Biodiversity survey of Ashmore Reef (Coral Sea) and comparison with surrounding reefs

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Report to Parks Australia, Department of the Environment

2017

Citation

Edgar GJ, Ceccarelli D, Stuart-Smith RD, Cooper AT (2017) Biodiversity survey of Ashmore Reef (Coral Sea) and comparison with surrounding reefs. Report for Parks Australia, Department of the Environment. Reef Life Survey Foundation Incorporated.

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Important disclaimer

Images

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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

Ashmore Reef is located in the northwestern Coral Sea, between the northern extension of the Great Barrier Reef and Papua New Guinea, close to the islands and reefs of the Torres Strait. Field surveys at Ashmore Reef and adjacent Boot Reef were conducted in 2013 and 2015 by a team of skilled divers from the Reef Life Survey program (www.reeflifesurvey.com) and the University of Tasmania. Ecological surveys were conducted at varying depths along 155 transects at 78 sites across Ashmore Reef, Boot Reef, and at reefs considered the most comparable. These reference reefs comprised the pinnacle reefs in the northern Coral Sea (e.g. Bougainville and Osprey Reefs), which are also remote and isolated from Australian continental reefs; and the platform reefs of the far northern Great Barrier Reef (GBR) and Torres Strait, which are in close proximity, but are located on the continental shelf. Data collected from each site consisted of abundance and size of fishes, abundance of mobile macroinvertebrates and cryptic fishes, and percentage cover of sessile biota.

Ashmore and Boot Reefs form part of the Coral Sea CMR, and due to their northern location and shelf-edge geomorphology they contribute ecological characteristics that are different from other Coral Sea reefs:

- Ashmore and Boot Reefs were more similar to the 'oceanic' reefs of the Coral Sea, but with some representation of the 'inshore' fish community – which is unusual among the reefs in the Coral Sea CMR; thus, inclusion of this northern area adds to the overall biodiversity coverage of the CMR.
- Ashmore Reef had anomalously high abundance and species richness of invertebrates, similar to the continental shelf reefs and much higher than the oceanic reefs.
- Ashmore and Boot Reefs had high coral cover (~30%) compared to reefs elsewhere in the Coral Sea (average ~18%).
- When compared with other Coral Sea reefs, Ashmore Reef stood out as having high macroinvertebrate diversity, Boot Reef had very high fish abundance, Ashmore and Boot Reefs both had high fish species richness, total biomass and large fish biomass.
- Shark biomass at Ashmore and Boot Reefs was as high as would be expected of highly protected reefs. They are potentially a valuable sanctuary for healthy predator populations.

An "inshore-offshore" gradient in the composition of reef fish assemblages, with some species typical of offshore reefs and others more characteristic of inshore reefs, was clearly evident in this study. Oceanic reefs at Osprey and Bougainville were characterised by an offshore fish assemblage, dominated by planktivores and small grazers that feed by cropping low-lying turf algae. The northern GBR and Torres Strait reefs had an 'inshore' assemblage, with omnivorous and farming damselfishes, large benthic invertivores and a broader range of grazers that included browsers that feed on fleshy macroalgae. Ashmore and Boot Reefs were most similar to the 'oceanic' reefs, but with some representation of the 'inshore' fish community.

Boot Reef had the richest fish assemblage in terms of density and diversity of all fishes, and a high biomass and density of sharks (~29 sharks per hectare) and other piscivores. Ashmore Reef had relatively low fish biomass, but shark density was high (~20 sharks per hectare). This was higher than the highest shark density recorded on the GBR (5.5 +/- 0.83SE individuals per hectare) on no-entry reefs, suggesting low fishing pressure and a relatively intact predator community. Coral assemblages appeared healthy, with coral cover ~30% across sites, with different coral growth forms distinguishing the different sites.

Interestingly, the mobile macroinvertebrate community showed patterns reflecting geographic distances between the reefs. Like reef fishes, invertebrates rely on larval dispersal between reefs, with negligible opportunity for adult migration. Ashmore Reef stood out as having high abundance and species richness of invertebrates, similar to the continental shelf reefs and much higher than the oceanic reefs. Most of the common invertebrates were more typical of offshore areas and exposed reef fronts, with a high proportion of filter-feeding feather stars

The fauna recorded on Ashmore and Boot Reefs represents a combination of those associated with the more sheltered habitats of the networked continental shelf reefs and the highly exposed and isolated oceanic reefs (even those quite distant to the south). Large predators are highly abundant, despite the reefs being open to fishing; their remoteness is likely to have protected them from overexploitation thus far. Prevailing currents are expected to provide good connectivity with the reefs nearby, both on the shelf and in the Coral Sea. The position of these reefs on the far northern edge of the shelf places them in danger of frequent exposure to high temperature anomalies; at present, however, their seemingly intact community structure suggests the potential for high resilience or an absence of major threats to date.

RECOMMENDATIONS

- Undertake ongoing monitoring at intervals of 1-5 years to build up a temporal dataset to assess changes relative to the baseline provided by this survey, with results reported using a comprehensive suite of sensitive environmental indicators;
- Collect data on fishing effort on the different reefs to assess differences in extractive use;
- Include timed swims for more accurate sampling of sharks and other large predators;
- Investigate food webs, including addressing the question of how such a large biomass of sharks influences the reef community;
- Apply ecological indicators for ongoing ecosystem health assessment; and
- Through the longer term, consider increased protection from fishing for Boot Reef as a sanctuary for higher predators, to be used as a scientific reference area with intact coral reef food web.

1 Introduction

Ashmore and Boot Reefs are located in the northwestern Coral Sea, between the northern extension of the Great Barrier Reef and Papua New Guinea, close to the islands and reefs of the Torres Strait. Anecdotal evidence from diving and fishing charter operations suggest that it provides a rich pelagic aggregation site for large predators. Negligible ecological data exists from Ashmore and Boot Reefs, making it difficult to assess biodiversity values and representation of these in the broader Coral Sea CMR.

Other reefs have been surveyed, and may therefore provide important context to the biodiversity of Ashmore and Boot Reefs; these include the pinnacle reefs in the northern Coral Sea (e.g. Bougainville and Osprey Reefs), platform reefs of the far northern Great Barrier Reef (GBR), and reefs in Torres Strait. Osprey Reef, the summit of a pinnacle rising from deep waters, is among the Coral Sea reefs that have been the focus of a relatively large volume of research (Ceccarelli et al. 2013). Recent research has explored the deeper reaches of Osprey Reef, primarily the mesophotic zone and the potential for this habitat to provide refugia for species frequently damaged by storms or temperature anomalies in shallower waters (Bongaerts et al. 2011). Among highly exposed Coral Sea reef communities, shallow Osprey Reef habitats have relatively high coral cover (Andrews et al. 2008) and high predator biomass (Ayling and Choat 2008). A recent Reef Life Survey study explored the reef communities of the far northern GBR and Torres Strait, and found abundant branching corals and high species richness compared with other reefs in the region (Ceccarelli et al. 2016).

This region of the Coral Sea is strongly influenced by the Hiri Gyre, which flows from the northern arm of the bifurcation of the South Equatorial Current at the Australian continental margin. It entrains larvae of marine species that spawn on the shallow reefs of the Gulf of Papua and far northern GBR and transports them into the Torres Strait and the northern GBR (Dennis et al. 2001; Miller 2009). It is unknown whether the Hiri Gyre enhances connectivity through the area, or acts as a barrier to dispersal (Ceccarelli et al. 2013). A geomorphological dispersal barrier exists for shallow water organisms in the form of the Coral Sea Basin, which is 4000 m deep and separates western reefs, such as Ashmore Reef, from eastern habitats such as the Louisiades and the Solomon Islands (Mora et al. 2012).

Deep water barriers to movement of adults and, potentially, larval dispersal patterns shaped by stronger westward than eastward flowing currents further drive differences between coral reef communities. Biogeographically, the oceanic Coral Sea reefs are located in the Cape Province, and the GBR and Torres Strait reefs in the Northeast IMCRA Transition Zone; Ashmore and Boot reefs are located on the boundary between the two. Such boundary habitats are important mixing points for fauna of two regions, and can often be genetic biodiversity hotspots and stepping stones connecting the two regions.

Ashmore Reef lies within the Coral Sea Commonwealth Marine Reserve (CMR), but management arrangements and marine reserve zoning for it and surrounding reefs remain to be finalised. Osprey Reef zoning has not yet come into force, but the location is officially closed to fishing. However, it is unclear whether this regulation is complied with. All the other reefs in this area can be considered open to fishing. Given the paucity of research conducted on the more remote reefs, the Reef Life Survey data offers a first glimpse of the coral reef communities of Ashmore Reef, and the opportunity to put them into context through comparisons with surrounding reefs. This report therefore presents baseline data on ecological communities of Ashmore, Boot, Osprey and Bougainville Reefs, sites within the far northern GBR and in the Torres Strait.

2 Methods

Field surveys at Ashmore Reef and surrounding reefs were conducted in 2013 and 2015 by a team of skilled divers from the Reef Life Survey program (www.reeflifesurvey.com) and the University of Tasmania. Geographical coordinates of sites (in WGS84) were recorded using handheld Garmin GPS units (APPENDIX 1). Ecological surveys were conducted at varying depths along 155 transects at 78 sites across the different reefs. Data collected from each site consisted of abundance and size of fishes, abundance of mobile macroinvertebrates and cryptic fishes, and percentage cover of sessile biota. These are described separately below. Sites were selected to encompass the range of reef types and depth, but with the depth range limited by dive safety considerations and bottom time restrictions.

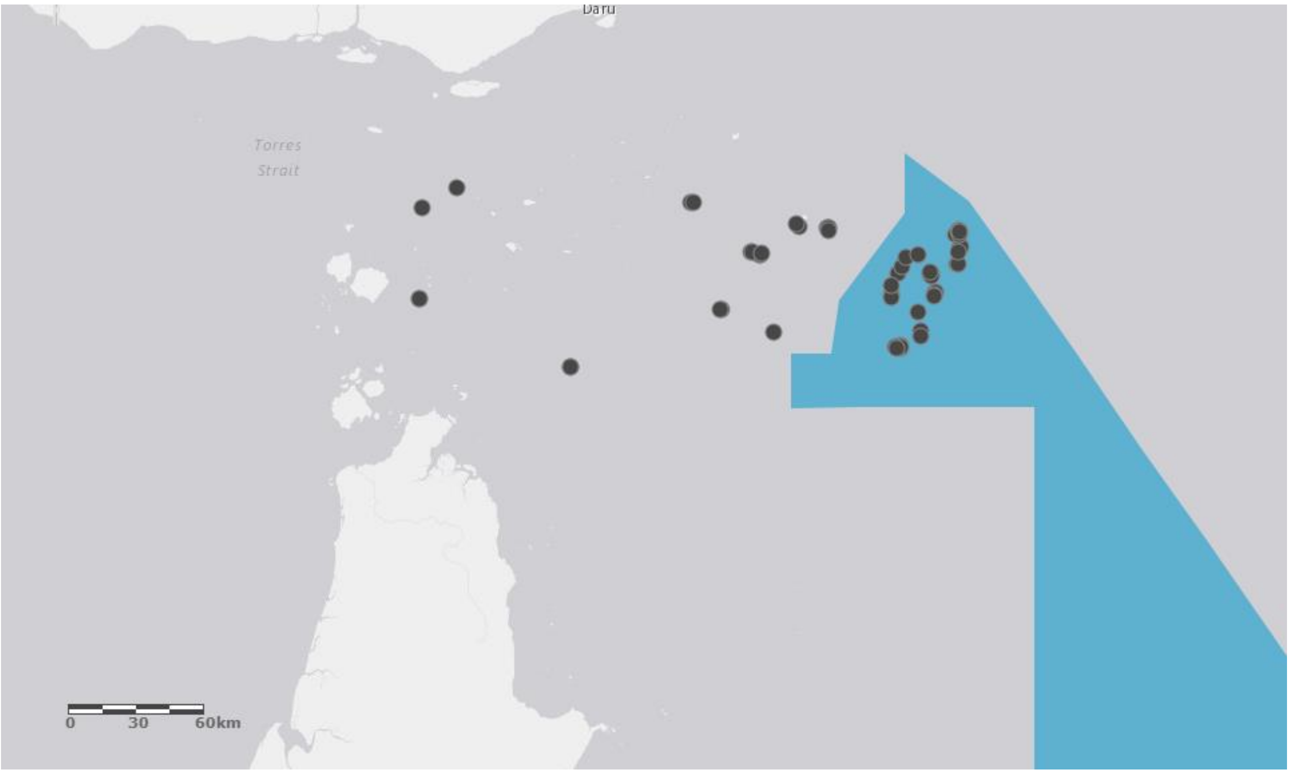


Figure 1. Map of Ashmore Reef sites surveyed during 2013 and 2015.

FISH SURVEYS (METHOD 1)

Fish census protocols involved a diver laying out a 50 m transect line along a depth contour on reef. The number and estimated size-category of all fishes sighted within 5 m blocks either side of the transect line were recorded on waterproof paper as the diver swam slowly along up and down each side. Size-classes of total fish length (from snout to tip of tail) used are 25, 50, 75, 100, 125, 150, 200, 250, 300, 350, 400, 500, 625 mm, and above. Lengths of fish larger than 500 mm were estimated to the nearest 12.5 cm and individually recorded.

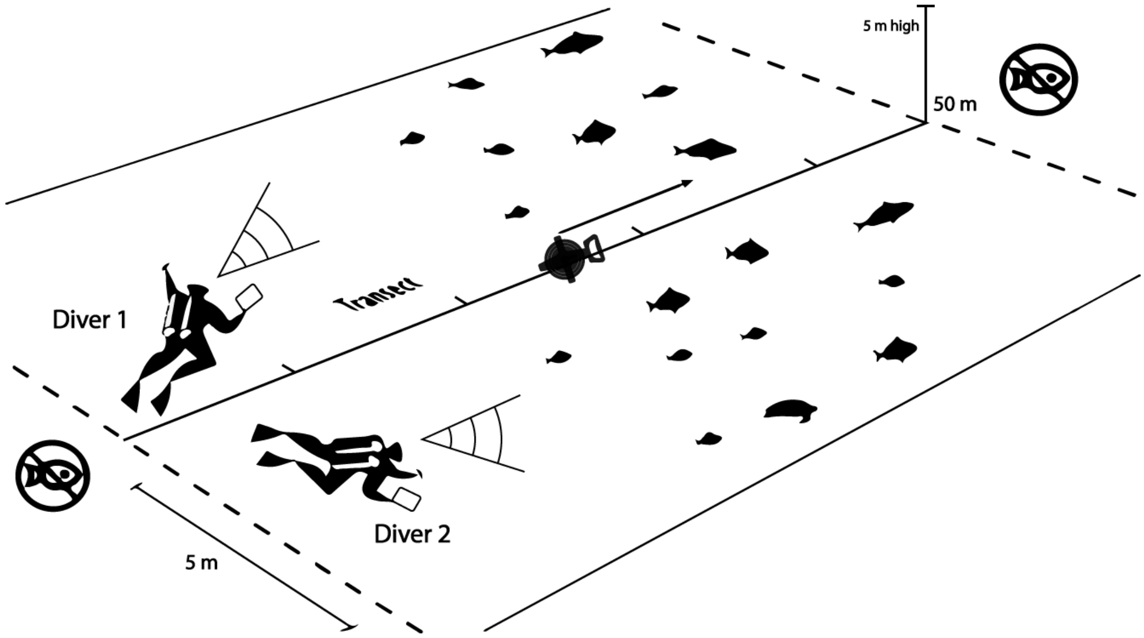


Figure 2. Stylised representation of method 1 survey technique

MACROINVERTEBRATE AND CRYPTIC FISH SURVEYS (METHOD 2)

Large macro-invertebrates (molluscs, echinoderms and crustaceans > 2.5 cm) and cryptic fishes (i.e. inconspicuous fish species closely associated with the seabed that were likely to be overlooked during general fish surveys) were censused along the same transect lines set for fish surveys. Divers swam along the bottom, up then down each side of the transect line, recording all mobile macroinvertebrates and cryptic fishes on exposed surfaces of the reef within 1 m of the line.

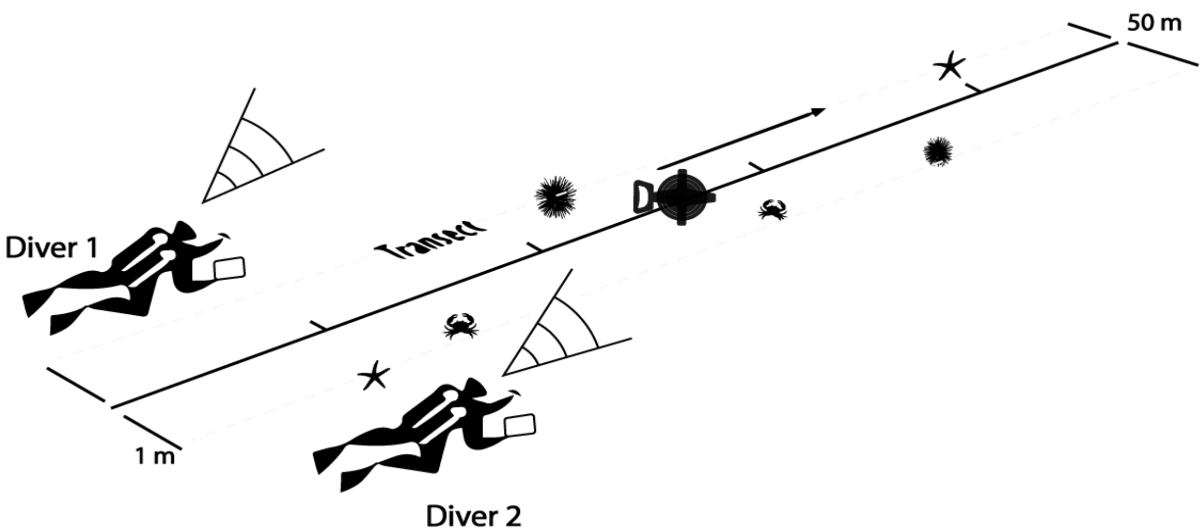


Figure 3. Stylised representation of method 2 survey technique

MACROALGAL AND SESSILE INVERTEBRATE SURVEYS

Information on the percentage cover of sessile animals and seaweeds along the transect lines set for fish and invertebrate censuses was recorded using photo-quadrats taken sequentially each 2.5 m (or 5 m, see below) along the 50 m transect. Digital photo-quadrats were taken vertically-downward from a height sufficient to encompass an area of at least 0.3 m x 0.3 m. The percentage cover of different macroalgal, coral, sponge and other attached invertebrate species in photo-quadrats was digitally quantified in the laboratory using the Coral Point Count with Excel extensions (CPCe) software (Kohler and Gill, 2006). A grid of 5 points was overlaid on each image and the taxon lying directly below each point recorded. Identification was to a set list of standard categories.

INDICATORS

Three indicators of reef condition were calculated for each survey: the biomass of large reef fishes (B20), the community temperature index (CTI), and an IUCN threatened species index. The biomass of large fishes (B20) is an indicator of fishing impacts, with previous analyses revealing lower values found in regions of higher impact around Australia. It 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 is a sensitive indicator of temperature changes. It is thus most useful for time series analyses, although spatial comparison can provide an indication of potential relative vulnerabilities to warming (e.g., Stuart-Smith et al. 2015). For its calculation, the midpoint of each species' thermal distribution (i.e. temperature at the centre of its range) 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. The IUCN threatened species index is calculated using the species list from the combined Method 1 and Method 2 data for a given survey, as the proportion of those species which are listed on the IUCN red list under the categories Vulnerable, Endangered, or Critically Endangered.

STATISTICAL ANALYSES

At most sites, multiple transects were surveyed at different depths (see Appendix 1). Because community types encountered along individual transects within a site generally matched more closely with transects at similar depths at other sites, rather than transects at other depths within the same site, each transect was regarded as an independent sample in analyses. Thus, the unit of replication was total value(s) per set of paired transect blocks (i.e. per 500 m^2 for fishes and per 100 m^2 for mobile macroinvertebrates). Sessile biota percent cover data were expressed as % per transect (i.e. 2 blocks).

Separate univariate analyses and data exploration techniques were used for fish, mobile macroinvertebrate communities, and sessile communities. Univariate metrics that described important community characteristics were calculated for each transect and compared between transects surveyed. Metrics examined for fishes were: relative abundance, estimated total biomass (see below for biomass estimation), biomass of fishes > 20 cm TL, and number of species. Mobile invertebrate metrics were: total relative abundance of mobile invertebrates and number of species. Sessile community/benthic cover metrics were: % crustose coralline algae, % bare rock, total sessile invertebrate cover, number of biotic taxa/groups, and % cover of the dominant cover categories.

Univariate metrics were applied in separate ANOVAs, with Reef as a fixed factor. All dependent variables were log(x+1) transformed. To explore patterns in fish community trophic structure, the abundance and biomass of fishes in different trophic groups were estimated. Trophic groups used in this analysis were:

benthic invertivores, carnivores (preying on both invertebrates and fishes), piscivores (mostly preying on fishes), omnivores (consuming plant and animal matter), planktivores, corallivores, grazers (including algal turf croppers, detritivores, macroalgal browsers, and scraping and excavating parrotfishes) and farmers (territorial damselfishes). Biomass estimates were made for each species on each transect block using fish abundance counts, size estimates, and the length-weight relationships presented for each species (in some cases genus and family) in Fishbase (Froese and Pauly 2016).

Relationships between 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 PRIMER+PERMANOVA program (Anderson et al. 2008). 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. Data were converted to a Bray-Curtis distance matrix relating each pair of sites after square root transformation of raw data. The transformation was applied to downweight the relative importance of the dominant species at a site, therefore allowing less abundant species to also contribute to the plots. MDS was followed up with ANOSIM (to test the significance of differences between reefs).

3 Results

FISH SURVEYS

Divers recorded 334 species of reef fish at Ashmore Reef and 273 species at Boot Reef; 547 species of fish were recorded along all transects on reefs of the northern Coral Sea, GBR and Torres Strait (APPENDIX 2). The fish community was a typical tropical reef fish assemblage, with abundance dominated by planktivorous damselfishes (e.g. *Chromis ternatensis*, *C. margaritifer*, *Lepidozygus tapeinosoma*) and fairy basslets (e.g. *Pseudanthias tuka*, *P. dispar*) at most reefs. Exceptions were the inner Torres Strait reefs and northern GBR reefs, where some of the most abundant fish species were omnivores (e.g. *Pomacentrus moluccensis*) and fusiliers (e.g. *Caesio cuning*). The dominant species in terms of biomass, on the other hand, were variable between the reefs. Ashmore Reef was dominated by the redfin bream *Monotaxis heterodon* and the bignose unicornfish *Naso vlamingii*; Boot Reef was dominated by the surgeonfishes *Acanthurus olivaceus*, *A. thompsoni* and *Naso vlamingii;* Bougainville had high biomass of smaller species (*Pomacentrus amboinensis*, *Oxycheilinus unifasciatus* and *Ostorhinchus cyanosoma*), inner Torres Strait and northern GBR reefs had a combination of planktivores, predators and large invertebrate feeders (*Caesio cuning, Carangoides fulvoguttatus, Carchanrhinus amblyrhynchos, Choerodon schoenleinii*); at Osprey Reef numerous grazers, planktivores and corallivores (e.g. *S. chameleon*, *Chromis atripes* and *Chaetodon plebius*) were present.

The fish assemblage distinguished the surveyed reefs into two main groups: the northern GBR and inner Torres Strait Reefs and the Coral Sea reefs (Figure 4). A few of the northern GBR sites overlapped with Ashmore Reef and Boot Reef, these two reefs were separated, for the most part, from Osprey and Bougainville Reefs. Therefore, reefs grouped according to geomorphological type (e.g. continental shelf reefs vs oceanic pinnacle reefs) and geographical proximity. Large groups of species separated the northern GBR and inner Torres Strait reefs from the Coral Sea reefs; a larger group of species characterised the former than the latter.

Boot Reef had the highest abundance, species richness and biomass of reef fishes, and the highest biomass of large fishes (Figure 5, Table 1). Bougainville Reef also had high abundance, but intermediate species richness and biomass, similar to reefs of the northern GBR. Ashmore and Osprey Reefs, and to some extent reefs of the inner Torres Strait, had lower abundance of fishes. Among these, Osprey tended to have the lowest values of all metrics. Planktivores, grazers and higher-order piscivores dominated the reef fish biomass across most sites, followed by invertivores and carnivores (Figure 6, Table 1). Piscivores were especially prevalent at Boot Reef, and Torres Strait sites had high (but also very variable) biomass of medium-level carnivores. Osprey Reef had relatively low biomass of most groups except piscivores. Ashmore Reef, in comparison to the other reefs, had high planktivore and grazer biomass, but among the lower biomass values for other groups.

The proportion of IUCN-listed species was similar between reefs, with a trend for higher values at Boot Reef and Osprey Reef. Community temperature Index (CTI) values were significantly lower on inner Torres Strait Reef than at Ashmore, Boot and Osprey Reefs, whilst Bougainville Reef and northern GBR reefs had intermediate values (Figure 7). This suggests communities at Ashmore and Boot Reefs (and Osprey) lack a component of fauna that extends further south, and/or contain additional species associated with warmer waters in the Coral Triangle. Given the species richness gradient, the latter is likely to be more prevalent, with the additional species found at Ashmore and Boot being those with smaller ranges within the Coral Triangle, rather than additional widespread Indo-Pacific species. CTI trends also suggest a fauna with relatively cooler affinity in the Torres Strait; an interesting finding given its close proximity.

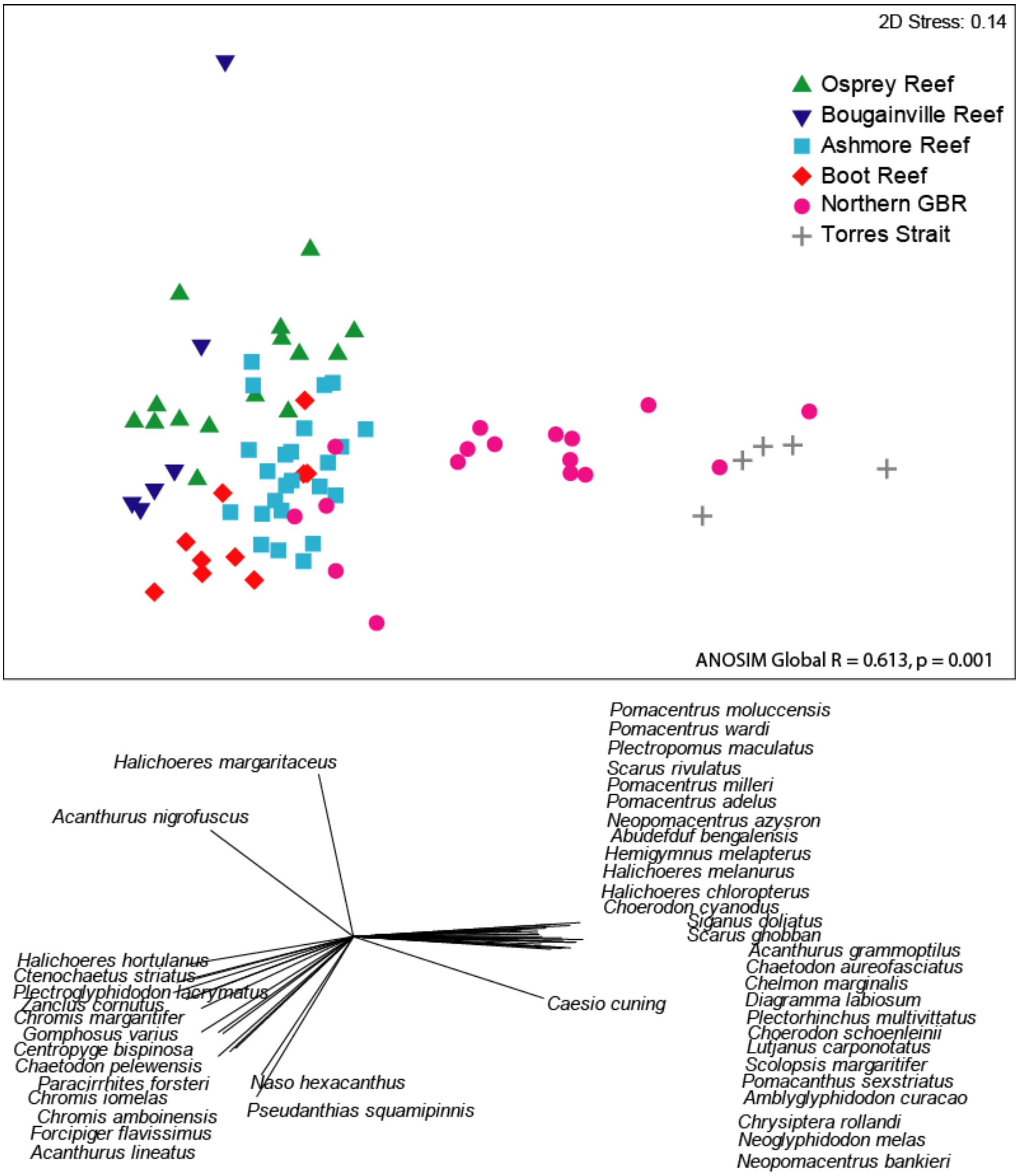


Figure 4. Multidimensional Scaling (MDS) based on reef fish biomass data. The analysis was conducted on the Bray-Curtis similarity matrix of the log(x+1) transformed data. Species vectors are shown if they have a correlation value of at least 0.6.

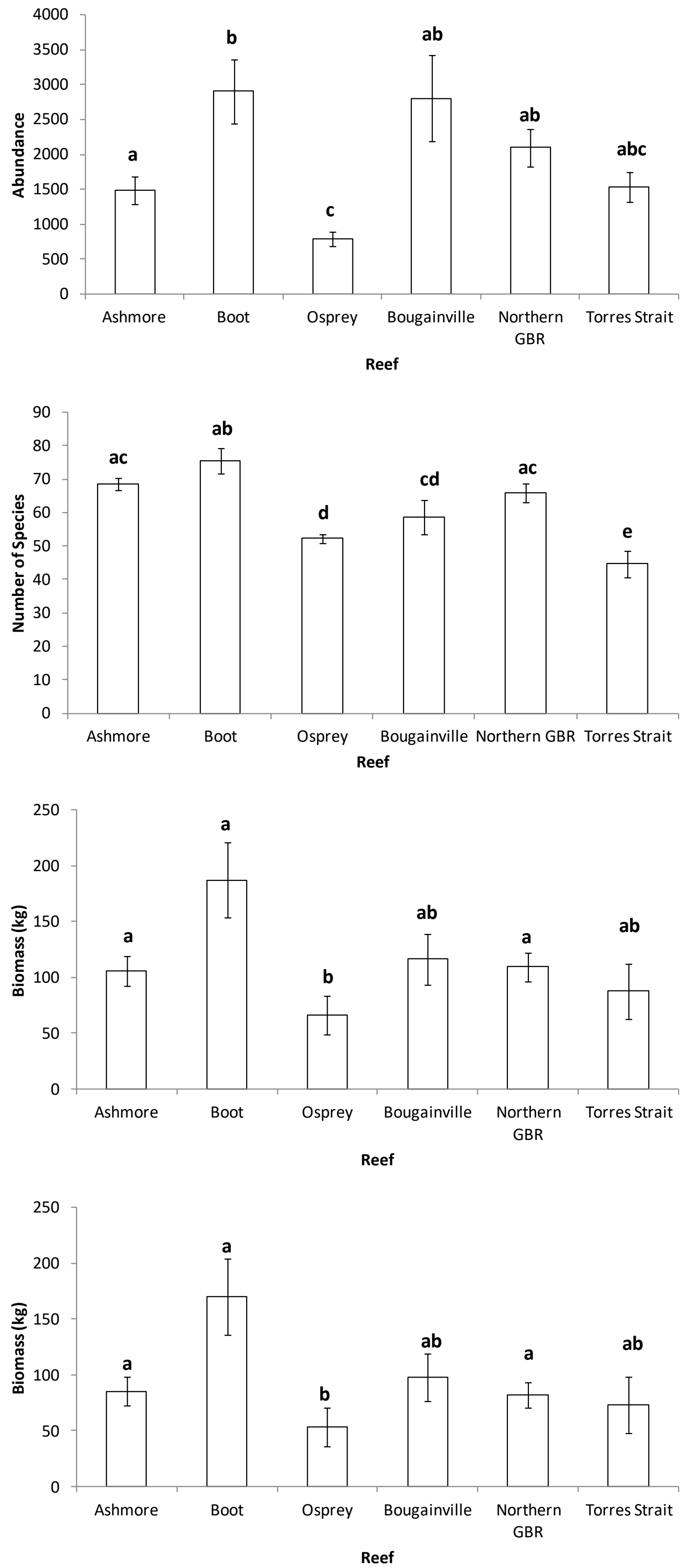


Figure 5. Abundance, species richness and biomass of all fishes, and biomass of large fishes (TL >20 cm), at reefs or groups of reefs in the northern GBR, Torres Strait and Coral Sea (per 500 m2 transect).

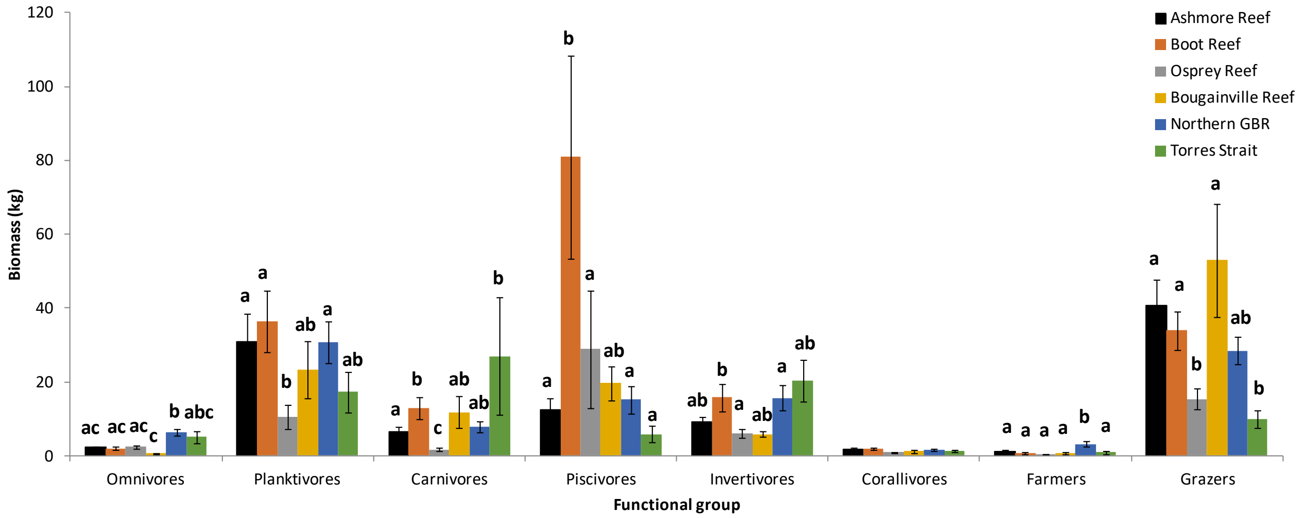


Figure 6. Biomass of functional groups of reef fishes at reefs or groups of reefs in the northern GBR, Torres Strait and Coral Sea (per 500 m^2 transect).

Table 1. ANOVA of key metrics of the fish assemblage, and functional groups, testing for differences between reefs. Data were log (x+1) transformed.

Metric	MS	$F_{5,149}$	p
Abundance	0.95	12.62	<0.001
Species Richness	0.14	14.12	<0.001
Biomass (total)	0.74	5.92	<0.001
Biomass (>20)	1.16	5.47	<0.001
Omnivores	1.00	13.09	<0.001
Planktivores	1.15	5.02	<0.001
Carnivores	1.69	9.57	<0.001
Piscivores	1.57	3.52	0.005
Invertivores	0.63	5.41	<0.001
Corallivores	0.07	1.23	0.122
Farmers	0.49	7.87	<0.001
Grazers	0.92	6.17	<0.001

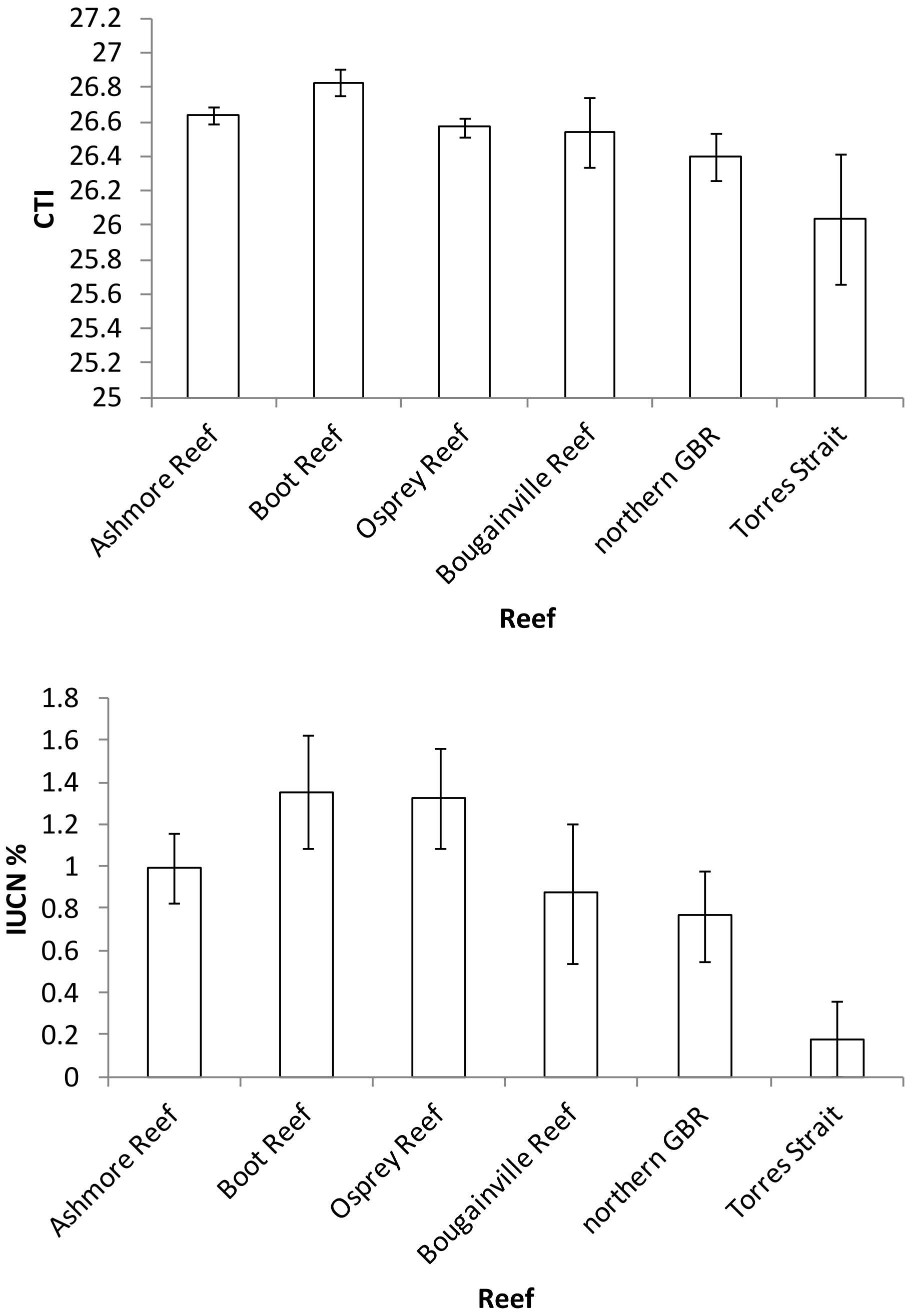


Figure 7. Reef health indicators (Community Temperature Index scores and the percentage of IUCN-listed threatened species) at reefs or groups of reefs in the northern GBR, Torres Strait and Coral Sea. Differences were not significant for IUCN –listed species, but for CTI scores ANOVA $F_{5,126}$ = 3.85, p=0.003.

BENTHIC SURVEYS

Across all the surveyed reefs, 79 transects were available with photoquadrats with which to assess benthic community structure; 30 at Ashmore Reef, 4 at Boot Reef, 11 at Bougainville Reef, 28 at Osprey Reef, and five on the northern GBR reefs. Photoquadrats were only available for one transect on the Torres Strait reefs at the time of this analysis, and so the Torres Strait reefs were excluded from the MDS and ANOVA for benthic cover. At Ashmore and Boot Reefs, coral cover was 31% and 34%, respectively, followed by algal turf (20 and 24%) and crustose coralline algae (20 and 19%). Across all reefs, live hard coral cover was also high, covering ~33% of the substratum and dominating benthic communities. Low-lying algal turf was also prevalent, covering ~23% of the reefs. Abiotic substrata such as bare rock, sand, rubble or recently dead corals made up 18%, and crustose coralline algae covered, on average, 15% of the surveyed reefs.

Ashmore, Osprey and Bougainville Reefs were significantly different from each other in their sessile communities, but overlapped with Boot Reef and the northern GBR reefs (Figure 8). Ashmore Reef sites were somewhat variable, and tended to have a combination of live corals (mostly tabular and branching corals), turf, sand and rubble. At Bougainville Reef, most sites were dominated by foliose corals and crustose coralline algae, but two sites stood out: one with high cover of branching and tabular corals, and the other with high cover of rubble. Osprey Reef was mostly dominated by massive corals, bare rock and rubble. Like Bougainville Reef, however, it also had a few sites dominated by branching and tabular corals, or turf and sand. Boot Reef and the northern GBR reefs appeared to have a relatively even combination of the most common benthic categories.

All the surveyed reefs had high cover of live sessile biota, ranging from 75% in the northern GBR to over 90% at Boot Reef (Figure 9). Benthic diversity (the number of categories present at each site) was highest at Osprey Reef, and relatively low at Bougainville Reef (Table 2). The Torres Strait transect had almost 100% cover of live hard corals, however, being the only transect available for analysis, it was not included in the figures and analyses, as these results cannot be extrapolated to a general overview of these reefs. Coral cover and turf cover were relatively even - mostly between 20 and 30% - across the other reefs. Crustose coralline algae were also present in similar amounts on most reefs except the northern GBR, which had less than half the crustose coralline algae cover than the other reefs. Boot Reef and Osprey Reef were rich in sponges compared to the other reefs.

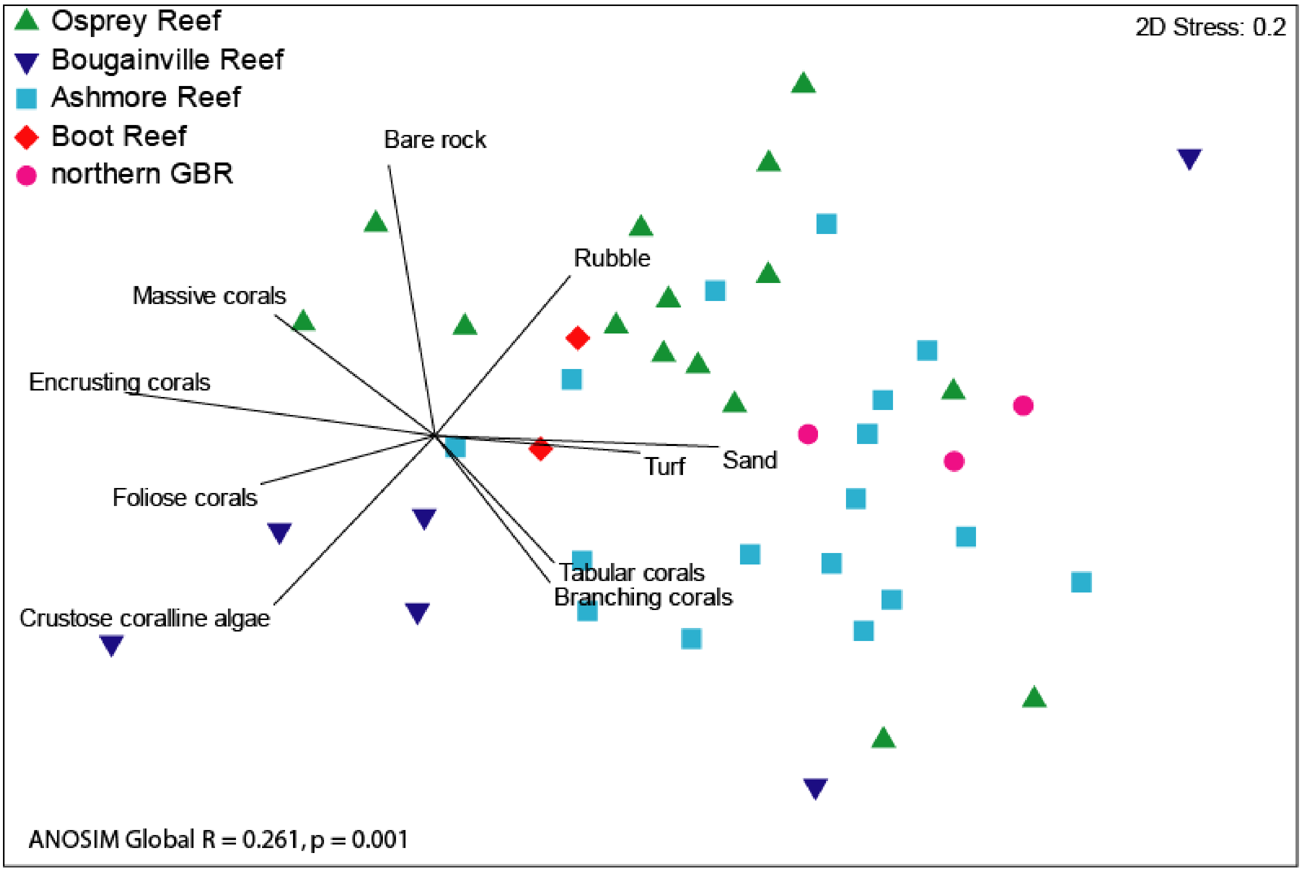


Figure 8. Multidimensional Scaling (MDS) plot of benthic community structure, recorded with Method 3, summarised into mean percent cover per site. The single Torres Strait transect was excluded. The analysis was conducted on the Bray-Curtis similarity matrix of the log(x+1) transformed data. Species vectors are shown if they have a correlation value of at least 0.5.

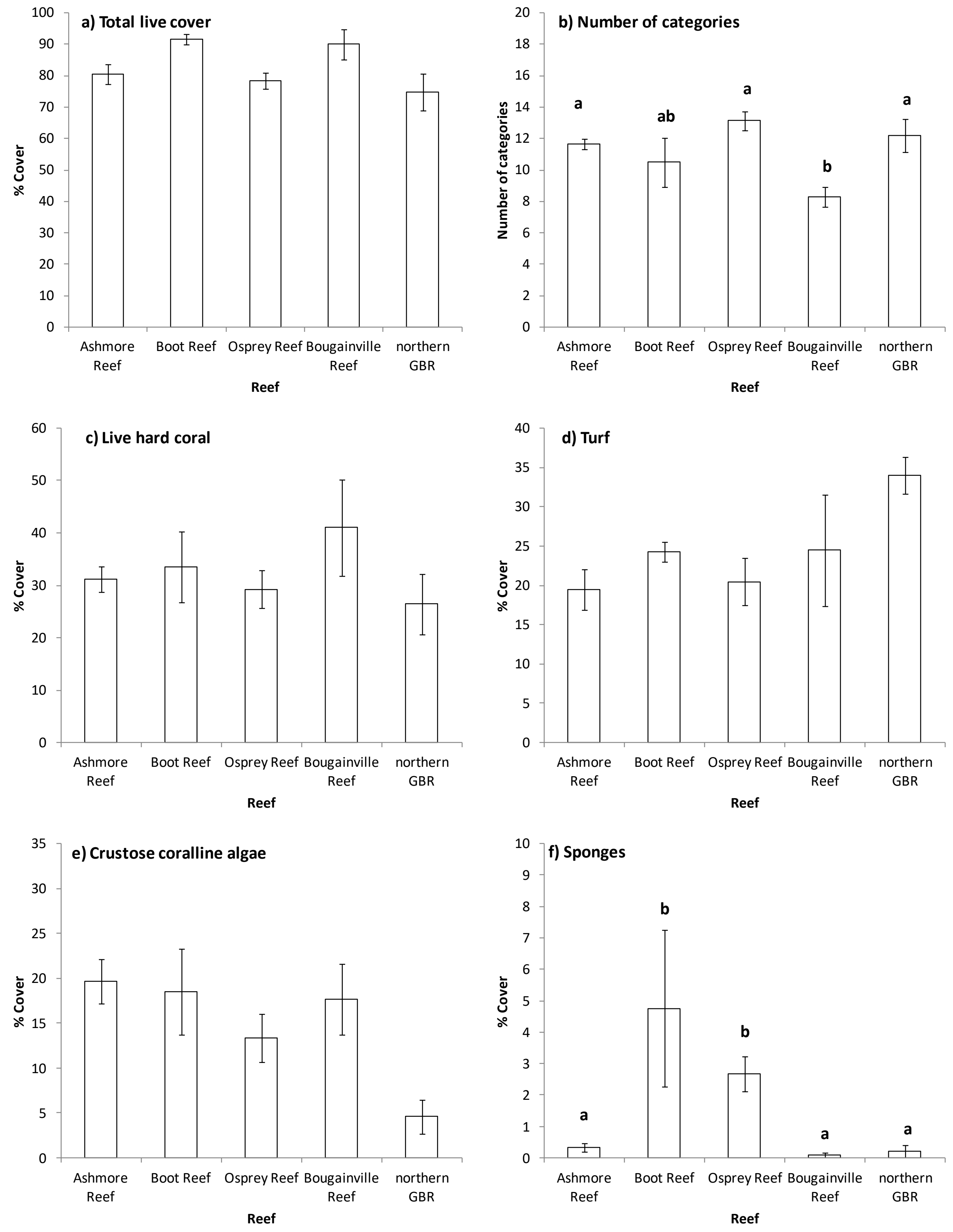


Figure 9. Variability in benthic community characteristics at reefs or groups of reefs in the northern GBR, Torres Strait and Coral Sea. a) Total cover of live biota, b) number of benthic categories, c) Live hard coral, d) Turf algae, e) Crustose coralline algae, f) Total sponges. Note the differences in the y-axes.

Table 2. ANOVA of key metrics of the benthic community, testing for differences between reefs. Data were log (x+1) transformed. The single Torres Strait transect was excluded from the analysis.

Benthic category	MS	$F_{4,73}$	p
Total live cover	0.01	1.42	0.236
Number of benthic categories	0.07	7.45	<0.001
Live hard coral	0.03	0.31	0.868
Turf	0.16	1.31	0.275
Macroalgae	0.05	0.83	0.511
Crustose coralline algae	0.56	2.88	0.028
Sponges	0.71	10.03	<0.001

MOBILE MACROINVERTEBRATE SURVEYS

Surveys of Ashmore and Boot Reefs yielded 94 and 23 species of mobile macroinvertebrates, respectively. Across all reefs, there were 129 invertebrate species, and a further 37 unidentified taxa (APPENDIX 3). Unlike other regions, echinoderms were not the only group to dominate abundance; molluscs and crustaceans were often also among the top five most abundant species. At Ashmore and Bougainville Reefs, crinoids and unidentified hermit crabs were among the most abundant species. Tridacnid clams were also abundant at all reefs, except Ashmore.

All reefs had different macroinvertebrate assemblages; ANOSIM identified only Osprey and Bougainville Reefs as being relatively similar (Figure 10), although there was some overlap in community structure between all reefs other than those in Torres Strait. Boot Reef had the broadest spread of sites in the MDS, indicating greater spatial patchiness in the types of invertebrates found across sites. In contrast, Ashmore Reef formed a tighter group, overlapping with northern GBR reefs, Boot Reef and to a lesser extent with Osprey Reef. Ashmore Reef and northern GBR reefs had high abundances of crinoids and common Indo-Pacific sea stars such as *Linckia laevigata* and *Fromia indica*. Bougainville Reef and some of the Osprey Reef sites were distinguished by high proportions of the sea urchin *Echinostrephus* sp. Reefs of the inner Torres Strait had a different assemblage, with high abundances of sea urchins such as *Diadema setosum*, *Echinostrephus* sp. and tridacnid clams. Most of the Osprey Reef sites were characterised by *Tridacna maxima* and *Bohadschia argus*.

Ashmore Reef and far northern GBR reefs had the highest abundance and species richness of invertebrates (Figure 11, Table 3). Ashmore Reef had an average of 70 individuals per $100m^2$, and northern GBR reefs had 109; the other surveyed reefs had between 7 and 45 individuals per $100m^2$. Differences in species richness were less pronounced, but still significant. Separated into the three most common phyla (crustaceans, echinoderms and molluscs), the differences between reefs were also significant (Figure 12, Table 3). Ashmore Reef had high abundance and species richness of crustaceans and echinoderms compared with the other reefs (with the exception of the northern GBR reefs, where echinoderms were more abundant and diverse), but mollusc abundance and diversity were similar to most other reefs. Mollusc abundance and species richness were relatively even between reefs. Northern GBR and inner Torres Strait reefs were remarkable for their relative lack of crustaceans.

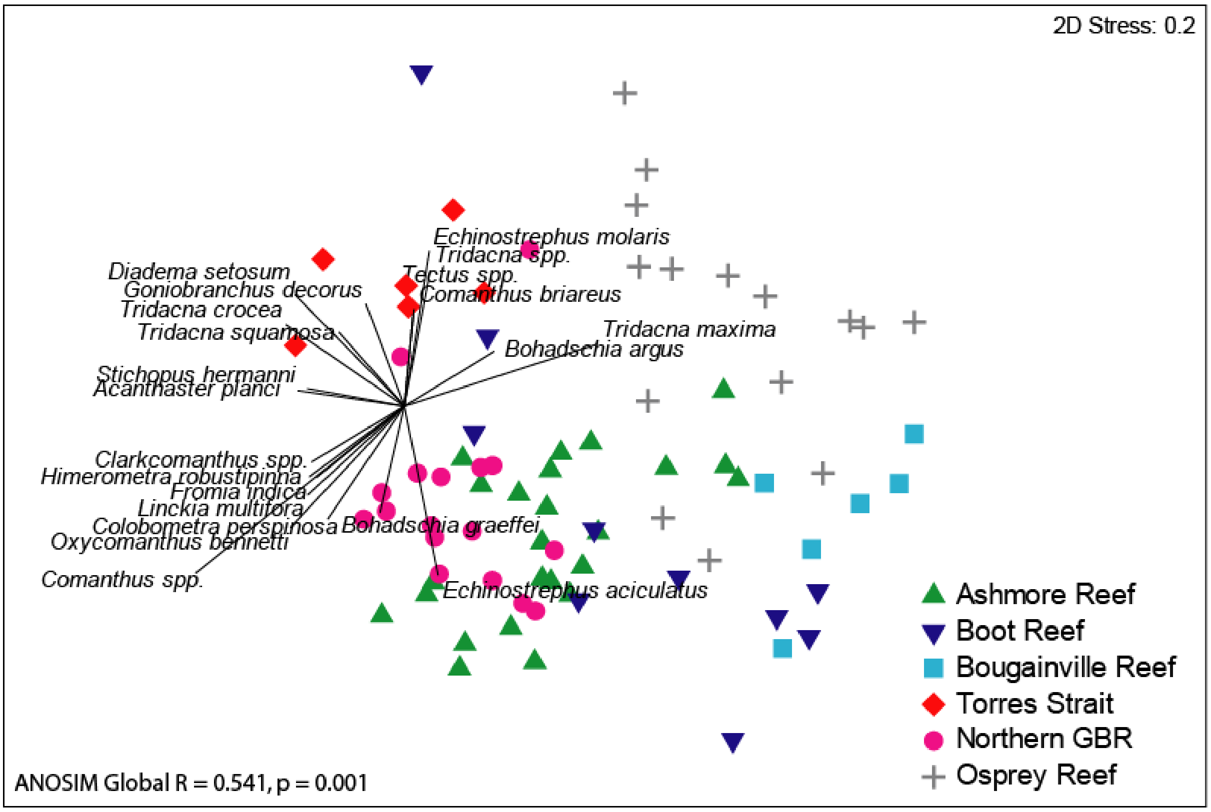
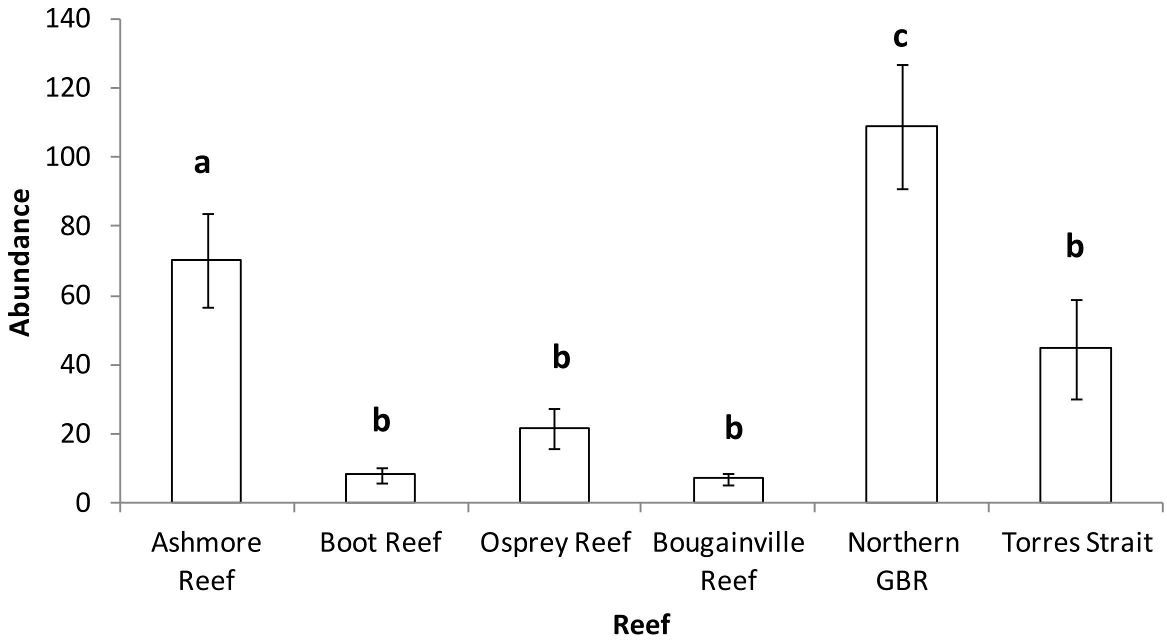


Figure 10. Multidimensional Scaling (MDS) plot of invertebrate abundance, recorded with Method 2, summarised by site. The analysis was conducted on the Bray-Curtis similarity matrix of the log(x+1) transformed data. Species vectors are shown if they have a correlation value of at least 0.3.



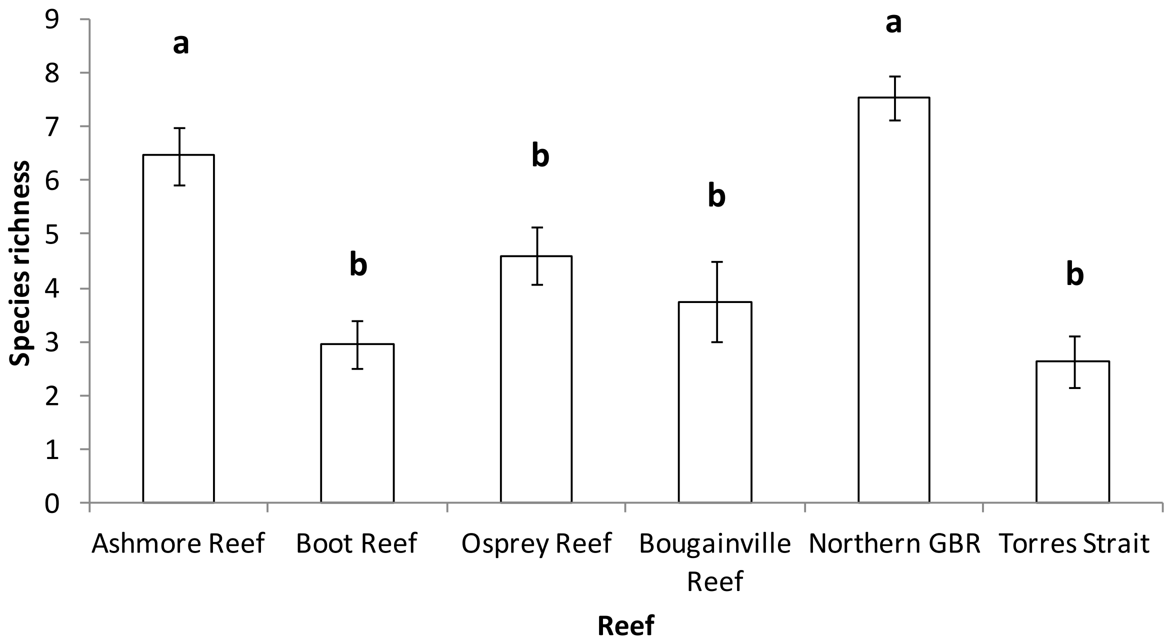
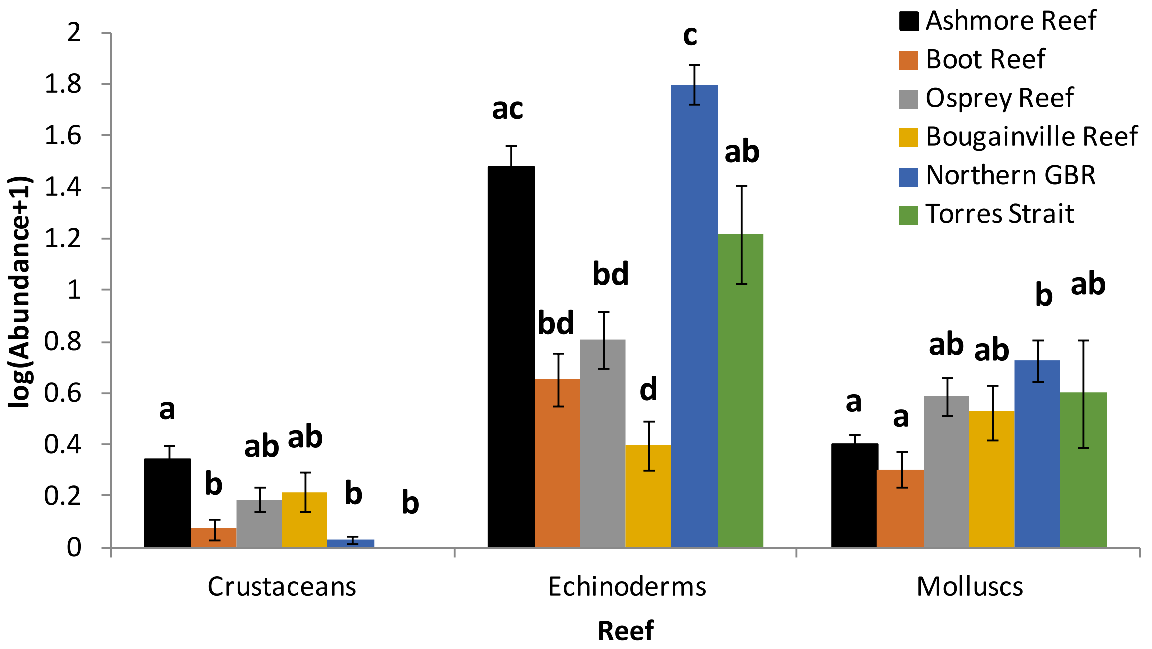


Figure 11. Abundance and species richness of macroinvertebrates at reefs or groups of reefs in the northern GBR, Torres Strait and Coral Sea (per 100 m2 transect).



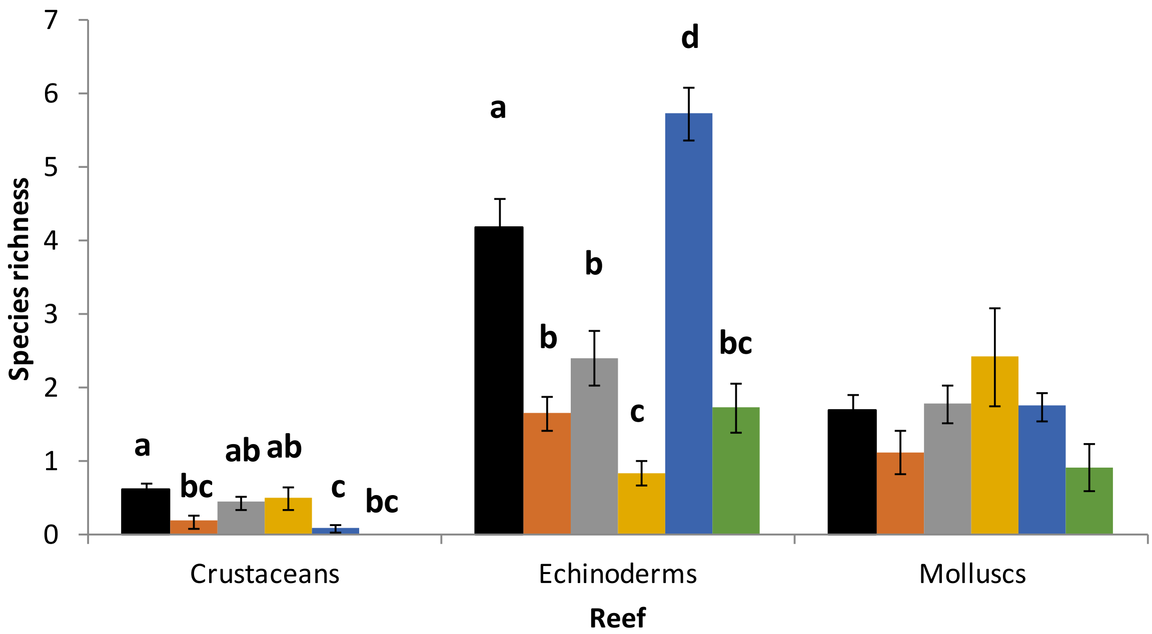


Figure 12. Abundance and species richness of key macroinvertebrate taxa at reefs or groups of reefs in the northern GBR, Torres Strait and Coral Sea (per 100 m^2 transect).

Table 3. ANOVA of key metrics of the invertebrate assemblage, and main groups, testing for differences between reefs. Data were log (x+1) transformed.

Metric	Group	MS	$F_{5,149}$	p
Abundance	Total	4.65	20.5	<0.001
	Crustaceans	0.55	7.28	<0.001
	Echinoderms	7.03	25.1	<0.001
	Molluscs	0.65	3.76	0.003
Species richness	Total	0.59	13.5	<0.001
	Crustaceans	0.14	7.85	<0.001
	Echinoderms	1.02	26.6	<0.001
	Molluscs	0.10	1.80	0.117

CRYPTIC FISH SURVEYS

Surveys at Ashmore and Boot Reefs yielded 60 and 43 species of cryptic fish, respectively. At least 147 species of cryptic fishes were recorded along the surveys of all reefs, and an additional 22 unidentified species (APPENDIX 4). The three most abundant species at Ashmore Reef were *Eviota guttata*, *Gnatholepis cauerensis* and *Helcogramma striatum*, common Indo-Pacific members of the cryptic fish community. *Myripristis* spp. were also among the most abundant species at Bougainville Reef, *Eviota* spp. were the most abundant on Osprey Reef, and cardinalfishes (apogonids) dominated the cryptic fish assemblage on the inner Torres Strait and far northern GBR reefs. Abundance of cryptic fishes was not significantly different between reefs, despite a tendency for greater abundance on reefs of the far northern GBR and Torres Strait than the more oceanic Coral Sea reefs (Figure 13). Species richness was lowest at Bougainville Reef and highest in the northern GBR, but although these two locations differed significantly from each other, they were both similar to the other reefs that had more intermediate diversity.

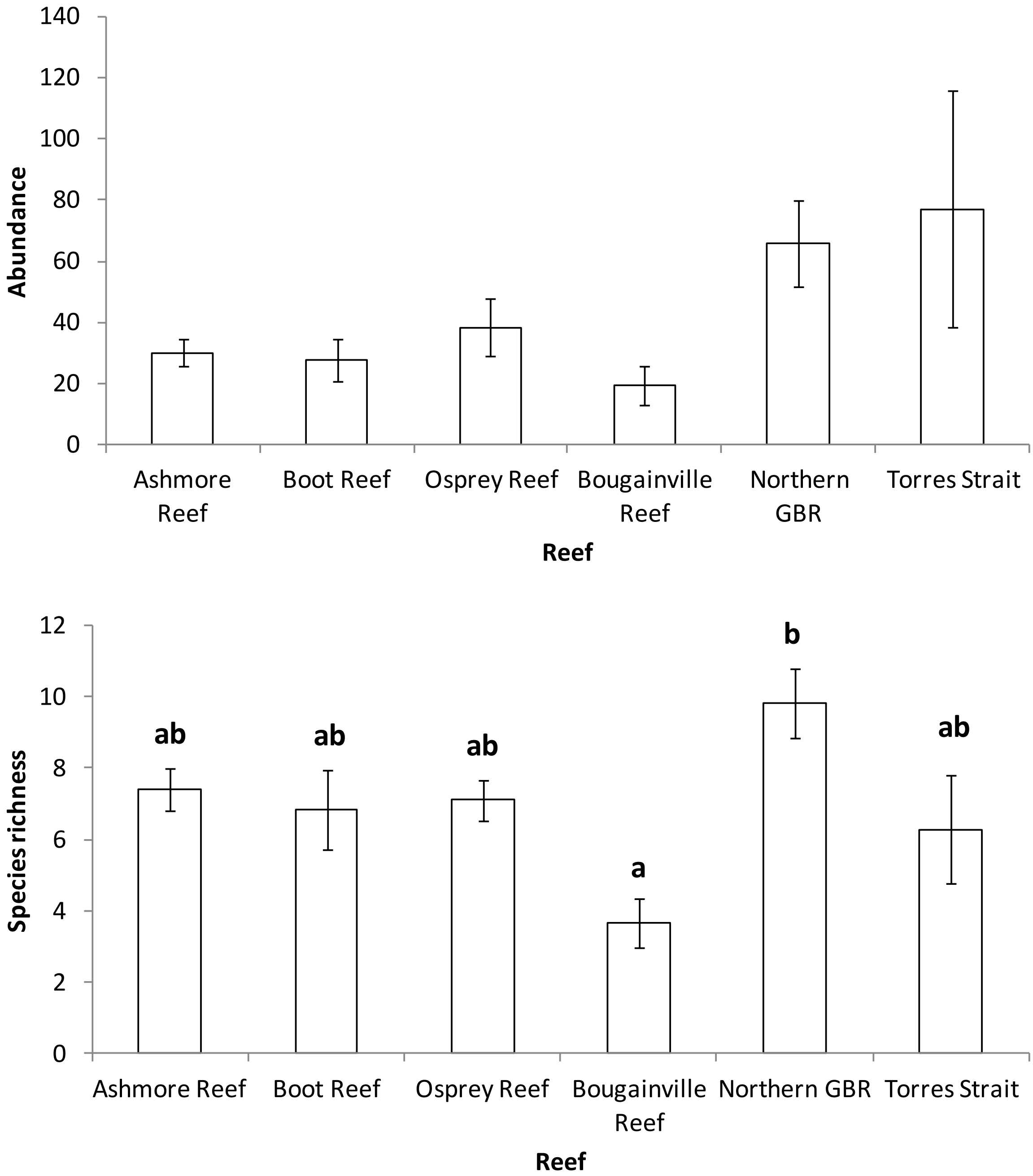


Figure 13. Abundance and species richness of cryptic fishes at reefs or groups of reefs in the northern GBR, Torres Strait and Coral Sea (per 100 m^2 transect).

THREATENED AND PROTECTED SPECIES

Species listed under the EPBC Act recorded on northern Coral Sea, GBR and Torres Strait reefs included the green turtle *Chelonia mydas* and the hawksbill turtle *Eretmochelys imbricata* (Vulnerable), while the olive sea snake *Aipysurus laevis* is listed as a Protected Marine species. *Chelonia mydas* was recorded at Boot Reef and in the Torres Strait, and *E. imbricata* occurred at Ashmore and Boot Reefs. *Aipysurus laevis* was only recorded at Ashmore Reef. All are known from the broader region and would be expected at other reefs.

Chelonia mydas and *E. imbricata* are also listed in the IUCN Red List, as Endangered and Critically Endangered, respectively. Among the sharks recorded during the surveys, *Carcharhinus albimarginatus*, *C. amblyrhynchos, C. melanopterus, C. limbatus* and *Triaenodon obesus* are listed as Near Threatened, and *Nebrius ferrugineus* is considered Vulnerable. Collectively, sharks were encountered everywhere except in the Torres Strait, but biomass tended to be low, except at Boot and Osprey Reefs (Figure 14). Six species of grouper recorded during this survey (*Epinephelus malabaricus, E. polyphekadion, E. lanceolatus, Plectropomus areolatus, P. laevis,* and *P. leopardus*) are listed as 'Near Threatened' or 'Vulnerable' on the Red List. Additionally, the sea cucumbers *Actinopyga mauritiana*, *A. miliaris*, *Holothuria whitmaei* and *Thelenota ananas* are listed as 'Vulnerable' or 'Endangered'.

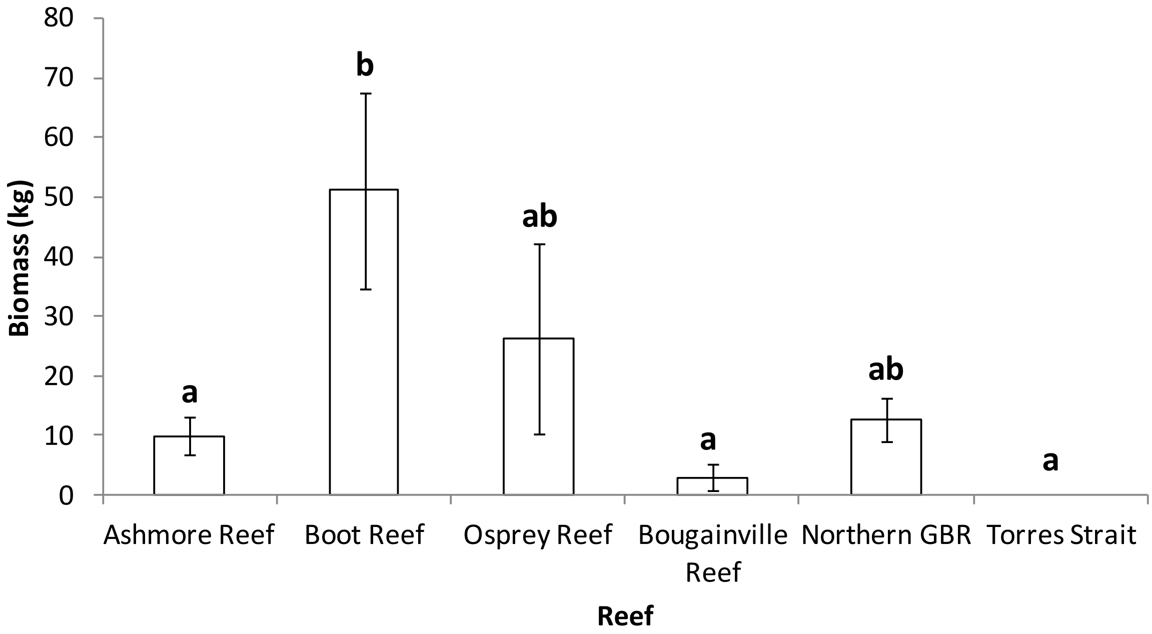


Figure 14. Biomass (kg) of sharks recorded with Method 1 at reefs or groups of reefs in the northern GBR, Torres Strait and Coral Sea. F = 4.04, p = 0.002 (per 500 m^2 transect).

4 Discussion

The reefs of the northern Coral Sea, far northern GBR and the Torres Strait share a typical Indo-Pacific coral reef fauna, with high biomass of predators on some reefs. The fish assemblage tends to distinguish the reefs along geomorphological differences, while the invertebrate fauna more closely reflects geographic proximity; all reefs had seemingly healthy coral communities, albeit with high cover of algal turf. The continental shelf reefs of the GBR and Torres Strait are mostly platform reefs and island fringing reefs; the Coral Sea reefs of Osprey and Bougainville are pinnacles rising from the deep sea (Heap and Harris 2008). Ashmore and Boot reefs, situated on the edge of the Australian continental shelf past the tip of Cape York, share characteristics of both reef types. Deep water barriers to the movement of adults further drive differences between coral reef communities (Jones et al. 2007).

Ashmore and Boot Reefs form part of the Coral Sea CMR, and due to their northern location and shelf-edge geomorphology they contribute ecological characteristics that are different from other Coral Sea reefs:

- Ashmore and Boot Reefs were more similar to the ‘oceanic’ reefs of the Coral Sea, but with some representation of the ‘inshore’ fish community – which is unusual among the reefs in the Coral Sea CMR, consequently inclusion of this northern area adds to the biodiversity coverage of the CMR.
- Ashmore Reef stood out as having high abundance and species richness of invertebrates, similar to the continental shelf reefs and much higher than the oceanic reefs.
- The Coral Sea reef average coral cover was previously recorded at 18%. Ashmore and Boot Reefs stand out as having high coral cover, at around 30%.
- When compared with other Coral Sea reefs, Ashmore Reef stood out as having high macroinvertebrate diversity, Boot Reef had very high fish abundance, Ashmore and Boot Reefs both had high fish species richness, total biomass and large fish biomass.
- Shark biomass at Ashmore and Boot Reefs was as high, or higher, than would be expected of highly protected reefs. Boot Reef, in particular, is potentially a valuable sanctuary for healthy predator populations.

Biogeographically, the oceanic Coral Sea reefs are located in the Cape Province, and the GBR and Torres Strait reefs in the Northeast IMCRA Transition Zone; Ashmore and Boot reefs are located on the boundary between the two (Commonwealth of Australia 2006). Such boundary habitats are important mixing points for fauna of two regions, and can often be genetic biodiversity hotspots and stepping stones connecting the two regions (Bellwood and Hughes 2001).

Continental shelf reefs typically have greater connectivity with one another than oceanic reefs, because the surrounding areas are shallower and offer diverse inter-reef habitats as “stepping stones” (Magris et al. 2016). Oceanic reefs are often more isolated, which makes them more vulnerable to population declines, but also protects them from concentrated human impacts by virtue of their distance offshore . An “inshore-offshore” gradient exists in the composition of reef fish assemblages, with species that are typical of offshore reefs and others that are more characteristic of inshore reefs (Graham et al. 2006). The oceanic reefs (Osprey and Bougainville) were clearly characterised by an offshore fish assemblage, dominated by planktivores and small grazers that feed by cropping low-lying turf algae. The northern GBR and Torres Strait reefs had an ‘inshore’ assemblage, with omnivorous and farming damselfishes, large benthic invertivores and a broader range of grazers that included browsers that feed on fleshy macroalgae (Done 1982; Fabricius et al. 2005; Cheal et al. 2012). Ashmore and Boot Reefs were more similar to the ‘oceanic’ reefs, but with some representation of the ‘inshore’ fish community.

Boot and Bougainville Reefs had the richest fish assemblage in terms of density and diversity of all fishes; Ashmore Reef was more similar to the continental shelf reefs in this regard. Exceptionally high biomass of sharks and other piscivores was evident at Boot Reef. Osprey Reef has been renowned for its high abundance of large predators, and Ashmore Reef is also subject to anecdotal reports of high biomass of large pelagic predators (Ayling and Choat 2008). The surveys captured lower than expected biomass, but high density (~29 sharks per hectare at Osprey and Boot Reefs). Large piscivores tend to be wide-ranging, moving freely across reefs and, as measured on Osprey Reef, can even cover large distances between reefs (Heupel et al. 2010). It is not known to what degree the surveyed reefs, by virtue of being located in the same region, ‘share’ populations of large pelagic predators. Methods for improving the accuracy of large fish and predator counts on coral reefs include long timed swims of at least 250 m (Ayling and Choat 2008). The RLS Method 0 counts allow for records beyond species encountered within the confines of the transects; it would be beneficial to ensure that all predators recorded with Method 0 are considered when discussing large, mobile species such as sharks.

Higher-order predators such as sharks and large groupers are generally the first part of the fish community to respond to fishing, or protection from fishing, through changes in density and biomass (Russ and Alcala 2004; Ayling and Choat 2008; Graham et al. 2011). The intensity of fishing on the survey reefs is unknown, but is presumed to be lower on the offshore reefs due to distance constraints. Ayling and Choat (2008) measured the mean density per hectare of reef sharks on fished, no-take and no-entry zones of the GBR, and the highest shark density (5.5 +/- 0.83SE individuals per hectare) was recorded on no-entry reefs. In this study, shark abundance far exceeded this estimate at most reefs. There were no sharks recorded on Torres Strait reefs, 3.3 sharks per hectare at Bougainville Reef, 20 and 29 at Ashmore and Boot Reefs, respectively, and between 13 and 30 sharks per hectare at all the other reefs. The difference between Ashmore and Boot Reefs was largely driven by higher densities of the smaller-bodied white tip reef shark *Triaenodon obesus* at Ashmore Reef, against greater densities of the large-bodied silvertip shark *Carcharhinus albimaginatus* at Boot Reef. Overall, these values suggest low fishing pressure and a relatively intact predator community.

Live hard corals, low-lying algal turf and crustose coralline algae dominated the benthos, typical for offshore reefs in exposed locations. Exposure to prevailing swells was probably what distinguished the sites that had greater cover of delicate tabular or branching corals from those with more robust massive, encrusting, or foliose corals. Different coral morphologies determine the type of habitats available to the invertebrate and fish communities (Chabanet et al. 1997; Arias-Gonzalez et al. 2006; Alvarez-Filip et al. 2011).

Interestingly, the mobile macroinvertebrate community was more reflective of geographic distances between the reefs than the fish community. Invertebrates rely solely on the larval stage for their dispersal between reefs. Ashmore Reef stood out as having high abundance and species richness of invertebrates, similar to the continental shelf reefs and much higher than the oceanic reefs. Some sites of Ashmore and Boot Reefs overlapped with northern GBR reefs, whereas others were more similar to Osprey and Bougainville Reefs; Torres Strait reefs formed a group of their own. Most of the common invertebrates, however, were more typical of offshore areas and exposed reef fronts, with a high proportion of filter-feeding feather stars, usually found in areas that experience a high degree of water movement (Greene 2015). The high abundance of tridacnid clams at some sites – especially in the Torres Strait and at Osprey Reef – did not include the giant clam *Tridacna gigas*. Similarly, only one specimen of the commercially-valuable sea cucumber, *Holothuria whitmaei*, was recorded at Ashmore Reef. Low dispersal is common in these species, making population recovery slow after a history of exploitation (Uthicke and Benzie 2001; Ceccarelli et al. 2011).

Ashmore and Boot reefs are on the boundary between the far northern GBR and Torres Strait, characterised by platform and island fringing reefs, and the Coral Sea, where the closest reefs have formed on pinnacles rising from deep water. The fauna recorded on these reefs reflects a unique combination of these ecoregions and geomorphic types, encompassing the more sheltered habitats of the networked continental shelf reefs and the highly exposed and isolated oceanic reefs. Ashmore and Boot Reefs host a rich Indo-Pacific reef assemblage characteristic of waters close to the centre of diversity, the Coral Triangle, just to the north of this region. Large predators are highly abundant, despite the reefs being open to fishing; their remoteness is likely to protect them from overexploitation. Prevailing currents are expected to provide good connectivity with the reefs nearly, both on the shelf and in the Coral Sea. The position of these reefs on the far northern edge of the continental shelf adjacent to the Gulf of Papua places them in danger of frequent exposure to high temperature anomalies; at present, however, their seemingly intact community structure suggests the potential for high resilience.

Through the longer term, consideration should be given to fully protecting from fishing a subset of the unique coral reef ecosystem present at Ashmore Reef/Boot Reef within the Coral Sea Commonwealth Marine Reserve. Boot Reef is the obvious location for such a sanctuary zone, being smaller and more remote than Ashmore Reef, and isolated from other reefs by deep water. Importantly, Boot Reef has a shark population with densities similar to Elizabeth and Middleton Reefs. Sharks consequently occur in higher numbers than at other locations around Australia, with densities only exceeded by the population at the Kermadecs Islands amongst Pacific nations investigated by Reef Life Survey divers (Figure 4, Coral Sea Report). Such high shark densities indicate that the Boot Reef like comprises one of the few remaining locations across the Pacific with an intact food web, including a full complement of higher predators.

5 Recommendations

- Undertake ongoing monitoring at intervals of 1-5 years to build up a temporal dataset to assess changes relative to the baseline provided by this survey, with results reported using a comprehensive suite of sensitive environmental indicators;
- Collect data on fishing effort on the different reefs to assess differences in extractive use;
- Include timed swims for more accurate sampling of sharks and other large predators;
- Investigate food webs, including addressing the question of how such a large biomass of sharks influences the reef community;
- Apply ecological indicators for ongoing ecosystem health assessment; and
- Through the longer term, consider increased protection from fishing for Boot Reef as a sanctuary for higher predators, to be used as a scientific reference area with intact coral reef food web.

6 Acknowledgements

The contributions of all divers and vessel crew who contributed their time and expertise to field data collection are gratefully acknowledged: Derek Shields, Joe Shields, Sue Baker, Bill Barker, Andrew Green, Kate Tinson, Meryl Larkin, Carly Giosio and Sonia Sagrista also collated reef area data used in analyses. Just Berkhout provided database support and Antonia Cooper provided maps and diagrams.

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8 Appendices

APPENDIX 1 – LIST OF SITES AND SITE DETAILS SURVEYED ACROSS THE NORTHERN CORAL SEA, GBR AND TORRES STRAIT.

SiteCode	Site name	SiteLat	SiteLong	Location	Depth	SurveyDate
CS153	Inner Osprey East	-13.85535	146.62455	Coral Sea	9.5	19/07/2013
					5	19/07/2013
CS154	Inside Osprey NE	-13.854	146.6254	Coral Sea	10	19/07/2013
					4.5	19/07/2013
CS155	Osprey Pass South	-13.8965	146.5553	Coral Sea	12	20/07/2013
					4.5	20/07/2013
CS156	Osprey Pass	-13.8851	146.5623	Coral Sea	11.5	20/07/2013
					4.5	20/07/2013
CS157	Osprey Pass Channel	-13.8954	146.5576	Coral Sea	12.5	20/07/2013
					5.5	20/07/2013
CS158	Osprey Castle	-13.8598	146.5744	Coral Sea	10	21/07/2013
					5	21/07/2013
CS159	Osprey Admiralties	-13.8527	146.574	Coral Sea	11	21/07/2013
					5.5	21/07/2013
CS171	Bougainville Reef southwest	-15.48855	147.0903	Coral Sea	15	14/07/2015
					5	14/07/2015
CS172	Bougainville Reef W central	-15.48253	147.0993	Coral Sea	5	14/07/2015
					14	14/07/2015
CS173	Bougainville Reef lagoon	-15.48651	147.1083	Coral Sea	2.2	15/07/2015
					2	15/07/2015
CS174	Bougainville Reef Lagoon East	-15.48433	147.10759	Coral Sea	2.2	15/07/2015
					2	15/07/2015
SiteCode	**Site name**	**SiteLat**	**SiteLong**	**Location**	**Depth**	**SurveyDate**

CS175	Bougainville Reef point	-15.4908	147.08723	Coral Sea	5	15/07/2015
					15	15/07/2015
CS176	Bougainville Reef inlet	-15.48135	147.10453	Coral Sea	5	15/07/2015
					12	15/07/2015
CS177	Osprey Reef Lagoon South	-13.98559	146.69139	Coral Sea	14	21/07/2015
					13.5	21/07/2015
CS178	Osprey South reef flat	-13.99381	146.69067	Coral Sea	2	21/07/2015
					1	21/07/2015
CS179	Osprey south bommie	-13.97563	146.67549	Coral Sea	6	22/07/2015
					13	22/07/2015
CS180	Osprey S W Bommie	-13.96688	146.66721	Coral Sea	6	22/07/2015
					13	22/07/2015
CS181	Osprey S E Lagoon	-13.96617	146.6806	Coral Sea	4.5	22/07/2015
					5	22/07/2015
CS182	Osprey Lagoon entrance bommie	-13.88962	146.57222	Coral Sea	5	23/07/2015
					12	23/07/2015
CS183	Osprey Lagoon Entrance NW Bommie	-13.88889	146.57036	Coral Sea	4.5	23/07/2015
					11	23/07/2015
CS184	Osprey Reef North Horn	-13.80117	146.54613	Coral Sea	6	23/07/2015
					14	23/07/2015
CS185	Ashmore reef lagoon South	-10.44533	144.44918	Coral Sea	2.5	30/07/2015
					2	30/07/2015
CS186	Ashmore South bommie	-10.43422	144.45243	Coral Sea	5	31/07/2015
					12	31/07/2015
CS187	Ashmore South lagoon shore	-10.44136	144.45293	Coral Sea	3	31/07/2015
					3.1	31/07/2015
CS188	Ashmore Rf Lagoon Bommie SW	-10.44121	144.43016	Coral Sea	10	31/07/2015
					6	31/07/2015
SiteCode	**Site name**	**SiteLat**	**SiteLong**	**Location**	**Depth**	**SurveyDate**

CS189	Ashmore Rf Lagoon SW	-10.44697	144.43347	Coral Sea	3	31/07/2015
					3.5	31/07/2015
CS190	Ashmore Reef lagoon east entrance	-10.3022	144.52468	Coral Sea	5	1/08/2015
					9	1/08/2015
CS191	Ashmore Rf Lagoon East Bommie	-10.37448	144.53391	Coral Sea	12	1/08/2015
					7	1/08/2015
CS192	Ashmore reef SW anchorage	-10.39655	144.53283	Coral Sea	3	1/08/2015
					2.5	1/08/2015
CS193	Boot Rf Wall	-10.03875	144.69198	Coral Sea	12	2/08/2015
					6	2/08/2015
CS194	Boot Reef lagoon bommie	-10.03484	144.69893	Coral Sea	2	2/08/2015
					8	2/08/2015
CS195	Ashmore North East Entrance	-10.21767	144.5954	Coral Sea	8	3/08/2015
					10	3/08/2015
CS196	Ashmore NE entrance bommie	-10.22136	144.59315	Coral Sea	4	3/08/2015
					12	3/08/2015
CS197	Ashmore NE Bommie	-10.22733	144.58955	Coral Sea	12	3/08/2015
					6	3/08/2015
CS198	Ashmore NE Lagoon	-10.23257	144.58684	Coral Sea	6	3/08/2015
					5	3/08/2015
CS199	Ashmore NW Wall	-10.14325	144.4407	Coral Sea	23	4/08/2015
					5	4/08/2015
CS200	Ashmore Reef NW slope	-10.11558	144.45777	Coral Sea	12	4/08/2015
					5	4/08/2015
CS201	Ashmore Reef NNW point	-10.07613	144.4715	Coral Sea	5	4/08/2015
					12	4/08/2015
CS202	Ashmore Reef NW	-10.06544	144.52417	Coral Sea	11	29/11/2015
					6	29/11/2015
SiteCode	**Site name**	**SiteLat**	**SiteLong**	**Location**	**Depth**	**SurveyDate**

CS203	Boot Rock W	-10.10677	144.68304	Coral Sea	6	29/11/2015
					13	29/11/2015
CS204	Boot Rock NW	-10.10505	144.68513	Coral Sea	10	29/11/2015
					5	29/11/2015
CS205	Boot Reef NW Point	-9.98595	144.67923	Coral Sea	8	30/11/2015
CS206	Boot Reef Birds	-9.97227	144.68823	Coral Sea	8	30/11/2015
CS207	Boot Reef Longiceps Point	-9.96837	144.69456	Coral Sea	7.5	30/11/2015
CS208	Boot Reef Lagoon E	-9.98877	144.6913	Coral Sea	3	30/11/2015
					6	30/11/2015
CS209	Boot Reef Lagoon W	-9.97456	144.694	Coral Sea	4	30/11/2015
					7	30/11/2015
					12	30/11/2015
CS210	Boot Reef South Point	-10.05642	144.68963	Coral Sea	5	30/11/2015
CS211	Kate's Garden	-10.14414	144.57626	Coral Sea	6	1/12/2015
					5	1/12/2015
CS212	Ashmore Reef NE bommy	-10.14587	144.57013	Coral Sea	16	1/12/2015
					6	1/12/2015
CS213	Ashmore Reef NE passage	-10.15276	144.57715	Coral Sea	6	1/12/2015
					12	1/12/2015
CS214	Gnathodentex Gulch	-10.13842	144.5742	Coral Sea	5.5	1/12/2015
					5	1/12/2015
CS215	Genicanthus Reef	-10.23352	144.41098	Coral Sea	22	2/12/2015
					6	2/12/2015
CS216	Genicanthus Reef NE	-10.23137	144.41408	Coral Sea	10	2/12/2015
					6	2/12/2015
CS217	Naso Rock	-10.23794	144.41244	Coral Sea	7	2/12/2015
					6	2/12/2015
CS218	Ctenochaetus Reef	-10.19376	144.41151	Coral Sea	6	2/12/2015
					12	2/12/2015
SiteCode	**Site name**	**SiteLat**	**SiteLong**	**Location**	**Depth**	**SurveyDate**

GBR50	Yule Passage	-10.38352	143.929	Great Barrier Reef	14	5/08/2015
					6	5/08/2015
GBR51	Seven Reefs east	-10.28793	143.71759	Great Barrier Reef	2	5/08/2015
					7	5/08/2015
					5	7/12/2015
					3.5	7/12/2015
GBR52	Seven Reefs Anchorage	-10.2875	143.70978	Great Barrier Reef	4	5/08/2015
					7	5/08/2013
					4.5	7/12/2015
					5.4	7/12/2015
QLD100	Murray Channel	-9.95826	144.15061	Queensland (other)	6	3/12/2015
					10	3/12/2015
QLD101	Mer Passage	-9.96107	144.15357	Queensland (other)	5	3/12/2015
					12	3/12/2015
QLD102	Mer Slope	-9.96049	144.15589	Queensland (other)	7	3/12/2015
					11	3/12/2015
QLD103	Waier Island	-9.9513	144.03178	Queensland (other)	4	4/12/2015
					3.8	4/12/2015
QLD104	Dowar Island SW	-9.94215	144.02049	Queensland (other)	5	5/12/2015
					4	5/12/2015
QLD105	The Maze Channel	-10.06687	143.86969	Queensland (other)	12	5/12/2015
					6	5/12/2015
QLD106	The Maze Anchorage	-10.0696	143.87544	Queensland (other)	3.5	5/12/2015
					3	5/12/2015
QLD107	Morning Maze	-10.06631	143.87446	Queensland (other)	6.2	6/12/2015
					6	6/12/2015
QLD108	Maze Lagoon Bommy	-10.05737	143.83832	Queensland (other)	7	6/12/2015
					3	6/12/2015
QLD109	Maze Lagoon Reef	-10.05785	143.84266	Queensland (other)	2.5	6/12/2015
SiteCode	**Site name**	**SiteLat**	**SiteLong**	**Location**	**Depth**	**SurveyDate**

					4	6/12/2015
QLD110	Round Maze	-10.0599	143.883	Queensland (other)	5	6/12/2015
					5.3	6/12/2015
QLD111	Dugong Island Anchorage	-10.51905	143.09294	Queensland (other)	7	8/12/2015
					7.2	8/12/2015
QLD112	Dugong Island	-10.52274	143.09259	Queensland (other)	4	8/12/2015
					5.5	8/12/2015
QLD92	Nagir Islet W	-10.24809	142.47267	Queensland (other)	4.9	26/11/2015
					5	26/11/2015
QLD93	Nagir Islet NW	-10.24569	142.47559	Queensland (other)	4	26/11/2015
					6	26/11/2015
QLD94	Mourilyan Reef	-9.7946	142.62988	Queensland (other)	4	27/11/2015
					3	27/11/2015
QLD96	Bourke Islet NW	-9.87725	142.48535	Queensland (other)	7	28/11/2015
QLD97	Hannah Banks SW	-9.8559	143.59106	Queensland (other)	5.5	28/11/2015
					6	28/11/2015
QLD98	Hannah Bank E	-9.85555	143.59785	Queensland (other)	3	28/11/2015
					2.5	28/11/2015
QLD99	Mer Outer Reef	-9.97146	144.1537	Queensland (other)	14	3/12/2015

APPENDIX 2 – AVERAGE ABUNDANCE AND BIOMASS OF REEF FISHES RECORDED WITH METHOD 1 AT EACH REEF.

Species	Abundance						Biomass					
	Ash	Boot	Boug	TS	N GBR	Osp	Ash	Boot	Boug	TS	N GBR	Osp
Abudefduf bengalensis	0	0	0	2.73	0.42	0	0	0	0	282.24	41.13	0
Abudefduf sexfasciatus	3.4	0.35	0	0	0.39	0	188.98	12.26	0	0	37.98	0
Abudefduf vaigiensis	1.54	7.29	0.17	0	0.53	0	140.62	551.69	11.33	0	9.74	0
Acanthochromis polyacanthus	52.52	42.12	0.83	101.1	172.7	61.3	1044.6	946.75	16.43	1471.3	3221.15	1121.66
Acanthocybium solandri	0	0	0.08	0	0	0	0	0	0	0	0	0
Acanthurus albipectoralis	0.21	0	0	0	0	0	88.65	0	0	0	0	0
Acanthurus auranticavus	3.96	12.71	0	0.18	0.82	0	2160.6	4085.88	0	48.21	447.26	0
Acanthurus blochii	2.83	0.82	31.42	0	1.97	2.07	1360.2	372.81	20350.6	0	1318.39	1056.69
Acanthurus dussumieri	0.02	0.35	0.5	0	0	0.13	16.7	260.56	400.86	0	0	82.88
Acanthurus grammoptilus	0	0	0	13.55	13.95	0	0	0	0	4850.97	7424.83	0
Acanthurus leucocheilus	0	0	0	0	0.42	0	0	0	0	0	117.05	0
Acanthurus lineatus	10.9	10.06	4.67	0	3.05	0.3	2970.8	2498.27	1041.02	0	1109.08	59.03
Acanthurus nigricans	0.27	0	1.08	0	0	1.57	139.74	0	196.13	0	0	260.28
Acanthurus nigricauda	1.85	2.24	7.67	0	0.61	0.33	520.37	743.92	2664.23	0	198.58	81.37
Acanthurus nigrofuscus	7.46	2.35	51.33	0	3.29	25.8	631.27	301.06	4677.88	0	283.28	1211
Acanthurus nigroris	0	0	0	0	0	0.37	0	0	0	0	0	23.79
Acanthurus olivaceus	3.94	0.35	0	0	2.53	0.73	1275.2	40.63	0	0	729.34	73.81
Acanthurus pyroferus	2.6	1.59	0.08	0	1.87	0.47	437.73	243.49	17.52	0	314.57	36.13
Acanthurus thompsoni	0.4	0.65	0.83	0	0	0.97	145.05	192.19	103.71	0	0	237.55
Acanthurus triostegus	2.85	1.71	0	0	0.03	0	644.67	267.81	0	0	4.13	0
Acanthurus xanthopterus	0.21	0.41	0	0	0.24	0.27	100.43	264.31	0	0	114.17	171.17
Aethaloperca rogaa	0	0.12	0	0	0.03	0.03	0	48.54	0	0	10.86	5.92
Aioliops megastigma	0	0	0	4.64	5.26	0	0	0	0	0	0	0
Amanses scopas	0.04	0	0	0	0	0	3.36	0	0	0	0	0
Amblyglyphidodon aureus	1.69	7.53	0	0	0.34	0.53	63.45	517.32	0	0	14.14	17.24

Species	Abundance Ash	Boot	Boug	TS	N GBR	Osp	Biomass Ash	Boot	Boug	TS	N GBR	Osp
Amblyglyphidodon curacao	0.77	0.94	0	99.73	69.26	0.07	7.18	16.94	0	856.07	1381.09	3.22
Amblyglyphidodon leucogaster	68.21	11.71	0	0.82	21.92	49.7	1207	301.13	0	15.31	523.55	545.99
Amphiprion akindynos	0	0	0	0	0.08	0.3	0	0	0	0	0.68	8.43
Amphiprion chrysopterus	1.9	0.76	0	0	1.42	0.27	19.54	7.21	0	0	20.81	2.66
Amphiprion clarkii	0.65	0.12	0	0	0.5	0.03	21.75	4.4	0	0	6.35	0.16
Amphiprion melanopus	0.15	0	0	0	0.61	0	0.7	0	0	0	24.38	0
Amphiprion percula	0	0	0	0	0.05	0	0	0	0	0	0.26	0
Amphiprion perideraion	0.25	0.29	0	0	0.34	0.13	1.66	1.44	0	0	5.76	1.4
Amphiprion polymnus	0	0	0	0	0.03	0	0	0	0	0	0	0
Anampses caeruleopunctatus	0.17	0	0.08	0	0.05	0	20.25	0	44.66	0	0.08	0
Anampses geographicus	0.13	0	0	0	0	0	0.57	0	0	0	0	0
Anampses melanurus	0	0.12	0	0	0	0	0	4.51	0	0	0	0
Anampses meleagrides	0	0.06	0	0	0	0	0	0.15	0	0	0	0
Anampses neoguinaicus	8.67	2.53	0.25	0	4.11	1.67	82.12	42.77	3.08	0	83.52	64.01
Anampses twistii	0.1	0.18	0.25	0	0	0	1.19	6.19	10.31	0	0	0
Anyperodon leucogrammicus	0.29	0	0	0.18	0.08	0.07	76.81	0	0	71.29	22.53	26.63
Aphareus furca	0.06	1	0.92	0	0	0.27	16.96	252.93	238.58	0	0	64.6
Apogon doederleini	0	0	0	0	3.97	0	0	0	0	0	2.83	0
Apogon flavus	0	0	0	0	0.39	0	0	0	0	0	0.17	0
Apogon limenus	0.06	0	0	0	0	0	41.22	0	0	0	0	0
Apolemichthys trimaculatus	0.1	0	0	0	0.21	0	13.2	0	0	0	53.59	0
Aprion virescens	0.42	0.06	0	0	0.03	0.13	458.7	117.68	0	0	27.75	119.96
Arothron caeruleopunctatus	0	0	0	0	0	0.03	0	0	0	0	0	46.84
Arothron hispidus	0	0	0.08	0	0.03	0	0	0	202.05	0	20.56	0
Arothron mappa	0	0.06	0	0	0.03	0	0	37.58	0	0	6.01	0
Arothron nigropunctatus	0.17	0.59	0.42	0	0.08	0.17	42.41	132.51	56.44	0	27.47	9.69
Arothron stellatus	0.02	0	0	0	0	0	96.13	0	0	0	0	0
Assessor flavissimus	0	0	0	0	1.45	0	0	0	0	0	1.26	0
Assessor macneilli	0	0	0	1.27	1.37	0	0	0	0	1.92	0.91	0

Species	Abundance						Biomass					
	Ash	Boot	Boug	TS	N GBR	Osp	Ash	Boot	Boug	TS	N GBR	Osp
Aulostomus chinensis	0.25	0.65	0	0	0.05	0.2	13.79	82.73	0	0	3.35	9.85
Balistapus undulatus	1.06	0.41	0.08	0	0.97	0.2	118.65	41.22	5.63	0	109.58	30.58
Balistoides conspicillum	0.65	0.12	0	0	0.05	0.1	201.5	48.7	0	0	27.75	66.07
Balistoides viridescens	0.15	0	0	0	0	0.27	165.29	0	0	0	0	665.49
Belonoperca chabanaudi	0.08	0.24	0	0	0	0.1	3.17	29.19	0	0	0	3.35
Bodianus anthioides	0	0	0.08	0	0	0	0	0	0.22	0	0	0
Bodianus axillaris	1	0.12	0.33	0.18	0.5	0.23	112.54	8.01	34.76	23.63	54.42	9.56
Bodianus diana	0.02	0.29	0.25	0	0	0	0.59	10.05	11.86	0	0	0
Bodianus dictynna	0.29	2.24	0	0	0.24	0	18.77	124.8	0	0	14.47	0
Bodianus loxozonus	0.38	0.12	0	0	0	0.03	73.84	25.3	0	0	0	2.57
Bodianus mesothorax	1.81	1.82	0.67	0	0.39	0.57	100.87	118.44	45.83	0	19.84	24.45
Bolbometopon muricatum	1.02	0	1.42	0	0.18	0.1	5460	0	5068.77	0	332.24	1525.79
Caesio caerulaurea	4.08	6.71	0	3.73	12.34	6.83	921.8	906.92	0	618.13	1478.9	995.9
Caesio cuning	1.77	0	0	158.7	61.47	0	394.25	0	0	13799	11433	0
Caesio lunaris	0.08	0.71	0	0	0.55	0	2.44	150.61	0	0	81	0
Caesio teres	0.92	0	0	4.55	5.13	2	70.09	0	0	313.93	980.97	192.38
Calotomus carolinus	0	0	0	0	0	0.13	0	0	0	0	0	83.78
Cantherhines dumerilii	0.04	0	0	0	0.08	0	9.69	0	0	0	7.05	0
Cantherhines pardalis	0.02	0.06	0	0	0.08	0.03	1.44	7.14	0	0	8.21	1.17
Canthidermis maculata	0.38	0	0	0	0	0	149.25	0	0	0	0	0
Canthigaster amboinensis	0	0	0	0	0	0.1	0	0	0	0	0	1.14
Canthigaster bennetti	0	0.06	0.08	0	0.03	0	0	2.92	1.77	0	0.02	0
Canthigaster papua	0	0	0	0.18	0.32	0	0	0	0	3.86	14.57	0
Canthigaster valentini	0.15	0.71	0.67	0	0.5	0.1	16.6	6.99	6.14	0	9.79	4.02
Carangoides fulvoguttatus	0	0.06	0	15.18	1.63	0	0	21.48	0	12460.7	943.55	0
Carangoides gymnostethus	0	0	0	0	0.03	0	0	0	0	0	18.85	0
Carangoides orthogrammus	0.04	0.76	0	0	0	0.03	14.58	327.59	0	0	0	20.59
Carangoides plagiotaenia	0.27	2.18	0.67	0	0.05	0	129.42	976.16	283	0	17.77	0
Caranx ignobilis	0	12.35	0.08	0	0	0	0	24720.4	105.34	0	0	0

Species	Abundance						Biomass					
	Ash	Boot	Boug	TS	N GBR	Osp	Ash	Boot	Boug	TS	N GBR	Osp
Caranx lugubris	0	0	0.5	0	0	0	0	0	241.69	0	0	0
Caranx melampygus	0.15	1.18	22.08	0	0	0.33	117.17	905.39	13464	0	0	170.48
Caranx sexfasciatus	0	0.94	0	0	0	0	0	474.83	0	0	0	0
Carcharhinus albimarginatus	0.02	0.41	0	0	0.05	0	353.48	27897	0	0	1557.26	0
Carcharhinus amblyrhynchos	0.75	0.82	0	0	0.29	0.37	5709.55	21385	0	0	7497.61	11378.54
Carcharhinus melanopterus	0	0	0	0	0.03	0	0	0	0	0	375.07	0
Centropyge bicolor	1.81	0.59	0	0	3.82	2.23	119.47	25.07	0	0	145.25	62.3
Centropyge bispinosa	3.42	2.65	7.75	0	1.53	3.1	60.09	53.85	116.03	0	17.26	39.61
Centropyge heraldi	0	0	0.08	0	0	0.13	0	0	4.26	0	0	12.4
Centropyge loricula	0	0	0.08	0	0	0	0	0	0	0	0	0
Centropyge tibicen	0.02	0	0	0	0	0	0.15	0	0	0	0	0
Centropyge vrolikii	1.42	2.59	1.75	0	2.55	2.3	45.04	95.56	52.36	0	85.8	55.18
Cephalopholis argus	0.6	2.06	0.08	0	0.11	0.3	287.45	764.2	2.1	0	43.27	140.52
Cephalopholis boenak	0	0	0	0.36	0.18	0	0	0	0	30.56	3.05	0
Cephalopholis cyanostigma	0.04	0.06	0.67	1.36	1.55	0	29.01	29.51	51.27	410.26	506.31	0
Cephalopholis leopardus	0.06	0.59	0	0	0.03	0	6.25	90.95	0	0	5.64	0
Cephalopholis microprion	0	0	0	0	0.03	0	0	0	0	0	2.63	0
Cephalopholis miniata	0.02	0.47	0.17	0	0	0	6.39	131.81	31.44	0	0	0
Cephalopholis sexmaculata	0.02	0.12	0	0	0	0	7.2	40.65	0	0	0	0
Cephalopholis spiloparaea	0	0	1.92	0	0	0	0	0	214.29	0	0	0
Cephalopholis urodeta	0.85	1.41	0	0	0.66	0.97	120.93	303.71	0	0	125.9	107.85
Cetoscarus bicolor	0.42	0.12	0	0	0	0.1	168.61	32.58	0	0	0	35.34
Cetoscarus ocellatus	0.23	0.94	0	0.09	0.39	0	0	0	0	0	0	0
Chaetodon aureofasciatus	0.04	0	0	11.45	2.05	0	11.46	0	0	634.33	114.4	0
Chaetodon auriga	0.44	1	1.33	0	0.71	0.7	55.46	99.44	156.58	0	82.89	67.04
Chaetodon baronessa	1.1	0.24	0	0	1.97	0	64.46	12.43	0	0	158.04	0
Chaetodon bennetti	0.02	0.18	0	0	0	0.4	1.04	27.92	0	0	0	37.97
Chaetodon citrinellus	0.46	1.53	4.92	0	0.89	2.37	12.8	40.57	151.92	0	56.18	70.11
Chaetodon ephippium	0.35	0.29	1.25	0	0.16	0.6	55.93	30.28	169.64	0	12.41	61.22

Species	Abundance Ash	Boot	Boug	TS	N GBR	Osp	Biomass Ash	Boot	Boug	TS	N GBR	Osp
Chaetodon flavirostris	0	0	0.08	0	0.13	0.07	0	0	16.91	0	1.32	29.41
Chaetodon kleinii	1.69	0.71	0	0	1.87	0.8	98.23	37.28	0	0	138.3	31.05
Chaetodon lineolatus	0.13	0.71	0.42	1.55	0.05	0.07	14.8	71.44	56.47	293.06	13.72	21.77
Chaetodon lunula	0.27	0	0.33	0	0.11	0.17	72.3	0	59.03	0	12.1	25.37
Chaetodon lunulatus	1.35	1.65	1.5	0	2.16	1	86.22	133.87	112.52	0	166.8	41.26
Chaetodon melannotus	0.29	0.41	0.33	0	0.21	0.3	195.49	19.67	34.3	0	22.89	98.35
Chaetodon mertensii	0.1	0	0.17	0	0	0.03	10.91	0	4.83	0	0	1.8
Chaetodon meyeri	0.02	0	0	0	0	0	3.69	0	0	0	0	0
Chaetodon ornatissimus	0.27	0	1.08	0	0.11	0.13	24.87	0	67.17	0	18.64	13.7
Chaetodon pelewensis	3.79	2.35	3.67	0	0.58	1.33	146.83	96.62	115.43	0	26	84.91
Chaetodon plebeius	2.48	2.47	0.92	2.18	3.05	1.1	98.64	136.53	38.09	91.62	120.19	38.37
Chaetodon punctatofasciatus	0.17	0	0	0	0.13	0	13.78	0	0	0	8.26	0
Chaetodon rafflesii	0	0	0	0	0.05	0	0	0	0	0	5.41	0
Chaetodon rainfordi	0	0	0	0.64	0.03	0	0	0	0	50.78	2.7	0
Chaetodon reticulatus	0.02	0	0	0	0	0.2	3.69	0	0	0	0	0.75
Chaetodon semeion	0.04	0.12	0	0	0.11	0	4.28	12.09	0	0	10.82	0
Chaetodon speculum	0.19	0.29	0.25	0.64	0.03	0	15.91	18.33	18.32	34.05	4.2	0
Chaetodon trifascialis	1.21	0.53	0	0	0.42	0.33	64.84	27.9	0	0	29.99	11.98
Chaetodon ulietensis	0.48	0.47	0	0	0.26	0.6	67.34	45.13	0	0	30.91	30.57
Chaetodon unimaculatus	0	0	0	0	0.13	0	0	0	0	0	22.28	0
Chaetodon vagabundus	0.13	0.12	0.75	0	0.87	0.07	13.52	10.26	52.68	0	52.7	5.81
Chaetodontoplus duboulayi	0	0	0	0.91	0.03	0	0	0	0	293.92	10.09	0
Cheilinus chlorourus	0.08	0.35	0.25	0.18	0.58	0.07	15.01	5.32	28.34	20.08	66.19	14.99
Cheilinus fasciatus	0.15	0.53	0	1.64	1.87	0.9	22.98	145.6	0	486.55	502.02	265.41
Cheilinus oxycephalus	0.06	0	0	0	0	0	5.24	0	0	0	0	0
Cheilinus trilobatus	0.29	0.06	0	0	0.08	0.13	59.61	3.77	0	0	14.34	19.22
Cheilinus undulatus	0.19	0.76	0.08	0	0.08	0.07	634.35	2354.55	283.11	0	396.08	457.12
Cheilodipterus artus	0.19	0	0	0.09	0.13	0.07	1.46	0	0	1.99	0.87	0.52
Cheilodipterus macrodon	0.13	0.29	0.08	0	0.34	0.13	7.23	11.42	4.48	0	23.46	3.69

Species	Abundance Ash	Boot	Boug	TS	N GBR	Osp	Biomass Ash	Boot	Boug	TS	N GBR	Osp
Cheilodipterus quinquelineatus	7.67	3.88	0	37.55	33.32	0.3	6.93	2.78	0	42.37	111.5	1.69
Cheiloprion labiatus	0	0	0	0	0.37	0	0	0	0	0	7.26	0
Chelmon marginalis	0	0	0	5.73	1.45	0	0	0	0	461.79	112.04	0
Chlorurus bleekeri	1.46	0	0	0.64	0.37	0.7	359.59	0	0	343.28	103.89	313.06
Chlorurus microrhinos	2.31	6.65	0.33	0.27	0.79	0.77	2596.45	6432.51	343.3	201.85	616.83	556.04
Chlorurus sordidus	15.08	5.71	3.25	0.55	7.63	22.9	2927.76	2479.53	1004.32	9.03	2212.65	2695.53
Choerodon anchorago	0	0	0	0.27	0.11	0	0	0	0	153.84	55.87	0
Choerodon cyanodus	0	0	0	1.73	0.34	0	0	0	0	314.26	103.66	0
Choerodon fasciatus	0	0.06	0	1.73	0.55	0.03	0	7.14	0	348.98	115.52	14.36
Choerodon schoenleinii	0	0	0	14.82	2.13	0	0	0	0	8983.49	2048.18	0
Choerodon vitta	0	0	0	0.09	0	0	0	0	0	0.36	0	0
Chromileptes altivelis	0	0	0	0	0.18	0	0	0	0	0	169.8	0
Chromis agilis	0	0	3.25	0	0	0.2	0	0	23.97	0	0	1.76
Chromis alpha	0.88	0.76	0	0	0.16	0	12.78	10.58	0	0	5.51	0
Chromis amboinensis	31.06	128.24	11.08	0	10.42	6.33	87.9	248.99	64.31	0	19.73	26.03
Chromis analis	0	0.12	0	0	0	0	0	3.39	0	0	0	0
Chromis atripectoralis	5.08	34	1.33	52.64	103.16	5.47	16.22	108.26	5.82	482.06	246.5	2.63
Chromis atripes	67.46	112.94	238.67	0	16.55	38.87	76.67	287.09	313.66	0	19.91	83.96
Chromis caudalis	0.02	0.12	0	0	0	0	0.01	0.05	0	0	0	0
Chromis chrysura	0	0	0	0	0.05	0	0	0	0	0	18.2	0
Chromis flavomaculata	0.02	0	0	0	0	0	0.8	0	0	0	0	0
Chromis iomelas	14.19	39.12	165.67	0	3.16	26.27	31.37	130.14	220.21	0	6.51	51.82
Chromis lepidolepis	6.31	28.24	0.33	0	11.42	2.57	8.34	21.46	4.13	0	33.09	6.51
Chromis margaritifer	38.85	126.76	114.83	0	5.29	79.63	42.87	52.61	150.77	0	10.29	108.85
Chromis nitida	0	0	0	1	0.08	0	0	0	0	3.33	0.59	0
Chromis retrofasciata	27.44	21.35	1.92	0	0.18	2.73	6.92	2.86	0.43	0	0.02	1.99
Chromis ternatensis	172.31	106.59	10	0	39.61	6.6	438.67	425.84	17.9	0	457.26	43.77
Chromis vanderbilti	0	1.94	3.58	0	0	0.33	0	0.78	2.84	0	0	0.47
Chromis viridis	14.35	0	0.08	0.45	180.47	0.5	22.25	0	1.05	1.77	409.24	1.94

Species	Abundance Ash	Boot	Boug	TS	N GBR	Osp	Biomass Ash	Boot	Boug	TS	N GBR	Osp
Chromis weberi	2.4	5.53	0.17	0.45	2.47	1.2	22.6	45.61	1.78	4.85	27.04	7.15
Chromis xanthochira	0.02	0	0	0	0.05	0	0.73	0	0	0	0.2	0
Chromis xanthura	15	11.47	0	0	0.05	1.9	409.36	299.43	0	0	1.84	40.89
Chrysiptera biocellata	0	0	3.67	0	0	5.03	0	0	7.14	0	0	35.39
Chrysiptera caesifrons	0	0	0	0	0.24	0	0	0	0	0	1.24	0
Chrysiptera flavipinnis	0.04	0.18	0	0.09	8.11	0	0.03	0.11	0	0.05	19.54	0
Chrysiptera glauca	0	0	2.08	0	0	0	0	0	41.66	0	0	0
Chrysiptera rollandi	0.02	0	0	81.27	11.13	0	0.01	0	0	315.97	10.11	0
Chrysiptera talboti	21.06	7.82	0	0	2.84	0	24.49	9.53	0	0	1.69	0
Chrysiptera taupou	0	0	0	0	0	14.13	0	0	0	0	0	31.03
Cirrhilabrus cyanopleura	0	0.35	0	0	0	0	0	0.92	0	0	0	0
Cirrhilabrus exquisitus	2.02	0	0	0	0	1.07	1.95	0	0	0	0	5.57
Cirrhilabrus lineatus	0	0	0	0	0	0.47	0	0	0	0	0	0.61
Cirrhilabrus punctatus	27.83	22.35	0	34.91	28.74	0.97	159.74	45.4	0	178.45	170.69	3.4
Cirrhitichthys falco	0.38	0.59	0	0	0.21	0	3.88	3.08	0	0	2.48	0
Coradion altivelis	0	0	0	0.18	0	0	0	0	0	27.27	0	0
Coradion chrysozonus	0.02	0	0	0	0.03	0	3.12	0	0	0	3.95	0
Coris aygula	0.31	0.06	0.25	0	0	0.17	116.08	0.34	38.63	0	0	6.92
Coris batuensis	0.1	0	0	1.45	14.03	0.03	0.74	0	0	9.21	143.01	0.13
Coris bulbifrons	0	0	0	0	0	0.03	0	0	0	0	0	6.81
Coris dorsomacula	0.04	0	0	0	0.03	0.03	1.51	0	0	0	0.49	0.27
Coris gaimard	1.44	0.24	0	0	0.13	0.63	57.15	0.9	0	0	9.97	19.75
Coris pictoides	0	0	0	0.18	1.05	0	0	0	0	2.43	8.45	0
Corythoichthys conspicillatus	0	0	0	0	0.03	0	0	0	0	0	0	0
Ctenochaetus binotatus	8.71	1.06	1.17	0.09	7.53	2.87	537.87	76.11	94.84	0.53	930.8	107.72
Ctenochaetus cyanocheilus	0	0	0.08	0	0.05	0.1	0	0	0.32	0	23.76	1.01
Ctenochaetus striatus	45.5	15.59	23.08	0	26.53	36.8	5031.7	1614.56	2826.98	0	2467.09	3477.08
Cypho purpurascens	0.02	0	0.42	0	0	0	0.06	0	0.97	0	0	0
Dascyllus aruanus	6.04	19.82	0	0	5.97	19.37	12.61	17.68	0	0	25.7	97.31

Species	Abundance Ash	Boot	Boug	TS	N GBR	Osp	Biomass Ash	Boot	Boug	TS	N GBR	Osp
Dascyllus reticulatus	107.75	38.76	11.75	0	25.32	26.2	295.76	39.27	128.8	0	83.05	100.83
Dascyllus trimaculatus	3.75	2.59	0.08	0	2.76	2.27	54.1	31.71	0.5	0	147.46	53.34
Diagramma labiosum	0.02	0	0	4.73	1.97	0	10.39	0	0	2958.38	4792.78	0
Diploprion bifasciatum	0	0	0	0.27	0.08	0	0	0	0	64.77	10.27	0
Dischistodus melanotus	1.71	0.59	0	0	2.92	0	26.45	18.76	0	0	229.48	0
Dischistodus perspicillatus	0	0	0	0	5.55	0	0	0	0	0	890.99	0
Dischistodus prosopotaenia	0.02	0	0	2.18	6.76	0	0.01	0	0	79.74	683.96	0
Dischistodus pseudochrysopoecilus	0.21	0.76	0	0.09	0.29	0	1.18	25.84	0	0.51	17.72	0
Echeneis naucrates	0.17	0.24	0	0.09	0.13	1.7	8.92	9.63	0	12.89	8.46	64.96
Elagatis bipinnulata	0.08	1.76	5.42	0	0	0	70.39	847.66	4093.1	0	0	0
Epibulus brevis	0.02	0	0	0	0	0	4.64	0	0	0	0	0
Epibulus insidiator	0.81	0.71	0.17	1.55	0.82	0.43	200.24	175.59	73.74	589.14	205.37	159.19
Epinephelus corallicola	0	0	0	0.09	0	0	0	0	0	40.95	0	0
Epinephelus cyanopodus	0.02	0	0	0	0	0	4.2	0	0	0	0	0
Epinephelus fasciatus	0.06	0.06	0	0.36	0.55	0	12.09	5.33	0	70.35	65.11	0
Epinephelus hexagonatus	0	0.06	0	0	0	0	0	10.3	0	0	0	0
Epinephelus howlandi	0	0	0	0	0	0.03	0	0	0	0	0	0
Epinephelus malabaricus	0	0	0	0	0.13	0	0	0	0	0	373.66	0
Epinephelus merra	1.75	0.82	1.17	0	0.03	1.17	26.49	96.08	31.12	0	0.66	78.69
Epinephelus polyphekadion	0.02	0.24	0	0	0	0.1	15.68	166.63	0	0	0	58.09
Epinephelus quoyanus	0	0	0	0.09	0.03	0.5	0	0	0	40.95	5.09	33.75
Epinephelus spilotoceps	0.02	0	0	0	0	0.03	9.38	0	0	0	0	10.36
Epinephelus tukula	0.02	0	0	0	0	0.03	16.6	0	0	0	0	292.7
Fistularia commersonii	0	0	0	0	0	0.1	0	0	0	0	0	7.7
Forcipiger flavissimus	1.35	2.59	2.58	0	0.37	0.47	34.02	67	50.81	0	9.12	6.23
Forcipiger longirostris	0	0	0	0	0	0.6	0	0	0	0	0	14.74
Genicanthus lamarck	0	0	0	0	0.03	0	0	0	0	0	2.8	0
Genicanthus melanospilos	0.92	0	0	0	0.39	0	0	0	0	0	0	0

Species	Abundance Ash	Boot	Boug	TS	N GBR	Osp	Biomass Ash	Boot	Boug	TS	N GBR	Osp
Glaucosoma magnificum	0	0	0	0.91	0	0	0	0	0	213.02	0	0
Gnathanodon speciosus	0	0	0	3	0.03	0	0	0	0	2019.7	1.92	0
Gnathodentex aureolineatus	3.04	2	3.67	0	0.05	5.6	692.85	544.17	464.6	0	9.73	910.63
Gomphosus varius	3.79	2.88	9.83	0	1.39	2.83	42.09	45.75	84.77	0	29.12	16.05
Gracila albomarginata	0	0.41	0.25	0	0	0	0	236.84	140.84	0	0	0
Grammatorcynus bilineatus	0	0.12	0	0.09	0.29	0	0	31.76	0	60.92	249.24	0
Gymnocranius microdon	1.08	0.06	0	0	0.16	0	699.4	31.83	0	0	101.81	0
Gymnosarda unicolor	0	0.06	0	0	0	0.03	0	321.78	0	0	0	737.53
Halichoeres biocellatus	2.1	2	1.5	0	0.66	0.93	14.3	17.72	4.62	0	12.06	11.85
Halichoeres chloropterus	0	0	0	1.09	9.61	0	0	0	0	20.56	135.45	0
Halichoeres chrysus	0.6	0.41	0	0.09	0.37	0	0.42	1.07	0	0.24	11.71	0
Halichoeres erdmanni	0	0	0	1.91	0.03	0	0	0	0	17.09	0.07	0
Halichoeres hortulanus	5.81	5.24	3.42	0	2.21	3	387.71	311.46	116.3	0	167.35	91.62
Halichoeres leucurus	0.02	0	0	0	0	0	0.95	0	0	0	0	0
Halichoeres margaritaceus	0	0	23.58	0	0	0.3	0	0	162.54	0	0	1
Halichoeres marginatus	0.63	0.59	0	0	0.24	0.07	10.58	11.4	0	0	10.96	0.33
Halichoeres melanurus	0.17	0	0	21.45	20.47	0	3.5	0	0	186.82	265.76	0
Halichoeres miniatus	0	0	0	0	4.05	0	0	0	0	0	8.76	0
Halichoeres nebulosus	0.6	0	2.42	0	16.18	0	120.42	0	1.48	0	48.96	0
Halichoeres nigrescens	0	0	0	1.18	0.11	0	0	0	0	4.88	1.33	0
Halichoeres prosopeion	1.96	4.41	0	0	0.26	0.07	32.7	208.61	0	0	6.32	0.39
Halichoeres richmondi	0	0	0	0.27	0.08	0	0	0	0	15.55	1.26	0
Halichoeres scapularis	0	0	0	0	0.68	0	0	0	0	0	19.8	0
Halichoeres trimaculatus	9.88	1.24	7.58	0	0.21	4.07	84.82	4.57	37.9	0	5.4	28.03
Hemiglyphidodon plagiometopon	1.35	0	0	3.36	3.03	0	38.43	0	0	702.2	382.55	0
Hemigymnus fasciatus	0.9	0.82	0.42	1.09	0.42	0.3	99.32	148.87	26.9	1.95	38.68	48.87
Hemigymnus melapterus	0.06	0	0	4.27	2.32	0.03	29.69	0	0	557.82	531.38	2.21
Hemitaurichthys polylepis	0.1	0.94	6.08	0	0.05	1.13	11.24	48.77	424.62	0	4.59	48.8
Heniochus acuminatus	0.08	1.18	0	0	0	0.07	33.71	323.46	0	0	0	12.57

Species	Abundance Ash	Boot	Boug	TS	N GBR	Osp	Biomass Ash	Boot	Boug	TS	N GBR	Osp
Heniochus chrysostomus	0.69	1.29	0.83	0	0.63	1.17	186.08	395.88	300.14	0	198.86	263.87
Heniochus monoceros	0.38	0.59	0.25	0	0	0.33	225.97	402.41	197.87	0	0	136.17
Heniochus singularius	0	0	0	0	0.05	0	0	0	0	0	34.41	0
Heniochus varius	0.58	0.18	0	0	0.87	0.1	149.82	15.31	0	0	287.6	15.75
Hipposcarus longiceps	3.56	1.71	0.08	0.18	0.21	0.63	1902.91	1168.12	86.05	21.42	171.95	173.21
Hologymnosus annulatus	0.35	0	0	0	0.08	0	9.37	0	0	0	0.24	0
Hologymnosus doliatus	0.08	0	0	0	0	0	0.42	0	0	0	0	0
Hoplolatilus starcki	0.06	0	0	0	0	0.1	2.31	0	0	0	0	2.44
Kyphosus cinerascens	1.04	4.24	0.08	0.09	0.53	0.03	460.75	3169.39	73.47	61.9	112.8	22.7
Kyphosus vaigiensis	0	1.24	0	0	0.16	0	0	645.87	0	0	82.56	0
Labrichthys unilineatus	1.75	4	0.08	0.18	2.29	0.03	49.54	11.76	0.03	5.29	50.04	0.09
Labroides bicolor	1.1	1.71	0.58	0	0.11	0.43	18.33	20.27	6.91	0	0.9	3.84
Labroides dimidiatus	8.1	13.82	10.42	5.27	13.26	3.67	34.43	134.03	41.73	87.21	95.75	15.16
Labropsis australis	0.19	0	0	0	0.21	0.2	1.56	0	0	0	1.15	4.09
Labropsis xanthonota	0.04	0.65	0.25	0	0	0	0.59	2.17	3.08	0	0	0
Lepidozygus tapeinosoma	60.52	880.24	1559.17	0	0	0	40.35	1550.14	4790.65	0	0	0
Leptojulis cyanopleura	0	0	0	3.82	2.37	0	0	0	0	3.81	2.58	0
Lethrinus erythracanthus	0	0	0	0	0.03	0	0	0	0	0	24.06	0
Lethrinus erythropterus	0	0	0	0	0.05	0	0	0	0	0	27.11	0
Lethrinus laticaudis	0	0	0	3.45	0.13	0	0	0	0	1696.18	67.76	0
Lethrinus lentjan	0	0	0	0	0.24	0	0	0	0	0	109.23	0
Lethrinus nebulosus	0	0.29	0	0	0	0	0	218.76	0	0	0	0
Lethrinus obsoletus	0	0	0	0	0.63	0	0	0	0	0	243.76	0
Lethrinus olivaceus	0.02	1	0.17	0	0	0.13	14.73	707.1	220.52	0	0	153.24
Lethrinus ornatus	0	0	0	0	0.05	0	0	0	0	0	27.11	0
Lutjanus argentimaculatus	0	0.06	0	0	0	0	0	44.46	0	0	0	0
Lutjanus bohar	1.67	3.76	0.33	0.09	0.63	0.7	1248.9	3634.52	455.96	57.54	386.92	846.44
Lutjanus carponotatus	0	0	0	21.55	1.79	0	0	0	0	7367.87	715.09	0
Lutjanus erythropterus	0	0	0	0.09	0.08	0	0	0	0	0	0	0

Species	Abundance						Biomass					
	Ash	Boot	Boug	TS	N GBR	Osp	Ash	Boot	Boug	TS	N GBR	Osp
Lutjanus fulviflamma	0	0	0	0.18	1.11	0	0	0	0	58.24	313.53	0
Lutjanus fulvus	0	0.06	0	0	0.03	0.17	0	12.58	0	0	5.63	44.07
Lutjanus gibbus	4.79	8.94	0.5	0	0.5	0.3	2311.81	4253.04	198.48	0	207.51	80.82
Lutjanus kasmira	2.6	0.35	25.67	0	1.71	0	706.12	106.65	6244.31	0	400.1	0
Lutjanus quinquelineatus	0.06	0	0	0	1.16	0	5.76	0	0	0	362.04	0
Lutjanus rivulatus	0.02	0.12	0	0	0	0	41.99	100.7	0	0	0	0
Lutjanus russellii	0	0	0	4	0	0	0	0	0	831.58	0	0
Lutjanus sebae	0	0	0	0.36	0.03	0	0	0	0	203.7	16.99	0
Lutjanus semicinctus	0	0.06	0	0	0.05	0	0	26.05	0	0	19.33	0
Lutjanus vitta	0	0	0	0	0.08	0	0	0	0	0	19.83	0
Luzonichthys waitei	0	0	49.83	0	0	0	0	0	108.34	0	0	0
Macolor macularis	1.67	9.12	2.83	0	0.16	0.73	850.48	7376.67	1152.51	0	41.04	321.92
Macolor niger	0.73	3.47	1.25	0	0.21	0.3	272.33	3112.99	801.14	0	57.25	65.17
Macropharyngodon choati	0	0	0	0	0.24	0	0	0	0	0	0.57	0
Macropharyngodon meleagris	0.96	0.12	0.83	0	0.13	0.63	9.01	0.31	2.47	0	0.75	6.55
Macropharyngodon negrosensis	0	0	0	0	0.03	0	0	0	0	0	0.01	0
Macropharyngodon ornatus	0.02	0	0	0	0	0	0.18	0	0	0	0	0
Malacanthus brevirostris	0.44	0	0	0	0	0	21.02	0	0	0	0	0
Malacanthus latovittatus	0	0	0	0	0.05	0	0	0	0	0	6.41	0
Melichthys vidua	0.02	0.29	0	0	0.08	0.03	7.63	55.46	0	0	18.8	3.81
Monotaxis grandoculis	0.19	0.88	1.42	0	0.13	0.97	44.7	464.13	904.78	0	73.87	128.62
Monotaxis heterodon	4.23	6.59	3	0	1.66	5.6	1495.54	2319.49	1251.82	0	664.69	1433.82
Mulloidichthys flavolineatus	0	5.35	0.75	0	0.05	0.57	0	1217.65	160.11	0	6.97	13.59
Mulloidichthys vanicolensis	0.04	23.82	0	0	0	9.43	5.53	3987.39	0	0	0	717.78
Myripristis adusta	0	0	0.5	0	0.05	0.1	0	0	175.03	0	15.55	41.65
Myripristis amaena	0	0	0	0	0	0.07	0	0	0	0	0	5.69
Myripristis berndti	0.96	6.53	4.42	0	0.55	1.47	286.57	2181.19	979.07	0	213.21	201.55
Myripristis hexagona	0	0	0	0	0.03	0.03	0	0	0	0	8.58	10.86
Myripristis kuntee	0.83	3.71	0.25	0	0.18	1.1	138.32	1208.64	124.87	0	58.32	214.49

Species	Abundance Ash	Boot	Boug	TS	N GBR	Osp	Biomass Ash	Boot	Boug	TS	N GBR	Osp
Myripristis murdjan	0	0.24	0.08	0	0	0	0	99.98	22.06	0	0	0
Myripristis violacea	0.08	2.12	1.25	0	1.13	0.97	29.07	627.78	535.85	0	402.09	183.7
Myripristis vittata	0.04	3.94	20.25	0	0.39	1.27	12.31	973.11	2511.41	0	116.64	219.68
Naso annulatus	0.25	0.82	0.58	0	0.89	0.03	132.19	569.81	655.4	0	548.5	2.93
Naso brachycentron	0.02	0.06	0.25	0	0.37	0	9.6	87.61	154.51	0	184.34	0
Naso brevirostris	6.71	1.12	0	0	0.92	0.27	5935.09	843.33	0	0	652.16	188.95
Naso caesius	0	0	0.33	0	0	0.03	0	0	262.59	0	0	26.26
Naso hexacanthus	7.17	3.65	4.75	0	0.24	0.03	7237.07	4606.31	4915.2	0	159.78	93.85
Naso lituratus	1.77	1.35	1.17	0	0.11	0.8	561.34	360.68	149.25	0	30.02	149.66
Naso thynnoides	1.38	0	0	0	0	0	286.77	0	0	0	0	0
Naso tonganus	0.98	1.71	4.67	0	0.16	0	1669.62	2067.45	5876.46	0	296.68	0
Naso tuberosus	0	0	0	0	0.16	0	0	0	0	0	0	0
Naso unicornis	2.35	1	0.08	0	0.5	0.1	1484.28	568.7	29.86	0	203.3	44.58
Naso vlamingii	1.23	2.59	2.67	0	0.26	0.73	999.95	2361.59	2208.49	0	226.18	422.31
Nebrius ferrugineus	0.04	0	0	0	0.08	0	323.26	0	0	0	785.03	0
Nemateleotris magnifica	0.56	1.47	0.42	0	0.18	1.37	1.33	2.73	0.57	0	0.33	2.4
Neoglyphidodon melas	0	0	0	10.36	9.66	0	0	0	0	524.38	337.78	0
Neoglyphidodon nigroris	3.67	3.18	0.08	9	5.63	0	30.72	53.06	4.63	354.27	40.37	0
Neoniphon argenteus	0.04	0	0	0	0.03	0	3.62	0	0	0	2.29	0
Neoniphon opercularis	0.04	0.35	0	0	0	0.03	8.27	70.07	0	0	0	11.21
Neoniphon sammara	2.4	5.53	6	0	0.32	0.37	174.76	476.31	391.65	0	24.92	20.04
Neopomacentrus azysron	0	0	0	73.82	18.16	0	0	0	0	116.92	32.14	0
Neopomacentrus bankieri	0	0	0	126.91	18.13	0	0	0	0	154.55	23.63	0
Neopomacentrus cyanomos	0	0	0	16.09	0.34	0	0	0	0	109.44	0.95	0
Novaculichthys taeniourus	0.04	0	0.17	0	0	0	0.42	0	0.06	0	0	0
Odonus niger	0.08	0	0	0	0.16	0	30.53	0	0	0	65.93	0
Ostorhinchus aureus	3.13	0	0.25	0	1.29	0	1.64	0	6.49	0	1.69	0
Ostorhinchus compressus	0	0	0	0.18	2.18	0	0	0	0	0	2.17	0
Ostorhinchus cyanosoma	0.25	0	0	0	8.74	0	0.91	0	0	0	0.06	0

Species	Abundance Ash	Boot	Boug	TS	N GBR	Osp	Biomass Ash	Boot	Boug	TS	N GBR	Osp
Ostorhinchus monospilus	0	0	0	0	0.71	0	0	0	0	0	0	0
Ostorhinchus neotes	4.17	0	0	9.09	0	0	0	0	0	0	0	0
Ostorhinchus nigrofasciatus	0.02	0.24	0	0	0.24	0	0.09	1.65	0	0	3.83	0
Ostorhinchus pallidofasciatus	0	0	0	0	0.08	0	0	0	0	0	0	0
Ostorhinchus properuptus	0	0	0	8.91	19.45	0	0	0	0	4.68	10.42	0
Ostorhinchus taeniophorus	0	0	0.17	0	0	0	0	0	0.57	0	0	0
Ostracion cubicus	0.04	0.06	0	0.09	0.03	0.03	1.52	3.69	0	0.95	2.94	11.38
Ostracion meleagris	0.23	0	0.08	0	0	0.13	19.5	0	5.22	0	0	8.79
Ostracion solorensis	0.04	0.29	0	0	0	0	4.65	16.5	0	0	0	0
Oxycheilinus digrammus	0.31	0.41	0	0.55	1	0.6	26.92	69.95	0	62.93	71.07	35.36
Oxycheilinus orientalis	0.19	0.82	0.08	0.09	0.32	0.63	5.93	24.95	0.27	0.91	3.32	18.18
Oxycheilinus unifasciatus	0.06	0	0.33	0	0.05	0.93	1.83	0	32.85	0	5.19	58.7
Oxymonacanthus longirostris	0.65	1	0.17	0	0.55	0.03	4.46	5.12	1.61	0	1.38	0.32
Paracaesio sordida	0	0.88	0	0	0	0	0	0	0	0	0	0
Paracanthurus hepatus	0	0	0.83	0	0	0	0	0	52.73	0	0	0
Paracentropyge multifasciatus	0.1	0.53	0	0	0.03	0.03	0	0	0	0	0	0
Paracirrhites arcatus	0.94	1.65	5.08	0	0.08	2.7	8.67	5.67	64	0	8.91	29.58
Paracirrhites forsteri	0.65	2.35	2.67	0	0.16	0.4	19.69	68.27	46.86	0	1.32	7.13
Paraluteres prionurus	0.1	0.65	0	0	0.08	0.03	1.34	2.09	0	0	2.03	0.11
Parapercis australis	0	0	0	0.18	0.16	0.03	0	0	0	1.27	3.7	0
Parapercis clathrata	0.27	0.76	0	0	0.05	0	9.86	28.71	0	0	1.85	0
Parapercis hexophtalma	0.23	0	0.67	0	0.21	0.13	0	0	0	0	0	0
Parapercis lineopunctata	0	0	0	0.18	0.08	0	0	0	0	3.16	1.88	0
Parapercis millepunctata	0	0	0.17	0	0.05	0	0	0	1.17	0	0.91	0
Parapercis multiplicata	0.1	0	0	0	0	0.17	1.16	0	0	0	0	3.14
Parapercis queenslandica	0.02	0	0	0.09	0.45	0	1.3	0	0	0.64	30.22	0
Parapercis stricticeps	0	0	0	0	0.05	0	0	0	0	0	0.91	0
Parapercis xanthozona	0	0.12	0	0	0.08	0	0	2.06	0	0	2.21	0
Paraplotosus butleri	0	0	0	0.09	0.08	0	0	0	0	114.02	61.46	0

Species	Abundance						Biomass					
	Ash	Boot	Boug	TS	N GBR	Osp	Ash	Boot	Boug	TS	N GBR	Osp
Parapriacanthus ransonneti	0	0	0	0	6.32	0	0	0	0	0	1.91	0
Parioglossus interruptus	0	0	0	0	1.32	0	0	0	0	0	0	0
Parupeneus barberinoides	0	0	0	0	0.16	0	0	0	0	0	26.56	0
Parupeneus barberinus	0.56	0.24	0.08	0.18	0.97	0.13	94.54	33.2	4.04	25.24	186.16	18.51
Parupeneus ciliatus	0.02	0	0.08	0	0.13	0	7.45	0	29.81	0	44.16	0
Parupeneus crassilabris	3.92	2.53	1.17	0	0.32	0.37	625.85	390.9	140.61	0	53.8	40.49
Parupeneus cyclostomus	0.94	0.82	0.08	0.09	0.16	0.4	144.86	99.41	16.34	48.19	25.34	56.57
Parupeneus indicus	0	0	0	0	0.24	0	0	0	0	0	57.84	0
Parupeneus multifasciatus	6.04	3.41	3.17	0	2.13	4.93	205.06	150.47	68.41	0	157.63	135.15
Parupeneus pleurostigma	0.73	0.18	0	0	0	0.13	67.75	31.15	0	0	0	19.25
Parupeneus spilurus	0	0	0	0	0	0.03	0	0	0	0	0	13.63
Pempheris analis	0	0	0	0.45	0	0	0	0	0	1.22	0	0
Pempheris oualensis	0.04	1.47	0.17	0	0	0	1.8	119.95	26.53	0	0	0
Pempheris schwenkii	0	0	0	3.36	0	0	0	0	0	9.06	0	0
Pentapodus aureofasciatus	0.08	0	0	0	0.24	1.77	5.23	0	0	0	14.63	37.51
Pervagor janthinosoma	0.08	0	0	0	0.03	0	5.4	0	0	0	1.92	0
Pervagor melanocephalus	0.02	0	0	0	0.05	0	1.52	0	0	0	3.84	0
Pictichromis paccagnellae	0.04	0	0	0	0.03	0.03	0.02	0	0	0	0.01	0.01
Platax orbicularis	0	0	0	0	0.53	0	0	0	0	0	582.68	0
Platax pinnatus	0.08	0	0	0.27	0.32	0	237.28	0	0	449.2	528.98	0
Platax teira	0	0	0	1.55	0	0	0	0	0	2375.59	0	0
Plectorhinchus albovittatus	0	0.18	0	0	0	0	0	263	0	0	0	0
Plectorhinchus chaetodonoides	0.23	0.12	0	0.27	0.11	0	442.58	96.03	0	148.45	85.92	0
Plectorhinchus gibbosus	0	0	0	0.45	0	0	0	0	0	347.23	0	0
Plectorhinchus lessonii	0.13	0.06	0	0	0.37	0.03	65.72	39.57	0	0	164.7	12.9
Plectorhinchus lineatus	0.48	0.06	0.17	0.09	0.39	0	342.27	24.12	59.15	37.28	172.37	0
Plectorhinchus multivittatus	0	0	0	1	0.11	0	0	0	0	550.77	51.53	0
Plectorhinchus picus	0	0.06	0	0	0	0	0	33.01	0	0	0	0
Plectroglyphidodon dickii	0.85	1.24	6.42	0	0.11	0.5	24.41	16.22	90.82	0	3.3	6.06

Species	Abundance Ash	Boot	Boug	TS	N GBR	Osp	Biomass Ash	Boot	Boug	TS	N GBR	Osp
Plectroglyphidodon johnstonianus	0.21	0.06	1.08	0	0.03	0.77	2.41	0.4	16.52	0	0.18	8.83
Plectroglyphidodon lacrymatus	49.06	41.06	15.17	0	17.24	14.97	763.5	473.13	311.91	0	255.26	277.81
Plectropomus areolatus	0	0	0.42	0	0	0	0	0	762.99	0	0	0
Plectropomus laevis	0.4	1.18	0.17	0	0.45	0.07	804.54	1996.31	103.62	0	806.53	175.83
Plectropomus leopardus	1.29	0.12	0.5	3.91	0.71	0.07	914.3	78.19	1626.18	2727.72	457.15	130.65
Plectropomus maculatus	0.23	0	0	2.82	0.97	0	87.68	0	0	1213.89	677.28	0
Plotosus lineatus	0.02	0	0	0	5.29	0	5.4	0	0	0	9.84	0
Pomacanthus imperator	0.19	0.06	0	0.09	0	0.03	183.76	51.46	0	4.99	0	12.78
Pomacanthus semicirculatus	0	0	0	0	0.05	0	0	0	0	0	25.83	0
Pomacanthus sexstriatus	0.04	0	0	4.82	1.66	0	23.59	0	0	1799.55	641.34	0
Pomacentrus adelus	0	0	0	18.27	36.63	0.13	0	0	0	109.73	270.18	0.37
Pomacentrus amboinensis	2.23	0.41	0	26.91	51.84	54.2	38.75	5.77	0	199.47	601.65	581.87
Pomacentrus auriventris	0	0	0	0	0.13	0	0	0	0	0	0.77	0
Pomacentrus bankanensis	41.25	18.94	3.08	0	40.37	5.53	65.31	44.78	14.34	0	70.24	22.09
Pomacentrus brachialis	27.46	5.65	0	11.18	120.37	0.4	272.74	58.46	0	13.12	521.92	1.75
Pomacentrus chrysurus	0.02	0	0	0	14.05	0	1	0	0	0	73.61	0
Pomacentrus coelestis	12.38	2.41	11.25	0.36	16.53	1.33	29.69	5.06	28.2	0.24	33.19	2.55
Pomacentrus grammorhynchus	0.06	0.65	0	0.18	7.84	0	1.12	1.69	0	0.76	146.94	0
Pomacentrus lepidogenys	27.63	4.59	0	1.09	31.58	0.2	195.62	17.91	0	3.13	89.18	0.83
Pomacentrus limosus	0	0	0	3.91	0	0	0	0	0	0	0	0
Pomacentrus milleri	0	0	0	18.64	1.47	0	0	0	0	108.99	6.47	0
Pomacentrus moluccensis	4.77	1.94	0	296.55	257	0.1	13.02	17.03	0	1731.49	1152.71	0.71
Pomacentrus nagasakiensis	0	0	0	0	0	2.33	0	0	0	0	0	6.08
Pomacentrus pavo	0	0	0	0	1.03	0.07	0	0	0	0	3.88	0.54
Pomacentrus philippinus	6.85	3.12	0	0	0.16	36.9	70.01	27.92	0	0	2.64	393.01
Pomacentrus reidi	4.88	0.18	0	0	0.79	0	42.03	1.99	0	0	12.28	0
Pomacentrus vaiuli	0.17	0.06	4.33	0	0	2.43	0.88	0.21	28.7	0	0	21
Pomacentrus wardi	0.04	0	0	11.45	12.71	0	0.22	0	0	44.57	37.75	0

Species	Abundance						Biomass					
	Ash	Boot	Boug	TS	N GBR	Osp	Ash	Boot	Boug	TS	N GBR	Osp
Premnas biaculeatus	0.04	0	0	0.18	0.82	0	1.65	0	0	5.54	24.97	0
Priacanthus hamrur	0.44	0.06	0	0	0.53	0.07	137.35	11.65	0	0	165.86	29.38
Pristiapogon kallopterus	0	0.06	0	0	0.03	0.07	0	2.17	0	0	0.37	0.75
Pristicon trimaculatus	0.02	0	0	0	0	0	1.97	0	0	0	0	0
Psammoperca waigiensis	0	0	0	0.27	0.26	0	0	0	0	43.43	52.97	0
Pseudanthias cooperi	0	0.59	0	0	0	0	0	7.14	0	0	0	0
Pseudanthias dispar	0.42	59	73.92	0	1.55	0	1.45	79.09	171.35	0	10.48	0
Pseudanthias pascalus	0.1	0	0	0	0	1.13	1.26	0	0	0	0	10.87
Pseudanthias pleurotaenia	0.33	0	0	0	0	0	4.05	0	0	0	0	0
Pseudanthias squamipinnis	19.92	247.41	15.25	0	23.13	0.03	77.14	394	21.96	0	55.36	0.84
Pseudanthias tuka	34.31	382.71	0	0	0.03	3.43	138.68	2385	0	0	0.32	43.43
Pseudocheilinus evanidus	0.31	0.53	0.17	0	0	0.63	1.26	6.13	0.93	0	0	5.32
Pseudocheilinus hexataenia	3.42	1.88	7.17	0	1.55	1.63	5.55	9.65	19.54	0	3.72	2.58
Pseudocheilinus octotaenia	0	0	0	0	0	0.1	0	0	0	0	0	0.18
Pseudochromis fuscus	0	0.06	0	0.09	0.21	0	0	0.17	0	3.54	1.57	0
Pseudochromis wilsoni	0	0	0	0.09	0	0	0	0	0	0.26	0	0
Pseudocoris yamashiroi	2.52	0	0	0	0	0.07	0.85	0	0	0	0	1.33
Pseudodax moluccanus	0	0.06	0	0	0.03	0	0	2.26	0	0	5.68	0
Ptereleotris evides	0.85	6.53	0.17	0	1.95	0.43	0.64	45.75	1.5	0	13.66	2.53
Ptereleotris heteroptera	0.04	0	0	0	0	0	18	0	0	0	0	0
Pterocaesio digramma	33.83	0	0	5.91	92.5	0	2691.41	0	0	253.83	7861.35	0
Pterocaesio marri	4.79	0	0	0	0	0.07	382.65	0	0	0	0	4.44
Pterocaesio pisang	0.63	0	0	0	0	0	23.43	0	0	0	0	0
Pterocaesio tile	32.44	4.12	0	0	15.11	29.8	3668.58	810.8	0	0	1635.07	4130.82
Pterocaesio trilineata	9.94	10	0	0	0.21	0	970.37	211.7	0	0	34.65	0
Pterois antennata	0	0.12	0	0	0	0.07	0	17.61	0	0	0	11.15
Pterois volitans	0	0	0	0.09	0.03	0	0	0	0	44.27	5.63	0
Pygoplites diacanthus	1.81	2.59	0.42	0	0.92	0.8	453.01	558.79	182.81	0	236.69	99.19
Rhabdamia gracilis	0	0	0	34.55	10.79	0	0	0	0	10.09	3.15	0

Species	Abundance Ash	Boot	Boug	TS	N GBR	Osp	Biomass Ash	Boot	Boug	TS	N GBR	Osp
Rhinecanthus aculeatus	0	0	0.08	0	0	0	0	0	1.3	0	0	0
Rhinecanthus rectangulus	0	0.06	0.17	0	0	0	0	2.09	2.59	0	0	0
Sargocentron caudimaculatum	0.56	0.65	0.25	0	3	0.43	99.45	87.21	27.77	0	401.43	47.38
Sargocentron diadema	0	0	0	0	0.21	0.23	0	0	0	0	24.24	10.26
Sargocentron melanospilos	0	0	0	0	0.03	0	0	0	0	0	2.92	0
Sargocentron rubrum	0	0	0	0.09	0.03	0	0	0	0	10.38	3	0
Sargocentron spiniferum	0.17	0.47	0.83	0	0.05	0.53	76.68	245.28	561.47	0	28.15	195.8
Sargocentron violaceum	0	0	0	0	0.05	0	0	0	0	0	19.58	0
Saurida gracilis	0.08	0.12	0	0	0	0	9.89	5.09	0	0	0	0
Saurida nebulosa	0.02	0.06	0	0	0.03	0	2.53	7.15	0	0	0.04	0
Scarus altipinnis	0.58	3.47	6.33	0	0.29	0.23	179.64	3045.84	5358.56	0	172.49	163.18
Scarus chameleon	3.92	0.06	0	0	0.32	1.13	616.34	15.56	0	0	95.18	394.46
Scarus dimidiatus	0.06	0	0.33	0	0.13	0.1	16.53	0	88.16	0	45.72	10.61
Scarus flavipectoralis	0	0	0.08	1.09	4.32	0.07	0	0	19.06	223.84	1145.11	15.24
Scarus forsteni	0.15	0.88	0.25	0	0.08	0.03	63.57	305.78	40.87	0	28.96	7.62
Scarus frenatus	2.54	0.88	0.33	0	1.68	0.03	1594.77	186.39	231.92	0	638.67	0.6
Scarus ghobban	0.1	0	0	4.18	1.76	0	29.55	0	0	1092.48	560.63	0
Scarus globiceps	0.21	0	0.17	0	0	0	110.54	0	88.43	0	0	0
Scarus longipinnis	0.13	0.29	0	0	0	0.13	36.41	125.1	0	0	0	19.43
Scarus niger	5.69	3.71	0.83	0.09	4.11	2.27	1047.94	756.6	276.83	25.17	1095.43	375.22
Scarus oviceps	0.88	0.65	0.42	0.27	0.16	0.53	378.21	246.97	193.78	197.53	84.56	178.14
Scarus psittacus	0.9	0	0.08	0	0.34	0.17	242.57	0	19.54	0	143.36	15.83
Scarus rivulatus	0	0	0	7.55	5.82	0.03	0	0	0	1602.64	2244.02	14.65
Scarus rubroviolaceus	0.19	1.59	0.33	0	0.03	0.17	194.4	1424.21	287.73	0	28.74	88.01
Scarus schlegeli	0.35	0.41	0	0	0.82	3.27	146.75	231.5	0	0	262.71	1143.76
Scarus spinus	0.31	0.18	0	0	0.34	0	152.16	84	0	0	74.7	0
Scarus tricolor	0	0	0	0	0	0.1	0	0	0	0	0	76.75
Scarus xanthopleura	0	0	0.08	0	0	0	0	0	0	0	0	0
Scolopsis bilineata	2.5	0.35	0	2	7.97	0.2	307.91	47.06	0	137.77	727.19	11.53

Species	Abundance						Biomass					
	Ash	Boot	Boug	TS	N GBR	Osp	Ash	Boot	Boug	TS	N GBR	Osp
Scolopsis margaritifer	0.02	0	0	1.55	2.63	0	0.48	0	0	230.4	503.07	0
Scolopsis monogramma	0	0	0	0.27	0.24	0	0	0	0	90.72	49.17	0
Scolopsis trilineata	0	0	0	0	0.18	0	0	0	0	0	13.85	0
Scomberoides commersonnianus	0	0	0	0.55	0	0	0	0	0	738.1	0	0
Scomberoides lysan	0.02	0.24	0	0	0	0	20.23	62.75	0	0	0	0
Scomberomorus commerson	0	0	0	1.45	0	0	0	0	0	590.73	0	0
Serranocirrhitus latus	0.69	1.94	3.83	0	0	1.6	8.62	6.22	37.89	0	0	15.07
Siganus argenteus	0.13	0.06	0	0	0	0	14.11	20.76	0	0	0	0
Siganus corallinus	0.1	0	0	0	0.95	0	17.93	0	0	0	109.72	0
Siganus doliatus	0	0	0	3.64	2.13	0	0	0	0	478.63	446.9	0
Siganus fuscescens	0	0	0	0	1.55	0	0	0	0	0	1.34	0
Siganus lineatus	0	0	0	1.18	1.05	0	0	0	0	646.56	571.48	0
Siganus puellus	0	0.47	0	0.18	0.08	0	0	64.51	0	24.92	10.82	0
Siganus punctatus	0.04	0.71	0.17	0.36	0	0	22.35	172.02	118.1	104.9	0	0
Siganus vulpinus	0.29	1	0	0	0.68	0	62.51	197.82	0	0	79.02	0
Solenostomus paradoxus	0	0	0	0	0.03	0	0	0	0	0	0	0
Sphyraena barracuda	0	0	0	0	0	0.07	0	0	0	0	0	595.97
Sphyraena flavicauda	0	0	0	0	0.61	0	0	0	0	0	18.05	0
Sphyraena obtusata	0	0	0	0	0.66	0	0	0	0	0	98.02	0
Sphyraena qenie	0.02	0	0	0	0	0	166.56	0	0	0	0	0
Stegastes apicalis	0	0	0	0.09	0.21	0	0	0	0	4.04	11.39	0
Stegastes fasciolatus	2.31	0.35	3	0	0	0.37	71.09	5.11	77.81	0	0	20.48
Stegastes nigricans	7.98	5.88	13.58	0	3.37	2.73	260.87	128.03	289.39	0	100.98	83.31
Stegastes obreptus	0	0	0	0	0.08	0	0	0	0	0	0.8	0
Stegastes punctatus	0	0	0	0	0	0.03	0	0	0	0	0	1.48
Stethojulis bandanensis	0.92	0	2.33	0	0.68	1.37	7.73	0	18.11	0	9.35	10.68
Stethojulis interrupta	0	0	0	0.36	4.82	0	0	0	0	0.96	36.02	0
Stethojulis trilineata	0	0	0	0	0	0.03	0	0	0	0	0	0.31
Strongylura incisa	0	0	0	0	0	0.03	0	0	0	0	0	33.14

Species	Abundance Ash	Boot	Boug	TS	N GBR	Osp	Biomass Ash	Boot	Boug	TS	N GBR	Osp
Sufflamen bursa	0.04	0.06	0	0	0.53	0.03	6.32	5.2	0	0	76.51	2.94
Sufflamen chrysopterum	0.21	0.12	0.5	0	0.89	0.13	79.65	10.39	57.56	0	153.49	31.31
Symphorus nematophorus	0	0	0	0.09	0.21	0	0	0	0	314.29	718.57	0
Synodus binotatus	0.02	0.06	0	0	0.03	0	0.23	2.17	0	0	0.29	0
Synodus dermatogenys	0	0	0	0	0.05	0	0	0	0	0	3.27	0
Synodus jaculum	0	0	0.08	0	0	0	0	0	0.51	0	0	0
Synodus variegatus	0.19	0.41	0	0.27	0.89	0.07	5.38	11.75	0	3.58	52.65	0.87
Taeniamia biguttata	0	0	0	5.45	0	0	0	0	0	0	0	0
Taeniamia fucata	0	0	0	0	0.42	0	0	0	0	0	0	0
Taeniamia melasma	0	0	0	1.82	0	0	0	0	0	0	0	0
Taeniura lymma	0	0	0	0.09	0.03	0	0	0	0	71.26	278.68	0
Thalassoma amblycephalum	11.38	36	38.67	0	0.82	26.43	24.21	42.74	143.43	0	5.28	35.63
Thalassoma hardwicke	13.67	8.65	9.25	0	3.63	6.63	149.17	81.23	51.17	0	113.14	54.29
Thalassoma jansenii	0.42	0.12	0	0	0.63	1.33	16.89	9.54	0	0	19.39	12.36
Thalassoma lunare	5.13	9.24	0.83	0.64	14	5.6	68.34	251.58	29.97	49.7	412.76	260.98
Thalassoma lutescens	0.02	0.71	2.5	0	0.55	1.6	0.13	9.41	33.52	0	12.39	21.76
Thalassoma nigrofasciatum	1.65	4.41	9.75	0	6.42	0.4	54.72	73.63	169.48	0	196.65	2.86
Thalassoma quinquevittatum	0.54	1.29	0.17	0	0.05	0.03	2.34	10.11	0.06	0	0.53	0.34
Trachinotus blochii	0	0	0.25	0	0	0	0	0	570.36	0	0	0
Triaenodon obesus	0.19	0.24	0.17	0	0.21	1.1	3510.79	1788.24	2986.58	0	2435.52	14999.02
Upeneus tragula	0	0	0	0	0.05	0	0	0	0	0	12.81	0
Variola albimarginata	0	0	0	0	0.08	0	0	0	0	0	22.95	0
Variola louti	0.21	0	0	0	0.08	0	57.59	0	0	0	24.24	0
Zanclus cornutus	2.25	3.88	2.33	0	0.84	2.93	1336.82	2757.55	1178.5	0	519.93	961.97
Zebrasoma scopas	22.04	5.35	16.5	0	6.39	7.33	2318.28	481.8	1263.63	0	579.5	453.06
Zebrasoma velifer	4.08	3.24	1.92	0.27	1.03	2.67	0	0	0	0	0	109.78
Zoramia fragilis	0	0	0	1.09	5.66	0	0	0	0	0.41	2.12	0
Zoramia leptacantha	0	0	0	1.36	0	0	0	0	0	5.02	0	0
Zoramia viridiventer	0	0	0	32.27	0	0	0	0	0	11.87	0	0

APPENDIX 3 – SPECIES OF MACROINVERTEBRATES RECORDED ON NORTHERN GBR, TORRES STRAIT AND CORAL SEA REEFS. FREQUENCY OF OCCURRENCE AND MEAN ABUNDANCE ARE GIVEN, INCLUDING FOR UNIDENTIFIED SPECIES.

Species	Transects Ash	Boot	Boug	TS	N GBR	Osp	Abundance Ash	Boot	Boug	TS	N GBR	Osp
Acanthaster planci	0	0	0	1	8	0	0	0	0	0.09	0.26	0
Actinopyga mauritiana	2	0	0	0	0	0	0.04	0.06	0	0	0	0
Actinopyga miliaris	2	0	0	0	2	0	0.04	0	0	0	0.08	0
Actinopyga palauensis	0	0	0	0	1	0	0	0	0	0	0.03	0
Amphimetra tessellata	2	0	0	0	0	0	0.08	0	0	0	0	0
Asthenosoma varium	0	0	0	0	1	0	0	0	0	0	0.03	0
Astralium calcar	0	0	0	0	1	0	0	0	0	0	0.03	0
Astralium spp.	0	0	0	0	1	0	0	0	0	0	0.03	0
Benimakia nodata	1	1	0	0	0	0	0.04	0.06	0	0	0	0
Bohadschia argus	10	2	0	0	6	10	0.35	0.12	0	0	0.16	0.6
Bohadschia graeffei	6	3	0	0	6	1	0.25	0.18	0	0	0.21	0.03
Calcinus gaimardii	0	1	0	0	0	0	0	0.06	0	0	0	0
Calcinus minutus	1	0	1	0	0	0	0.02	0	0.42	0	0	0
Calcinus spp.	0	1	0	0	0	0	0	0.06	0	0	0	0
Capillaster multiradiatus	2	0	0	0	3	0	0.1	0	0	0	2.18	0
Celerina heffernani	3	0	0	0	0	0	0.08	0	0	0	0	0
Cenolia glebosus	0	0	0	0	0	2	0	0	0	0	0	0.2
Cenometra bella	3	0	0	0	3	0	0.88	0	0	0	0.5	0
Cerithium nodulosum	0	0	1	0	0	0	0	0	0.08	0	0	0
Chelidonura electra	0	0	0	0	3	0	0	0	0	0	0.11	0
Chelidonura inornata	0	0	0	0	1	0	0	0	0	0	0.03	0
Choriaster granulatus	0	1	0	0	0	1	0	0.06	0	0	0	0.03
Chromodoris africana	0	0	0	0	1	0	0	0	0	0	0.05	0

Species	Transects Ash	Boot	Boug	TS	N GBR	Osp	Abundance Ash	Boot	Boug	TS	N GBR	Osp
Chromodoris lochi	0	2	0	0	0	0	0	0.18	0	0	0	0
Cladolabes perspicillum	1	0	0	0	0	0	0.02	0	0	0	0	0
Clarkcomanthus comanthipinna	1	0	0	0	3	0	0.1	0	0	0	0.42	0
Clarkcomanthus littoralis	1	0	0	0	0	0	0.04	0	0	0	0	0
Clarkcomanthus luteofuscum	1	0	0	0	0	0	0.04	0	0	0	0	0
Clarkcomanthus spp.	2	0	0	0	3	0	0.71	0	0	0	0.87	0
Clibanarius seurati	2	0	0	0	0	0	0.13	0	0	0	0	0
Colobometra perspinosa	9	0	0	0	3	0	1.38	0	0	0	0.18	0
Comanthus briareus	0	0	0	0	0	1	0	0	0	0	0	0.03
Comanthus parvicirrus	0	0	0	0	0	1	0	0	0	0	0	0.17
Comanthus sp. (Black sparse)	2	0	0	0	0	0	0.04	0	0	0	0	0
Comanthus sp. (black w. orange tips)	1	0	0	0	0	0	0.19	0	0	0	0	0
Comanthus sp. (black white speckled)	3	0	0	0	0	2	0.9	0	0	0	0	0.97
Comanthus sp. (black white tips)	1	0	0	0	0	0	0.02	0	0	0	0	0
Comanthus sp. (black)	1	0	0	0	0	0	0.21	0	0	0	0	0
Comanthus sp. (blue)	0	0	0	0	0	4	0	0	0	0	0	0.73
Comanthus sp. (dark olive green)	1	0	0	0	0	0	0.15	0	0	0	0	0
Comanthus sp. (orange)	0	0	0	0	0	2	0	0	0	0	0	0.2
Comanthus sp. (yellow tips)	2	0	0	0	0	0	0.56	0	0	0	0	0
Comanthus spp.	42	5	1	5	34	6	41.4	2.82	0.08	0.91	62.76	0.3
Comaster multifidus	2	0	0	0	0	0	0.04	0	0	0	0	0
Comaster nobilis	1	0	0	0	2	0	0.06	0	0	0	0.13	0
Comaster schlegelii	0	0	0	0	1	0	0	0	0	0	0.05	0
Comasterid spp.	0	0	0	0	3	0	0	0	0	0	4.29	0
Comatella spp.	0	0	0	0	1	0	0	0	0	0	0.53	0
Conomurex luhuanus	1	0	0	0	0	0	0.04	0	0	0	0	0
Conus capitaneus	0	0	1	0	0	0	0	0	0.08	0	0	0

Species	Transects Ash	Boot	Boug	TS	N GBR	Osp	Abundance Ash	Boot	Boug	TS	N GBR	Osp
Conus flavidus	2	0	1	0	1	1	0.04	0	0.42	0	0.03	0.03
Conus imperialis	0	0	1	0	0	0	0	0	0.17	0	0	0
Conus litteratus	0	0	1	0	0	0	0	0	0.08	0	0	0
Conus marmoreus	0	0	1	0	0	0	0	0	0.08	0	0	0
Conus miles	1	0	0	0	1	0	0.02	0	0	0	0.03	0
Conus muriculatus	0	0	1	0	0	0	0	0	0.08	0	0	0
Conus musicus	1	0	0	0	0	0	0.04	0	0	0	0	0
Conus mustelinus	0	0	0	0	1	0	0	0	0	0	0.03	0
Conus spp.	2	0	0	0	0	2	0.04	0	0	0	0	0.07
Conus varius	0	0	1	0	0	0	0	0	0.17	0	0	0
Conus vexillum	0	0	1	0	0	0	0	0	0.08	0	0	0
Coralliophila costularis	0	0	0	0	1	0	0	0	0	0	0.03	0
Coralliophila neritoidea	1	0	0	0	0	1	0.02	0	0	0	0	0.03
Crinoidea spp.	2	0	0	0	0	0	5.42	0	0	0	0	0
Cuapetes spp.	1	0	0	0	0	0	0.02	0	0	0	0	0
Culcita novaeguineae	0	0	0	0	1	1	0	0	0	0	0.03	0.03
Cymatium spp.	1	0	0	0	0	0	0.02	0	0	0	0	0
Cypraea tigris	1	0	0	0	0	1	0.02	0	0	0	0	0.03
Dardanus lagopodes	0	0	1	0	0	0	0	0	0.08	0	0	0
Dardanus spp.	2	0	0	0	0	0	0.06	0	0	0	0	0
Diadema setosum	1	0	0	10	5	0	0.02	0	0	28.91	1.24	0
Drupa ricinus	1	0	0	0	0	0	0.02	0	0	0	0	0
Drupella cornus	3	0	1	0	0	1	0.08	0	0.08	0	0	0.03
Echinaster luzonicus	1	0	0	0	5	2	0.02	0	0	0	0.26	0.07
Echinometra mathaei	4	0	1	0	1	5	0.23	0	0.08	0	0.03	0.17
Echinostrephus aciculatus	28	10	8	0	9	6	6.1	2.82	2.08	0	13.03	4.1
Echinostrephus molaris	0	0	0	0	0	9	0	0	0	0	0	7.43
Echinothrix calamaris	1	0	0	0	0	0	0.02	0	0	0	0	0

Species	Transects Ash	Boot	Boug	TS	N GBR	Osp	Abundance Ash	Boot	Boug	TS	N GBR	Osp
Flabellina albomarginata	0	0	0	0	0	1	0	0	0	0	0	0.03
Fromia indica	3	1	0	0	17	0	0.06	0.12	0	0	0.76	0
Fromia milleporella	1	0	0	0	1	0	0.02	0	0	0	0.03	0
Fromia spp.	1	0	0	0	0	0	0.02	0	0	0	0	0
Goniobranchus decorus	0	1	0	0	0	0	0	0.12	0	0	0	0
Goniobranchus kuniei	0	0	0	0	1	0	0	0	0	0	0.03	0
Gymnodoris citrina	0	0	0	0	0	1	0	0	0	0	0	0.03
Gymnodoris spp.	1	0	0	0	0	0	0.02	0	0	0	0	0
Halgerda aurantiomaculata	1	0	0	0	0	0	0.02	0	0	0	0	0
Himerometra robustipinna	11	0	0	0	6	2	0.94	0	0	0	0.66	0.4
Holothuria atra	1	0	0	0	2	0	0.02	0	0	0	0.05	0
Holothuria edulis	0	0	0	0	11	5	0	0	0	0	0.42	0.23
Holothuria leucospilota	0	0	0	1	1	0	0	0	0	0.09	0.03	0
Holothuria spp.	1	0	0	0	3	0	0.02	0	0	0	0.08	0
Holothuria whitmaei	1	0	0	0	2	0	0.02	0	0	0	0.05	0
Hypselodoris bullocki	0	2	0	0	0	0	0	0.12	0	0	0	0
Hypselodoris maculosa	0	0	0	0	1	0	0	0	0	0	0.03	0
Hypselodoris spp.	0	1	0	0	0	0	0	0.06	0	0	0	0
Lambis chiragra	0	0	0	0	1	1	0	0	0	0	0.03	0.03
Lambis lambis	1	0	1	0	0	0	0.02	0	0.08	0	0	0
Lambis scorpius	1	0	0	0	0	0	0.02	0	0	0	0	0
Lambis truncata	1	0	0	0	0	0	0.02	0	0	0	0	0
Latirolagena smaragdula	1	0	0	0	0	0	0.02	0	0	0	0	0
Latirus gibbulus	3	0	0	0	1	0	0.08	0.06	0	0	0.03	0
Latirus polygonus	0	0	1	0	0	0	0	0	0.08	0	0	0
Linckia guildingi	0	0	0	0	2	0	0	0	0	0	0.08	0
Linckia laevigata	3	0	0	0	12	0	0.13	0	0	0	0.97	0
Linckia multifora	7	0	0	0	9	0	0.38	0	0	0	0.53	0

Species	Transects Ash	Boot	Boug	TS	N GBR	Osp	Abundance Ash	Boot	Boug	TS	N GBR	Osp
Linckia spp.	0	0	0	0	2	0	0	0	0	0	0.11	0
Mancinella alouina	0	0	0	0	1	0	0	0	0	0	0.03	0
Mollusca spp.	2	0	0	0	0	0	0.08	0	0	0	0	0
Nardoa galatheae	0	0	0	0	1	0	0	0	0	0	0.03	0
Nardoa novaecaledoniae	0	0	0	0	4	0	0	0	0	0	0.13	0
Nardoa spp.	0	0	0	0	1	0	0	0	0	0	0.03	0
Nardoa tuberculata	0	0	0	1	4	0	0	0	0	0.09	0.34	0
Nembrotha cristata	1	0	0	0	0	0	0.02	0	0	0	0	0
Neoferdina cumingi	1	1	0	0	0	0	0.02	0.06	0	0	0	0
Octopus cyanea	0	0	0	0	1	0	0	0	0	0	0.03	0
Oligometra serripinna	3	0	0	0	1	0	0.1	0	0	0	0.05	0
Oxycomanthus bennetti	16	2	0	0	21	3	2.92	0.12	0	0	6.24	0.23
Oxycomanthus spp.	2	0	0	0	1	0	0.71	0	0	0	0.53	0
Pagurid spp.	1	0	0	0	0	0	0.02	0	0	0	0	0
Paguritta spp.	1	0	0	0	1	0	0.02	0	0	0	0.05	0
Paguroidea spp.	20	0	4	0	1	12	2.46	0	0.5	0	0.03	0.83
Panulirus versicolor	1	0	0	0	0	0	0.04	0	0	0	0	0
Periclimenes soror	0	1	0	0	0	0	0	0.18	0	0	0	0
Phyllidia coelestis	1	0	0	0	0	0	0.02	0	0	0	0	0
Phyllidia elegans	0	0	1	0	0	0	0	0	0.08	0	0	0
Phyllidia ocellata	0	0	0	0	1	0	0	0	0	0	0.05	0
Phyllidia spp.	0	1	0	0	0	0	0	0.06	0	0	0	0
Phyllidia varicosa	0	0	1	0	0	0	0	0	0.08	0	0	0
Phyllidiella pustulosa	4	0	0	1	1	0	0.08	0	0	0.09	0.03	0
Pinctada margaritifera	3	0	0	1	1	1	0.06	0	0	0.09	0.05	0.1
Pteraeolidia ianthina	1	0	0	0	0	1	0.02	0	0	0	0	0.03
Pteria lata	0	0	0	0	1	0	0	0	0	0	0.03	0
Ranularia pyrum	1	0	0	0	0	0	0.02	0	0	0	0	0

Species	Transects Ash	Boot	Boug	TS	N GBR	Osp	Abundance Ash	Boot	Boug	TS	N GBR	Osp
Rhinoclavis aspera	0	0	0	0	1	0	0	0	0	0	0.03	0
Rhinoclavis sinensis	0	0	1	0	0	0	0	0	0.08	0	0	0
Rhinoclavis vertagus	0	0	0	0	1	0	0	0	0	0	0.03	0
Roboastra spp.	1	0	0	0	0	0	0.02	0	0	0	0	0
Spondylus varius	2	1	1	0	0	0	0.04	0.18	0.08	0	0	0
Stegopontonia commensalis	0	0	0	0	1	0	0	0	0	0	0.03	0
Stephanometra indica	1	0	0	0	2	0	0.02	0	0	0	0.05	0
Stephanometra spp.	2	0	0	0	0	0	0.23	0	0	0	0	0
Stichopus chloronotus	1	0	0	0	4	6	0.04	0	0	0	0.13	0.2
Stichopus hermanni	1	0	0	1	3	0	0.02	0	0	0.18	0.08	0
Stomatopoda spp.	0	0	0	0	0	1	0	0	0	0	0	0.03
Synapta maculata	0	0	0	0	1	0	0	0	0	0	0.03	0
Tambja morosa	1	0	0	0	0	0	0.02	0	0	0	0	0
Tectus pyramis	5	0	0	0	0	1	0.29	0	0	0	0	0.03
Tectus spp.	0	0	0	0	0	1	0	0	0	0	0	0.07
Tectus virgatus	0	0	1	0	0	0	0	0	0.08	0	0	0
Thelenota ananas	5	0	0	0	4	2	0.19	0	0	0	0.16	0.07
Thelenota anax	0	0	0	0	1	1	0	0	0	0	0.08	0.13
Thelenota rubrolineata	1	0	0	0	0	0	0.02	0	0	0	0	0
Thuridilla gracilis	2	0	0	0	2	1	0.04	0	0	0	0.05	0.03
Thuridilla spp.	4	0	0	0	0	0	0.08	0	0	0	0	0
Tridacna crocea	7	1	0	4	19	4	0.17	0.06	0	13.55	7.42	0.43
Tridacna derasa	2	1	0	0	2	4	0.04	0.06	0	0	0.11	0.17
Tridacna gigas	1	0	0	0	2	3	0.02	0	0	0	0.11	0.37
Tridacna maxima	9	1	7	2	3	12	0.21	0.06	1.25	0.18	0.08	1.5
Tridacna spp.	0	0	0	0	0	6	0	0	0	0	0	1.03
Tridacna squamosa	9	4	0	2	13	10	0.29	0.35	0	0.45	1.42	0.57
Tropiometra afra	0	0	0	0	1	0	0	0	0	0	0.05	0

Species	Transects Ash	Boot	Boug	TS	N GBR	Osp	Abundance Ash	Boot	Boug	TS	N GBR	Osp
Turbo argyrostomus	0	1	2	0	0	0	0	0.06	0.25	0	0	0
Turrilatirus turritus	0	0	0	0	1	0	0	0	0	0	0.03	0
Vasum ceramicum	1	0	1	0	0	0	0.04	0	0.08	0	0	0
Vasum turbinellum	0	0	2	0	1	0	0	0.06	0.25	0	0.03	0

APPENDIX 4 – SPECIES OF CRYPTIC FISHES RECORDED ON NORTHERN GBR, TORRES STRAIT AND CORAL SEA REEFS. FREQUENCY OF OCCURRENCE AND MEAN ABUNDANCE ARE GIVEN, INCLUDING FOR UNIDENTIFIED SPECIES.

Species	Transects						Abundance					
	Ash	Boot	Boug	TS	N GBR	Osp	Ash	Boot	Boug	TS	N GBR	Osp
Aioliops megastigma	0	0	0	0	1	0	0	0	0	0	0.03	0
Amblyeleotris guttata	4	0	0	0	1	0	0.17	0	0	0	0.03	0
Amblyeleotris spp.	2	0	0	0	0	0	0.06	0	0	0	0	0
Amblyeleotris steinitzi	0	0	0	0	3	1	0	0	0	0	0.11	0.07
Amblyeleotris wheeleri	0	0	0	0	7	0	0.1	0	0	0	0.39	0
Amblygobius decussatus	0	0	0	1	2	0	0	0	0	0.27	0.08	0
Amblygobius nocturnus	0	0	0	0	2	1	0	0	0	0	0.29	0.1
Amblygobius phalaena	0	0	0	3	6	3	0	0	0	0.36	0.55	0.17
Apogon doederleini	0	0	0	0	3	0	0	0	0	0	4.29	0
Apogon spp.	2	0	0	0	1	0	0.17	0	0	0	0.03	0
Apogonid spp.	1	0	0	0	2	0	0.46	0	0	0	0.05	0
Assessor flavissimus	0	0	0	0	5	0	0	0	0	0	0.89	0
Assessor macneilli	0	0	0	1	7	0	0	0	0	0.91	1.76	0
Atrosalarias holomelas	0	1	0	0	2	0	0	0.35	0	0	0.13	0
Brotula multibarbata	0	0	0	0	1	0	0	0	0	0	0.03	0
Bryaninops natans	1	0	0	0	0	3	0.04	0	0	0	0	2.33
Bryaninops spp.	1	0	0	0	3	0	0.15	0	0	0	0.42	0
Cheilodipterus artus	1	2	0	1	2	0	0.1	0.18	0	0.09	0.24	0
Cheilodipterus isostigmus	0	0	0	1	0	0	0	0	0	0.64	0	0
Cheilodipterus macrodon	1	2	1	1	5	4	0.02	0.18	0.08	0.09	0.21	0.2
Cheilodipterus quinquelineatus	4	2	0	6	18	6	0.85	0.18	0	15.18	8.87	0.57
Cirrhitichthys aprinus	1	0	0	0	0	0	0.06	0	0	0	0	0
Cirrhitichthys falco	10	5	1	0	6	2	0.69	0.53	0.08	0	0.26	0.07
Cirrhitichthys oxycephalus	0	0	1	0	0	1	0	0	0.08	0	0	0.03
Cirripectes castaneus	0	0	0	0	2	0	0	0	0	0	0.24	0

Species	Transects Ash	Boot	Boug	TS	N GBR	Osp	Abundance Ash	Boot	Boug	TS	N GBR	Osp
Cirripectes chelomatus	1	0	0	0	0	0	0.02	0	0	0	0	0
Cirripectes spp.	0	0	1	0	0	0	0	0	0.08	0	0	0
Cirripectes stigmaticus	2	3	0	0	0	0	0.33	0.29	0	0	0	0
Corythoichthys conspicillatus	4	0	0	0	0	0	0.19	0	0	0	0	0
Crossosalarias macrospilus	0	0	0	0	1	0	0	0	0	0	0.03	0
Cryptocentrus fasciatus	0	0	0	1	0	0	0	0	0	0.36	0	0
Cryptocentrus strigilliceps	0	0	0	1	4	0	0	0	0	0.09	0.13	0
Ctenogobiops mitodes	2	1	0	0	5	0	0.13	0.24	0	0	0.82	0
Ctenogobiops pomastictus	3	0	0	2	12	6	0.15	0	0	0.18	2.71	1.2
Ctenogobiops tangaroai	0	0	0	0	0	0	0.02	0	0	0	0	0
Cymbacephalus beauforti	1	0	0	0	0	0	0.02	0	0	0	0	0
Diplogrammus goramensis	0	0	0	0	2	0	0	0	0	0	0.11	0
Ecsenius aequalis	6	0	0	0	1	1	0.44	0	0	0	0.05	0.03
Ecsenius australianus	1	0	0	0	0	3	0.02	0	0	0	0	0.13
Ecsenius bicolor	0	0	0	1	4	0	0	0	0	0.09	0.16	0
Ecsenius fourmanoiri	0	0	0	0	0	0	0.04	0	0	0	0	0
Ecsenius mandibularis	0	0	0	1	13	0	0	0	0	0.36	1.21	0
Ecsenius schroederi	0	0	0	0	2	0	0	0	0	0	0.11	0
Ecsenius spp.	2	0	0	0	0	0	0.06	0	0	0	0	0
Ecsenius stictus	0	0	0	3	14	2	0	0	0	1.27	1.18	0.23
Ecsenius tigris	0	0	3	0	0	9	0	0	0.25	0	0	0.87
Enneapterygius spp.	0	1	0	1	0	0	0	0.06	0	0.18	0	0
Eocallionymus papilio	0	0	0	1	3	0	0	0	0	0.09	0.11	0
Eviota atriventris	0	0	0	0	1	2	0	0	0	0	0.08	1.23
Eviota bifasciata	0	0	0	0	0	3	0	0	0	0	0	6.83
Eviota guttata	20	8	5	2	18	18	3.98	6.06	0.83	1.36	2.37	4.83
Eviota melasma	2	1	0	0	0	0	0.06	0.06	0	0	0	0
Eviota pellucida	1	0	0	0	1	7	0.04	0	0	0	0.03	3.5
Eviota prasites	2	1	0	0	5	9	0.77	0.59	0	0	0.47	2.77

Species	Transects Ash	Boot	Boug	TS	N GBR	Osp	Abundance Ash	Boot	Boug	TS	N GBR	Osp
Eviota sebreei	0	1	0	1	13	1	0.56	0.24	0	1.45	3.34	0.13
Eviota sigillata	0	0	0	3	2	1	0	0	0	1	0.29	0.27
Eviota smaragdus	0	0	0	0	1	0	0	0	0	0	0.03	0
Eviota spp.	4	1	1	1	0	2	0.58	0.24	0.25	0.09	0	0.33
Exyrias belissimus	0	0	0	2	0	0	0	0	0	0.18	0	0
Fusigobius duospilus	7	1	0	2	12	0	1.08	0.06	0	1.09	2.68	0
Fusigobius inframaculatus	0	0	0	0	1	0	0	0	0	0	0.05	0
Fusigobius signipinnis	3	0	0	2	8	3	0.23	0	0	0.64	0.61	0.57
Fusigobius spp.	0	0	0	0	0	2	0	0	0	0	0	0.17
Gnatholepis anjerensis	0	0	0	0	0	6	0	0	0	0	0	0.77
Gnatholepis cauerensis	11	4	0	0	5	1	2.67	0.88	0	0	0.58	0.07
Gobiid spp.	4	2	0	1	3	2	0.17	0.12	0	0.09	0.16	0.37
Gobiodon citrinus	0	1	0	0	0	0	0.17	0.06	0	0	0	0
Gobiodon okinawae	0	0	0	0	0	1	0.02	0	0	0	0	0.03
Gobiodon spilophthalmus	0	0	0	0	1	0	0	0	0	0	0.05	0
Gobiodon spp.	0	0	0	1	2	0	0.19	0	0	0.09	0.34	0
Gymnothorax javanicus	2	0	0	0	2	0	0.06	0	0	0	0.05	0
Gymnothorax spp.	0	0	0	0	0	0	0.02	0	0	0	0	0
Helcogramma striatum	3	1	0	0	3	0	1.54	0.12	0	0	0.08	0
Istigobius decoratus	1	0	0	1	3	1	0.02	0	0	0.36	0.37	0.03
Istigobius rigilius	10	0	0	1	10	0	0.94	0	0	1.09	0.89	0
Istigobius spp.	0	1	0	0	0	0	0	0.06	0	0	0	0
Koumansetta rainfordi	4	0	0	0	12	7	0.1	0	0	0	0.61	1.1
Lotilia klausewitzi	0	0	0	0	0	0	0.02	0	0	0	0	0
Macrodontogobius wilburi	0	0	0	1	0	0	0	0	0	0.09	0	0
Meiacanthus atrodorsalis	6	5	0	0	13	3	1.02	1	0	0	1.05	0.2
Meiacanthus grammistes	0	0	0	0	5	0	0	0	0	0	0.24	0
Meiacanthus lineatus	0	0	0	0	1	4	0	0	0	0	0.03	0.63
Meiacanthus phaeus	0	0	0	0	0	1	0	0	0	0	0	0.03

Species	Transects Ash	Boot	Boug	TS	N GBR	Osp	Abundance Ash	Boot	Boug	TS	N GBR	Osp
Myripristis amaena	0	0	0	0	0	1	0	0	0	0	0	0.03
Myripristis berndti	0	2	2	0	0	4	0.19	0.59	1.58	0	0	0.57
Myripristis kuntee	2	4	1	0	2	1	0.44	1.47	0.75	0	0.18	0.43
Myripristis murdjan	1	0	0	0	0	2	0.04	0	0	0	0	0.17
Myripristis spp.	2	0	0	0	1	0	0.08	0	0	0	0.03	0
Myripristis violacea	1	4	1	0	6	5	0.02	0.82	2.33	0	0.24	0.63
Myripristis vittata	1	5	4	0	1	7	0.15	4.18	4	0	0.16	1.9
Nemateleotris magnifica	5	3	0	0	2	9	1.29	1.06	0	0	0.05	1
Neoniphon argenteus	1	1	0	0	1	1	0.06	0.06	0	0	0.05	0.03
Neoniphon opercularis	0	1	0	0	0	1	0	0.35	0	0	0	0.03
Neoniphon sammara	6	6	2	0	2	1	0.96	1.76	1	0	0.18	0.03
Neoniphon spp.	1	0	0	0	0	0	0.04	0	0	0	0	0
Ostorhinchus aureus	0	0	0	0	1	0	1.04	0	0	0	0.53	0
Ostorhinchus compressus	0	0	0	2	3	0	0	0	0	0.27	0.32	0
Ostorhinchus cyanosoma	2	0	0	0	7	0	0.19	0	0	0	8.21	0
Ostorhinchus neotes	0	0	0	1	0	0	1.04	0	0	0.91	0	0
Ostorhinchus nigrofasciatus	2	3	1	0	4	1	0.88	0.29	0.08	0	0.11	0.03
Ostorhinchus properuptus	0	0	0	2	5	0	0	0	0	5.18	5.95	0
Ostracion cubicus	0	0	0	0	1	0	0	0	0	0	0.03	0
Paracentropyge multifasciatus	0	1	0	0	0	0	0	0.06	0	0	0	0
Paracirrhites arcatus	10	8	9	0	2	16	1.21	1.47	6.42	0	0.11	1.37
Paracirrhites forsteri	7	6	7	0	0	4	0.25	1.12	1.08	0	0	0.17
Parapercis australis	0	0	0	0	1	1	0	0	0	0	0.05	0.03
Parapercis clathrata	0	0	0	0	2	1	0.58	0	0	0	0.05	0.03
Parapercis hexophtalma	2	0	0	0	0	0	0.04	0	0	0	0	0
Parapercis lineopunctata	0	0	0	0	2	0	0	0	0	0	0.37	0
Parapercis multiplicata	5	0	0	0	0	2	0.15	0	0	0	0	0.07
Parapercis queenslandica	0	0	0	0	0	0	0.02	0	0	0	0	0
Parapercis xanthozona	0	0	0	0	1	0	0	0	0	0	0.05	0

Species	Transects						Abundance					
	Ash	Boot	Boug	TS	N GBR	Osp	Ash	Boot	Boug	TS	N GBR	Osp
Paraplotosus butleri	0	0	0	1	3	0	0	0	0	0.09	0.08	0
Pempheris analis	0	0	0	1	0	0	0	0	0	0.45	0	0
Pempheris oualensis	1	2	0	0	0	0	0.02	0.29	0	0	0	0
Pempheris schwenkii	0	0	0	0	0	1	0	0	0	0	0	0.07
Pempheris spp.	0	0	0	0	0	1	0	0	0	0	0	0.03
Pictichromis paccagnellae	0	0	0	0	0	6	0.04	0	0	0	0	0.33
Plagiotremus laudandus	11	4	0	0	2	2	0.9	0.53	0	0	0.16	0.1
Plagiotremus rhinorhynchos	0	4	0	0	2	0	0.04	0.53	0	0	0.05	0
Plagiotremus tapeinosoma	1	2	0	0	1	0	0.04	0.12	0	0	0.05	0
Pleurosicya spp.	0	0	0	1	1	0	0	0	0	0.09	0.03	0
Priacanthus blochii	0	0	0	0	1	0	0	0	0	0	0.03	0
Priacanthus hamrur	2	0	0	0	1	3	0.27	0	0	0	0.03	0.1
Pristiapogon exostigma	0	0	0	0	0	1	0	0	0	0	0	0.03
Pristiapogon kallopterus	0	0	0	0	1	0	0	0	0	0	0.05	0
Pseudochromis fuscus	1	0	0	1	5	0	0.02	0	0	0.09	0.26	0
Pseudochromis spp.	0	1	0	0	0	0	0	0.06	0	0	0	0
Ptereleotris evides	0	1	1	0	0	0	0	0.06	0.17	0	0	0
Pterois antennata	0	0	0	0	1	2	0	0	0	0	0.03	0.07
Rhabdamia gracilis	0	0	0	1	1	0	0	0	0	12.09	0.79	0
Salarias alboguttatus	0	0	0	0	1	0	0	0	0	0	0.05	0
Salarias ceramensis	0	0	0	0	1	0	0	0	0	0	0.08	0
Salarias fasciatus	0	0	0	0	1	0	0	0	0	0	0.03	0
Salarias spp.	0	0	0	0	1	0	0	0	0	0	0.03	0
Sargocentron caudimaculatum	3	4	0	0	2	2	0.29	0.41	0	0	1.24	0.17
Sargocentron diadema	0	0	0	0	0	4	0	0	0	0	0	0.27
Sargocentron rubrum	0	0	0	1	0	1	0	0	0	0.09	0	0.1
Sargocentron spiniferum	3	5	2	0	1	3	0.17	0.65	0.25	0	0.03	0.17
Sargocentron spp.	0	0	0	0	0	1	0	0	0	0	0	0.03
Saurida gracilis	0	2	0	0	1	1	0.02	0.12	0	0	0.03	0.03

Species	Transects Ash	Boot	Boug	TS	N GBR	Osp	Abundance Ash	Boot	Boug	TS	N GBR	Osp
Saurida nebulosa	1	0	0	0	3	1	0.02	0	0	0	0.08	0.03
Scorpaena cardinalis	0	0	0	0	0	1	0	0	0	0	0	0.03
Scorpaenid spp.	0	0	0	0	0	0	0.02	0	0	0	0	0
Signigobius biocellatus	0	0	0	0	4	1	0	0	0	0	0.18	0.03
Sphaeramia nematoptera	0	0	0	1	0	0	0	0	0	0.09	0	0
Synchiropus spp.	0	0	0	0	1	0	0	0	0	0	0.13	0
Synodus binotatus	0	0	0	0	1	0	0	0	0	0	0.03	0
Synodus dermatogenys	0	0	0	0	1	0	0.02	0	0	0	0.03	0
Synodus rubromarmoratus	0	0	0	0	2	0	0.02	0	0	0	0.08	0
Synodus spp.	0	0	0	1	0	0	0	0	0	0.09	0	0
Synodus variegatus	9	2	0	1	18	7	0.48	0.18	0	0.27	0.82	0.27
Taeniamia biguttata	0	0	0	1	0	0	0	0	0	4.55	0	0
Taeniamia fucata	0	0	0	0	1	0	0	0	0	0	0.53	0
Taeniamia melasma	0	0	0	3	0	0	0	0	0	2.73	0	0
Taeniura lymma	0	0	0	2	0	0	0	0	0	0.18	0	0
Trimma benjamini	0	0	0	0	0	0	0.04	0	0	0	0	0
Trimma spp.	0	0	0	0	0	0	0.31	0	0	0	0	0
Trimma striatum	0	1	0	0	0	0	0	0.12	0	0	0	0
Ucla xenogrammus	0	0	0	1	2	0	0	0	0	0.09	0.05	0
Valenciennea longipinnis	0	0	0	0	1	0	0	0	0	0	0.26	0
Valenciennea muralis	0	0	0	1	2	0	0	0	0	0.09	0.32	0
Valenciennea puellaris	0	0	0	0	1	0	0	0	0	0	0.08	0
Valenciennea sexguttata	0	0	0	0	1	0	0	0	0	0	0.08	0
Valenciennea spp.	0	0	0	1	0	0	0	0	0	0.09	0	0
Valenciennea strigata	2	0	1	0	0	2	0.17	0	0.17	0	0	0.2
Zoramia fragilis	0	0	0	0	2	0	0	0	0	0	3.42	0
Zoramia leptacantha	0	0	0	1	0	0	0	0	0	1.36	0	0
Zoramia viridiventer	0	0	0	2	0	0	0	0	0	20.64	0	0