1	0	0.1	0	0	0	0	0	0	0	0	0	0	0
Balistidae	*Rhinecanthus aculeatus*	0	0	0	0	0.1	0	0	0	0	0	0	0.1	0	0.2	0	0
Balistidae	*Rhinecanthus rectangulus*	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0.1	0	0
Balistidae	*Rhinecanthus verrucosus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Balistidae	*Sufflamen bursa*	0	0	0	0	0.3	0.5	0	0	0.1	0.4	0.4	0.4	0.2	0.2	0.1	0.1
Balistidae	*Sufflamen chrysopterum*	1.2	0.7	0	0.2	0	0	0	0	0.3	0	0.1	0	0	0.1	0.4	0.6
Belonidae	*Strongylura incisa*	0	0	0	0	0	0	0	0	0	0	0	0	1.3	0	3	0
Belonidae	*Tylosurus crocodilus*	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0
Blenniidae	*Aspidontus taeniatus*	0	0	0.2	0	0	0	0	0	0	0	0	0.1	0	0	0.1	0
Blenniidae	*Atrosalarias holomelas*	0.1	0	0.6	0.1	0	0	0	0	0	0	0	0	0	0	0	0

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Blenniidae	Blenniid spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blenniidae	*Cirripectes castaneus*	0	0	0	0	0	0	0	0	0	0	0.1	0.3	0	0.3	0	0.2
Blenniidae	*Cirripectes* sp. [dark eye]	0	0	0	0	2.5	0	0	0	0	0	0.2	0.6	0.7	0.2	0	0
Blenniidae	*Cirripectes* spp.	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0.1
Blenniidae	*Crossosalarias macrospilus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blenniidae	*Ecsenius alleni*	0	0	0	0	0.8	1.2	0	0	0	0	0.7	3.5	1.8	7.7	0.6	2.3
Blenniidae	*Ecsenius bicolor*	0.3	0	0	0.1	0.2	0.1	0	0	0.8	0.3	0.2	0.1	0.3	1	0.2	0.6
Blenniidae	*Ecsenius lividanalis*	2.3	0.8	2.1	2.1	0	0	0	0	0	0	0	0	0	0	0	0
Blenniidae	*Ecsenius schroederi*	0	0	0	0	0.2	0.4	1	2	0	0	0.6	0.8	0	0.1	0	0.1
Blenniidae	*Ecsenius* sp. [black]	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0
Blenniidae	*Ecsenius yaeyamaensis*	0.5	0.8	2.2	0.1	0	0	0	0	0	0.4	0	0	0	0	0	0
Blenniidae	*Exallias brevis*	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0
Blenniidae	*Glyptoparus delicatulus*	0	0	0	0	0	0	0	0	0	0	0	0.9	0	0	0	0
Blenniidae	*Meiacanthus atrodorsalis*	0	0	0.1	0.1	0.4	1.4	1.5	2	0	0	1.7	1.8	0.2	0.5	0.9	2.8
Blenniidae	*Meiacanthus ditrema*	0	0	0	0	0	3.1	0	0	0	0	0	0	0	0.2	0	0.3
Blenniidae	*Meiacanthus grammistes*	1	0.1	1.2	0.9	0	0	0	0	0.2	0.7	0	0	0	0	0	0
Blenniidae	*Meiacanthus lineatus*	0	0.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blenniidae	*Meiacanthus* sp. [yellow tail]	0	0	0	0	0	0.2	0.5	0.5	0	0	0	0	0	0	0	0
Blenniidae	*Meiacanthus* spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blenniidae	*Plagiotremus laudandus*	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0.1	0	0.2
Blenniidae	*Plagiotremus rhinorhynchos*	0.1	0.3	0.1	0.4	0	0.1	0	0	0.2	0	0.2	0.5	0.1	0.2	0.4	1.2
Blenniidae	*Plagiotremus tapeinosoma*	0.1	0.1	0.8	0	0.1	0.1	0	0	0.5	0.1	1.1	0.4	0.2	0.3	0.1	0.4
Blenniidae	*Salarias alboguttatus*	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0
Blenniidae	*Salarias fasciatus*	0.3	0	0	0	0	0	0	0	0	0	0	0.3	0	0	0	0
Blenniidae	*Salarias patzneri*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blenniidae	*Salarias* sp. *(alboguttatus)*	0	0	0	0	0	0	0	0.5	0	0	0	0.2	0	0	0	0

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Blenniidae	*Salarias* spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bothidae	*Bothus mancus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caesionidae	*Caesio caerulaurea*	0	11.5	0	19.7	0	0	0	0	0	10.6	0	0	0	0	1.5	0
Caesionidae	*Caesio cuning*	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	6.6
Caesionidae	*Caesio lunaris*	0	1.2	11	5.5	3.4	0	0	0	0.3	3.5	2.6	0	13.2	2.1	3.2	0
Caesionidae	*Caesio teres*	0	20	0	24.2	0.8	1.1	0	0	0	1.4	0.4	0	2.6	2	4.3	0
Caesionidae	*Pterocaesio digramma*	0	0	0	0.5	0.3	0	0	0	0.8	0	0	0	0	0	0.2	0
Caesionidae	*Pterocaesio pisang*	0	0	0	0	0	0	0	0	6.8	11.6	0	0	0	0	68.5	0.2
Caesionidae	*Pterocaesio tile*	0	3.1	0	0	3.6	2.2	0	0	0	0	7.5	0	12.5	12.4	27.3	1.4
Caesionidae	*Pterocaesio trilineata*	0	53.2	0	12.5	0	0	0	0	0.3	0	0	0	0	0	11.5	5.5
Callionymidae	*Diplogrammus goramensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callionymidae	*Neosynchiropus ocellatus*	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0
Caracanthidae	*Caracanthus unipinna*	0.5	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0
Carangidae	Carangid spp.	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0
Carangidae	*Carangoides ferdau*	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0
Carangidae	*Carangoides orthogrammus*	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0.1	3.7	0.1
Carangidae	*Carangoides plagiotaenia*	0	0	0	0	0	0.1	0	0	0	0	0	0	0.1	0	0.1	0.5
Carangidae	*Caranx ignobilis*	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Carangidae	*Caranx lugubris*	0	0	0	0	0	0	0	0	0	0	1	0.1	1.5	2.5	0	1.7
Carangidae	*Caranx melampygus*	1.4	0.3	0.2	0.4	1.3	0.1	0	0	5	0.1	0.2	0.1	0.1	0.2	1.9	0.2
Carangidae	*Caranx sexfasciatus*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0	0
Carangidae	*Decapterus macarellus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0.6	0.2	0
Carangidae	*Elagatis bipinnulata*	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	1.1	0
Carangidae	*Scomberoides lysan*	0	0	0	0.3	0	0	0	0	0	0	0	0	0	0	1.1	0.2
Carangidae	*Trachinotus blochii*	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0
Chaetodontidae	*Chaetodon adiergastos*	0	0.3	0.2	0.8	0.8	0.2	0	0	0.5	0.2	0.5	0.1	0.4	0.3	1	0.9

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Chaetodontidae	*Chaetodon auriga*	0.7	1.1	2.5	1.9	1	1.6	0.5	12.5	0	0.6	1.6	1	1.1	0.7	1	0.2
Chaetodontidae	*Chaetodon baronessa*	1.1	0.3	0.1	0.3	0	0	0	0	0.2	0	0	0	0	0	1.6	0.6
Chaetodontidae	*Chaetodon bennetti*	0	0	0	0	0.7	0.1	0	0	0	0	0.1	0.1	0.3	0.2	0	0.1
Chaetodontidae	*Chaetodon citrinellus*	0	0.3	0	0	0.2	0.2	0	0	1	0.3	0.3	0.3	0	0.1	0.8	0.7
Chaetodontidae	*Chaetodon ephippium*	0.3	0.8	1.2	0.9	1	0.6	2	1.5	0.2	0.6	0.8	0.3	0.7	0.1	0.1	1
Chaetodontidae	*Chaetodon kleinii*	1.1	0	0.2	0.5	0	0	0	0	3.7	3.4	0	0	0	0	0.2	0.4
Chaetodontidae	*Chaetodon lineolatus*	0	0.1	0	0.1	0.1	0.1	0	0	0	0	0.2	0.1	0	0.1	0	0
Chaetodontidae	*Chaetodon lunula*	0.5	0	0.8	0.4	1.1	1.5	0	3	0.5	0.4	0.9	0.2	1.1	0.5	0.5	0.4
Chaetodontidae	*Chaetodon lunulatus*	5.6	7.6	8.6	7	4.4	4.4	4	6	2.3	2.5	2.3	2	2.6	2	4.3	2
Chaetodontidae	*Chaetodon melannotus*	0.5	0.5	0.8	0.3	0	0	0	0	0.2	0.9	0	0	0	0	0	0
Chaetodontidae	*Chaetodon meyeri*	0	0.1	0	0	0.2	0.2	0	0	0.4	0.3	0.3	0.2	0.7	0.2	0.4	0.2
Chaetodontidae	*Chaetodon ocellicaudus*	0	0	0	0.2	0	0	0	0	0	0.1	0	0	0	0	0	0
Chaetodontidae	*Chaetodon ornatissimus*	0	0.1	0	0	2.5	2.4	0	0	0.1	0.2	2.6	2	3.2	1.6	1	1.2
Chaetodontidae	*Chaetodon oxycephalus*	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Chaetodontidae	*Chaetodon plebeius*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chaetodontidae	*Chaetodon punctatofasciatus*	0	0	0	0	3	2.1	0	0	0	0	0.6	2.5	2.2	1.4	1.1	0.9
Chaetodontidae	*Chaetodon rafflesii*	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0.1	0
Chaetodontidae	*Chaetodon semeion*	0	0.4	0	0	0.2	0.1	0.5	1	0	0	0.4	0.4	0.3	0	0.4	0
Chaetodontidae	*Chaetodon speculum*	0	0.1	0	0	0.3	0.1	0	0.5	0	0	0.8	0.4	0.5	0.7	0	0.1
Chaetodontidae	*Chaetodon trifascialis*	0.6	0.3	0.2	1.1	1.9	2.1	6	10	0.4	0.4	1.4	1.4	1.5	0.8	3.3	0.1
Chaetodontidae	*Chaetodon trifasciatus*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
Chaetodontidae	*Chaetodon ulietensis*	0.5	1.2	1.2	1.8	3.1	1.4	0	0	0.2	0.2	2	2.1	2.9	2.1	1.4	0.6
Chaetodontidae	*Chaetodon unimaculatus*	0	0	0.1	0	0.1	0	0	0	0.1	0.1	1	0	0.3	0.6	0	0
Chaetodontidae	*Chaetodon vagabundus*	0.7	1	1.6	2.2	0.2	0	0	0	0.1	0.4	0	0	0	0	1.3	0.2
Chaetodontidae	*Forcipiger flavissimus*	0	0	0	0	1.2	0.3	0	0	0.5	1.1	0.4	0.3	2.3	0.9	0.7	0.5
Chaetodontidae	*Forcipiger longirostris*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0	0

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Chaetodontidae	*Hemitaurichthys polylepis*	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0.5	0	0
Chaetodontidae	*Heniochus acuminatus*	0	0	0	0	0.3	0	0	0	0	0	0.3	0	0.2	0	0	0
Chaetodontidae	*Heniochus chrysostomus*	0	0.2	0.1	0.3	0.4	1.4	0	0	0.5	0.3	1	0.2	1.7	0.7	0.7	0.6
Chaetodontidae	*Heniochus monoceros*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.2	0	0
Chaetodontidae	*Heniochus singularius*	0	0	0	0	0.1	0	0	0	0	0	0.2	0	0.2	0.2	0	0.1
Chaetodontidae	*Heniochus varius*	0.1	0.5	0.1	0.1	1.2	0.6	0	0	0.8	0.4	1.3	0.8	1.7	1.6	0.8	0.1
Cirrhitidae	*Cirrhitichthys oxycephalus*	0.1	0	0	0	0	0	0	0	0	0.1	0.3	0.2	0.3	0	0	0
Cirrhitidae	*Cirrhitus pinnulatus*	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0
Cirrhitidae	*Paracirrhites arcatus*	0	0	0	0	0	0.1	0	0	0	0	0	0.3	0	0	0.1	0
Cirrhitidae	*Paracirrhites forsteri*	0.2	1.3	0	0.7	2	2.9	0	0	1.2	1.6	4.5	5.4	2.5	6.6	1.9	2.3
Clupeidae	Clupeoid spp.	0	564.8	0	0	0	2.9	0	0	0	69.8	0	5.7	0	63.5	0	0
Clupeidae	*Spratelloides gracilis*	0	0	0	0	0	0	0	0	118.2	0	0	0	0	0	37	0
Congridae	*Heteroconger hassi*	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0
Diodontidae	*Diodon hystrix*	0.1	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diodontidae	*Diodon liturosus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Echeneidae	*Echeneis naucrates*	0	0.2	0	0	0	0	0	0.5	0	0	0	0	0	0.1	0	0
Ephippidae	*Platax batavianus*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
Ephippidae	*Platax teira*	0.1	0.5	0.1	0.5	0	0	0	0	0	0	0	0	0	1.1	0	0
Fistulariidae	*Fistularia commersonii*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gobiesocidae	*Diademichthys lineatus*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0	0
Gobiidae	*Amblyeleotris guttata*	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0.1
Gobiidae	*Amblyeleotris steinitzi*	0	0	0	0	0	0.1	0	0	0	0	0	0.2	0.8	0.7	0.2	0.8
Gobiidae	*Amblyeleotris wheeleri*	0	0.2	0	0	0	0	0	0	0	0.2	0	0	0.1	0.1	0	0.1
Gobiidae	*Amblygobius decussatus*	0	0.1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Amblygobius nocturnus*	0	0	0	0.2	0.2	1.1	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Amblygobius phalaena*	0	0	1.5	0.2	0.1	0.3	0	0.5	0	0	0.5	0.1	0.1	0.3	0.1	0

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Gobiidae	*Amblygobius* spp.	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Asterropteryx semipunctata*	0	0	0	0	0.2	3.2	0	9	0	0	0	0.8	0	0.1	0	0
Gobiidae	*Bryaninops amplus*	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0
Gobiidae	*Bryaninops erythrops*	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Bryaninops natans*	0	0	0	0	1.2	5.5	0	0	0	0	0	1.1	0	0.7	0	0
Gobiidae	*Bryaninops nexus*	0	0	0	0	0.2	2.3	0	0	0	0	0	1.2	0	0	0	0
Gobiidae	*Cryptocentrus strigilliceps*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Ctenogobiops mitodes*	0	0	0	0.2	0.1	1.1	0	0	0	0	0.1	1	0	0.1	0	0
Gobiidae	*Ctenogobiops pomastictus*	0.3	0.1	7.6	0.5	0.1	0.3	0	0.5	0.1	0	0.1	0	0.1	0.5	0.1	0.5
Gobiidae	*Ctenogobiops* spp.	0	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Ctenogobiops tangaroai*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Eviota guttata*	0	0.1	0	0.8	0.2	2.3	0	0	0	0.5	0	7.6	0.1	1.3	0	0.2
Gobiidae	*Eviota nigriventris*	0	0	0	0	0.1	2.8	0	0	0	0	0	1.1	0	0.1	0	0
Gobiidae	*Eviota prasites*	0.2	0.2	0.1	0.3	0.3	0.7	1	0	0	0	0	0.1	0	0.3	0	0
Gobiidae	*Eviota punctulata*	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Eviota queenslandica (cf)*	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Eviota* sp. [red eyes]	0	0	0	0	0	0	0	0	0	0	0	0.8	0	0	0	0
Gobiidae	*Eviota* sp. [storthynx gold shield]	0	0	0	0	0	0.3	0	0	0	0	0	0.4	0	0.2	0	0
Gobiidae	*Eviota* sp. [trans white & red streaks]	0	0	0	0	0	0.4	0	0.5	0	0	0	0.1	0	0.1	0	0
Gobiidae	*Eviota* spp.	0	0	0.1	0	0	0	0	0	0	0	0.2	0	0	0	0	0
Gobiidae	*Exyrias belissimus*	0	0	0.6	0.2	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Fusigobius duospilus*	0	0.1	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Fusigobius neophytus*	0.1	0	0	0.1	0.1	2.7	0	0	0	0	0	0	0	0.3	0	0
Gobiidae	*Fusigobius pallidus (cf)*	0	0	0	0	0	0.4	0	0	0	0	0	0.1	0	0.1	0	0
Gobiidae	*Fusigobius signipinnis*	0.1	0.1	0.6	0.3	0	0.5	0	0	0	0	0	0	0	0	0.1	0
Gobiidae	*Fusigobius* sp.	0	0	0	0	0.1	0	0	0	0	0	0.2	0	0	0	0	0

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Gobiidae	*Gnatholepis anjerensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0
Gobiidae	*Gnatholepis cauerensis*	0	2.9	0	8.1	0.6	5.4	0	0	0	0.3	0.3	3	0.5	5.1	0.6	0.9
Gobiidae	Gobiid spp.	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Gobiodon ?histrio*	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Gobiodon citrinus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Gobiodon quinquestrigatus*	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Gobiodon spilophthalmus*	0	0	0	0	1.4	1.9	3	0.5	0	0	0	0.3	0.2	0	0.1	0
Gobiidae	*Gobiodon* spp.	0	0.1	0	0.1	0	0.1	0	0	0	0.2	0	0	0	0	0	0.1
Gobiidae	*Istigobius decoratus*	0	0.8	0.2	1.6	0	0	0	0	0.1	0	0	0	0	0	0	0
Gobiidae	*Istigobius goldmanni*	0.2	0.7	1.5	0.4	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Istigobius rigilius*	0.4	0.3	3	0.3	0	2.1	0	0	0.1	0	0	0.1	0	0.1	0.6	0
Gobiidae	*Istigobius* spp.	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Koumansetta rainfordi*	0.1	0.2	1.1	0.7	0.9	1.9	0	0	0	0	0.5	0.2	0.4	1	0.4	0
Gobiidae	*Lotilia graciliosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Lotilia klausewitzi*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Gobiidae	*Paragobiodon echinocephalus*	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Signigobius biocellatus*	0	0.2	0.6	0.3	0	0	0	0	0	0	0	0	0	0	0.1	0
Gobiidae	*Trimma readerae*	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0.1	0	0
Gobiidae	*Trimma* sp. [gold spots]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Trimma* spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Trimma striata*	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Valenciennea longipinnis*	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0
Gobiidae	*Valenciennea sexguttata*	0.4	0.1	1.5	0.5	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Valenciennea strigata*	0	0.1	0	0	0.1	0	0	0	0.2	0.1	0	0.1	0	0	0	0
Haemulidae	*Diagramma labiosum*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
Haemulidae	*Plectorhinchus chaetodonoides*	0	0	0	0	0.2	0.6	0	0	0.1	0.1	0.5	0.5	1.3	2.1	0.7	0.8

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Haemulidae	*Plectorhinchus lessonii*	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0.1	0	0
Haemulidae	*Plectorhinchus vittatus*	0	0	0	0	0	0	0	0	0.1	0.1	0	0	0	0	0	0
Holocentridae	*Myripristis adusta*	0	0	0	0.2	0.2	0	0	0	0	0	0	0.1	0.2	2.4	0.6	1.1
Holocentridae	*Myripristis berndti*	0	0	0	0	0.8	1.6	0	0	0	0.4	0.8	0.5	1.3	2.9	1.6	0.7
Holocentridae	*Myripristis hexagona*	0	0.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Holocentridae	*Myripristis kuntee*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
Holocentridae	*Myripristis murdjan*	0	0	0	0	0	0.4	0	0	0	0.4	0.2	0	0	0.3	1	0.3
Holocentridae	*Myripristis* spp.	0	0	0.1	0.3	0	0	0	0	0	0.4	0	0	0	0	0	0
Holocentridae	*Myripristis violacea*	0.7	0.8	0	2.3	0.2	1.3	0	0	0.2	1.8	2.5	1.3	1	0.7	1.3	1.2
Holocentridae	*Myripristis vittata*	0	0	0	0	0	0.4	0	0	0	0	0	0	0.2	0.5	0	0
Holocentridae	*Neoniphon argenteus*	0	0.1	0	0	0	0.1	0	0	0	0	0.4	0.1	0	0	0	0.5
Holocentridae	*Neoniphon opercularis*	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0.1	2.3	0
Holocentridae	*Neoniphon sammara*	0	0	0	0	0	0.2	0	0	0.7	3.8	0	0	0	0	2.7	0.7
Holocentridae	*Sargocentron caudimaculatum*	0	0	0	0	0.5	0.2	0	0	0.3	0.3	0.3	0.2	0.4	0.8	1.2	0.4
Holocentridae	*Sargocentron cornutum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0
Holocentridae	*Sargocentron diadema*	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0.1	0.2
Holocentridae	*Sargocentron microstoma*	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0.3	0	0
Holocentridae	*Sargocentron spiniferum*	0	0.3	0.1	0.3	0.5	0.5	0	1	0	0.1	0.5	0.2	0.3	0.4	0.7	0.6
Holocentridae	*Sargocentron* spp.	0	0	0.1	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Holocentridae	*Sargocentron tiere*	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0
Holocentridae	*Sargocentron violaceum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1
Kyphosidae	*Kyphosus cinerascens*	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0.1	35.4	1.3
Kyphosidae	*Kyphosus* spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kyphosidae	*Kyphosus vaigiensis*	0	0.1	0	0	0	0	0	0	0	0	0.2	0	0	0.1	2.4	0.7
Labridae	*Anampses caeruleopunctatus*	0	0	0	0	0.1	0	0	0	0	0.7	0	0	0	0	0.1	0
Labridae	*Anampses geographicus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Labridae	*Anampses* spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Labridae	*Anampses twistii*	0	0	0	0.1	0	0.4	0	0	0.5	0.3	0.5	0.5	0.9	0.6	0.4	0.2
Labridae	*Bodianus axillaris*	0.1	0.6	1.4	0.5	0.3	0.2	0	0	0.7	0.4	0.6	0.6	0.3	0.6	0.2	0.2
Labridae	*Bodianus diana*	0	0	0	0	0	0	0	0	0.1	0.2	0.1	0	0	0.3	0.1	0
Labridae	*Bodianus mesothorax*	0	0.5	0.1	1	0	0	0	0	0.5	0.2	0	0	0	0	0	0.1
Labridae	*Cheilinus chlorourus*	0.2	0.7	0.2	0.7	0.2	0.1	0	4.5	0.2	2.1	0.1	0.2	0.1	0.1	0.1	0.2
Labridae	*Cheilinus fasciatus*	0.8	0.8	2.1	2	0.9	0.8	0	0.5	0.7	1.5	0.7	0.5	1.3	0.7	0	0.1
Labridae	*Cheilinus oxycephalus*	0.1	0.3	0.4	0	0	0	0	0	0.4	0.8	0	0	0	0	0	0
Labridae	*Cheilinus* spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Labridae	*Cheilinus trilobatus*	1	0.5	0	0.8	0.1	0	1	0	1.1	1.3	0	0.1	0.1	0.1	0.1	0.1
Labridae	*Cheilinus undulatus*	0	0	0	0.1	0.8	0.1	0	0	0	0.1	0.8	0.5	0.1	0.1	0.1	0
Labridae	*Cirrhilabrus cyanopleura*	0	0.3	4.9	0	0	0	0	0	0	0	0	0	0	0	0	0.2
Labridae	*Cirrhilabrus exquisitus*	2.2	2.9	3.1	0	0	0	0	0	69.7	8.9	0	0	0	0.5	4.9	10.5
Labridae	*Cirrhilabrus randalli*	6.4	0	0	0.1	1.3	1.7	0	0	3.3	8.1	1.1	0	1.1	0.8	0.1	6.6
Labridae	*Cirrhilabrus* spp.	0	0	0	0	0	0	0	0	0	15.4	0	1.7	0	1.1	0	0
Labridae	*Coris aygula*	0	0.1	0	0.2	0.2	0	0	0	0	0	0.2	0.1	0.1	0	0	0.2
Labridae	*Coris batuensis*	11.5	2.7	12.2	3.2	0	0	0	0	2.2	1.9	0	0	0	0	0.9	0.9
Labridae	*Coris gaimard*	0	0.2	0	0	0	0.1	0	0	0.6	0.6	0	0.3	0	0.1	0	0.6
Labridae	*Epibulus brevis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Labridae	*Epibulus insidiator*	0.3	0.2	0.2	0.2	1.8	1.4	0	4.5	0.5	0.9	0.3	0.9	1	1.1	0.1	0.2
Labridae	*Gomphosus caeruleus*	0.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0
Labridae	*Gomphosus varius*	2.8	3.7	1.2	2.7	8.3	13.5	4.5	1.5	4.8	7.7	8	15.8	6.3	6.3	3.1	2.8
Labridae	*Halichoeres biocellatus*	6.3	0	28.5	0	0.5	0.5	0	0	5	2	1.8	0.7	1.1	0.5	0.3	0.1
Labridae	*Halichoeres chrysus*	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0
Labridae	*Halichoeres erdmanni*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Labridae	*Halichoeres hortulanus*	2.6	11.1	0.2	6.4	8.2	5.1	0	0	25.9	22	11.7	10	10.7	7.3	16.8	8.7

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Labridae	*Halichoeres margaritaceus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Labridae	*Halichoeres marginatus*	4.3	5.7	0	1.6	2.2	1.6	0	0	1.8	5.5	3.2	7.1	1.1	1	3.2	1.8
Labridae	*Halichoeres melanochir*	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0.4
Labridae	*Halichoeres melanurus*	36.4	32.2	31.9	29.5	0	0	0	0	1	0.6	0	0	0	0	11	14.4
Labridae	*Halichoeres nebulosus*	23.4	10.2	0	0	0	0	0	0	2.3	4.4	0	0	0	0	0	0
Labridae	*Halichoeres nigrescens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Labridae	*Halichoeres prosopeion*	0.3	0.1	1.9	0.8	0	0	0	0	0.3	0.3	0	0	0	0	0.4	0.7
Labridae	*Halichoeres richmondi*	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Labridae	*Halichoeres scapularis*	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Labridae	*Halichoeres trimaculatus*	3.3	3.7	15	5.6	12	18.7	11.5	4	0.7	4.3	13.5	17.6	6.2	1.7	16.7	14.4
Labridae	*Hemigymnus fasciatus*	0.4	0	0.1	2.3	0.8	0.6	0	0	0.4	0.3	0.5	0	0.1	0.1	0.1	0.2
Labridae	*Hemigymnus melapterus*	1.7	1.3	1.8	1.7	2	1.2	0.5	1.5	0.6	1.5	2.2	0.5	1.4	0.3	0.3	0.2
Labridae	*Hologymnosus doliatus*	0	0	0	0.1	0	0	0	0	0.1	0.1	0	0	0	0	0	0
Labridae	*Labrichthys unilineatus*	3.3	2.3	1.5	2.5	3.5	5.3	3.5	3	0.5	0.3	7	3	1.7	0.5	4.4	0.2
Labridae	Labrid spp.	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0
Labridae	*Labroides bicolor*	0.9	1.8	2.9	2.6	2.3	1.4	0	6	0.7	1.4	1.8	1.2	3.3	0.7	1.4	0.7
Labridae	*Labroides dimidiatus*	10.8	6.2	13.1	5.3	6.6	2.5	2.5	3.5	13	5.6	8.3	4.9	6.6	3.3	7.1	5.4
Labridae	*Labroides pectoralis*	0	0.2	0	0	3.2	2	0	0	0.4	0.1	3.9	2.6	3.9	2.4	0.2	0.3
Labridae	*Labropsis australis*	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0
Labridae	*Labropsis xanthonota*	0	0.1	0	0	0.1	1.2	0	0	0	0	0.8	0.7	0.1	0.3	0	0
Labridae	*Macropharyngodon meleagris*	0	0	0	0	0.1	0.3	0	0	0	0	0.5	0.2	0.1	0.5	0	0.1
Labridae	*Macropharyngodon ornatus*	2.7	0.9	0.2	0.3	0.1	0	0	0	16	9	0	0	0	0	0.9	1.5
Labridae	*Novaculichthys taeniourus*	0	0	0	0.1	0	0	0	0	0.1	0.1	0	0	0	0	0	0.1
Labridae	*Oxycheilinus bimaculatus*	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Labridae	*Oxycheilinus digrammus*	1.1	1	4.9	2.5	0.2	0.3	0	0	1.1	2.6	0.1	0.1	0	0.2	0.5	0.7
Labridae	*Oxycheilinus orientalis*	0.6	0	3.1	0	0.1	0	0	0	1	0	0.2	0	0.3	0	0.3	0

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Labridae	*Oxycheilinus unifasciatus*	0	0	0	0.5	0.2	0.1	0	0	0.1	0.1	0.2	0.3	0.1	0	0	0.1
Labridae	*Pseudocheilinus evanidus*	0	0	0	0	0	0	0	0	0	0	0	0.2	0.4	0.1	0	0.3
Labridae	*Pseudocheilinus hexataenia*	4.2	2.4	10.8	9.7	1.8	3.1	0	0	7.4	3	1.6	3.3	2.3	1.7	3.1	2.8
Labridae	*Pseudocheilinus octotaenia*	0	0	0	0	0.6	0.8	0	0	0.1	0.2	0.4	0.5	0.2	0.4	0.4	0
Labridae	*Pseudocoris yamashiroi*	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0	0.4
Labridae	*Pseudodax moluccanus*	0	0.1	0	0.4	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0
Labridae	*Pteragogus enneacanthus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Labridae	*Pteragogus flagellifer*	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0
Labridae	*Pteragogus* spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Labridae	*Stethojulis bandanensis*	1.8	2.3	0	1.9	1.3	3.9	0	2	2.7	7.7	1.4	3	0.2	0.4	0.5	1
Labridae	*Stethojulis interrupta*	0.1	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0
Labridae	*Stethojulis strigiventer*	0	0	0	0	0	0.7	1	4	0	0	0	1.3	0	0	0	0
Labridae	*Stethojulis trilineata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0
Labridae	*Thalassoma amblycephalum*	9.3	6.6	2.4	6.1	149.9	76.9	0	0	11.5	5	68.5	51.9	147.5	95.9	67.6	76.1
Labridae	*Thalassoma hardwicke*	6.9	1.9	1.4	5.8	18.9	11.1	7	9.5	4.1	4.6	24.5	15.8	19.5	7	13.5	8.1
Labridae	*Thalassoma jansenii*	6	0.9	0	0.1	0	0	0	0	4.7	3.6	0	0	0	0.1	0	0
Labridae	*Thalassoma lunare*	11.2	12.9	27.2	20.1	0.4	0.1	0	0	11	19.8	0.5	0.1	0.1	0.3	5.5	5.2
Labridae	*Thalassoma lutescens*	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0
Labridae	*Thalassoma quinquevittatum*	0.3	0.7	0	0.5	12.5	11.6	0	0	0.1	4.2	5.6	13.2	14.4	15.6	0.7	13.1
Lethrinidae	*Gnathodentex aureolineatus*	0	0	0	0	2.2	1.5	0	0	0	0	0	0	0	9.2	11.5	10.5
Lethrinidae	*Lethrinus atkinsoni*	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2
Lethrinidae	*Lethrinus erythracanthus*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
Lethrinidae	*Lethrinus erythropterus*	0.2	0.2	0	0.3	0.9	0.9	0	22.5	0	0.1	0.4	0.8	0.2	0.7	1.7	0.1
Lethrinidae	*Lethrinus obsoletus*	0	0.3	0	0.2	0.1	0	0	0	0	0	0	0	0	0.1	1.7	0.5
Lethrinidae	*Lethrinus olivaceus*	0	0	0	0	1	0.2	0	0	0.5	0.2	0.4	0.1	0.2	1.1	1.7	0.4
Lethrinidae	*Lethrinus* spp.	0	0	0.4	0	0	0	0	0	0.8	0	0	0	0	0	0	0

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Lethrinidae	*Lethrinus xanthochilus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lethrinidae	*Monotaxis grandoculis*	1.5	3.9	5.5	5.9	0	0.1	0	0.5	0.8	3.5	0	0.2	0	0	1	0.9
Lethrinidae	*Monotaxis heterodon*	0	1.6	0	3.3	9.7	2.7	0	3.5	0	1	6.2	1.2	6.9	4.5	1.3	1.9
Lutjanidae	*Aphareus furca*	0	0	0	0	0.9	0.4	0	0	0	0.1	0.8	0.4	0.5	0.5	0	0.1
Lutjanidae	*Aprion virescens*	0	0	0	0	0	0	0	0	0.2	0	0.1	0	0	0	0.1	0
Lutjanidae	*Lutjanus bohar*	0.3	2.3	1.6	1.4	1.1	0.3	0	0	1.6	0.7	0.6	0.6	1.8	1.2	0.6	0.1
Lutjanidae	*Lutjanus decussatus*	1.2	3.8	1	3.5	5.5	3	0	10.5	1.4	1.9	3.8	2	8.1	4.1	44.2	15.5
Lutjanidae	*Lutjanus fulviflamma*	0	0	0.9	3.6	0	0	0	0	0	0.1	0	0	0	0	0	0
Lutjanidae	*Lutjanus fulvus*	0.1	8.2	0.4	0.9	0	0	0	0	0	0	0	0	0	0	0	0
Lutjanidae	*Lutjanus gibbus*	11.8	19.6	0	9.2	2.5	0.2	0	0	1	5.8	0.5	0.7	0.9	0.6	6.8	15.7
Lutjanidae	*Lutjanus kasmira*	0	1.8	0	0	7.5	6.6	0	0	1.5	0	0	0	0.9	3.1	0	0
Lutjanidae	*Lutjanus lemniscatus*	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lutjanidae	*Lutjanus monostigma*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0
Lutjanidae	*Lutjanus quinquelineatus*	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Lutjanidae	*Lutjanus rivulatus*	0	0	0	0	0	0	0	0	0	0	0	0.1	0.2	0.1	0	0
Lutjanidae	*Lutjanus* spp.	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0
Lutjanidae	*Macolor macularis*	0	0	0	0	0.4	0	0	0	0.1	0	0	0	0.3	0.1	0.1	0
Lutjanidae	*Macolor niger*	0	1.3	0.5	0.2	0.2	0.4	0	0	0.3	0.5	0.2	0.6	1.4	1.6	1.1	0.5
Lutjanidae	*Symphorichthys spilurus*	0	0.1	0	0	0.2	0.1	0	0	0	0	0.3	0.3	0.1	0.1	0.3	0.1
Malacanthidae	*Hoplolatilus starcki*	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0
Malacanthidae	*Malacanthus brevirostris*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0
Malacanthidae	*Malacanthus latovittatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microdesmidae	*Nemateleotris magnifica*	0	0	0	0	0.2	0.2	0	0	0.3	0.3	0.3	0.4	0.3	0.5	1.4	1.9
Microdesmidae	*Ptereleotris evides*	6.3	0.3	37.5	0	0.4	0.3	0	0	2.3	1.1	0.1	0.3	0.1	1.1	6.5	2.7
Microdesmidae	*Ptereleotris microlepis*	0	0	0	0	0	0.2	0	0	0	0	0	0.2	0.6	0	0	0
Microdesmidae	*Ptereleotris* spp.	0	0	37.5	0	0	0	0	0	0	0	0	0	0	0	1.5	0

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Microdesmidae	*Ptereleotris zebra*	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0
Monacanthidae	*Aluterus scriptus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monacanthidae	*Amanses scopas*	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monacanthidae	*Cantherhines dumerilii*	0.1	0	0	0	0	0	0	0	0.1	0	0	0	0	0.1	0	0.1
Monacanthidae	*Cantherhines pardalis*	0	0	0	0	0.1	0	0	0	0.3	0.6	0	0	0	0	0.1	0
Monacanthidae	*Oxymonacanthus longirostris*	0	0.6	0	0.4	0.2	0.6	1	2	0.1	0.5	0.2	0.4	0.1	0.6	0.3	0
Monacanthidae	*Paraluteres prionurus*	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mullidae	*Mulloidichthys flavolineatus*	2	0.2	0	0.6	1	0.5	0	0	0.3	0.2	0	0.4	0	0	0	0
Mullidae	*Mulloidichthys vanicolensis*	0	0	6.2	0	0	0	0	0	2	0	0.8	0	0	0	0.4	0
Mullidae	*Parupeneus barberinoides*	0.1	0	0.5	0.1	0	0	0	0	0	0	0	0	0	0	0.7	0
Mullidae	*Parupeneus barberinus*	3.4	2.2	3.9	2.5	1.9	0.1	1.5	0	0.3	0.1	0.4	0.1	0.5	0.2	0.2	0.3
Mullidae	*Parupeneus ciliatus*	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0
Mullidae	*Parupeneus crassilabris*	0	0	0	0	0.3	0.1	0	0	0	0.3	6.4	0	1.5	0.5	0.3	0.1
Mullidae	*Parupeneus cyclostomus*	0	0	0	0	0	0	0	0	0.5	0.1	0	0	0	0	0.1	0.1
Mullidae	*Parupeneus multifasciatus*	1.1	2.1	3.1	2.4	0	0.2	0	0.5	8.2	5.4	0.1	0.1	0.5	0.3	1.6	0.5
Mullidae	*Parupeneus pleurostigma*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mullidae	*Upeneus tragula*	0.6	0.2	0.4	0	0	0	0	0	0	0	0	0	0	0	0	0
Muraenidae	*Gymnomuraena zebra*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Muraenidae	*Gymnothorax buroensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Muraenidae	*Gymnothorax flavimarginatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Muraenidae	*Gymnothorax javanicus*	0	0.1	0	0	0	0	0	0	0	0	0	0.1	0	0	0.2	0
Nemipteridae	*Pentapodus emeryii*	0.1	0.1	0	0	0	0	0	0	0.1	0	0	0	0	0	0.3	0
Nemipteridae	*Scolopsis affinis*	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nemipteridae	*Scolopsis bilineata*	0.8	0	1.4	0.8	2.2	1.7	1.5	0	0.6	0.6	1.3	0.9	1.4	1.1	0.7	0.5
Nemipteridae	*Scolopsis margaritifer*	4.5	3	6.6	2.5	0	0	0	0	0	0.8	0	0	0	0	0.3	0.1
Nemipteridae	*Scolopsis trilineata*	1.2	1.2	5.4	1.2	0.1	0	0	0	0	0.3	0	0.2	0	0	0	0

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Ostraciidae	*Ostracion cubicus*	0	0	0.1	0.1	0	0	0	0	0	0	0	0	0.1	0	0	0
Ostraciidae	*Ostracion meleagris*	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0.1	0
Pempheridae	*Pempheris oualensis*	0	0	0	0	0	0.3	0	0	0	0	0	1	0	0.1	0.3	0.1
Pempherididae	*Parapriacanthus ransonneti*	0	0	0	0	0	0	0	0	13.6	0	22.2	0	0	0.3	0	0
Pinguipedidae	*Parapercis clathrata*	2.3	1.1	0.1	0	0	0.1	0	0	1	1.2	0	0.2	0	0.1	0	0
Pinguipedidae	*Parapercis millepunctata*	0	0	0	0	0.1	0	0	0	0	0	0.2	0	0	0	0	0
Pinguipedidae	*Parapercis pacifica*	0.3	0	1.4	0.5	0	0	0	0	0.3	0.1	0	0	0	0	0.4	0
Plesiopidae	*Calloplesiops altivelis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pomacanthidae	*Apolemichthys trimaculatus*	0	0	0	0	0	0.1	0	0	0.5	0.3	0.2	0	0.1	0	0	0.1
Pomacanthidae	*Centropyge bicolor*	0.1	0.2	0.1	0.2	0	0	0	0	0.5	0.4	0	0	0	0	1.5	1.4
Pomacanthidae	*Centropyge bispinosa*	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0.1	0	0.1
Pomacanthidae	*Centropyge eibli*	0	0	0	0	1.7	1.2	0	0.5	0	0	1.4	1.8	1.2	1.1	0	0.1
Pomacanthidae	*Centropyge tibicen*	0.2	0.2	0.9	0.1	0	0	0	0	0.2	0.1	0	0	0	0	0	0
Pomacanthidae	*Centropyge vrolikii*	2.2	2.8	2.1	3.1	0	0	0	0	5.5	5	0.1	0	0	0	3.3	1.8
Pomacanthidae	*Chaetodontoplus mesoleucus*	0	0	0.4	0.3	0	0	0	0	0	0	0	0	0	0	0	0
Pomacanthidae	*Pomacanthus imperator*	0	0.2	0.1	0	0	0	0	0	0.2	0.1	0	0	0	0	0	0
Pomacanthidae	*Pomacanthus navarchus*	0	0	0	0	0.3	0.2	0	0	0	0	0.4	0.1	0.7	0.4	0	0.1
Pomacanthidae	*Pomacanthus sexstriatus*	0	0.2	0	0	0.2	0.1	0	0	0.1	0.1	0	0.1	0.1	0.1	0	0.1
Pomacanthidae	*Pomacanthus xanthometopon*	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0
Pomacanthidae	*Pygoplites diacanthus*	0.3	0.8	1.4	2.3	0.3	0.2	0	0	0.7	0.5	0.3	0.4	0.8	0.7	1	0.4
Pomacentridae	*Abudefduf sexfasciatus*	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0
Pomacentridae	*Abudefduf vaigiensis*	4.7	6.3	1.1	4.8	4.1	0.4	0	0	0.8	14.1	0.6	5	5.1	1.3	11.7	4.7
Pomacentridae	*Acanthochromis polyacanthus*	7.5	1.2	22.2	5.6	0	0	0	0	7.7	4.9	0	0	0	0	0	3.8
Pomacentridae	*Amblyglyphidodon aureus*	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0.8	0.8	0.4
Pomacentridae	*Amblyglyphidodon batunai*	0	0.2	0	2.4	0	0	0	0	0	0	0	0	0	0	0	0
Pomacentridae	*Amblyglyphidodon curacao*	104.9	41.6	220.6	104.2	11.2	29.1	13.5	12	99.1	53.1	13	4.7	4.9	10.3	4.9	0.5

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Pomacentridae	*Amblyglyphidodon leucogaster*	3.5	0	2	0.9	0	0	0	0	0	0	0	0	0	0	0.4	0
Pomacentridae	*Amphiprion clarkii*	0	0	0	0	0.2	0.4	0	0	0.3	0.1	0.5	0.6	0.1	0	0	0.1
Pomacentridae	*Amphiprion frenatus*	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0
Pomacentridae	*Amphiprion ocellaris*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1
Pomacentridae	*Amphiprion perideraion*	0.3	0	0	0	0.2	0.4	0	0	0	0	0.3	0	0.3	0.7	0.1	0
Pomacentridae	*Chromis alpha*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.2	0	0
Pomacentridae	*Chromis amboinensis*	0	0	0	0.5	8.1	5.1	0	0	0	0	0	0	3.6	7.3	0	0
Pomacentridae	*Chromis atripectoralis*	11	2.6	3.8	12.8	5	3.1	0	0	0.8	2.4	0	0	2	0.3	0	0
Pomacentridae	*Chromis atripes*	0.1	1.8	0.1	2	12	35.2	0	0	0	0.3	1.6	15.8	12.6	15.1	3.2	5.7
Pomacentridae	*Chromis lepidolepis*	2.5	0.3	10	15.2	0	0	0	0	0	2.2	0	2.6	0.3	21.5	38.6	7.1
Pomacentridae	*Chromis lineata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pomacentridae	*Chromis margaritifer*	3	30.7	6.6	17.5	120.8	40.8	0	0	78.6	109.8	93.1	268.8	107.8	91.7	58.1	141.8
Pomacentridae	*Chromis ternatensis*	12.1	86.6	3.8	32.8	44.1	55.1	0	0	40	31.1	6.6	1.5	7.7	9	64.4	5
Pomacentridae	*Chromis viridis*	7.1	45.9	17.9	340.4	204.7	224.2	405	0	0	3.3	178.9	88.9	57.6	54.3	25.3	0.8
Pomacentridae	*Chromis weberi*	12	116.5	76.5	65.5	8.3	75.3	0	0	286.6	159	118.3	162.4	4.1	10.4	11.8	76.9
Pomacentridae	*Chromis xanthochira*	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0	0	0
Pomacentridae	*Chromis xanthura*	0	1.2	0	3.6	5.4	0.7	0	0	3.7	1.3	3.6	0	5.4	6.7	27.4	7.8
Pomacentridae	*Chrysiptera biocellata*	0	0	0	0.3	2.6	3.4	0	13	0	0.1	1.6	8	0	0.3	16.4	3.1
Pomacentridae	*Chrysiptera brownriggii*	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0.1
Pomacentridae	*Chrysiptera cyanea*	0.1	0.2	0	0.9	52.9	28.9	0	3	0	0.7	119.6	73.4	9.4	5.8	8.8	1.6
Pomacentridae	*Chrysiptera hemicyanea*	1.7	4	38.2	6.7	10.5	3.7	0.5	0	0	0	5.9	1.5	7.1	1.1	0.5	0
Pomacentridae	*Chrysiptera rex*	0.5	4.1	1.1	6.7	0	0	0	0	8.8	11	0	0	0	0	97	106.6
Pomacentridae	*Chrysiptera talboti*	2.3	1.2	0.9	2.9	0	0	0	0	0.1	0	0	0	0	0	0	0
Pomacentridae	*Dascyllus aruanus*	14.2	76.8	23	63.2	62.7	90.1	111.5	395.5	1.7	12.7	53.8	41.5	50.2	15.1	6.9	3.8
Pomacentridae	*Dascyllus reticulatus*	6.9	15.6	6.5	24.4	0.3	2.9	0	0	1.6	5.5	0.9	3.1	2.9	1.3	10.5	49.1
Pomacentridae	*Dascyllus trimaculatus*	4.5	10.4	0.6	4.5	1.4	0.8	0	0	0.3	1.2	0.8	0.5	2.1	1.2	16.3	2.6

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Pomacentridae	*Dischistodus melanotus*	1	0.6	1.1	2.7	0	0	0	0	0.3	0.5	0	0	0	0	0	0
Pomacentridae	*Dischistodus perspicillatus*	4.6	1	17.1	7.1	2.5	7.4	3.5	9	0	0.1	3.3	0.7	0.7	1.7	0.1	0.3
Pomacentridae	*Dischistodus prosopotaenia*	0	0.3	3.5	1.5	0.3	0.1	2	0.5	0	0.5	0	0	0.2	1.3	0	0
Pomacentridae	*Dischistodus pseudochrysopoecilus*	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pomacentridae	*Hemiglyphidodon plagiometopon*	3.1	2.2	1.4	0.2	2	1	23.5	2	0	0	4	1.2	0	0.1	0	0
Pomacentridae	*Neoglyphidodon melas*	4.4	6.9	11.5	13.8	0	0	0	0	0.9	1.8	0	0	0	0	0.1	0.2
Pomacentridae	*Neoglyphidodon nigroris*	10.1	2.8	14.4	9.7	0	0	0	0	23.3	9.6	0	0	0	0	0	0
Pomacentridae	*Neoglyphidodon oxyodon*	0	0	0	1.8	0	0	0	0	0	0	0	0	0	0	0	0
Pomacentridae	*Neopomacentrus azysron*	0	0.2	20.9	0	0	0	0	0	2.3	0.1	0	0	0	0	0	0
Pomacentridae	*Plectroglyphidodon dickii*	1.2	0.8	0	0.4	1.8	1.1	0	0	1.3	1.7	4.6	5.7	0.8	1.5	4.1	0.6
Pomacentridae	*Plectroglyphidodon johnstonianus*	0.2	0.2	0	0	1.1	0.6	0	0	2.4	1.7	1.7	0.2	0	0.1	0.6	0.1
Pomacentridae	*Plectroglyphidodon lacrymatus*	4	6.3	6.5	6.6	0	0	0	0	6.6	34.7	0	0	0	0.9	7.3	13.8
Pomacentridae	*Pomacentrid* sp. (NWS GJE)	0	0	0	0	0	0	0	0	0	0	5.6	0	0	0	0	0
Pomacentridae	*Pomacentrus adelus*	91.8	72.9	55.5	74.6	39.8	39.4	26.5	203.5	6.2	14.5	11.3	5.6	11.1	16.9	5.4	54.9
Pomacentridae	*Pomacentrus alexanderae*	2.5	1.7	7.6	6.1	0	0	0	0	0	0	0	0	0	0	0	0
Pomacentridae	*Pomacentrus amboinensis*	47.3	13.2	31.9	10.5	0	0	0	0	0.3	1.2	0	0	0	0	30.3	14.5
Pomacentridae	*Pomacentrus auriventris*	0	0	0	2.3	0	0	0	0	0	0	0	0	0	0	0	0
Pomacentridae	*Pomacentrus bankanensis*	23.3	28.1	14.2	5.9	1.6	9.8	0	1.5	3.2	9	0.5	17.9	8	1.9	7.6	28.9
Pomacentridae	*Pomacentrus chrysurus*	0.7	0.1	0	3.3	0	0	0	0	0	0.4	0	0	0	0	2	0
Pomacentridae	*Pomacentrus coelestis*	188.9	32.1	5.2	18.6	7.2	9.1	0	0	525.4	108.9	63.6	27	6.6	19.8	0.3	2.1
Pomacentridae	*Pomacentrus grammorhynchus*	0	0	0	0	2.2	4.3	31.5	11.5	0	0	0.6	1.1	0.1	0.6	0	0
Pomacentridae	*Pomacentrus lepidogenys*	70.7	120.2	15.2	129.3	0	0	0	0	76.9	59.8	0	0	0	0	133.9	122.1
Pomacentridae	*Pomacentrus moluccensis*	8.4	2.4	5.9	6.4	39.8	51.4	0	0.5	1.4	0.9	51.3	27.2	50.9	16.5	18	12.8
Pomacentridae	*Pomacentrus nigromarginatus*	0	0	0	0	0	0	0	0	0	0	0	0	4.9	9.2	0	0
Pomacentridae	*Pomacentrus pavo*	44.4	49.5	34.4	50.1	30.4	47.3	9	55	0.1	2	14.1	12.9	42.8	16.1	10.1	5
Pomacentridae	*Pomacentrus philippinus*	7	16.5	8.2	20	60.8	61.8	0	0	4.8	4.4	140.1	105.8	137.3	122.2	79.6	173.2

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Pomacentridae	*Pomacentrus vaiuli*	1.2	7.2	4.9	7.2	98.5	88.6	0	0	28.3	28.7	92	132.5	187.3	92.5	27.7	31.8
Pomacentridae	*Pomachromis richardsoni*	0	0	0	0	119.4	18.1	0	0	0	0.1	128.1	64.8	160.9	29.5	1.8	0.6
Pomacentridae	*Stegastes fasciolatus*	0.5	2.3	0	5.5	0.4	0.2	0	0	0	1.3	0.8	1.3	1.4	2.5	1	1
Pomacentridae	*Stegastes nigricans*	1.1	0	0.2	1.8	12.7	9.1	20	25	1	4	57.4	17.1	5.7	5.9	2	11.1
Pomacentridae	*Stegastes punctatus*	0	0	0	0	9.1	5.9	84	0	0	0	1.7	0	0.5	0.2	0	0
Pseudochromidae	*Labracinus cyclophthalmus*	0.2	0	0	0.2	0	0	0	0	0	0.3	0	0	0	0	0	0.1
Pseudochromidae	*Manonichthys splendens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0
Pseudochromidae	*Pictichromis paccagnellae*	0	0	0	0	0.1	0.1	0	0	0	0	0	0	0.7	1	0	0
Pseudochromidae	*Pseudochromis bitaeniatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0
Pseudochromidae	*Pseudochromis cyanotaenia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0
Pseudochromidae	*Pseudochromis fuscus*	0.3	0.8	0.9	1.5	0.8	1	0.5	4.5	0.4	0	0.7	0.1	0.4	0.7	0.6	0.2
Scaridae	*Bolbometopon muricatum*	0	0	0	0	0.2	0.1	0	0	0	0	0.4	0.2	0	0.1	0.5	0
Scaridae	*Calotomus carolinus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Scaridae	*Calotomus spinidens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scaridae	*Cetoscarus bicolor*	0.1	0	0.2	0	1.2	0	0	0	0.4	0	0.3	0	0.8	0	0.4	0
Scaridae	*Cetoscarus ocellatus*	0	0	0	0.3	0	0.4	0	0	0	0.6	0	0.2	0	0.5	0	0.6
Scaridae	*Chlorurus bleekeri*	2.2	0	1.4	0.4	0.8	0	0	0	1.2	0.8	0	0	0.7	0.7	0	0.1
Scaridae	*Chlorurus microrhinos*	0	0.4	0.2	0.1	4.1	1.7	1	0	0.5	0.6	2.6	2.8	8.1	3.2	2.1	0.8
Scaridae	*Chlorurus rhakoura*	0	0	0	0	0	0.3	0	0	0	0	0	0.1	0	0	0	0
Scaridae	*Chlorurus sordidus*	44.3	20.5	36.9	47.6	14.7	28.3	35.5	41.5	15.7	26	13.4	24	8.8	11.1	22.6	38.9
Scaridae	*Hipposcarus longiceps*	6.4	2	2.9	8.6	2.2	2.3	0	7.5	1	1.9	0.5	1.5	0.7	0.9	0.1	1.4
Scaridae	*Scarus altipinnis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scaridae	*Scarus chameleon*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scaridae	*Scarus dimidiatus*	0.1	0.4	0.1	0.8	7.5	7.3	19.5	6.5	0.6	0.8	3.8	6.1	2.4	1.3	0	0.7
Scaridae	*Scarus flavipectoralis*	0.6	0.9	2.1	1.5	0	0	0	0	0	0	0	0	0	0.3	0	0.1
Scaridae	*Scarus forsteni*	0	0	0	0	0.2	1.8	0	0	0.2	2.7	0.2	0.1	0.5	1	0	0.2

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Scaridae	*Scarus frenatus*	0.2	0	0.1	0.2	0.5	1.1	0	0.5	0.2	1.6	0.4	0.5	0.8	0.3	0.1	0.8
Scaridae	*Scarus ghobban*	0	0.1	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Scaridae	*Scarus globiceps*	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0	0.1	0
Scaridae	*Scarus niger*	1.5	2.6	1.5	4.7	0.2	0.9	0	0	3	1.6	0.1	0	0.3	1.4	1.2	2.1
Scaridae	*Scarus oviceps*	0.2	0.1	0	0.1	2.8	1	10	17.5	0	0	1.2	1.8	0.4	0	0	0.1
Scaridae	*Scarus prasiognathos*	0.2	0	0.1	0.2	2.4	2	5.5	7	0.4	0	0.3	3.8	0.3	0.5	1.4	0.1
Scaridae	*Scarus psittacus*	1	0	0	0	0	0	0	0	0	0	0	0.4	0	0.2	0.3	0.2
Scaridae	*Scarus rubroviolaceus*	0	0	0	0	0	0	0	0	0	0.4	0	0	0.1	0.1	0.4	0.6
Scaridae	*Scarus schlegeli*	0.1	0	4.1	1.2	0	0.5	0	0.5	0	0.9	0	0.1	0.4	1.2	0.1	0.5
Scaridae	*Scarus spinus*	0	0	0	0	0.1	0.1	0	0	0.2	0.3	0	0.1	0	0	0.1	0
Scaridae	*Scarus* spp.	0	3	0.1	3.5	9.1	0	10.5	2	0.4	4.3	1.6	1.3	1.9	0.2	0.8	14.1
Scombridae	*Grammatorcynus bilineatus*	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0
Scombridae	*Gymnosarda unicolor*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scombridae	Scombrid spp.	0	0	0	0	0	0	0	0	0	0	0	0	0.9	0	0	0
Scorpaenidae	*Pterois antennata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scorpaenidae	*Pterois volitans*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Serranidae	*Aethaloperca rogaa*	0.4	0.3	0.2	0.1	0.1	0.1	0	0	0.8	0.4	0.2	0	0	0.2	0.3	0.3
Serranidae	*Anyperodon leucogrammicus*	0	0.1	0.1	0.1	0	0.1	0	0	0	0	0.2	0.2	0.1	0.1	0.5	0
Serranidae	*Belonoperca chabanaudi*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Serranidae	*Cephalopholis argus*	0.8	1.8	1.1	4	2.7	2.4	0	4	2.2	1.4	3.2	3.1	4.2	5.7	1.9	3.1
Serranidae	*Cephalopholis cyanostigma*	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Serranidae	*Cephalopholis leopardus*	0	0.2	0.1	0	0	0.1	0	0	0	0.2	0	0.3	0	0	0.2	0.4
Serranidae	*Cephalopholis miniata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Serranidae	*Cephalopholis sexmaculata*	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0
Serranidae	*Cephalopholis sonnerati*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Serranidae	*Cephalopholis urodeta*	0.4	0.1	0	0	0.5	0.4	0	0	1.6	1.1	1.4	1.7	0.1	0.6	1.7	1.3

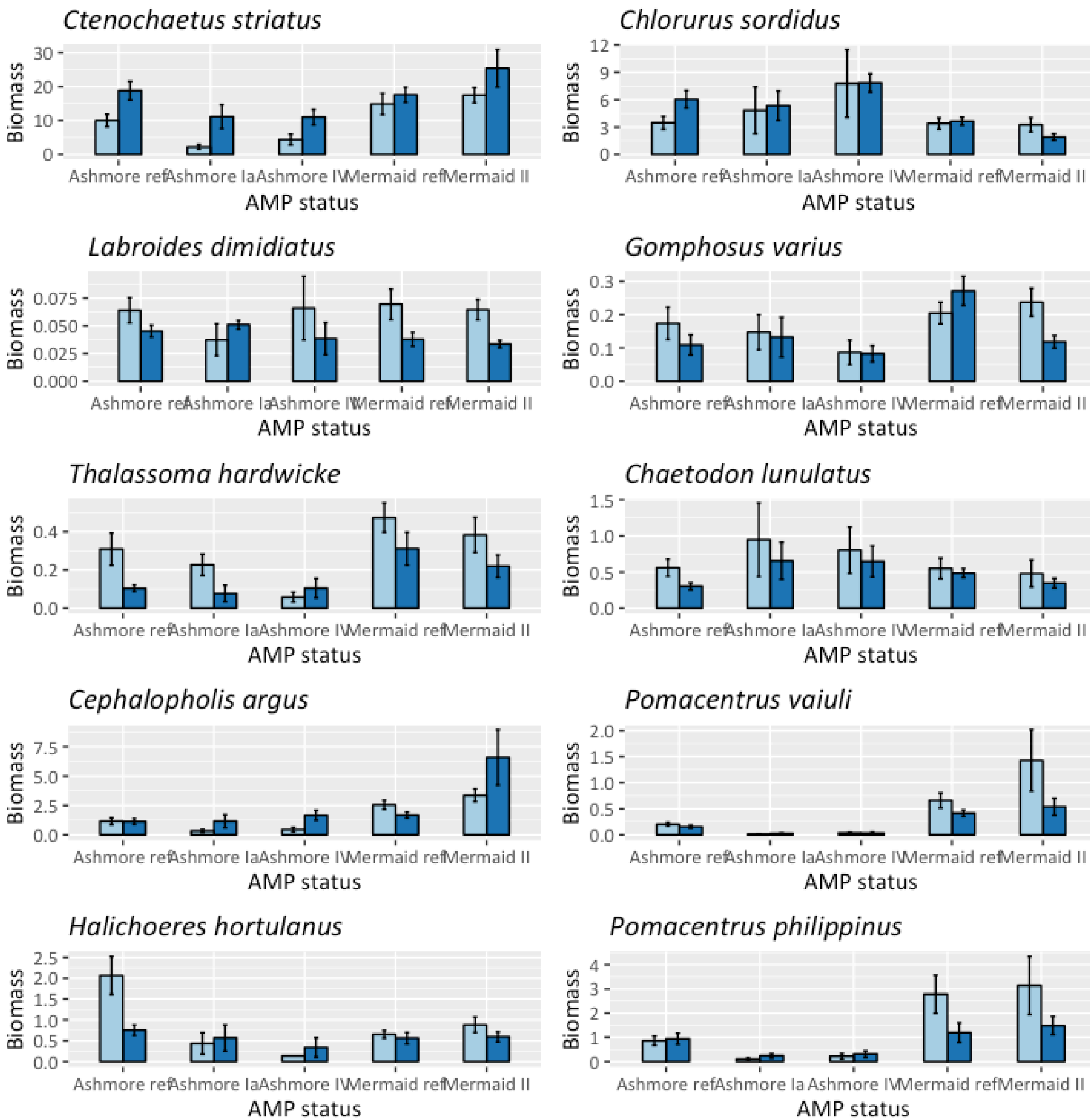
FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Serranidae	*Epinephelus fasciatus*	0	0	0	0	0	0	0	0	0	0	0.3	0.4	0	0	0	0
Serranidae	*Epinephelus hexagonatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Serranidae	*Epinephelus merra*	0.4	0.8	0.4	0.8	0.8	2.4	0.5	4	0.1	0.2	0.5	5.7	0.4	0.7	3.2	2.4
Serranidae	*Epinephelus ongus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Serranidae	*Epinephelus polyphekadion*	0	0	0	0	0.3	0.2	1.5	0	0	0	0.4	0.1	0.2	0.2	0	0.1
Serranidae	*Epinephelus spilotoceps*	0	0	0	0	0.1	0	0	0	0	0	0.3	0.1	0.1	0	0	0.1
Serranidae	*Epinephelus* spp.	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0
Serranidae	*Epinephelus tauvina*	0	0	0	0	0	0	0	0	0	0	0.1	0	0.1	0.1	0.1	0
Serranidae	*Epinephelus tukula*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Serranidae	*Gracila albomarginata*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
Serranidae	*Plectropomus areolatus*	0	0	0	0	0.4	0.3	2.5	4	0	0	0.5	1.1	0.3	0.3	0	0
Serranidae	*Plectropomus laevis*	0	0	0	0.1	0.1	0.1	0	0	0.2	0.5	0.8	0.1	0.6	0.2	0	0.1
Serranidae	*Plectropomus leopardus*	0	0.3	0.1	0.1	0	0	0	0	0.1	0	0	0	0	0	0.4	0.1
Serranidae	*Plectropomus oligacanthus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1
Serranidae	*Pseudanthias ?tuka*	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	37.5	0
Serranidae	*Pseudanthias huchtii*	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0
Serranidae	*Pseudanthias squamipinnis*	0	1.8	0	0	0	0	0	0	0	0	0	0	0	0	0.9	0
Serranidae	*Pseudanthias tuka*	0	0	0	0	75.4	178.2	0	0	0	0	12.8	10.1	16.8	15.3	0	94.5
Serranidae	Serranid spp.	0	0.1	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0
Serranidae	*Variola albimarginata*	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0.1
Serranidae	*Variola louti*	0	0	0	0	0	0	0	0	0	0.1	0.1	0	0.1	0.1	0	0
Siganidae	*Siganus argenteus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0.1
Siganidae	*Siganus corallinus*	0	0	0	0	0	0.1	0	0	0	0	0	0.1	0.1	0	0.1	0
Siganidae	*Siganus doliatus*	0	0.4	0.6	0.7	0.4	0.7	0	9	0	0	0.2	0.3	0.1	0.1	0	0
Siganidae	*Siganus puellus*	0.1	0.9	0	1.3	0.5	0.5	4	12.5	0.1	0.4	0.7	1.7	0.5	0.3	0.1	0.5
Siganidae	*Siganus punctatus*	0	0	0	0.3	0.2	0.1	0	52	0	0	0.1	0.4	0.3	0.2	0	0.1

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Siganidae	*Siganus vulpinus*	0	0	0	0.4	0.8	0.4	0	0	0.1	0.1	0.8	1.1	1.4	0.7	0.2	0.2
Sphyraenidae	*Sphyraena flavicauda*	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0
Sphyraenidae	*Sphyraena* spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Synanceiidae	*Corythoichthys conspicillatus (cf)*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Syngnathidae	*Corythoichthys flavofasciatus (cf)*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Syngnathidae	*Corythoichthys schultzi*	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0
Syngnathidae	*Corythoichthys* sp. [10 RK]	0	0	0	0	0	0.3	0	0	0	0	0.1	0	0	0	0	0
Syngnathidae	*Syngnathid spp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Synodontidae	*Saurida gracilis*	0	0	0.4	0	0	0	0	0	0.2	0	0	0	0	0	0	0
Synodontidae	*Saurida nebulosa*	0	0	0	0	0.1	0.1	0	0	0	0	0	0.1	0	0	0	0
Synodontidae	*Synodus binotatus*	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Synodontidae	*Synodus dermatogenys*	0	0	0.1	0	0	0.2	0	0	0.1	0	0	0.2	0	0	0.3	0
Synodontidae	*Synodus jaculum*	0	0	0	0	0	0	0	0	0.1	0	0.1	0	0	0	0.2	0.2
Synodontidae	*Synodus variegatus*	0.2	0.2	0.1	0.3	0.1	0.1	0	0	0.2	0.4	0	0	0	0.1	0	0.1
Tetraodontidae	*Arothron hispidus*	0	0	0	0	0.1	0.1	0	0	0	0	0	0.1	0	0.1	0.1	0
Tetraodontidae	*Arothron nigropunctatus*	0.1	0.1	0	0	0.1	0.1	0	0	0	0.1	0	0.6	0.1	0.8	0	0
Tetraodontidae	*Arothron stellatus*	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0
Tetraodontidae	*Canthigaster bennetti*	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0
Tetraodontidae	*Canthigaster janthinoptera*	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tetraodontidae	*Canthigaster papua*	0	0	0	0	0.3	0.9	0	0	0	0	0.1	0.4	0	0.5	0.4	0.5
Tetraodontidae	*Canthigaster valentini*	0.2	0.2	1	1.1	0.1	0	0	0	0.5	0.5	0	0	0	0	0	0
Tripterygiidae	*Helcogramma chica*	0	0	0	0	0	0.4	0	0	0	0	0	1.4	0.3	0.7	0	0
Tripterygiidae	*Helcogramma* sp. [orange scales]	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0
Tripterygiidae	*Helcogramma striatum*	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0
Tripterygiidae	*Ucla xenogrammus*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
Zanclidae	*Zanclus cornutus*	0.1	1.2	2	0.6	2	1.3	0	0	1.9	1.8	1.2	0.7	4	3.1	1.9	1.6

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Carcharhinidae	*Carcharhinus amblyrhynchos*	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0.1	0	0
Carcharhinidae	*Carcharhinus* spp.	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Carcharhinidae	*Triaenodon obesus*	0	0.2	0	0	0.1	0.1	0	0	0	0	0.1	0	0.1	0.3	0	0
Dasyatidae	*Neotrygon kuhlii*	0.2	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0
Dasyatidae	*Pastinachus atrus*	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dasyatidae	*Taeniura lymma*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ginglymostomatidae	*Nebrius ferrugineus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Myliobatidae	*Aetobatus ocellatus*	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0
Myliobatidae	*Manta alfredi*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stegostomatidae	*Stegostoma fasciatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cheloniidae	*Chelonia mydas*	0.7	0	0.6	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Elapidae	*Aipysurus duboisii*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0
Elapidae	*Emydocephalus annulatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1
Hydrophiidae	*Aipysurus laevis*	0	0	0	0	0	0	0	0	0.5	0.7	0	0	0	0	0.3	0.4

APPENDIX 3. FISH BIOMASS BY SPECIES

Biomass of 10 most frequently encountered reef fish species at Ashmore Reef Marine Parks, Mermaid Reef Marine Parks and reference sites in the North-west bioregion. Error Bars = 1 SE.



APPENDIX 4. MACROINVERTEBRATE SPECIES LIST

Average number of each invertebrate species recorded along 100 m^2 transects with method 2, in 2013 and 2018.

CLASS	FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
			13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Asteroidea	Echinasteridae	*Echinaster luzonicus*	0	0	0.1	0	0	0.1	0	0	0	0	0	0	0	0	0.1	0.1
Asteroidea	Goniasteridae	*Fromia milleporella*	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Asteroidea	Goniasteridae	*Fromia monilis*	0	0	0.1	0	0.1	0.1	0	0	0	0	0	0.1	0.2	0.4	0	0.4
Asteroidea	Goniasteridae	*Fromia nodosa*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
Asteroidea	Goniasteridae	*Neoferdina cumingi*	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0
Asteroidea	Goniasteridae	*Neoferdina offreti*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
Asteroidea	Ophidiasteridae	*Celerina heffernani*	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0
Asteroidea	Ophidiasteridae	*Linckia guildingi*	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asteroidea	Ophidiasteridae	*Linckia laevigata*	1.7	3.2	1.9	2.5	0.4	0.6	0	0	0	0.1	0	0.4	0	0	0	0.1
Asteroidea	Ophidiasteridae	*Linckia multifora*	0	0	0	0	0.1	1.4	0	0	0	0.3	0	0	0	0.5	0	0.3
Asteroidea	Oreasteridae	*Choriaster granulatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0
Asteroidea	Oreasteridae	*Culcita novaeguineae*	0	0	0	0	0	0.1	0	0.5	0	0	0.1	0.2	0.1	0.1	0	0.1
Bivalvia	Ostreidae	*Alectryonella plicatula*	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0	0	0
Bivalvia	Spondylidae	*Spondylus varius*	0	0	0	0	0	0	0.5	0	0	0	0	0	0.1	0	0	0
Bivalvia	Tridacnidae	*Hippopus hippopus*	0.1	0	0	0.1	0.1	0.1	0	0	0.1	0	0	0	0	0	0	0
Bivalvia	Tridacnidae	*Tridacna crocea*	0.5	1.5	0.1	3.3	33.9	30.6	0	0	0.9	2.4	11.7	26.3	11.2	12	2.7	4
Bivalvia	Tridacnidae	*Tridacna derasa*	0	0	0	0	0	4.1	0	0.5	0	0	0.1	0.2	0.2	1.2	0	0
Bivalvia	Tridacnidae	*Tridacna gigas*	0	0.3	0	0	0.8	0.1	0.5	0	0.1	0	0.1	0.2	0.5	0.1	0	0
Bivalvia	Tridacnidae	*Tridacna maxima*	0.4	0.2	0.4	0.2	10.6	9.6	0	0	1.8	0.6	8.1	16.4	7.1	10.9	0.9	0.8
Bivalvia	Tridacnidae	*Tridacna squamosa*	0	0.4	0	0.3	3.2	1.1	0	0	0.6	0.8	1	0.6	3.3	1.3	0	0.3
Crinoidea		Crinoidea spp.	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0
Crinoidea	Colobometridae	*Colobometra perspinosa?*	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0
Crinoidea	Comasteridae	*Comanthus parvicirrus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0

CLASS	FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
			13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Crinoidea	Comasteridae	*Comanthus* sp. (black)	0	0	0	0	0	0	0	0	0	0	0.2	0	0.1	0	0	0
Crinoidea	Comasteridae	*Comanthus* sp. *(cf schlegeli)*	0	0	0	0	0.1	0	0	0	0	0	0	0	0.2	0	0	0
Crinoidea	Comasteridae	*Comanthus* spp.	0	1.7	0	0.2	0.9	0.7	0	0	0.2	2	1.1	13.3	1.4	3.8	0.3	0.6
Crinoidea	Comasteridae	*Comasterid* sp. 1	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0
Crinoidea	Comasteridae	*Comasteridae* spp.	0.1	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0.2	0
Crinoidea	Comasteridae	*Oxycomanthus bennetti*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0.3	0.2
Echinoidea	Cidaridae	*Eucidaris metularia*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
Echinoidea	Cidaridae	*Phyllacanthus imperialis*	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0
Echinoidea	Echinometridae	*Echinometra mathaei*	0.3	0.2	0	0.1	1.3	3.3	0	0	1.5	2.9	3.1	9.6	0.9	3.5	1.6	4.2
Echinoidea	Echinometridae	*Heterocentrotus mamillatus*	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0	0	0
Gastropoda		Nudibranch spp.	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Gastropoda	Buccinidae	*Latirus* spp.	0	0	0	0	0.1	0	0	0	0	0	0	0	0.1	0	0	0
Gastropoda	Buccinidae	*Pollia undosa*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
Gastropoda	Cerithiidae	*Cerithium echinatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2
Gastropoda	Cerithiidae	*Cerithium nodulosum*	0	0	0	0	0.1	0.1	0	0	0	0	0	0	0	0.4	0	0
Gastropoda	Chromodorididae	*Chromodoris elisabethina*	0	0	0	0	0.1	0	0	0	0	0	0	0	0.1	0	0	0
Gastropoda	Chromodorididae	*Chromodoris strigata*	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0.1	0	0
Gastropoda	Conidae	*Conus distans*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Gastropoda	Conidae	*Conus flavidus*	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0
Gastropoda	Conidae	*Conus imperialis*	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0
Gastropoda	Conidae	*Conus miles*	0	0	0.1	0	0	0.3	0	0	0	0.1	0.1	0.1	0.1	0.1	0	0
Gastropoda	Conidae	*Conus musicus*	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0.2	0	0
Gastropoda	Conidae	*Conus* spp.	0	0.1	0	0	0	0.1	0	0	0	0.2	0	0.1	0.1	0.1	0	0
Gastropoda	Conidae	*Conus vexillum*	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gastropoda	Cypraeidae	*Cypraea tigris*	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0.1	0	0
Gastropoda	Cypraeidae	*Monetaria caputserpentis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0
Gastropoda	Cypraeidae	*Monetaria moneta*	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0

CLASS	FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
			13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Gastropoda	Fasciolariidae	*Benimakia fastigium*	0	0	0	0	0	0.1	0	0	0	0	0	0.1	0	0.1	0	0
Gastropoda	Fasciolariidae	*Benimakia nodata*	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0.2	0	0
Gastropoda	Fasciolariidae	*Latirolagena smaragdula*	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0
Gastropoda	Fasciolariidae	*Latirolagena smaragdulus*	0	0	0	0	0	0	0	0	0	0	0	0.6	0	0	0	0
Gastropoda	Fasciolariidae	*Latirus polygonus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Gastropoda	Fasciolariidae	*Peristernia nassatula*	0	0	0	0	0.8	0.7	0	0	0	0	0	0.2	0.2	0.5	0	0
Gastropoda	Fasciolariidae	*Turrilatirus turritus*	0	0	0	0	0	0.1	0	0	0	0	0	0.1	0.1	0.2	0	0
Gastropoda	Haliotidae	*Haliotis* spp.	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0
Gastropoda	Lamellariidae	*Coriocella nigra*	0	0.2	0	0.4	0	0.1	0	0	0	0	0	0	0	0	0	0
Gastropoda	Muricidae	*Chicoreus microphyllus*	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0
Gastropoda	Muricidae	*Coralliophila neritoidea*	0	0	0	0	0	0.1	0	0	0	0.3	0	0	0	0	0	0
Gastropoda	Muricidae	*Drupa ricinus*	0	0	0	0	0	0.1	0	0	0	0.1	0	0	0	0.2	0	0
Gastropoda	Muricidae	*Drupa rubusidaeus*	0	0	0	0	0	0.4	0	0	0	0.2	0	0.1	0	0.3	0	0
Gastropoda	Muricidae	*Drupella cornus*	0	0.3	0	0	0.8	0.4	0	0	0	0.3	2.5	0.4	0.4	0.1	0	0.1
Gastropoda	Muricidae	*Drupella rugosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0
Gastropoda	Muricidae	*Mancinella echinata*	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0
Gastropoda	Muricidae	*Morula uva*	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0
Gastropoda	Phyllidiidae	*Phyllidia coelestis*	0	0	0	0	0	0	0	0	0	0.3	0	0	0	0	0	0.1
Gastropoda	Phyllidiidae	*Phyllidia elegans*	0	0.1	0	0	0.1	0.2	0	0	0	0	0	0.1	0.1	0.3	0	0
Gastropoda	Phyllidiidae	*Phyllidia varicosa*	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0
Gastropoda	Phyllidiidae	*Phyllidiella nigra*	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0
Gastropoda	Phyllidiidae	*Phyllidiella pustulosa*	0	0.1	0.1	0	0	0.1	0	0	0.1	0.8	0.1	0	0.1	0.1	0.1	0.1
Gastropoda	Plakobranchidae	*Thuridilla gracilis*	0	0.2	0	0.5	0	0	0.5	0	0	0.1	0	0	0	0	0	0
Gastropoda	Polyceridae	*Nembrotha kubaryana*	0.1	0.1	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0
Gastropoda	Strombidae	*Lambis truncata*	0	0	0	0	0.2	0.1	0	0	0	0	0	0.4	0	0	0	0
Gastropoda	Tegulidae	*Tectus virgatus*	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0
Gastropoda	Tethydidae	*Melibe viridis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.7

CLASS	FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
			13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Gastropoda	Trochidae	*Tectus niloticus*	0	0	0	0	0.1	0.1	0	0	0	0	0	0.2	0	0.5	0	0.1
Gastropoda	Trochidae	*Tectus pyramis*	0	0	0	0	0.1	0.1	0	0	0.1	0.4	0.2	0.6	0	0.1	0.1	0.4
Gastropoda	Turbinellidae	*Vasum turbinellus*	0	0	0	0	0.1	0	0	0	0	0	0	0.2	0	0.1	0	0.1
Gastropoda	Turbinidae	*Turbo argyrostomus*	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0.2	0	0
Holothuroidea	Holothuriidae	*Actinopyga miliaris*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
Holothuroidea	Holothuriidae	*Bohadschia argus*	0	0	0	0	0.2	0.4	0	0	0	0.1	0.1	0.3	0.5	0.3	0	0
Holothuroidea	Holothuriidae	*Bohadschia graeffei*	0.1	0.2	0.8	0	0.2	0.2	0	0	0.5	0.1	0.2	0.1	0.3	0.9	0	0
Holothuroidea	Holothuriidae	*Holothuria atra*	0	0.4	0	0.6	0.2	0.4	0	0	0	0.1	0.2	0.2	0.7	0.6	0	0.1
Holothuroidea	Holothuriidae	*Holothuria edulis*	0.3	0.4	0.4	0.1	0.4	0.4	0	0	0.1	0.2	0.1	0.5	0.4	1.1	0.1	0.3
Holothuroidea	Holothuriidae	*Holothuria leucospilota*	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0
Holothuroidea	Holothuriidae	*Holothuria* spp.	0	0.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Holothuroidea	Holothuriidae	*Holothuria whitmaei*	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0.2	0	0
Holothuroidea	Stichopodidae	*Stichopus chloronotus*	0	0.2	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0
Holothuroidea	Stichopodidae	*Stichopus* spp.	0	0	0	0.1	0	0.1	0	0	0	0	0	0	0	0	0	0
Holothuroidea	Stichopodidae	*Thelenota ananas*	0	0.1	0	0	0.2	0.2	0	0	0	0	0.1	0	0.2	0.2	0	0
Malacostraca		Paguroidea spp.	0.7	0.2	0	0.5	0.3	0	0	0	0.2	0.6	0.3	0	0.3	0	1	0.8
Malacostraca	Diogenidae	*Calcinus latens*	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0
Malacostraca	Diogenidae	*Calcinus lineapropodus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2
Malacostraca	Diogenidae	*Calcinus minutus*	0	0.8	0	0	0.1	0.3	0	0	0	1.5	0	0.1	0.1	0.1	0	0.4
Malacostraca	Diogenidae	*Calcinus morgani*	0	0	0	0	0.1	0	0	0	0	0.1	0	0	0.2	0.2	0	0.2
Malacostraca	Diogenidae	*Calcinus pulcher*	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0
Malacostraca	Diogenidae	*Calcinus* sp. [NWS]	0	0	0	0	0.1	0.1	0	0	0	0	0	0	0	0	0	0
Malacostraca	Diogenidae	*Calcinus* spp.	0	0	0	0	0	0.1	0	0	0	0	0	0	0.1	0.1	0	0.1
Malacostraca	Diogenidae	*Dardanus guttatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0
Malacostraca	Diogenidae	*Dardanus lagopodes*	0	0.1	0	0	0.2	0.3	0	0	0	0.3	0.3	0.3	0.1	0.1	0	0.1
Malacostraca	Diogenidae	*Dardanus* spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Malacostraca	Diogenidae	Diogenid sp. [white claw black blotch]	0	0	0	0	0.3	0	0	0	0	0	0.1	0	0	0	0	0

CLASS	FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
			13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Malacostraca	Paguridae	Pagurid spp.	0	0	0	0	0	0.7	0	0	0	0	0	0	0	0.1	0	0
Malacostraca	Paguridae	*Paguritta vittata*	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0
Malacostraca	Palinuridae	*Panulirus versicolor*	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0
Malacostraca	Trapeziidae	*Trapezia rufopunctata*	0	0	0	0	0.1	0	0	0	0	0	0.2	0	0.4	0	0.1	0
Malacostraca	Trapeziidae	*Trapezia* spp.	0.1	0	0.1	0	0	0	0	0	0.1	0	0	0	0	0	0.2	0
Rhabditophora	Pseudocerotidae	*Pseudobiceros fulgor*	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Turbellaria	Pseudocerotidae	*Pseudoceros* spp.	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0

APPENDIX 5. CRYPTIC FISH SPECIES LIST

Average number of each cryptic fish species recorded along 100 m^2 transects with method 2, in 2013 and 2018.

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Apogonidae	*Apogon doederleini*	0	0	0	7.3	0	0	0	0	0	0	0	0	0	0	0	0
Apogonidae	Apogonid spp.	0	0	6.2	0	0	0	0	0	0	0	0	0	0	0	0	0
Apogonidae	*Archamia bleekeri*	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apogonidae	*Cheilodipterus artus*	0	0	0.1	0	0	0	0	0	0	0.1	0	0.1	0.1	0.1	0	0
Apogonidae	*Cheilodipterus isostigmus*	0	0.1	0	0	0	1.6	0	0.5	0	0	0	2	0	0.1	0	0
Apogonidae	*Cheilodipterus macrodon*	0	0	0	0	0	0.1	0	0	0	0	0	0.1	0	0.9	0	0
Apogonidae	*Cheilodipterus quinquelineatus*	1.3	3.6	2.2	3.1	1.7	0	0.5	0	0.2	0	0.8	0	0.2	0	1.8	2.4
Apogonidae	*Nectamia ?luxuria*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0
Apogonidae	*Nectamia bandanensis*	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0
Apogonidae	*Ostorhinchus compressus*	1.3	0.3	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0
Apogonidae	*Ostorhinchus cyanosoma*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.7	0
Apogonidae	*Ostorhinchus nigrofasciatus*	0	0	0	0.2	0	0.1	0	0	0	0	0	0.1	0	0.4	0	0
Apogonidae	*Ostorhinchus sealei*	0	6.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apogonidae	*Ostorhinchus wassinki*	0	0	0	0	0	0	0	0	2	1.1	0	0	0	0	0	0
Apogonidae	*Pristiapogon exostigma*	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apogonidae	*Pristiapogon kallopterus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.7	0
Apogonidae	*Rhabdamia gracilis*	0	237.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apogonidae	*Taeniamia biguttata*	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blenniidae	*Aspidontus taeniatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blenniidae	*Atrosalarias holomelas*	0.2	0.2	0	0	0	0.1	0	0	0	0	0	0.2	0	0	0	0
Blenniidae	Blenniid spp.	0	0.2	0	0	0	0	0	0	0.1	0.2	0	0	0.3	0	0.1	0
Blenniidae	*Cirripectes alleni*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3
Blenniidae	*Cirripectes castaneus*	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0.1	0	0.2
Blenniidae	*Cirripectes* sp. [dark eye]	0	0	0	0	0	0	0	0	0	0	0	0.2	0.3	0	0	0

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Blenniidae	*Cirripectes* spp.	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0.2	0	0
Blenniidae	*Ecsenius alleni*	0	0	0	0	7.4	6	0	0	0	0	5.4	48.9	5.8	39.2	3.4	7.8
Blenniidae	*Ecsenius bicolor*	0.2	0.2	0	0	0	0.1	0	0	1.5	0.1	0.1	0.4	0.1	1.2	0.7	0.5
Blenniidae	*Ecsenius lividanalis*	2.3	2	1.8	3.5	0	0	0	0	0	0	0	0	0	0	0	0
Blenniidae	*Ecsenius schroederi*	0	0	0	0	0.4	2.6	7.5	21.5	0	0	1.3	1.5	0.2	0.7	0.2	0
Blenniidae	*Ecsenius* spp.	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0
Blenniidae	*Ecsenius trilineatus*	0	0	0	0	0	0	0	0	0.2	0.1	0	0	0	0	0	0
Blenniidae	*Ecsenius yaeyamaensis*	1.5	4.8	2	4.5	0	0	0	0	0.5	1.4	0	0	0	0	0	0.3
Blenniidae	*Glyptoparus delicatulus*	0	0	0	0	0.1	0	0	0	0	0	0.1	0.3	0.3	0	0	0
Blenniidae	*Meiacanthus atrodorsalis*	0	0	0.1	0	0.2	0.7	1	3.5	0	0	0	2	0	0.1	0.7	1.5
Blenniidae	*Meiacanthus ditrema*	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0
Blenniidae	*Meiacanthus grammistes*	0	0	0	0.4	0	0	0	0	0	0	0.1	0	0.1	0	0	0
Blenniidae	*Meiacanthus* sp. [yellow tail]	0	0	0	0	0.1	0.1	4	0.5	0	0	0	0	0	0	0	0
Blenniidae	*Plagiotremus laudandus*	0	0	0	0	0.1	0	1	0	0	0	0	0	0	0	0	0
Blenniidae	*Plagiotremus rhinorhynchos*	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0.1	0	0.5
Blenniidae	*Plagiotremus tapeinosoma*	0	0	0	0	0	0.3	0	0	0	0	0	0	0.1	0	0	0
Blenniidae	*Salarias alboguttatus*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
Blenniidae	*Salarias fasciatus*	0.6	0	0	0	0	0	0	0	0	0.1	0	0.3	0	0.1	0.1	0.1
Blenniidae	*Salarias patzneri*	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0
Blenniidae	*Salarias* sp. *(alboguttatus)*	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0
Callionymidae	*Diplogrammus goramensis*	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0
Caracanthidae	*Caracanthus maculatus*	0	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0
Caracanthidae	*Caracanthus* spp.	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0
Caracanthidae	*Caracanthus unipinna*	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0.6	0
Cirrhitidae	*Cirrhitichthys oxycephalus*	0.1	0	0	0	0	0	0	0	0	0	0.2	0.4	0.1	0.1	0	0
Cirrhitidae	*Cirrhitus pinnulatus*	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0
Cirrhitidae	*Paracirrhites arcatus*	0	0	0	0	0.1	0.1	0	0	0	0	0	0	0	0	0.1	0.1

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Cirrhitidae	*Paracirrhites forsteri*	0	0.3	0.1	0.1	1.8	2.1	0	0	0.5	0.5	0.6	3.1	1.3	4.1	1.7	1.1
Gobiesocidae	*Diademichthys lineatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0
Gobiesocidae	*Discotrema crinophilum*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
Gobiesocidae	Gobiesocid spp.	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Amblyeleotris steinitzi*	0	0	0	0	0.1	0.1	0	0	0	0	0.2	0	0.6	0.4	0	0.1
Gobiidae	*Amblyeleotris wheeleri*	0	0.1	0	0	0	0	0	0	0.1	0.5	0	0	0.1	0.1	0	0.3
Gobiidae	*Amblygobius nocturnus*	0	0	0	0.7	0.3	1.8	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Amblygobius phalaena*	0	0	0.8	0.1	0.2	1	0	24.5	0.1	0	0	0	0	0.1	0	0.2
Gobiidae	*Amblygobius* spp.	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Asterropteryx semipunctata*	0	0	0	0	0.5	6.4	32.5	163	0	0	0.2	1.4	0	0.6	0	0
Gobiidae	*Bryaninops amplus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0
Gobiidae	*Bryaninops erythrops*	0	0.7	0	1.8	0	0	0	0	0	0.1	0	0	0	0	0	0
Gobiidae	*Bryaninops natans*	0	0	0	0.2	0.9	1.3	0	0	0	0	0	0.1	0	0	0	0
Gobiidae	*Bryaninops nexus*	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0
Gobiidae	*Cryptocentrus cinctus*	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Ctenogobiops mitodes*	0	0.2	0	0.5	0.6	1.4	0	1.5	0	0	0	0.8	0	0.8	0.2	0
Gobiidae	*Ctenogobiops pomastictus*	0.5	2	0.2	3.3	0.2	0.9	0	0	0.1	0	1.2	0	0.3	0.4	0.1	0.3
Gobiidae	*Ctenogobiops* spp.	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Eviota guttata*	0	7.4	0	4	0.8	11	0	0.5	0	6	0	43.2	0.1	13.5	1.7	3.7
Gobiidae	*Eviota nigriventris*	0	0	0	0	0.6	2.5	0	0	0	0	0	0.3	0	0.2	0	0
Gobiidae	*Eviota prasites*	1.2	3.1	2.4	2.6	2.6	2.1	8.5	0	0	0.6	0	0.6	0.4	1.7	0.1	0.3
Gobiidae	*Eviota punctulata*	0	0	0.4	0	0	0	0	0	0.1	0	0	0	0	0	0	0
Gobiidae	*Eviota sebreei*	0.1	1.9	0	0.1	0.2	0	0	0	0	0	0	0	0.1	0	0	0
Gobiidae	*Eviota* sp. (red)	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0
Gobiidae	*Eviota* sp. [green]	0.9	0	2.8	0	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Eviota* sp. [red eyes]	0	0	0	0	0	0	0	0	0	0	0	2.4	0	0	0	0
Gobiidae	*Eviota* sp. [storthynx gold shield]	0	0	0	0	0	0.1	0	0	0	0	0	0.1	0	6.2	0	0.1

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Gobiidae	*Eviota* sp. [trans white & red streaks]	0	0	0	0	0	14.9	0	0	0	0	0	13	0	2.3	0	0
Gobiidae	*Eviota spilota*	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Eviota* spp.	0.1	0	0	0	0.7	0.1	1	1	0.5	0.1	0.7	0	0.5	0.1	0.1	0.3
Gobiidae	*Eviota storthynx*	0	0.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2
Gobiidae	*Exyrias belissimus*	0	0.1	0.6	0.1	0.1	0	0	0	0	0	0	0	0.1	0	0	0
Gobiidae	*Fusigobius duospilus*	0.2	0.1	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Fusigobius neophytus*	0.1	0.3	0.1	0.3	0.3	1.6	0	0.5	0	0.1	0.2	1	0.1	1.3	0	0
Gobiidae	*Fusigobius pallidus*	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Fusigobius pallidus (cf)*	0	0	0	0	0	2.7	0	0	0	0	0	11.6	0	0.2	0	0
Gobiidae	*Fusigobius signipinnis*	0.4	1	1.4	0.8	0.1	0.9	0	0	0	0	0	0.1	0.1	0.1	0.1	0.1
Gobiidae	*Fusigobius* sp.	0	0.1	0	0	1.2	0	1.5	0	0	0	0	0	0.3	0	0	0
Gobiidae	*Fusigobius* spp.	0	0	0	0	0.1	0	0	0	0	0	0	0	0.1	0	0	0
Gobiidae	*Gnatholepis anjerensis*	0.6	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Gnatholepis cauerensis*	0.6	9.9	0.9	11.3	3	15	1.5	33	0	0.7	0.8	28.5	3.1	8.1	0.8	10.6
Gobiidae	Gobiid spp.	0	0	12.5	0.3	0	0	0	0	0	0	0.1	0	0.2	0	0.1	0.2
Gobiidae	*Gobiodon ?histrio*	0.1	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0.3	0
Gobiidae	*Gobiodon histrio*	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Gobiodon quinquestrigatus*	0	0	0	0.3	0	0	0	0	0	0	0	0	0	0	3.6	0
Gobiidae	*Gobiodon rivulatus*	0	0	0	0	0	0	0	0	0.3	0	0	0	0	0	0	0
Gobiidae	*Gobiodon spilophthalmus*	0	0	0	0	3.6	2.1	6	0.5	0	0	0.1	1	0.1	0.1	0.1	0
Gobiidae	*Gobiodon* spp.	0.5	0.4	0	0.2	0	0	0	0	0	1	0	0.1	0	0.3	1.2	0.1
Gobiidae	*Istigobius decoratus*	0.4	1.2	0.9	1.6	0	0	0	0	0	0.1	0	0	0	0	0	0
Gobiidae	*Istigobius goldmanni*	0.1	0.5	0	0.4	0	0	0	0	0	0	0	0	0.3	0	0	0
Gobiidae	*Istigobius rigilius*	7.9	4.1	16.5	2.9	0.5	0.9	0	0	0	0.2	0.3	0.7	0.2	0.4	0.4	0.5
Gobiidae	*Istigobius* spp.	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0
Gobiidae	*Koumansetta rainfordi*	1.3	0.2	1.8	1	1.4	2.1	0	0	0	0	0.6	0.2	0.6	0.2	0.7	0.1
Gobiidae	*Oplopomus atherinoides?*	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Gobiidae	*Paragobiodon echinocephalus*	0	1.4	0	1.5	0	0	0	0	0	0.7	0	0	0	0	0	0.3
Gobiidae	*Signigobius biocellatus*	0	0.4	1	1.8	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Trimma readerae*	0	0	0	0.1	0	0	0	0	0	0	0	0.6	0	0.1	0	0.1
Gobiidae	*Trimma striata*	0.2	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Trimma striatum*	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Valenciennea sexguttata*	0.5	0.9	0.5	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	*Valenciennea strigata*	0	0	0	0	0.1	0	0	0	0.5	0	0	0	0	0	0	0.1
Holocentridae	*Myripristis adusta*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.9	0.1	0.3
Holocentridae	*Myripristis berndti*	0	0.2	0	0	0	0.4	0	0	0	0	0.2	0	0.3	1.2	0.1	0
Holocentridae	*Myripristis kuntee*	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0	0.2
Holocentridae	*Myripristis murdjan*	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0.3	0.7
Holocentridae	*Myripristis* spp.	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0.1
Holocentridae	*Myripristis violacea*	0.2	0	0	0.8	0	0.4	0	0	0	0.8	0.1	0.1	0.2	0.8	0.7	0.2
Holocentridae	*Myripristis vittata*	0	0	0	0	0	0.2	0	0	0	0	0	0	0.1	0	0	0
Holocentridae	*Neoniphon argenteus*	0	0.1	0	0	0	0	0	0	0	0	0	0.5	0	0	0.1	0
Holocentridae	*Neoniphon opercularis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	2	0
Holocentridae	*Neoniphon sammara*	0	0.1	0	0	0	0.1	0	0	0.1	2.5	0	0	0	0	2.6	0.3
Holocentridae	*Sargocentron caudimaculatum*	0	0.1	0	0	0.1	0.4	0	0	0.1	0	0	0.1	0.1	0.4	0.3	0.2
Holocentridae	*Sargocentron cornutum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0
Holocentridae	*Sargocentron diadema*	0	0	0	0	0	0.1	0	0	0	0	0.1	0	0	0.1	0	0.1
Holocentridae	*Sargocentron spiniferum*	0	0.2	0	0	0	0.1	0	0	0	0	0	0.2	0.1	0.1	0.1	0
Holocentridae	*Sargocentron tiere*	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0.1	0	0
Holocentridae	*Sargocentron violaceum*	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microdesmidae	*Nemateleotris magnifica*	0	0	0	0	0	0.1	0	0	0	0.1	0	0.3	0	0.1	0	0.7
Microdesmidae	*Ptereleotris evides*	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0.1	0	0
Muraenidae	*Gymnothorax javanicus*	0	0.1	0	0	0	0.2	0	0	0	0	0	0	0	0.1	0.3	0
Pempheridae	*Pempheris oualensis*	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Pinguipedidae	*Parapercis clathrata*	0.5	0.2	0.1	0	0	0.1	0	0	0.5	1	0.3	0.2	0	0	0	0
Pinguipedidae	*Parapercis millepunctata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0
Pinguipedidae	*Parapercis pacifica*	0.2	0.2	0.1	0.1	0	0	0	0	0	0	0	0	0	0	0.1	0.1
Pseudochromidae	*Labracinus cyclophthalmus*	0.1	0.2	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0.1
Pseudochromidae	*Pictichromis paccagnellae*	0	0	0	0	0	0	0	0	0	0	0	0	0	1.5	0	0
Pseudochromidae	*Pseudochromis bitaeniatus*	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0.1	0.1
Pseudochromidae	*Pseudochromis fuscus*	0.7	1.1	1.1	0.6	0.2	0.6	0.5	1.5	0.2	0.1	0.2	0.1	0.2	0	0.4	0.4
Scorpaenidae	*Pterois antennata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0
Scorpaenidae	*Sebastapistes cyanostigma*	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Serranidae	*Aethaloperca rogaa*	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Serranidae	*Anyperodon leucogrammicus*	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0.1	0	0
Serranidae	*Cephalopholis argus*	0.2	0.4	0.1	0.2	0.2	0.7	0	1.5	0.1	0.1	0.2	1.8	0.5	1.8	0.6	0.5
Serranidae	*Cephalopholis leopardus*	0.1	0.2	0	0.1	0	0.1	0	0	0.1	0.2	0	0.1	0	0.1	0.3	0.5
Serranidae	*Cephalopholis urodeta*	0	0	0	0	0	0.2	0	0	0.1	0.2	0	0.8	0	0.1	0.4	0.7
Serranidae	*Epinephelus fasciatus*	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0
Serranidae	*Epinephelus hexagonatus*	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0
Serranidae	*Epinephelus merra*	0.2	0.5	0	0.3	0.1	1.8	0	8.5	0.1	0	0.3	2.8	0.1	0.7	1.1	2.1
Serranidae	*Epinephelus polyphekadion*	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0
Serranidae	*Epinephelus spilotoceps*	0	0	0	0	0	0.1	0	0	0	0	0	0.1	0.1	0	0	0
Serranidae	*Epinephelus tauvina*	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0.1	0	0
Synanceiidae	*Corythoichthys conspicillatus (cf)*	0	0	0	0	0	0.5	0	0	0	0	0	0.4	0	0	0	0
Syngnathidae	*Corythoichthys flavofasciatus (cf)*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Syngnathidae	*Corythoichthys schultzi*	0	0.1	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0.1
Syngnathidae	*Corythoichthys* sp. [10 RK]	0	0	0	0	0.2	0.9	0.5	1.5	0	0	0.3	0	0.1	0	0	0
Synodontidae	*Saurida gracilis*	0.4	0	0.1	0	0	0	0	0	0	0	0.1	0	0	0	0	0
Synodontidae	*Saurida nebulosa*	0	0.1	0	0.1	0.1	0.3	0	0.5	0	0	0	0.2	0	0.1	0	0
Synodontidae	*Synodus binotatus*	0	0	0	0.1	0	0	0	0	0	0.2	0	0	0.2	0	0	0.3

FAMILY	SPECIES	Ash NT		Ash R		Clerke NTZ		Clerke RZ		Hib F		Imp NTZ		Mer NT		Scott F	
		13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18
Synodontidae	*Synodus dermatogenys*	0.2	0	0	0	0	0.4	0	0	0.1	0	0	0.1	0	0	0.1	0
Synodontidae	*Synodus jaculum*	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0.3
Synodontidae	*Synodus* spp.	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Synodontidae	*Synodus variegatus*	0.1	0.6	0.2	0.3	0	0.1	0	0	0.5	0.3	0	0.2	0	0.1	0.3	0.1
Tripterygiidae	*Enneapterygius* spp.	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0	0	0
Tripterygiidae	*Helcogramma chica*	0	0	0	0	0.4	2.5	0	0.5	0.5	2.1	0	13	0.2	9.1	0	0.4
Tripterygiidae	*Helcogramma* sp. [orange scales]	0	0	0	0	0.5	0	0	0	0	0	0.8	0	0.3	0	0	0
Tripterygiidae	*Helcogramma* spp.	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
Tripterygiidae	*Helcogramma striatum*	0.2	0.5	0	0.4	0	0	0	0	0.1	0	0	0	0	0	0	0
Tripterygiidae	*Ucla xenogrammus*	0	0	0	0	0.1	0.3	0	0	0	0	0.2	0.8	0.1	3	0	0
Dasyatidae	*Neotrygon kuhlii*	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0