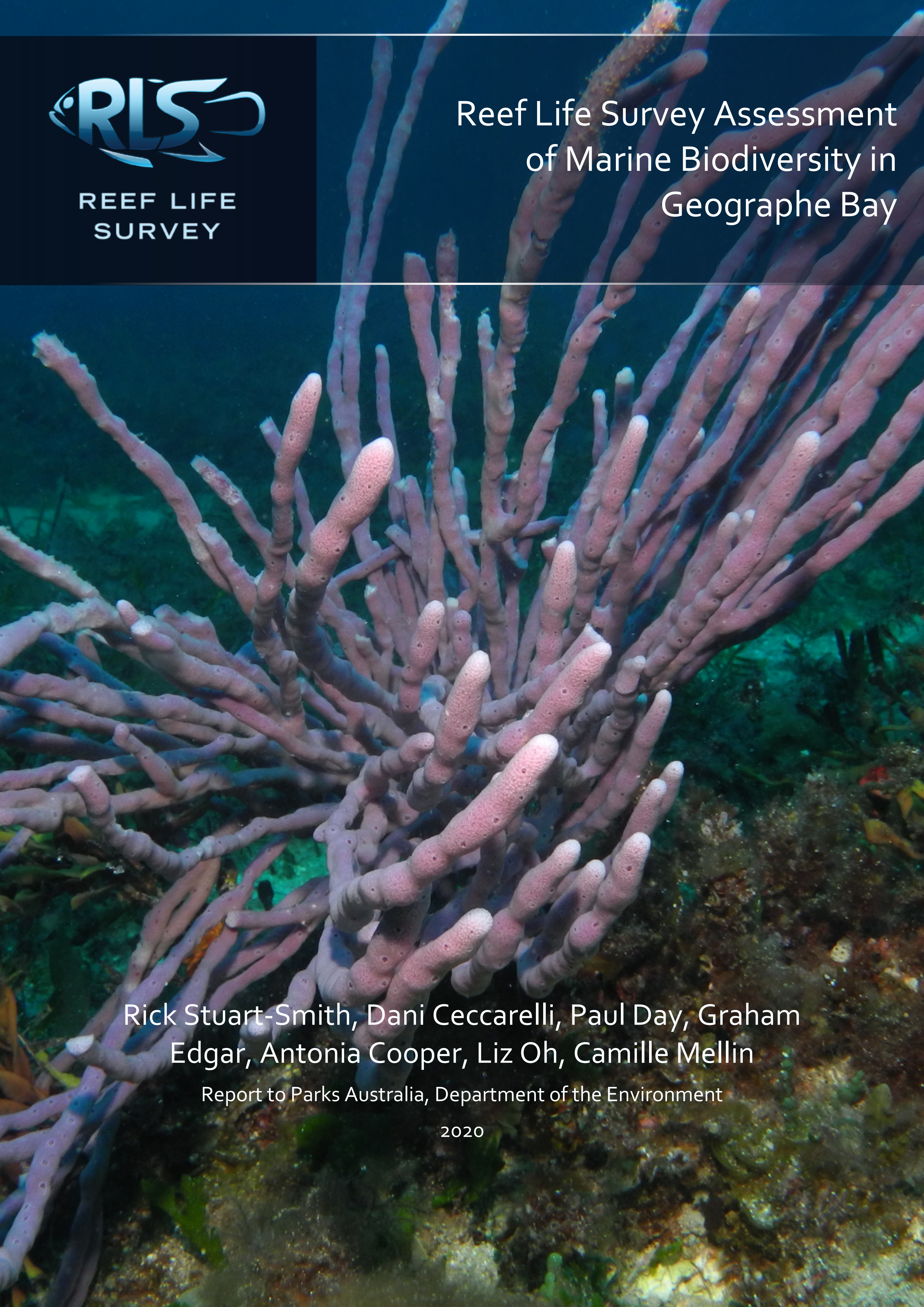

REEF LIFE SURVEY

Reef Life Survey Assessment of Marine Biodiversity in Geographe Bay

Rick Stuart-Smith, Dani Ceccarelli, Paul Day, Graham Edgar, Antonia Cooper, Liz Oh, Camille Mellin

Report to Parks Australia, Department of the Environment

2020

Citation

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Images

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1 Contents

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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

The Geographe Marine Park is one of 14 Australian Marine Parks established in the South-west Marine Parks Network (SWMPN), which emcompasses an area of 508,371 km2 within the South-west Marine Region that extends from eastern Kangaroo Island, South Australia, to 70 km offshore of Shark Bay, Western Australia (WA). Four zoning categories exist within the Geographe Marine Park: Habitat Protection (IUCN IV), Multiple Use (IUCN VI), Special Purpose (Mining Exclusion, IUCN VI) and National Park (IUCN II) zones (Parks Australia 2019). There has been very little research in the Geographe Marine Park to help understand differences in biodiversity values protected in each of these zones and provide adequate baselines for future evaluation of management effectiveness. This report presents the findings of Reef Life Survey (RLS) surveys conducted in 2017 and 2019, which targeted reef habitats in two zoning categories before and just following implementation of the Geographe Marine Park.

Fish, macroinvertebrate and benthic communities in Geographe Marine Park changed little between 2017 and 2019, both in the Habitat Protection (IUCN IV) and Multiple Use (IUCN VI) zones. Minor changes observed reflected largely idiosyncratic trends associated with the small number of surveys (only four sites were surveyed; two in each zone). The similarity in reef communities between years in both zones was expected because the park management plan was formally implemented less than a year prior to the 2019 surveys (i.e. there was insufficient time for any ‘management effect’), and because no sites were within the National Park Zone in the final zoning scheme (IUCN II, with greater fishing restrictions). Stability in fish biomass and Community Temperature Index values suggested no substantial human or environmentally driven changes occurred between the 2017 and 2019 surveys either. The high similarity between sites suggests that sites within the Multiple Use Zone are well matched to the Habitat Protection Zone sites in terms of habitat and reef communities, and should therefore act as good reference sites. Similarly, the lack of major differences between years suggests that the overall period investigated should provide a good baseline against which future change can be assessed.

MANAGEMENT AND RESEARCH RECOMMENDATIONS

We recommend that:

- ongoing monitoring of shallow reef habitat in the Geographe Marine Park should ideally take place on annual to biennial basis, using methods consistent with baseline surveys described here and;

- survey effort should be increased to include at least two sites within the National Park Zone, assuming suitable habitat can be found.

2 Introduction

Geographe Bay is a large, sheltered embayment located 270 km south of Perth, Western Australia. The seabed is varied, and consists of a limestone substratum covered in sand and occasionally protruding in the form of small patch reefs, interspersed with extensive seagrass beds that cover 70% of the bay (McMahon et al. 1997). The seagrass meadows in the bay are among the largest and most continuous temperate seagrass in Australia, with at least ten different seagrass species recorded (McMahon et al. 1997). A low limestone reef ridge runs parallel to the shore in seagrass at approximately 16 m depth (Westera et al. 2009). The bay also hosts a high diversity of fish species (White et al. 2011).

The Geographe Marine Park is one of 14 Australian Marine Parks established in the South-west Marine Parks Network (SWMPN). The SWMPN includes Commonwealth waters from the eastern end of Kangaroo Island, South Australia, to 70 km offshore of Shark Bay, Western Australia (WA), encompassing a total area of 508,371 km^2. The Geographe Marine Park covers 977 km^2, and a depth range of approximately 15 to 40 m within Geographe Bay. Three zoning categories exist within the Geographe Marine Park: Habitat Protection (IUCN IV), Multiple Use (IUCN VI), Special Purpose (Mining Exclusion, IUCN VI) and National Park (IUCN II) zones (Parks Australia 2019). The conservation values listed specifically for this Marine Park include foraging areas for seabirds, migratory habitat for humpback whales and blue whales (Recalde-Salas et al. 2014), seagrass beds (White et al. 2011), rock lobster habitat (MacArthur et al. 2007), and high benthic productivity and biodiversity.

There has been very little research done in the Geographe Marine Park to help understand the biodiversity values encompassed within the different levels of protection. Reef Life Survey (RLS) first surveyed the isolated reef ridge in 2009, which found the associated fauna to be quite different to the inshore sites monitored by RLS and the Australian Temperate Reef Collaboration (including the University of Tasmania and WA Department of Biodiversity, Conservation and Attractions). Following the subsequent zoning plan for the new Geographe Marine Park, RLS surveyed two sites along this reef within the proposed National Park Zone in 2017, and two within the Multiple Use Zone to provide reference sites. Very little shallow reef exists within the Park, making a more comprehensive survey design difficult. These four sites were resurveyed in 2019, however the zones were changed for the final management plan, leaving the RLS monitoring sites within the Habitat Protection Zone (2 sites) and the Multiple Use Zone (2 sites). No sites were surveyed in the new National Park Zone. This report presents the findings of the 2017 and 2019 surveys, examining data from reef habitat in two levels of zoning before and just following formal establishment of the Geographe Marine Park. While the report is as comprehensive as possible, only four sites were surveyed, so it is necessarily brief.

3 Methods

Reef Life Survey (RLS) dive teams surveyed 8 transects in 2017 and 11 transects in 2019, spread over 4 sites within the Geographe Marine Park (Figure 3, Appendix 1). All surveys were conducted using the standardised underwater visual census methods applied globally by Reef Life Survey. RLS involves recreational divers trained to a scientific level of data-gathering to make it possible to conduct ecological surveys across broad geographic areas in a cost-effective manner. RLS divers partner with management agencies and university researchers to undertake detailed assessment of biodiversity on coral and rocky reefs, but all divers and boat crew do so in a voluntary capacity. A summary of these methods is provided here. Full details can be downloaded at: http://reeflifesurvey.com/files/2008/09/NEW-Methods-Manual_15042013.pdf.

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

FISH SURVEYS (METHOD 1)

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

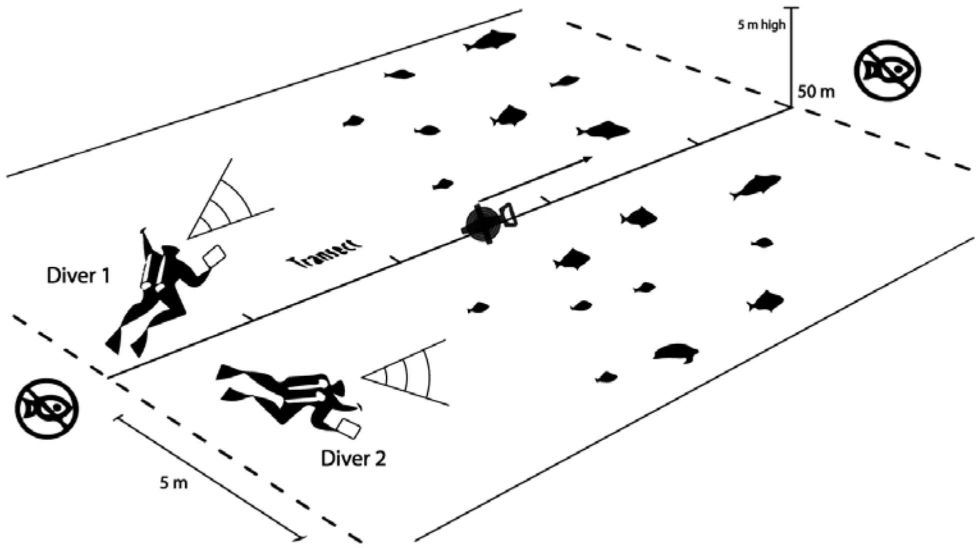

Figure 1. Stylised representation of method 1 survey technique

MACROINVERTEBRATE AND CRYPTIC FISH SURVEYS (METHOD 2)

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

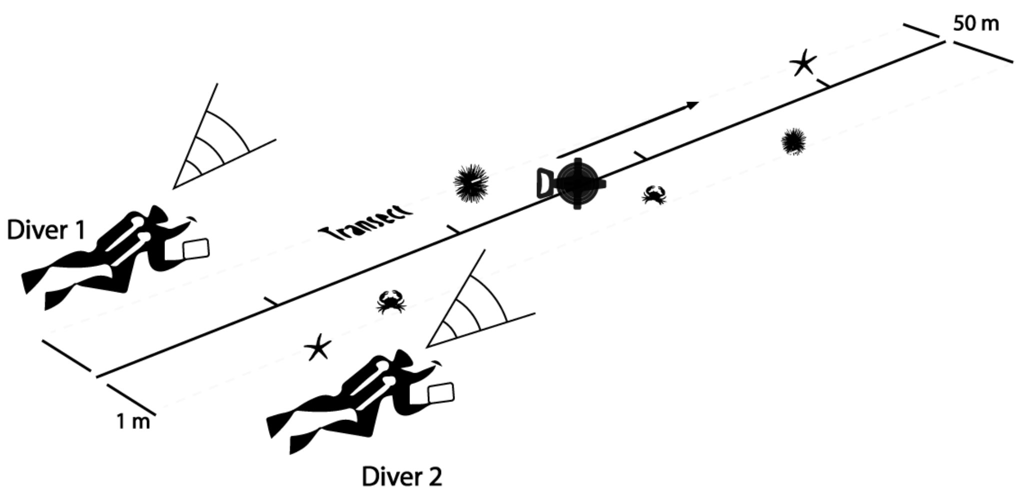

Figure 2. Stylised representation of method 2 survey technique

PHOTO-QUADRATS OF BENTHIC COVER (METHOD 3)

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

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

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

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

STATISTICAL ANALYSES

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

UNIVARIATE ANALYSES

A range of univariate metrics were calculated from survey data: fish species richness, biomass of fish functional groups, total fish biomass, abundance and species richness of macroinvertebrates and cryptic fishes, and percent cover of corals and other key benthic organisms. Two standard global indicators of reef condition were also calculated for each survey: the biomass of large reef fishes (B20) and the community temperature index (CTI). The biomass of large fishes (B20) is an indicator of fishing impacts, with previous analyses revealing lower values in regions of higher fishing impact around Australia (Stuart-Smith et al. 2017b). 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 responds to sea temperature changes (Stuart-Smith et al. 2015). For its calculation, the midpoint of each species' thermal distribution (i.e. the temperature range experienced across its geographic distribution) is used as a value of thermal affinity. The mean thermal affinity of species recorded on a survey is then taken, weighted by the log of their abundance on the survey. All metrics represent mean values per 500 m^2 transect area for Method 1 fishes, per 100 m^2 transect area for Method 2 fishes and invertebrates, and percent cover of benthic organisms from photo-quadrats.

Analysis of Variance (ANOVA) with appropriate transformation was conducted on the above metrics, with Year and IUCN Status as fixed factors.

MULTIVARIATE ANALYSES

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

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

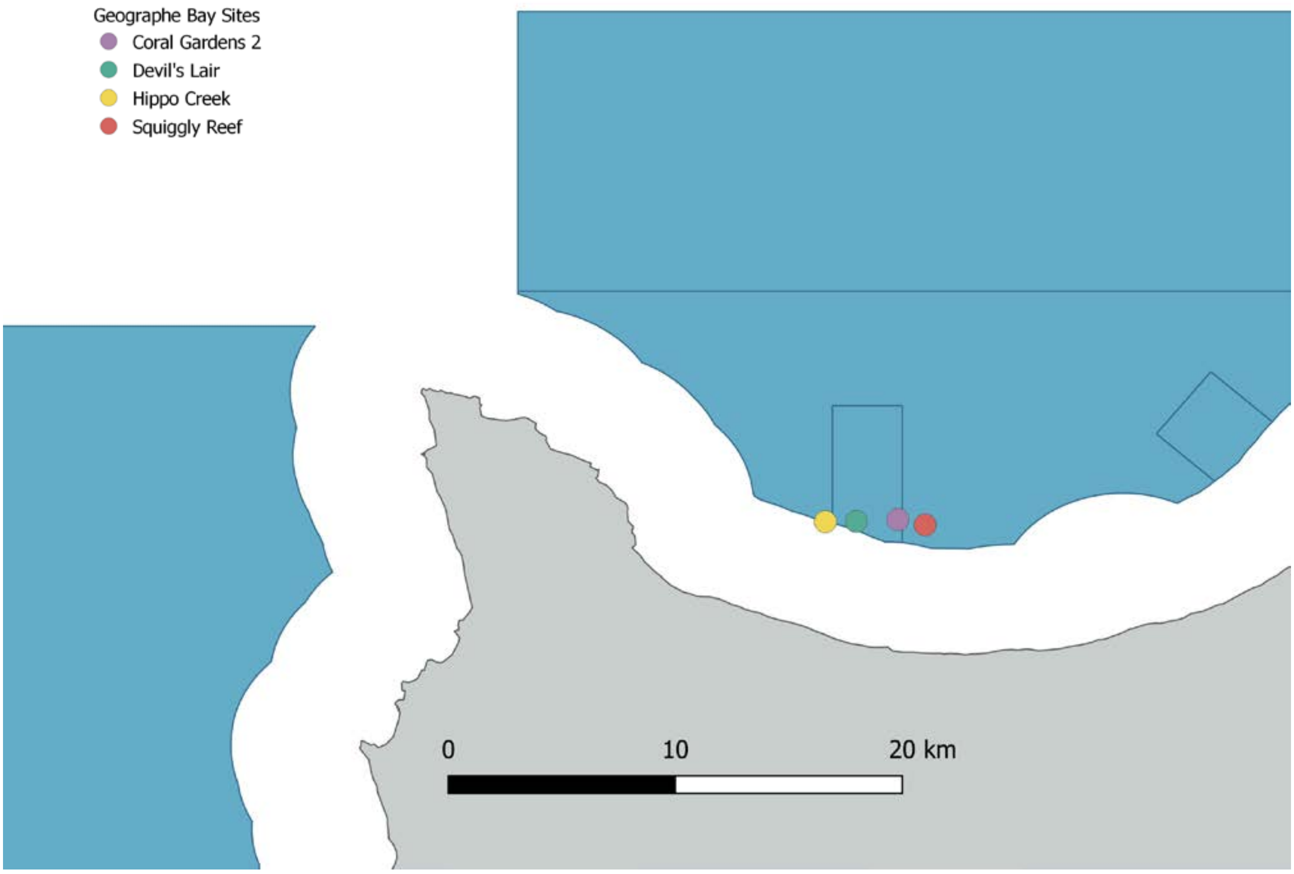

Figure 3. Map of the Geographe Bay sites surveyed in 2017 and 2019.

4 Results

4.1 Fish Community

4.1.1 COMMUNITY STRUCTURE

Reef fish surveys in 2017 and 2019 recorded a total of 76 species . A noticeable, but not statistically significant (Table 1), shift in the fish assemblage structure occurred between 2017 and 2019 (Figure 4), but the species that were most influential in driving the shift were generally rare, and only encountered in one of the two survey years. For example, the one individual of the wrasse *Suezichthys cyanolaemus* and a large school of samson fish (*Seriola hippos*) were encountered in 2017, but not in 2019; the opposite was true of the leatherjacket *Meuschenia freycineti* (Figure 4, Appendix 2). IUCN IV sites were more similar to each other in 2017 than IUCN VI; in 2019 all sites were more similar in terms of their fish assemblage (Figure 4). A school of southern bluefin tuna (*Thunnus maccoyii*) was recorded as method 0 in the 2017 surveys, as they circled the divers at the end of the dive.

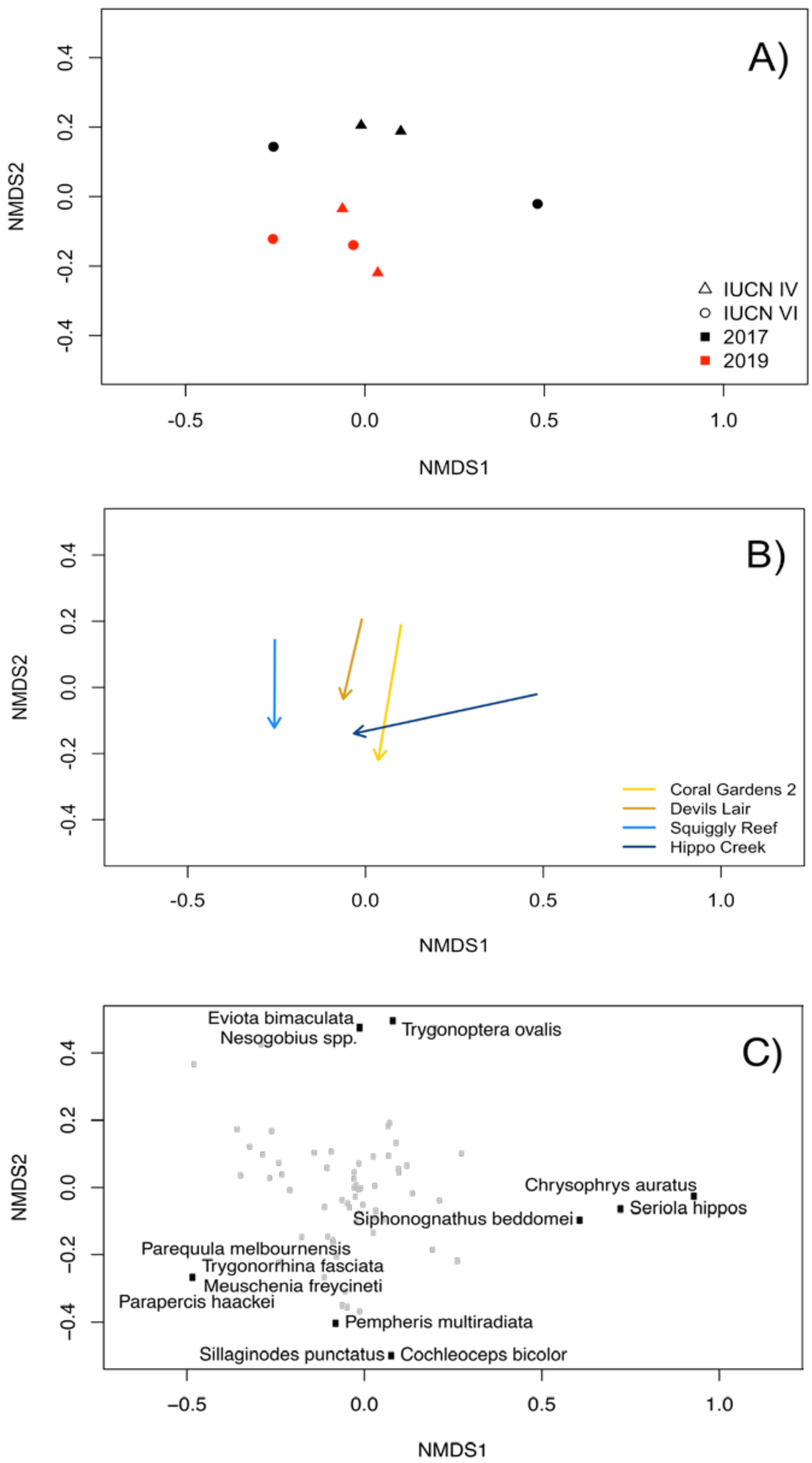

Figure 4. Multidimensional scaling (MDS) plot of reef fish biomass across all sites surveyed in 2017 vs 2019, either coded by IUCN status (A) or sites (B; with arrows between 2017 to 2019), and performed on the Bray-Curtis similarity matrix of the square-root transformed data (stress value = 0.07). Species scores are shown on C). For clarity, species labels are only shown for species with the best fit.

Table 1. PERMANOVA of fish community structure changes between 2017 and 2019 (Year) and between IUCN IV and IUCN VI sites.

	Df	SumsOfSqs	MeanSqs	F.Model	R2	Pr(>F)
Year	1	0.196	0.196	2.774	0.269	**0.068**
IUCN Status	1	0.153	0.153	2.160	0.209	**0.094**
Year x IUCN Status	1	0.098	0.098	1.381	0.134	**0.323**
Residuals	4	0.283	0.071	NA	0.388	**NA**
Total	**7**	**0.729**	**NA**	**NA**	**1.000**	**NA**

4.2 Fish biomass and species richness

Fish biomass and species richness increased at IUCN IV sites (Figure 5), but not significantly (Table 2). However, the magnitude of biomass change was significantly different between the zone types largely as a result of the school of samson fish observed in the IUCN VI zone in 2017 but not 2019.

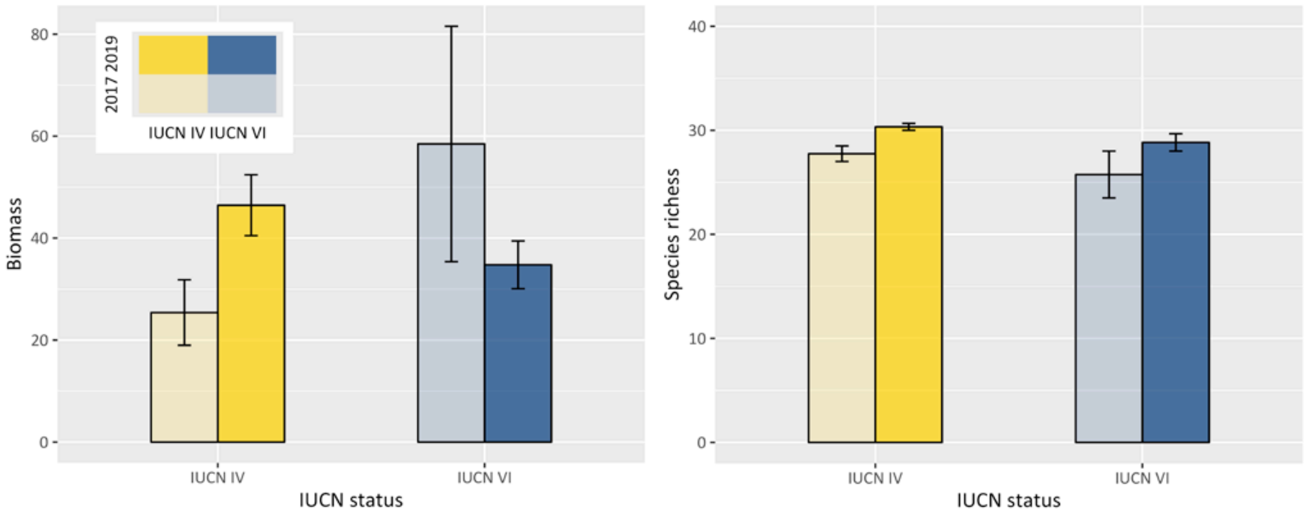

Figure 5. Biomass in kg and species richness of reef fishes per 500 m^2 transect at survey sites within IUCN IV and IUCN VI zones of Geographe Bay. Error Bars = 1 SE.

Table 2. ANOVA of fish biomass and species richness changes between 2017 and 2019 (Year) and between IUCN IV and IUCN VI sites.

SPECIES RICHNESS

Variable	Factor	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Biomass	IUCN Status	1	0.525	0.525	0.219	**0.647**
	Year	1	0.151	0.151	0.063	**0.805**
	IUCN Status x Year	1	12.246	12.246	5.096	**0.039**
	Residuals	15	36.049	2.403	NA	**NA**
Species richness	IUCN Status	1	12.465	12.465	1.053	**0.321**
	Year	1	38.206	38.206	3.228	**0.093**
	IUCN Status x Year	1	0.217	0.217	0.018	**0.894**
	Residuals	15	177.533	11.836	NA	**NA**

4.2.1 FISH BIOMASS BY TROPHIC GROUPS

The relative biomass of different functional groups appeared to vary slightly between years, but no changes were statistically significant (Figure 6; Table 3).

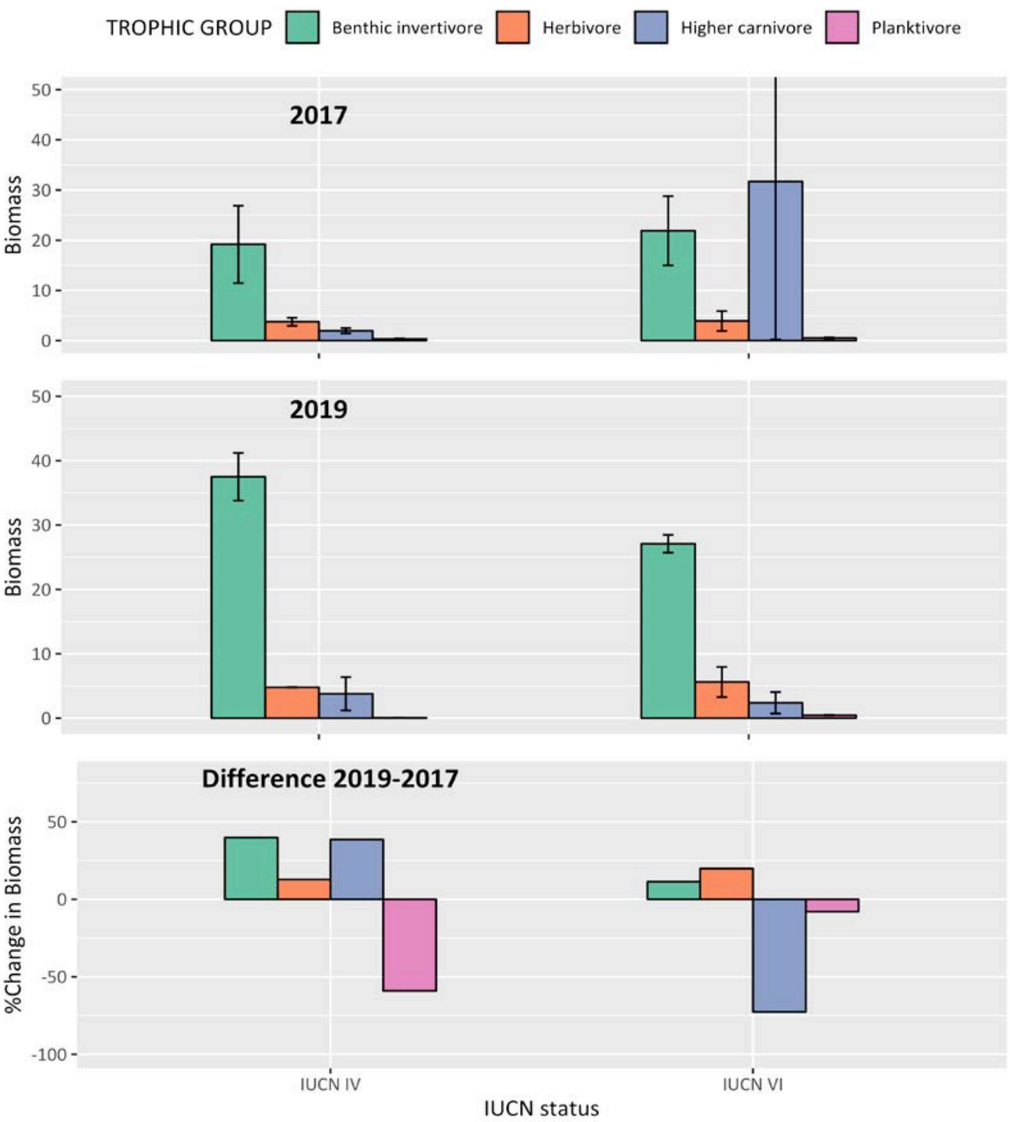

Figure 6. Biomass in kg of functional group of reef fishes per 500 m^2 transect within IUCN IV and IUCN VI sites. Error Bars = 1 SE.

Table 3. ANOVAs of the change in biomass of fish functional groups between 2017 and 2019, testing for differences between IUCN IV and IUCN VI sites.

Functional Group	Factor	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Benthic invertivores	IUCN Status	1	1118.48	1118.480	0.211	**0.691**
	Residuals	2	10604.32	5302.159	NA	**NA**
Herbivores	IUCN Status	1	2436.960	2436.960	0.979	**0.427**
	Residuals	2	4976.725	2488.363	NA	**NA**
Higher carnivores	IUCN Status	1	1.089	1.089	0	**0.995**
	Residuals	2	47769.095	23884.548	NA	**NA**
Planktivores	IUCN Status	1	2324.751	2324.751	2.501	**0.255**
	Residuals	2	1858.779	929.390	NA	NA

4.2.2 FISH B20 AND CTI

The biomass of large (>20cm TL) reef fishes remained stable at IUCN IV sites, but declined significantly at IUCN VI sites (Figure 7, Table 4), once again largely driven by the school of Samson fish only encountered in 2017. CTI values were remarkably similar between zones and years.

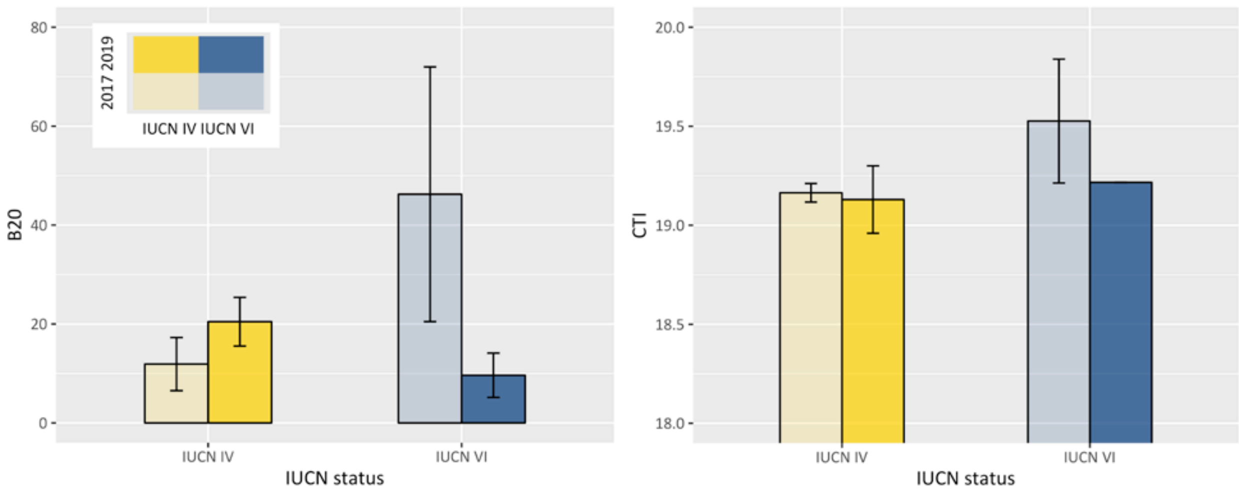

Figure 7. Biomass in kg per 500 m^2 transect of large (>20cm TL) reef fishes (left) and Community Temperature Index (right) within IUCN IV and IUCN VI in 2017 and 2019. Error Bars = 1 SE.

Table 4. ANOVAs of the biomass of large (>20cm TL) reef fishes (B20) and Community Temperature Index (CTI) differences between 2017 and 2019 (Year) and between IUCN IV and IUCN VI sites.

Variable	Factor	Df	Sum Sq	Mean Sq	F value	Pr(>F)
B20	Year	1	5.643	5.643	1.729	**0.208**
	IUCN Status	1	0.207	0.207	0.064	**0.804**
	Year x IUCN Status	1	23.406	23.406	7.173	**0.017**
	Residuals	15	48.944	3.263	NA	**NA**
CTI	Year	1	0.059	0.059	0.918	**0.392**
	IUCN Status	1	0.101	0.101	1.561	**0.280**
	Year x IUCN Status	1	0.038	0.038	0.587	**0.486**
	Residuals	4	0.258	0.065	NA	**NA**

4.3 Mobile macroinvertebrates

4.3.1 INVERTEBRATE COMMUNITY STRUCTURE

Surveys in 2019 recorded 17 species of mobile macroinvertebrates at the four sites in Geographe Bay, dominated by echinoderms, especially the sea cucumber *Australostichopus mollis* (Appendix 3). In 2017 there were also 17 species, and echinoderms dominated, with a slightly different species composition. The most abundant species were relatively widespread across all sites in both years, but there were shifts in community structure at all sites (Figure 8), albeit not significant at the community level. Significant differences in invertebrate community structure between IUCN IV and IUCN VI sites persisted in both years (Table 5).

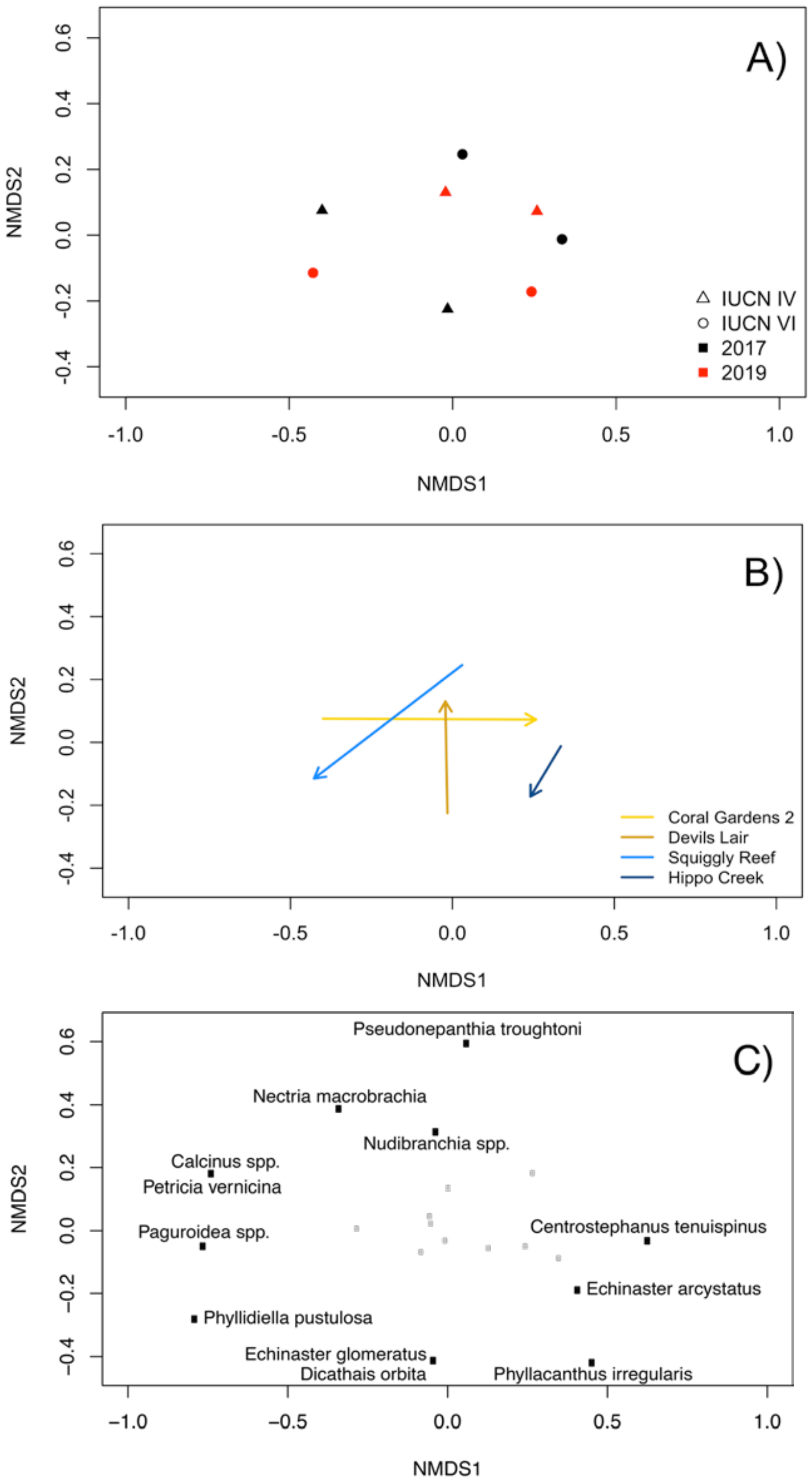

Figure 8. Multidimensional Scaling (MDS) plot of mobile macroinvertebrate abundance across all sites surveyed in 2017 vs 2019, either coded by IUCN status (A) or sites (B; with arrows between 2017 to 2019), and performed on the Bray-Curtis similarity matrix of the square-root transformed data (stress = 0.09). Species scores are shown on C). For clarity, species labels are only shown for species with the best fit.

Table 5. PERMANOVA of invertebrate community structure changes between 2017 and 2019 (Year) and between IUCN IV and IUCN VI sites.

	Df	SumsOfSqs	MeanSqs	F.Model	R2	Pr(>F)
Year	1	0.150	0.150	1.674	0.183	**0.137**
IUCN Status	1	0.223	0.223	2.488	0.271	**0.013**
Year x IUCN Status	1	0.090	0.090	1.005	0.110	**0.457**
Residuals	4	0.359	0.090	NA	0.436	**NA**
Total	**7**	**0.823**	**NA**	**NA**	**1.000**	**NA**

4.3.2 INVERTEBRATE ABUNDANCE AND SPECIES RICHNESS

The abundance and species richness of invertebrates was similar among IUCN IV and VI sites, and remained stable between 2017 and 2019 (Figure 9, Table 6).

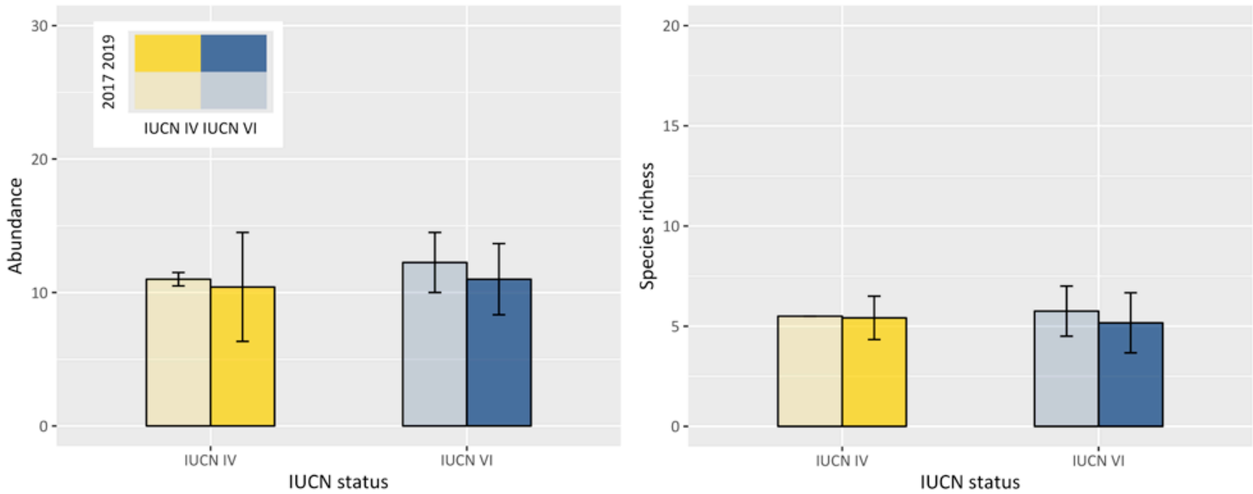

Figure 9. Abundance and species richness of mobile macroinvertebrates per 100 m^2 transect at survey sites within IUCN IV and IUCN VI zones of Geographe Bay. Error Bars = 1 SE.

Table 6. ANOVAs of the differences in abundance and species richness of invertebrates between 2017 and 2019 (Year) and between IUCN IV and IUCN VI sites.

Variable	Factor	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Abundance	IUCN Status	1	0.091	0.091	0.093	**0.765**
	Year	1	0.279	0.279	0.284	**0.602**
	IUCN Status x Year	1	0.048	0.048	0.049	**0.827**
	Residuals	15	14.701	0.980	NA	NA

4.3.3 INVERTEBRATE ABUNDANCE BY PHYLUM

In both years, the invertebrate community was dominated by echinoderms at both IUCN IV and VI sites (Figure 10). A change in echinoderm abundance occurred at IUCN IV and VI sites; abundance increased at IUCN IV sites and decreased at IUCN VI sites (Table 7). Molluscs declined and arthropods increased at IUCN IV sites while remaining stable at IUCN VI sites (Figure 10, Table 7).

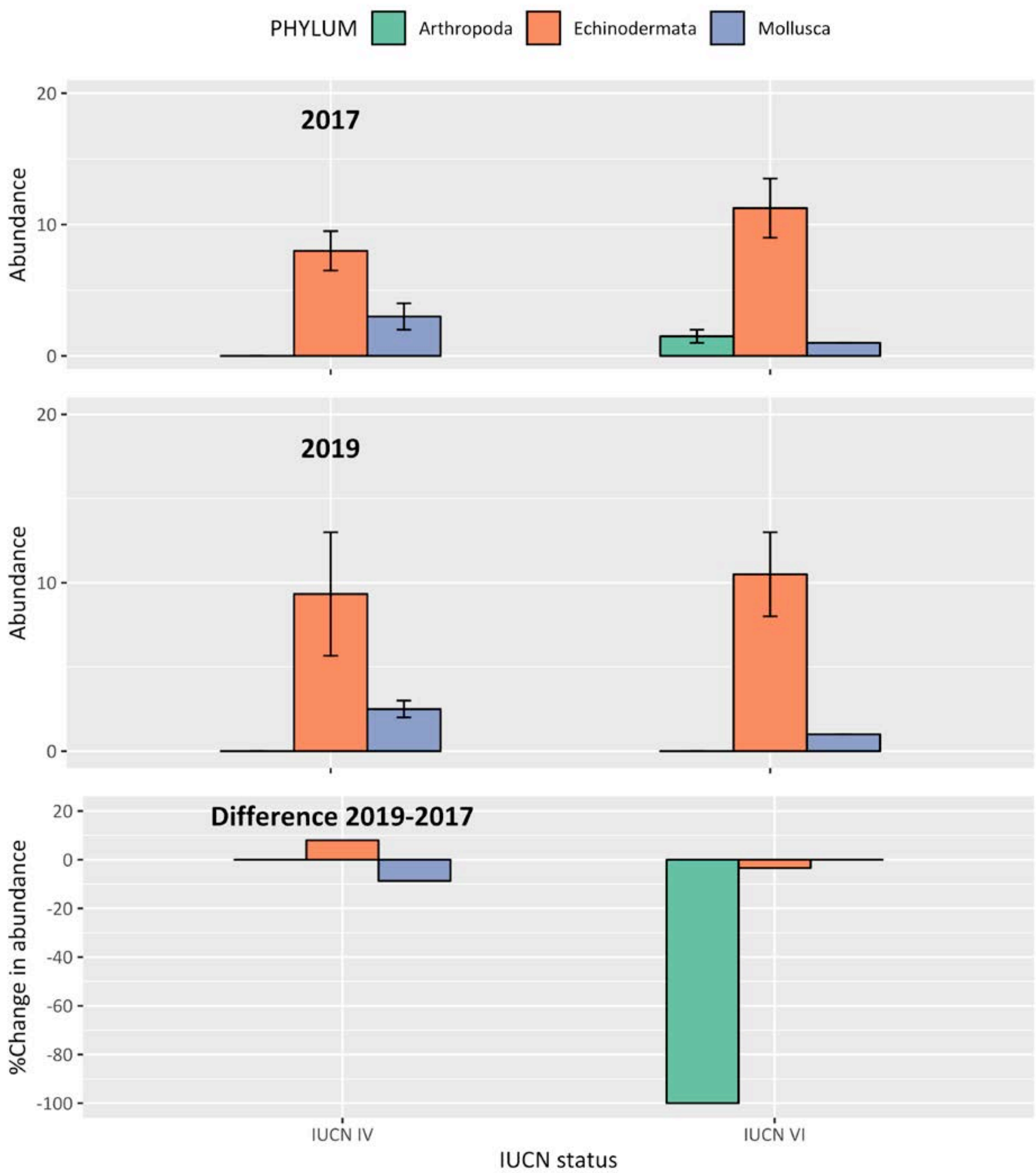

Figure 10. Total abundance of each phylum of mobile macroinvertebrates per 100 m^2 transect at survey sites within IUCN IV and IUCN VI zones of Geographe Bay. Error Bars = 1 SE.

Table 7. ANOVAs of the change in abundance and species richness of invertebrate phyla between 2017 and 2019, testing for differences between IUCN IV and IUCN VI sites.

Variable	Phylum	Factor	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Abundance	Arthropoda	IUCN	1	0.561	0.561	8.456	**0.004**
		Residuals	359	23.816	0.066	NA	**NA**
	Echinodermata	IUCN	1	3.352	3.352	0.112	**0.738**
		Residuals	359	10709.895	29.833	NA	**NA**
	Mollusca	IUCN	1	5.691	5.691	7.33	**0.007**
		Residuals	359	278.713	0.776	NA	**NA**
Species richness	Arthropoda	IUCN	1	0.280	0.280	8.274	**0.004**
		Residuals	720	24.408	0.034	NA	**NA**
	Echinodermata	IUCN	1	2.524	2.524	0.925	**0.337**
		Residuals	720	1965.171	2.729	NA	**NA**
	Mollusca	IUCN	1	1.122	1.122	8.591	**0.003**
		Residuals	720	94.026	0.131	NA	NA

4.4 Cryptic fish

4.4.1 CRYPTIC FISH SPECIES RICHNESS AND ABUNDANCE

Surveys of cryptic fishes resulted in 13 species in 2017 and 19 species in 2019. In both years, abundance was dominated by sweepers (Pempheridae) and cardinalfishes (Apogonidae, Appendix 4). The abundance and species richness of cryptic fishes was not significantly different between IUCN IV and VI sites or years (Table 8; Figure 11).

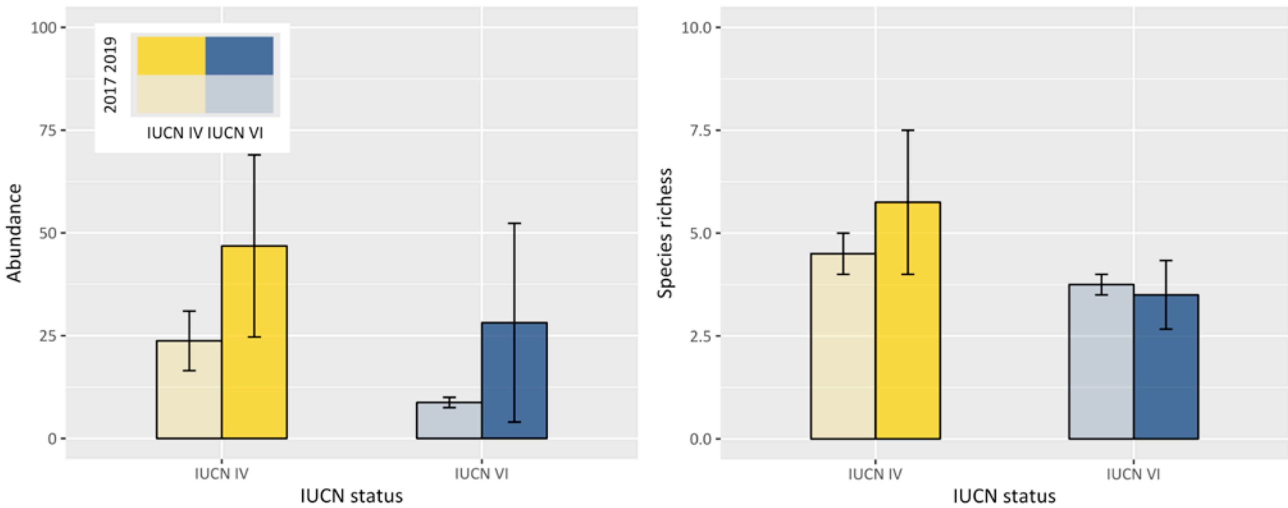

Figure 11. Abundance and species richness of cryptic fishes per 100 m^2 transect at survey sites within IUCN IV and IUCN VI zones of Geographe Bay. Error Bars = 1 SE.

Table 8. ANOVAs of the differences in the abundance and species richness of cryptic fishes between 2017 and 2019 (Year) and between IUCN IV and IUCN VI sites.

Variable	Factor	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Abundance	IUCN Status	1	890.501	890.501	0.420	**0.527**
	Year	1	1677.077	1677.077	0.791	**0.388**
	IUCN Status x Year	1	0.678	0.678	0.000	**0.986**
	Residuals	15	31813.533	2120.902	NA	**NA**
Species richness	IUCN Status	1	9.284	9.284	1.574	**0.229**
	Year	1	0.424	0.424	0.072	**0.792**
	IUCN Status x Year	1	1.526	1.526	0.259	**0.618**
	Residuals	15	88.450	5.897	NA	NA

4.5 Benthic Community

4.5.1 BENTHIC COMMUNITY STRUCTURE

There were no clear differences in benthic composition between sites of different IUCN status (Figure 12, Appendix 5). However, each site appeared to have a unique benthic composition, and there were large changes at each site between 2017 and 2019. Each site changed in a different way, resulting in no significant differences when tested (Table 9).

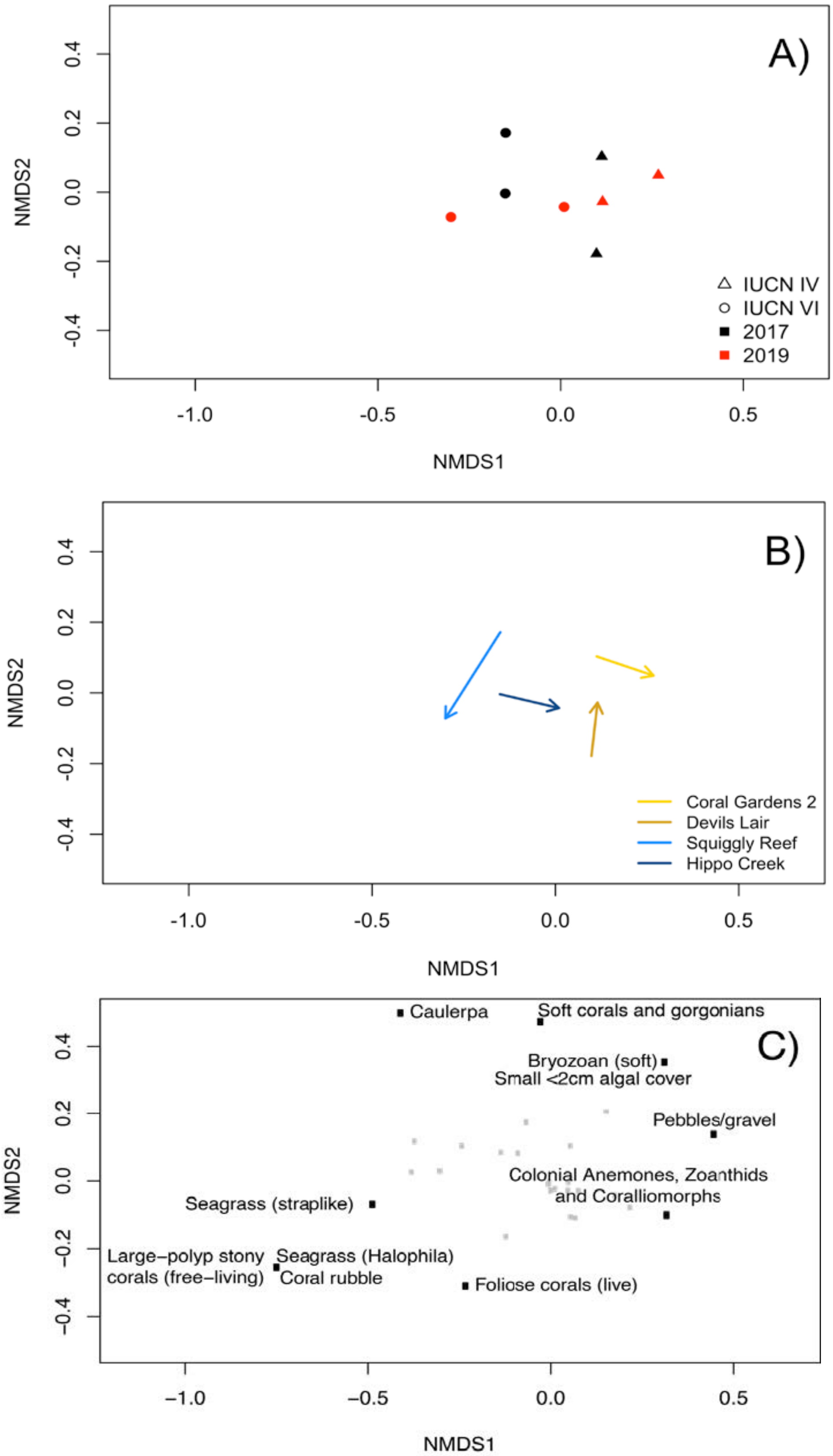

Figure 12. Multidimensional Scaling (MDS) plot of major benthic categories covers across all sites surveyed in 2017 vs 2019, either coded by IUCN status (A) or sites (B; with arrows between 2017 to 2019) and performed on the Bray-Curtis similarity matrix of the square-root transformed data (stress = 0.05). Species scores are shown on C). For clarity, labels are only shown for benthic categories with the best fit.

Table 9. PERMANOVA of benthic community structure changes between 2017 and 2019 (Year) and between IUCN IV and IUCN VI sites.

Factor	Df	SumsOfSqs	MeanSqs	F.Model	R2	Pr(>F)
Year	1	0.070	0.070	2.354	0.402	**0.189**
IUCN Status	1	0.027	0.027	0.896	0.153	**0.511**
Year x IUCN Status	1	0.018	0.018	0.612	0.104	**0.644**
Residuals	2	0.060	0.030	NA	0.341	**NA**
Total	**5**	**0.175**	**NA**	**NA**	**1.000**	**NA**

4.5.2 BENTHIC COVER

The cover of most benthic categories was similar between IUCN zones and remained stable between years (Figure 13, Table 10). The cover of turf, however, changed significantly between years; in 2017 there was more turf at IUCN VI sites, but in 2019 it had declined to just under 15% in both zones. Total live organism cover was high (above 90%), coral cover was very low and variable (between 1 and 8%), and the dominant benthic component was macroalgae (25-35%).

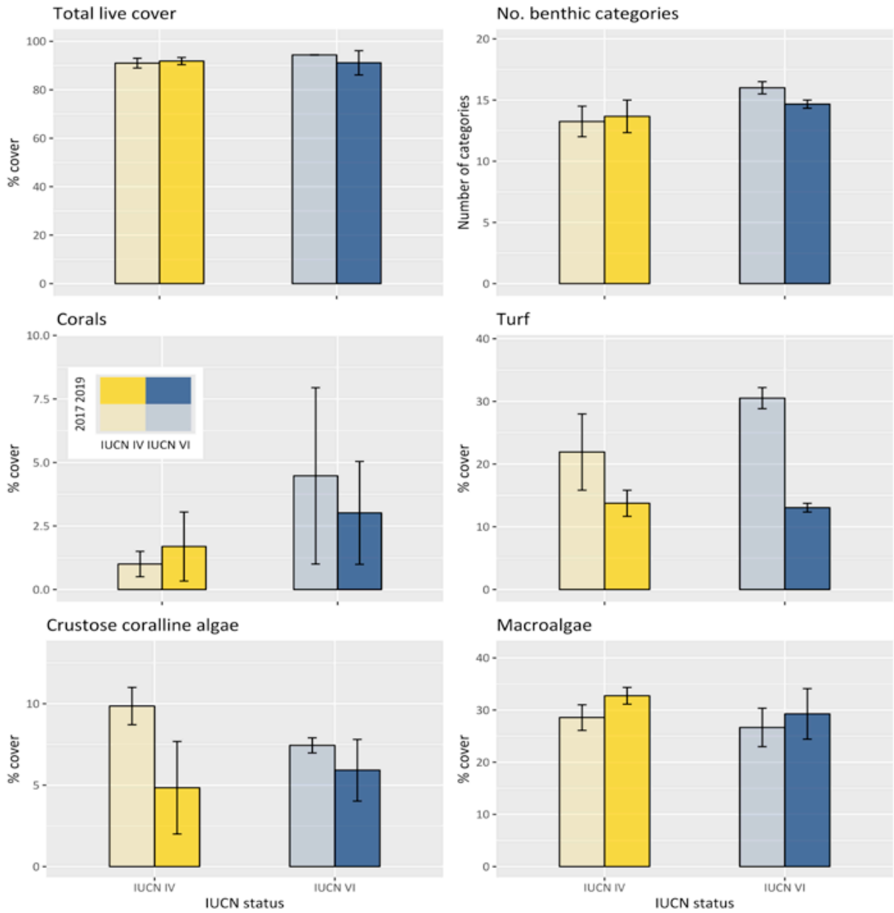

Figure 13. Total live cover (%), total number of categories and percent cover of key benthic categories at survey sites within IUCN IV and IUCN VI zones of Geographe Bay. Error Bars = 1 SE. Note that plots have different y-axis scales.

Table 10. ANOVAs of the differences in the cover of different benthic categories between 2017 and 2019 (Year) and between IUCN IV and IUCN VI sites. CCA: Crustose coralline algae.

Category	Factor	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Total live cover	Year	1	1.822	1.822	0.041	**0.843**
	IUCN Status	1	2.467	2.467	0.056	**0.817**
	Year x IUCN Status	1	46.769	46.769	1.063	**0.325**
	Residuals	11	484.195	44.018	NA	**NA**
N. benthic categories	Year	1	9.344	9.344	1.458	**0.253**
	IUCN Status	1	13.333	13.333	2.080	**0.177**
	Year x IUCN Status	1	0.556	0.556	0.087	**0.774**
	Residuals	11	70.500	6.409	NA	**NA**
Coral	Year	1	6.664	6.664	0.409	**0.535**
	IUCN Status	1	26.101	26.101	1.604	**0.232**
	Year x IUCN Status	1	0.068	0.068	0.004	**0.950**
	Residuals	11	179.035	16.276	NA	**NA**
Turf	Year	1	612.216	612.216	28.237	**0.000**
	IUCN Status	1	149.729	149.729	6.906	**0.023**
	Year x IUCN Status	1	141.467	141.467	6.525	**0.027**
	Residuals	11	238.491	21.681	NA	**NA**
CCA	Year	1	38.136	38.136	3.501	**0.088**
	IUCN Status	1	11.312	11.312	1.038	**0.330**
	Year x IUCN Status	1	21.496	21.496	1.973	**0.188**
	Residuals	11	119.838	10.894	NA	**NA**
Macroalgae	Year	1	72.108	72.108	1.206	**0.296**
	IUCN Status	1	26.531	26.531	0.444	**0.519**
	Year x IUCN Status	1	25.347	25.347	0.424	**0.528**
	Residuals	11	657.838	59.803	NA	NA

5 Discussion

Reef communities in Geographe Bay were very similar between 2017 and 2019, both in protected (IUCN IV) and fished zones (IUCN VI). Fish biomass fluctuations were largely driven by the presence of a large school of the samson fish *Seriola hippos* in one year and not the other, and similarly, other minor changes observed reflected largely idiosyncratic trends associated with the small sample sizes. Other than the bluefin tuna scored on method 0, the surveys did not reveal species or populations of conservation or commercial significance. However, as previously identified by RLS surveys (Stuart-Smith et al. 2017a), the shallow reef habitat in Geographe Bay tends to support cryptic and deeper-water species that are rarely observed in shallow reef surveys elsewhere around Australia (e.g. western blue devil, *Paraplesiops sinclairi*; spotty seaperch, *Hypoplectrodes wilsoni;* and yellowspotted boarfish, *Paristiopterus gallipavo*).

The findings of no major change between survey periods was expected, not only because the park was only formally declared less than a year before the 2019 surveys (i.e. there has been insufficient time for any 'management effect'), but also because no sites ended up within the National Park Zone in the final zoning scheme (IUCN II, with greater fishing restrictions). Pronounced ecological changes may not even occur over longer time periods within the Habitat Protection Zone, which allows recreational fishing, although long-term monitoring will assist in determining this.

While no major trends between zones and years were detected within this set of analyses, this can be seen as a positive for long-term monitoring. The sites surveyed in the Multiple Use Zone appear well matched to the Habitat Protection Zone sites in terms of habitat and reef communities and should act as good reference sites through time. Likewise, stability in fish biomass and Community Temperature Index values suggested no substantial human or environmentally driven changes occurred between the 2017 and 2019 surveys. The combination of well-matched sites and limited change indicates that these surveys reported here will collectively provide a good baseline for detecting change in the future. Given only small sample sizes (not many sites) will ever be possible for tracking change in shallow reef habitats in the Geographe Marine Park (due to limited shallow reef habitat availability), this is especially important. Had these surveys suggested more variability between zones and years, an alternative more comprehensive ongoing monitoring design may have been needed, but impossible in practice.

In terms of ongoing monitoring, it will be important to identify additional sites within the National Park Zone, where any management effect will be most likely detected. Preliminary investigation of habitat maps suggest it may be difficult finding equivalent reef habitat within this zone, however.

6 Recommendations

- ongoing monitoring of shallow reef habitat in the Geographe Marine Park should ideally take place on an annual to biennial basis, using methods consistent with those presented here;
- sampling effort should be increased to include at least two sites within the National Park Zone, assuming suitable habitat can be found.

7 Acknowledgements

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Appendices

APPENDIX 1. SURVEY SITES

Site details

Site Code	Site Name	Longitude	Latitude	IUCN Status	2017	2019
WA18	Coral Gardens 2	115.23128	-33.59231	IUCN IV (yellow)	2	3
WA97	Devils Lair	115.211448	-33.593202	IUCN IV (yellow)	2	2
WA98	Squiggly Reef	115.244253	-33.594858	IUCN VI (blue)	2	3
WA99	Hippo Creek	115.196697	-33.593392	IUCN VI (blue)	2	3

APPENDIX 2. AVERAGE ABUNDANCE OF EACH FISH SPECIES RECORDED ALONG 500 M² TRANSECTS WITH METHOD 1, IN 2017 AND 2019

		IUCN IV (yellow)				IUCN VI (blue)			
		Coral Gardens 2		Devil's Lair		Hippo Creek		Squiggly Reef	
FAMILY	**Species**	**2017**	**2019**	**2017**	**2019**	**2017**	**2019**	**2017**	**2019**
Apogonidae	*Apogon victoriae*	9.5	1.3	0	0	2.5	0	1	0.7
Apogonidae	*Siphamia cephalotes*	0	10	0	0	0	50	0	0
Aulopidae	*Latropiscis purpurissatus*	0	0	1	0.5	1	0	0	0
Carangidae	*Pseudocaranx georgianus*	0	1	30	0	0	0.7	49.5	42.3
Carangidae	*Seriola hippos*	0.5	1.3	0	0	46.5	0	0	0
Chaetodontidae	*Chelmonops curiosus*	4.5	5.3	4.5	6	4	4	3	5
Cheilodactylidae	*Cheilodactylus gibbosus*	0	0.3	0.5	0.5	0.5	1	0	0
Cheilodactylidae	*Dactylophora nigricans*	0	0	0	1.5	0	0	1.5	0.7
Cheilodactylidae	*Nemadactylus valenciennesi*	0	0	0	0.5	0	0.3	1	0
Dinolestidae	*Dinolestes lewini*	1	17.3	0	0	0	0.7	0	6.7
Diodontidae	*Diodon nicthemerus*	0.5	0.3	2.5	0	0	0	0	0
Enoplosidae	*Enoplosus armatus*	1	3	1	2.5	2	2.7	0	0
Gerreidae	*Parequula melbournensis*	0	0	0	0	0	0	0	0.3
Glaucosomatidae	*Glaucosoma hebraicum*	0	1.3	0	1	0	0.3	0	0.3
Gobiesocidae	*Cochleoceps bicolor*	0	0.7	0	0	0	0	0	0
Gobiidae	*Eviota bimaculata*	0	0	1	0	0	0	0	0
Gobiidae	*Nesogobius* spp.	0	0	2	0	0	0	0	0
Haemulidae	*Plectorhinchus flavomaculatus*	0	0	0.5	0	0	0	0.5	0

		IUCN IV (yellow)				IUCN VI (blue)			
		Coral Gardens 2		Devil's Lair		Hippo Creek		Squiggly Reef	
FAMILY	Species	2017	2019	2017	2019	2017	2019	2017	2019
Kyphosidae	*Girella zebra*	0	1	0	2	0.5	0	0.5	0.3
Kyphosidae	*Kyphosus sydneyanus*	0	0	0	0	0	0.7	2.5	0
Kyphosidae	*Neatypus obliquus*	20.5	18.3	6.5	5	36.5	4.7	19	39.7
Kyphosidae	*Scorpis aequipinnis*	0	0	0	0	2	1.3	0	0.7
Kyphosidae	*Tilodon sexfasciatus*	0	0	0	0	0	0	2	0
Labridae	*Achoerodus gouldii*	0	0.7	0	0	0	0	0.5	0
Labridae	*Austrolabrus maculatus*	38	15	31.5	24.5	26	33.7	29.5	16.7
Labridae	*Bodianus frenchii*	1.5	2.3	2.5	5.5	0.5	1.3	1	1.3
Labridae	*Choerodon rubescens*	0.5	0.7	0	1.5	0.5	0.3	0.5	2
Labridae	*Coris auricularis*	26	7.7	38	25	66	13.7	57	11.3
Labridae	*Dotalabrus alleni*	0	0	0	0.5	0	0.7	0	0
Labridae	*Eupetrichthys angustipes*	0	0	0	0	0.5	0.3	0	0
Labridae	*Halichoeres brownfieldi*	1	0	0	2.5	0	0	2	0.7
Labridae	*Notolabrus parilus*	8.5	1	2	5	2.5	1.7	2	2.7
Labridae	*Ophthalmolepis lineolatus*	6.5	4.7	10	6	13.5	7.7	8	5.7
Labridae	*Pseudolabrus biserialis*	19.5	10	13	18.5	12	15	16.5	12.7
Labridae	*Suezichthys cyanolaemus*	0.5	0	0	0	0	0	0	0
Latidae	*Psammoperca waigiensis*	0	0	0	1	0	0	0	0
Monacanthidae	*Acanthaluteres brownii*	0	0	0	1	0	0.3	0	0
Monacanthidae	*Eubalichthys mosaicus*	0	0	0	0.5	0	0	0	0
Monacanthidae	*Meuschenia flavolineata*	7	7	5	5	2	4	5.5	2
Monacanthidae	*Meuschenia freycineti*	0	0	0	0	0	0	0	0.7

		IUCN IV (yellow)				IUCN VI (blue)			
		Coral Gardens 2		Devil's Lair		Hippo Creek		Squiggly Reef	
FAMILY	**Species**	**2017**	**2019**	**2017**	**2019**	**2017**	**2019**	**2017**	**2019**
Monacanthidae	*Meuschenia galii*	2	0.7	2.5	1.5	0	1.7	3	0.7
Monacanthidae	*Meuschenia hippocrepis*	0.5	0	0	0	0	0	0.5	0.7
Monacanthidae	*Scobinichthys granulatus*	0.5	0	0	0	0	0.3	0	0
Mullidae	*Upeneichthys vlamingii*	3	1.3	0	1.5	1	1	0	1
Odacidae	Odacidae spp.	0	0	0	0	1	0	0	0
Odacidae	*Siphonognathus beddomei*	0	0	0	0	14	0.3	0	0.7
Odacidae	*Siphonognathus caninis*	0	0.3	0	0	0	1	0.5	1
Odacidae	*Siphonognathus* spp.	0	0	0	0	0	0.3	0	0
Ostraciidae	*Aracana aurita*	0	1	2	0.5	1	0.3	0	0.7
Pempheridae	*Pempheris klunzingeri*	141.5	131	121.5	370.5	26	114.7	43	98.7
Pempheridae	*Pempheris multiradiata*	0.5	37.7	0	0	0	1.3	0	27.7
Pempheridae	*Pempheris ornata*	18.5	39	0	52.5	0	87.3	5	16.7
Pempherididae	*Parapriacanthus elongatus*	0	36.7	25	340	0	83.7	20	133.3
Pentacerotidae	*Paristiopterus gallipavo*	0	0	0	0	0	1	0	0
Pentacerotidae	*Pentaceropsis recurvirostris*	0	0.3	0.5	0	0	0	0	0
Pinguipedidae	*Parapercis haackei*	0	0	0	0	0	0	0	0.3
Plesiopidae	*Paraplesiops meleagris*	2	5	1.5	3.5	3	3.3	2.5	1.3
Plesiopidae	*Trachinops brauni*	197.5	198	240	202.5	46.5	268.7	181.5	70.7
Plesiopidae	*Trachinops noarlungae*	1112.5	3020.7	1640	1870	535	3700	2210	3067.3
Pomacentridae	*Chromis klunzingeri*	67	8.3	47	29	34	14.7	57.5	5
Pomacentridae	*Parma mccullochi*	0	2.3	0	0.5	0	3.3	0	0.7
Pomacentridae	*Parma occidentalis*	0.5	0	0	0	0	0	0	0.3

		IUCN IV (yellow)				IUCN VI (blue)			
		Coral Gardens 2		Devil's Lair		Hippo Creek		Squiggly Reef	
FAMILY	**Species**	**2017**	**2019**	**2017**	**2019**	**2017**	**2019**	**2017**	**2019**
Pomacentridae	*Parma victoriae*	3	1.3	3	6	0	1	1.5	1.7
Scorpaenidae	*Scorpaena sumptuosa*	1.5	1	1.5	3	1	0.7	1	0
Serranidae	*Epinephelides armatus*	0.5	0.7	1.5	0.5	0	0.3	0.5	1.3
Serranidae	*Hypoplectrodes nigroruber*	0.5	2	2	0.5	1	0	2	0.3
Serranidae	*Hypoplectrodes wilsoni*	0	0	0	1	0	0.3	0	0
Serranidae	*Othos dentex*	1.5	0.7	0.5	0.5	0	0	0	0
Sillaginidae	*Sillaginodes punctatus*	0	83.3	0	0	0	0	0	0
Sparidae	*Chrysophrys auratus*	0	0	0	0	1	0	0	0
Tetraodontidae	*Omegophora cyanopunctata*	1	0.3	1.5	0	1	0.3	0	0.7
Tripterygiidae	*Helcogramma decurrens*	0	0	0	0	0	0.3	0.5	0
Rhinobatidae	*Trygonorrhina fasciata*	0	0	0	0	0	0	0	0.3
Urolophidae	*Trygonoptera ovalis*	1	0	0.5	0	0	0	0	0
Urolophidae	*Urolophus circularis*	0	0	0	0	0	0	0.5	0

APPENDIX 3. INVERTEBRATE SPECIES LIST

Average number of each invertebrate species recorded along 100 m² transects with method 2, in 2017 and 2019.

			IUCN IV (yellow)				IUCN VI (blue)			
			Coral Gardens 2		Devil's Lair		Hippo Creek		Squiggly Reef	
CLASS	**FAMILY**	**Species**	**2017**	**2019**	**2017**	**2019**	**2017**	**2019**	**2017**	**2019**
Asteroidea	Asterinidae	*Nepanthia crassa*	0	0	0	0	0.5	0	0	0
Asteroidea	Asterinidae	*Pseudonepanthia troughtoni*	0	0	0	0.5	0	0	0	0
Asteroidea	Asteropseidae	*Petricia vernicina*	0	0	0	0	0.5	0	0	0
Asteroidea	Echinasteridae	*Echinaster arcystatus*	0	0.3	0.5	0	0	0.7	0	1
Asteroidea	Echinasteridae	*Echinaster glomeratus*	0	0	0	0	0	0	0	0.3
Asteroidea	Echinasteridae	*Echinaster varicolor*	0.5	0	0	0.5	0.5	0	1	0.7
Asteroidea	Echinasteridae	*Plectaster decanus*	0.5	0.3	0.5	0	0.5	0.3	0	0.3
Asteroidea	Goniasteridae	*Fromia polypora*	1	0.7	1	0.5	2	0.7	1	1.3
Asteroidea	Goniasteridae	*Pentagonaster dubeni*	2.5	0.7	4	2.5	3	2	3	1.3
Asteroidea	Oreasteridae	*Nectria macrobrachia*	0	0	0	0.5	0.5	0	0	0
Cephalopoda	Sepiidae	*Sepia apama*	0	0.3	1	0.5	0	0	0	0.3
Crinoidea	Comasteridae	*Comanthus* spp.	0.5	0	3	6	0.5	0.3	0.5	1
Crinoidea	Comasteridae	*Comanthus trichoptera*	0	0.7	0	0.5	0	1.3	0	0.7
Echinoidea	Cidaridae	*Phyllacanthus irregularis*	0	0.3	0	0	0	0	0	0
Echinoidea	Diadematidae	*Centrostephanus tenuispinus*	0	0	0	0	0	0.3	0	0
Gastropoda		Nudibranchia spp.	0.5	0	0	0	0	0	0	0
Gastropoda	Chromodorididae	*Chromodoris westraliensis*	3.5	0.3	1	1	0	0.3	0	0
Gastropoda	Muricidae	*Dicathais orbita*	0	0	0	0	0	0	0	0.3
Gastropoda	Phyllidiidae	*Phyllidiella pustulosa*	0	0	0	0	0	0	0.5	0
Holothuroidea	Psolidae	*Ceto cuvieria*	1	0.3	0	0.5	0.5	0	0	0.3
Holothuroidea	Stichopodidae	*Australostichopus mollis*	0.5	2.3	0.5	1.5	5	2.3	3.5	6
Malacostraca		Paguroidea spp.	0	0	0	0	0.5	0	0.5	0
Malacostraca	Diogenidae	*Calcinus* spp.	0	0	0	0	0.5	0	0	0

APPENDIX 4. CRYPTIC FISH SPECIES LIST

Average number of each cryptic fish species recorded along 100 m^2 transects with method 2, in 2017 and 2019.

		IUCN IV (yellow)				IUCN VI (blue)			
		Coral Gardens 2		Devil's Lair		Hippo Creek		Squiggly Reef	
FAMILY	**Species**	**2017**	**2019**	**2017**	**2019**	**2017**	**2019**	**2017**	**2019**
Apogonidae	*Apogon victoriae*	4.5	1.3	0	0	3.5	0	2	0
Apogonidae	*Siphamia cephalotes*	0	0	0	25	0	0	0	0
Blenniidae	Blenniid spp.	1.5	0	0	0	0	0	0	0
Callionymidae	*Eocallionymus papilio*	0	0	0	0	0	0	0	0.3
Gobiesocidae	*Cochleoceps bicolor*	0	0	0	0	0.5	0.7	0	0
Gobiidae	*Eviota bimaculata*	0	0	0	0	0	0	0	1
Gobiidae	*Nesogobius* spp.	1	0.3	1	3.5	0	0	0	0
Pempheridae	*Pempheris klunzingeri*	0	0	10	15	0	20.7	0.5	0
Pempheridae	*Pempheris multiradiata*	17.5	0	0	0	0	0	0	0
Pempheridae	*Pempheris ornata*	0	16.7	0	18	0	23.3	0	0
Pinguipedidae	*Parapercis haackei*	0	0	0	0	0	0	0.5	0.3
Plesiopidae	*Paraplesiops meleagris*	4.5	1.3	1.5	2	3	4	3.5	1
Plesiopidae	*Paraplesiops sinclairi*	1	0	1	0	0	0.7	0	0
Scorpaenidae	*Scorpaena sumptuosa*	1	1.3	2.5	1	1	0.7	1	0.7
Serranidae	*Epinephelides armatus*	0	0	0	0.5	0	0	0	0
Serranidae	*Hypoplectrodes nigroruber*	0	1.7	0	1.5	1	0.7	0	0.7
Serranidae	*Hypoplectrodes wilsoni*	0	0	0	0	0	0.3	0	0
Serranidae	*Othos dentex*	0	0	0.5	0.5	0	0	0	0
Tripterygiidae	*Helcogramma decurrens*	0	2	0	0.5	1	1.3	0	0
Tripterygiidae	Tripterygiid spp.	0	0	0	1	0	0	0	0
Urolophidae	*Trygonoptera ovalis*	0	0	0	0.5	0	0	0	0

APPENDIX 5. CRYPTIC FISH SPECIES LIST

Average % cover of each benthic category recorded along 100 m^2 transects with method 3, in 2017 and 2019.

	IUCN IV (yellow)				IUCN VI (blue)			
	Coral Gardens 2		Devil's Lair		Hippo Creek		Squiggly Reef	
	2017	2019	2017	2019	2017	2019	2017	2019
Algal fuzz slime not trapping sediment	0	0	0	0	0.8	0.9	0.9	1.2
Ascidians unstalked	0.9	1	5.7	1.9	0.8	1.8	0.9	1.2
Bare Rock	0	0	0	1.9	0	0	0	0.8
Bryozoan hard	0	0	0	1	0.8	0.9	0.9	0
Bryozoan soft	0.9	0	0	0	0	0	0	0
Caulerpa	0	0	0	0	0	0	1.8	0
Colonial Anemones, Zoanthids and Coralliomorphs	0	0	0	0.9	0	0	0	0
Coral rubble	0	0	0	0	0	0	0	2.9
Crustose coralline algae	8	1.9	10.5	7.2	6.5	7.2	6.4	5
Encrusting corals live	0	0	0	1.4	1.7	0	7.3	4.6
Encrusting leathery algae	3.9	2.9	1.4	2.4	3.3	4.3	0.9	1.7
Filamentous epiphytic algae	15.6	24.8	12.9	22	5.7	25	5.9	16.1
Filamentous rock attached algae	1.8	4.5	1	1.4	0.8	2.3	0	0.8
Foliose corals live	0	0	1	0	0	1.8	0	2.5
Geniculate coralline algae	11.5	9	1.4	1	3.3	1.8	6.4	2.9
Green calcified algae *Halimeda*	0.9	1.9	1.9	1	1.6	0.9	0	0
Large polyp stony corals free living live	0	0	0	0	0	0	0	0.8
Massive corals live	1.8	1	0	2.8	0	0.9	3.2	0
Medium foliose brown algae	12.7	22.2	13.4	12.5	9.4	14.8	15.1	9.5
Medium foliose green algae	1.9	0	0	0	1.2	0.9	1.4	2
Medium foliose red algae	3.7	3.9	4.3	3.8	4.7	3.7	2.7	4
Other fucoids	7.5	7.1	12	12.9	6.1	12.8	7.8	5.4

	IUCN IV (yellow)				IUCN VI (blue)			
	Coral Gardens 2		Devil's Lair		Hippo Creek		Squiggly Reef	
	2017	2019	2017	2019	2017	2019	2017	2019
Pebbles gravel	0.9	1	0	1	0	0	0	0
Sand	9.7	6.1	6.7	7.1	9.5	3.6	5	9.3
Seagrass *Halophila*	0	0	0	0	0	0	0	0.8
Seagrass straplike	0	0	0	0	11.8	0.9	0.9	14.3
Small 2cm algal cover not trapping sediment	1	0	0	0	0	0	0	0
Soft corals and gorgonians	0.9	0	0	0	0	0	0.9	0
Sponges encrusting	0	0	0	1	2.4	0.9	2.3	2.5
Sponges erect	1	0	0	1.9	2	0.9	1.8	0.8
Sponges hollow	0	1.4	0	0	0	0	0.9	0.8
Sponges massive	0.9	0	1	0	0.8	0.9	0	0
Turfing algae	14.5	11.3	26.8	14.9	26.7	12.7	26.5	10.2

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