A Baseline Survey for Ecosystem monitoring within the Jurien Bay Marine Protected Area

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Introduction

A core component of marine conservation planing within Australia during the past decade has been the development of a national system of representative marine protected areas (NRSMPA's) (ANZEEC 1999). Concurrent with the implementation of this system comes the need for effective monitoring programs to assess the ability of MPAs to perform this desired role. While the current focus of MPA planning and implementation is the conservation of biodiversity, MPA's can provide a wide range of important roles. These include acting as baseline reference areas for assessing the success of current conservation and fisheries management strategies in coastal ecosystems, and their use in fisheries management through protection of spawner biomass and conservation of critical habitats. By studying the changes that occur following protection we may be able to determine to what extent MPAs meet this wide range of possible roles and which MPA designs and management strategies are most effective in achieving the desired outcomes. To properly determine whether changes observed within MPAs are the result of protection (rather than natural variation in space and time) it is important to conduct effective baseline surveys within and adjacent to proposed MPAs before their declaration, and to re-survey these locations after biologically meaningful time intervals. With this methodology the effectiveness of various levels of protection can be distinguished from more general long-term trends in coastal waters, when changes in protected areas are found to be significantly larger or smaller than changes outside them.

With a grant from FRDC and the assistance of State conservation agencies, the Tasmanian Aquaculture and Fisheries Institute has conducted baseline surveys in a range of proposed temperate MPAs from Western Australia, Victoria, Tasmania and New South Wales. Observations of changes occurring in each of these areas following protection will build on the information currently available from long-term monitoring of Tasmania's existing MPAs, and by using a similar quantitative methodology, allow for the direct comparison of results between differing locations, designs and management strategies. Ultimately this information will be of value for future planning to ensure MPAs fulfil their desired roles effectively.

In Western Australia, baseline surveys have recently been completed at Jurien Bay, the location of a proposed MPA approximately 400 km north of Perth. This is currently the most developed proposal within the temperate waters of Western Australia, with an advanced draft zoning scheme that has been subject to several rounds of review. The proposed area is centred around the towns of Jurien and Cervantes and extends for approximately 80 km of coastline to a distance of 5 km offshore (Fig. 1). The proposed MPA is characterised by an extensive offshore development of limestone pavement, structured reef and islands that provide a protective barrier from the prevailing swells and seas. As a general rule swells are substantially reduced at a distance of 5-7 km offshore where a sharp depth transition occurs. The inner three kilometres of coastal waters essentially form a protected lagoon where water depths are generally shallower than five metres and isolated structured reefs outcrop from a flat limestone pavement that is predominantly covered in sand and seagrass. The current proposal for Jurien Bay is to have a zoned MPA with zones ranging from general use to sanctuary. The protected component of the MPA includes 7 sanctuary zones (5% of the area) and 3 scientific reference areas

where commercial lobster fishing and shore-based line fishing are allowed (21% of the area).
The surveys completed to date have involved detailed underwater visual census of fish, large mobile invertebrates and macroalgae at between 8 to 9 sites within each of the major zone types (general use, sanctuary and scientific reference area). The degree of replication within each of these zones should be sufficient to adequately characterise each of these zones at the point in time surveyed. It should also allow the detection of biologically significant changes in the abundance and size distribution of a wide range of species through time and between treatments (zones). The survey methodology is broadly based, collecting as much information on as many species as possible in the time available. The intention of this methodology is to not only detect changes in heavily exploited species, but to also be able to detect any cascading ecosystem effects of fishing and to document long term variability in the reef assemblages within this region. The methodology focuses on reef systems as these are currently the most heavily exploited habitats and are most likely to show the greatest change following protection. Within the Jurien Bay survey the sites examined were confined to moderately sheltered structured reefs of approximately 3 m depth. Almost all structured reefs within the sanctuary zones fall within this category and similar reef types were therefore surveyed in the general use and scientific reference zones to maintain an even balance of habitats and assemblages between zones.

Methods

A total of 25 sites were surveyed within the proposed MPA at Jurien Bay in October 1999 and October 2000, with sites chosen on the basis of the latest draft of the proposed zoning map. Sites were carefully selected to give a balance between the different zones, and to ensure each was sufficiently large to have enough reef to place a 200 m length transect. Eight sites were surveyed in each of the General Use and Sanctuary zones and nine sites were surveyed in the Scientific Reference zone (Fig. 1, Table 1). This was the maximum number of sites able to be surveyed in the time available given the windy conditions experienced at the time of sampling and the availability of suitable reef.

Census methodology
Visual census techniques were used in the study because sampling needed to be non-destructive within proposed "no-take" areas and a large amount of data needed to be collected on a range of species within the short (ten day) survey period. A broad range of species were surveyed because, although target species are suspected to show the most significant recovery initially, there may be significant secondary effects of fishing that will go undetected unless greater species numbers are censused.

At each reef site the abundance and size structure of large fishes, the abundance of cryptic fishes and benthic invertebrates, and the percent cover of macroalgae, corals and other cover forming invertebrates, were each censused separately along four 50 m transects. The transect lines were laid end to end along a fixed depth contour (generally the 5 m depth contour, although when this was not possible the 3 m contour was used). Some reefs were relatively flat with no obvious contour to follow. For these reefs sketch maps were created to allow similar positions to be relocated on subsequent surveys.

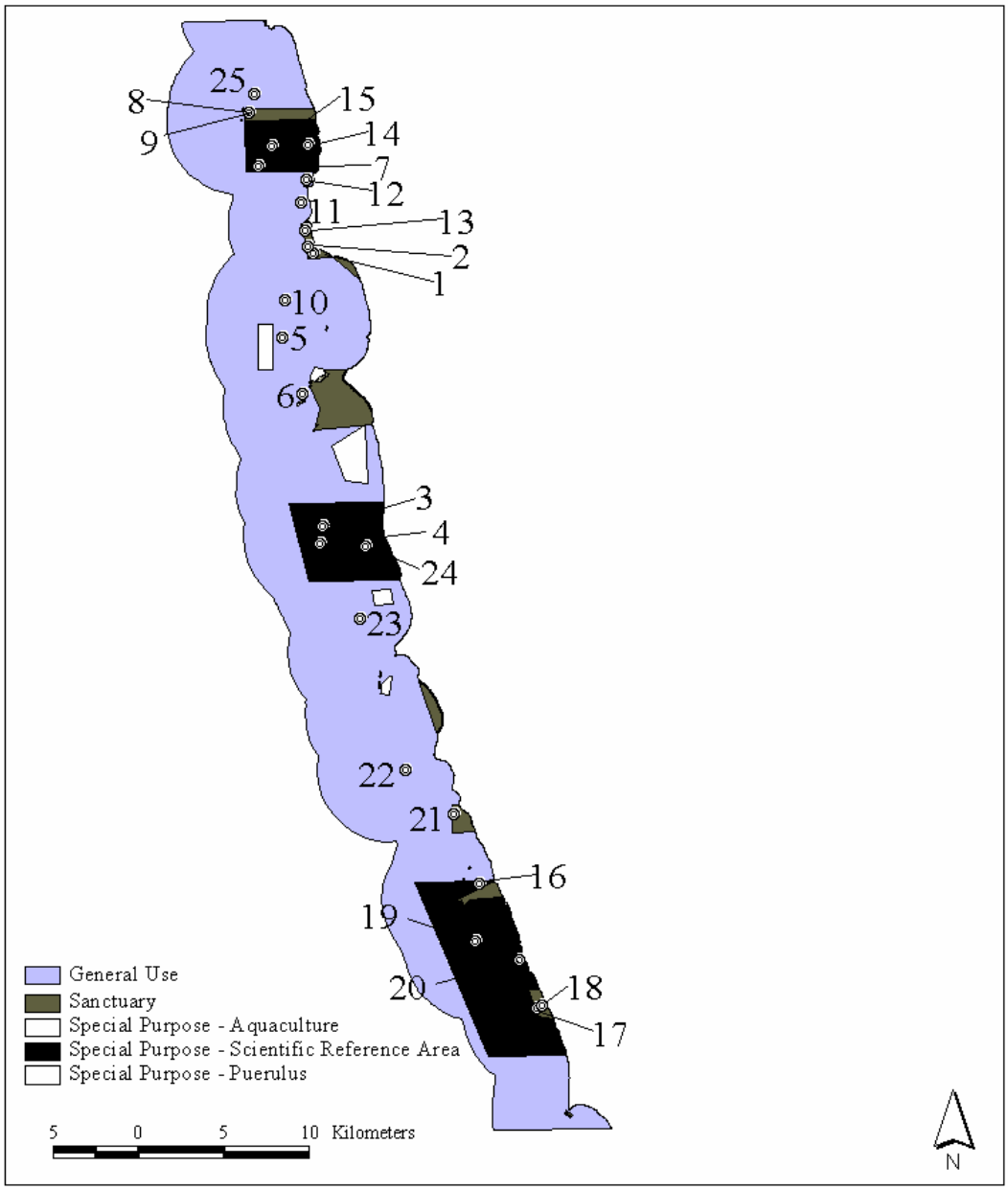

Fig.1. Map showing the location of sites surveyed in October 1999 and October 2000 within the proposed Jurien Bay MPA.

For fish transects, the density and estimated size-class of fish within 5 m of each side of the line was recorded on waterproof paper, with the diver swimming up one side of the line and then back along the other in the middle of a 5 m wide lane. Size-classes of total fish length used in the study were 25, 50, 75, 100, 125, 150, 200, 250, 300, 350, 375, 400, 500, 625, 750, 875 and 1000+ mm.

Table 1. Site details for locations surveyed in Jurien Bay in 1999 and 2000. Positions given are those recorded by GPS in 2000 with selective availability off. Positions are ten minute averages.

Site number	Survey 1 date	Survey 2 date	Site name	Proposed zone	Position (GPS) Long./Lat.
1	26/10/1999	23/10/2000	North Head 1	Sanctuary	30º13.912' 114º59.924'
2	26/10/1999	23/10/2000	Sandland Island	Scientific Reference	30º12.914' 114º59.524'
3	27/10/1999	24/10/2000	Outer Rocks - Inner Coffins	Scientific Reference	30º25.285' 115º00.116'
4	27/10/1999	24/10/2000	Outer Rocks (North) 2	Scientific Reference	30º26.026' 114º59.984'
5	27/10/1999	30/10/2000	Escape Island	General Use	30º19.'745' 114º59.263'
6	28/10/1999	30/10/2000	Inside Seaward Ledge	General Use	30º17.404' 114º58.349'
7	29/10/1999	28/10/2000	Juddy Reef	Scientific Reference	30º10.275' 114º57.330'
8	29/10/1999	25/10/2000	Fishermans Is. 1	Sanctuary	30º08.042' 114º56.935'
9	29/10/1999	25/10/2000	Fishermans Is. 2	Sanctuary	30º08.042' 114º56.935'
10	30/10/1999	28/10/2000	North Tail	General Use	30º15.870' 114º58.500'
11	30/10/1999	28/10/2000	Australia Lump	General Use	30º11.788' 114º59.316'
12	30/10/1999	26/10/2000	Sandy Cape	General	30º10.882' 114º59.577'
13	31/10/1999	23/10/2000	North Head Island	Sanctuary	30º13.610' 114º59.611'
14	31/10/1999	26/10/2000	North Lumps	Scientific Reference	30º09.412' 114º59.'730'
15	31/10/1999	26/10/2000	Middle Lumps	Scientific Reference	30º09.407' 114º58.011'
16	01/11/1999	27/10/2000	Longman Reef (off Gray)	Scientific Reference	30º40.131' 115º07.316'
17	01/11/1999	27/10/2000	Flat Rock	Sanctuary	30º45.343' 115º09.898'
18	01/11/1999	27/10/2000	Flat Rock Reef	Sanctuary	30º45.249' 115º10.174'
19	02/11/1999	29/10/2000	Gazely Reef	Scientific Reference	30º42.557' 115º07.084'
20	02/11/1999	29/10/2000	Kearn Reef	Scientific Reference	30º43.322' 115º09.042'
21	02/11/1999	31/10/2000	Cavenagh Reef	General Use	30º37.246' 115º06.143'
22	02/11/1999	29/10/2000	Inner Seven Ft Rocks	General Use	30º35.397' 115º03.889'
23	03/11/1999	31/10/2000	Sams Reef	General Use	30º29.108' 115º01.'799'
24	03/11/1999	24/10/2000	No Name Reef	Scientific Reference	30º26.111' 115º02.130'
25	04/11/1999	25/10/2000	Fisherman Island	General Use	30º07.224' 114º57.219'

Notes:
Datum system - Aus84
All longitudes and latitudes in degrees and decimal minutes

Cryptic fishes and megafaunal invertebrates (large molluscs, echinoderms, crustaceans) were next counted along the transect lines used for the fish survey by recording animals within 1 m of one side of the line (a total of four 1 m x 50 m transects). The distance of 1 m was assessed using a stick carried by the diver. The maximum length of abalone and the carapace length of rock lobsters were measured underwater using vernier callipers whenever possible.

The area covered by different macroalgal, coral, sponge and other attached invertebrate species was then quantified by placing a 0.25 m^2 quadrat at 10 m intervals along the transect line and determining the percent cover of the various plant species. Cover was assessed by counting the number of times each species occurred directly under the 50 positions on the quadrat at which perpendicularly placed wires crossed each other (a total of 1.25 m^2 for each of the 50 m sections of transect line).

The position of each site was recorded in 1999 and 2000 using a hand held GPS (Scoutmaster), using the Aus 84 Datum System to record position in degrees and decimal minutes. The position was post processed in 1999 to overcome difficulties associated with selective availability of the GPS system. This was not needed in 2000. Site positions and site details are shown in Table 1.
All data was entered onto an Excel spreadsheet and checked for errors.

Results.

Site similarities
To examine the degree of biotic similarity between the assemblages present at the sites sampled the fish and invertebrate assemblages were compared using abundance data from 1999 and 2000. If changes are to be compared between protected and unprotected sites it is essential to ensure these changes are occurring within similar communities. This form of analysis allows the community relationships to be visualised and outlying sites to be removed from the analysis if necessary. In a similar manner, examination of the variation between years indicates the degree of stability of the community present and the reliability of the relationships shown for any one year. Similarity was estimated using the Bray-Curtis similarity index on square root transformed abundance data. The resulting relationships are presented graphically using Multi Dimensional Scaling (MDS) and shown in Figs 2 & 3. For the invertebrate assemblages (Fig. 2) the degree of dispersal between sites was similar between treatments (sanctuary, reference and general use) and while sites are not identical in their community types, the variance is mostly due to site differences rather than differences between treatments. Sites 8 & 9, two sanctuary sites at the Fisherman's Islands, and site 10 at North Tail in the general use zone were slight outliers, however examination of their assemblage composition (Tables 4 and 5) indicates that these differences are not substantial. The overall relationship between sites remained relatively stable over the two year period indicating that the relationship shown is a good estimate of the similarity between sites.

Fishes
The fish assemblage data showed a similar relationship between sites with a strong overlap of sites between the three treatments (Fig. 3). Sites 8 & 9 at the Fisherman's

Islands were again slight outliers, predominantly due to a strong influence of tropical species such as *Thalassoma lutescens* and *T. Lunare*, as well as an abundance of silver drummer (*Kyphosus cornelii*) (Tables 2 & 3).

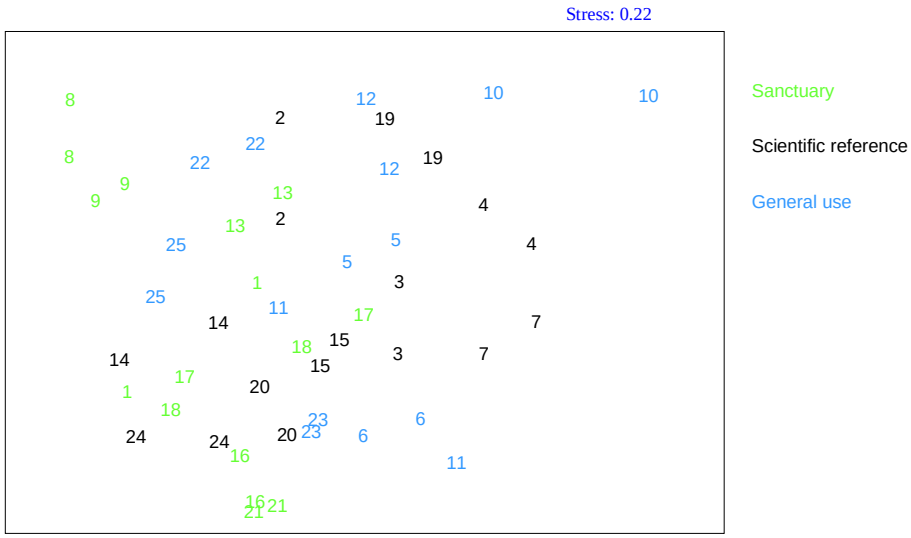

Fig. 2. Two-dimensional MDS plot of the relationship between sites (surveyed in 1999 and 2000) within the proposed Jurien Bay MPA using invertebrate and cryptic fish assemblage data. The relationship is based on pairwise comparison of square root transformed abundance data using the Bray-Curtis similarity index.

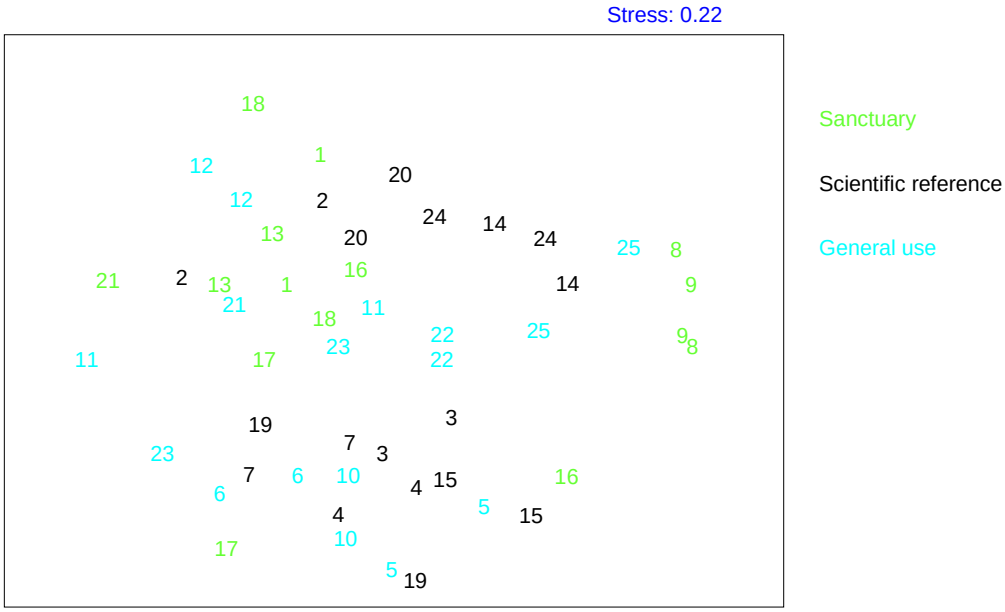

Fig. 3. Two-dimensional MDS plot of the relationship between sites (surveyed in 1999 and 2000) within the proposed Jurien Bay MPA using fish assemblage data. The relationship is based on pairwise comparison of square root transformed abundance data using the Bray-Curtis similarity index.

The relationship between sites remained relatively stable between the two years surveyed with few sites showing a substantial shift in the assemblage present. The total abundances of fish and invertebrates recorded from each site and from each year are shown in Tables 2 & 3. The fish data is shown in order of relative abundance with *Coris auricularis*, *Parma mccullochi* and *Notolabrus parilus* being the three most common species and present at all sites. *Halichoeres brownfeldi* was also very common and present at all sites in the 2000 survey. Tropical species formed a notable component of the fish assemblage at most locations with *Thalassoma lutescens* and *T. lunare* being common and particularly abundant at the Fisherman's Islands. The Fisherman's Islands sites (8, 9 & 25) appeared to have higher levels of recruitment of tropical species than the remaining sites and were characterised by the presence of juveniles of a range of species including *Anampses geographicus* and *Pomacentrus milleri.* The kyphosid species *Kyphosus cornelii* and *K. sydneyanus* were amongst the most abundant of the larger fishes with numbers of up to 200 being recorded per site and were present as large schools at most sites.

The inter-annual and inter-site abundances of some of the more common fishes are presented in Fig. 4 to give an indication of variation between sites and between years. Wrasse species tend to be relatively long-lived site-attached reef residents with relatively stable population structures (Barrett, 1995, 1997) and this appears to be the case for the wrasses at Jurien Bay. *Coris auricularis, Halichoeres brownfeldi, Notolabrus parilus Opthalmolepis lineolatus, Thalassoma lunare* and *T. lutescens* all displayed a similar pattern of site distribution and relative abundances between years, with abundances rarely varying by more than 50% between years. A similar pattern was observed with the damselfish *Parma mcullochi.* Damselfishes are another strongly site-attached group (Thresher 1984) and resilience in population structure would also be expected in these species. There was slightly more variation in the large schooling Kyphosid species (*Kyphosus sydneyanus* and *K. cornelii*) (Fig. 4), however for the majority of sites where these species were present, abundance estimates varied less than 50%. For such species a moderate degree of variation between years is expected given that they are schooling species and chance encounters of schools generally gives greater variation in estimates than chance encounters between individuals. These species are also highly mobile and have the potential to move between reefs. Of the common species, the bullseye *Pempheris klunzingeri* displayed the most variation between sites and years. While bullseyes are another group of resident reef fishes the variation in *P. klunzingeri* numbers appears to be related to strong fluctuations in the abundance of newly recruited juveniles. A strong (but patchy between sites) recruitment pulse was recorded in the 2000 survey with the vast majority of individuals being less than 2.5 cm and certainly less than one year old. The size distribution of other commonly encountered species appeared to be reasonably stable over the two year period surveyed (Fig. 5), with no large peaks due to recent recruitment pulses.

When the distribution of the more common fish species was examined with respect to the three main zoning types within the proposed MPA, there appeared to be a broad similarity between zones (Fig. 6). As this pattern applied across the five common species examined it appears that the habitats contained within the sanctuary zone are representative of the inshore habitats occurring more widely throughout the MPA.

Table 2. Fish abundance totals per site recorded during surveys at Jurien Bay in October 1999.

Species	Common name / Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total
Coris auricularis	Western king Wrasse	182	114	63	146	95	60	67	236	271	112	19	24	42	130	65	207	65	78	74	73	76	116	185	115	178	2793
Parma mccullochi	McCulloch's Scalyfin	9	81	92	46	27	14	25	132	219	18	70	50	47	184	110	223	29	38	64	110	21	199	79	244	148	2279
Notolabrus parilus	Brown-spotted Wrasse	62	100	33	38	22	23	24	42	41	26	61	100	82	109	45	85	64	98	22	104	77	83	83	114	61	1599
Kyphosus cornelii	Western Buffalo Bream	2	0	29	14	26	29	0	375	329	42	129	0	0	133	0	4	4	16	19	9	0	36	0	78	144	1418
Halichoeres brownfeldi	Brownfield's Wrasse	56	13	10	34	94	48	13	32	82	8	36	94	57	37	4	19	13	23	0	4	47	23	18	5	32	802
Pempheris klunzingeri	Rough Bullseye	0	8	15	196	47	0	0	31	21	0	1	183	13	0	19	53	0	0	71	0	0	4	0	0	3	665
Schuettea woodwardi	Woodward's Pomfret	0	0	0	0	75	0	0	0	0	0	0	0	0	52	114	80	0	0	66	0	0	0	0	0	0	387
Kyphosus sydneyanus	Silver Drummer	1	0	2	12	14	0	0	0	0	1	12	0	38	72	29	45	0	16	0	44	0	40	0	3	3	332
Odax cyanomelas	Herring Cale	7	0	3	39	17	13	14	0	0	12	2	14	37	0	7	3	12	3	15	0	1	4	4	0	7	214
Pictilabrus viridis	False Senator Wrasse	0	1	3	0	8	0	2	0	0	3	14	29	8	1	1	6	18	6	31	18	1	43	18	0	3	214
Ophthalmolepis lineolatus	Maori Wrasse	0	0	2	9	22	12	18	0	2	52	4	0	0	0	7	15	0	1	11	0	7	0	43	0	2	207
Thalassoma lutescens	Green moon Wrasse	0	0	1	5	3	0	2	43	34	10	0	2	0	16	23	0	0	0	5	1	0	7	0	2	45	199
Neatypus obliquus	Footballer Sweep	0	0	0	22	0	0	0	0	0	0	0	0	1	6	89	0	45	23	0	0	0	0	0	0	0	186
Pseudolabrus biserialis	Red-banded Wrasse	0	0	11	9	3	0	6	15	31	9	1	0	1	0	13	28	1	0	1	0	0	2	1	21	0	153
Thalassoma lunare	Moon Wrasse	0	0	24	0	1	0	0	49	47	0	0	0	0	1	4	0	0	0	3	0	0	8	0	2	14	153
Scorpis georgianus	Banded Sweep	0	16	9	8	2	0	0	0	0	1	10	4	9	0	8	14	9	13	12	26	1	5	0	2	3	152
Austrolabrus maculatus	Black-spotted Wrasse	3	2	13	1	0	7	1	14	18	9	0	0	0	0	8	25	1	3	1	0	6	2	5	12	11	142
Parma occidentalis	Western Scalyfin	13	1	0	4	4	0	2	4	3	0	4	12	15	6	2	0	5	15	1	10	13	5	3	3	3	128
Pictilabrus laticlavius	Senator Wrasse	0	0	8	17	6	3	6	15	4	16	7	6	0	0	3	2	1	0	9	0	8	4	4	3	2	124
Anampses geographicus	Scribbled Chisel-toothed Wrasse	0	0	1	0	4	8	0	28	61	0	0	0	1	0	0	11	0	0	0	0	0	0	0	0	7	121
Parupeneus signatus	Blackspot Goatfish	13	0	2	0	1	4	1	23	41	0	0	0	0	10	1	0	1	0	0	0	0	0	0	0	1	98
Enoplosus armatus	Old Wife	0	0	2	3	0	0	0	45	9	0	0	0	1	0	14	2	0	0	0	0	0	4	4	4	2	90
Epinephelides armatus	Breaksea Cod	4	1	4	3	0	0	1	5	3	1	2	1	0	0	1	8	3	2	3	7	2	2	2	7	7	69
Chelmonops curiosus	Western Talma	1	0	0	1	0	1	0	3	2	1	3	0	0	5	1	3	1	0	0	1	0	0	3	13	10	49
Pempheris multiradiatus	Common Bullseye	0	0	0	2	0	0	0	1	1	2	0	0	0	0	0	13	1	0	0	4	0	0	0	22	0	46
Dotalabrus alleni	Little rainbow Wrasse	3	0	0	8	5	0	1	0	0	8	2	0	0	2	0	0	1	3	2	0	4	2	4	0	0	45
Labracinus lineata	Lined Dottyback	3	8	1	0	0	0	0	0	1	0	2	2	1	1	1	7	1	2	0	4	1	5	2	3	0	45
Plectorhinchus flavomaculatus	Gold-spotted Sweetlips	2	1	0	0	1	0	0	3	9	0	4	0	2	2	3	0	0	2	1	0	1	0	1	3	7	42
Pomacentrus milleri	Miller's Damsel	0	0	0	0	0	0	0	0	0	0	0	2	0	5	1	0	0	0	0	0	0	0	0	0	20	28
Bodianus frenchi	Western Foxfish	2	1	0	1	0	0	0	0	1	0	0	0	0	0	0	4	1	1	0	1	0	0	0	11	0	23
Choerodon rubescens	Baldchin Groper	0	0	0	0	0	0	1	9	2	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	8	22
Cheilodactylus rubrolabiatus	Red-lipped Morwong	0	0	0	1	0	2	1	0	2	0	0	0	0	1	0	0	0	2	1	4	0	1	0	0	3	18
Paraplesiops meleagris	Western Blue Devil	0	1	1	0	0	0	0	0	0	1	2	0	0	0	0	0	1	0	1	1	0	1	2	0	0	11
Thalassoma septemfasciata	Seven-banded Wrasse	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	7	10
Unidentified fish		0	0	0	0	1	0	0	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	10
Meuschenia hippocrepis	Horseshoe Leatherjacket	0	0	3	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	8

Table 2. Fish abundance totals per site recorded during surveys at Jurien Bay in October 1999 (continued).

Species	Common name / Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total
Tilodon sexfasciatum	Moonlighter	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Arripis georgianus	Tommy Rough	0	0	4	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	7
Meuschenia galii	Blue-lined Leatherjacket	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3	0	0	7
Psammoperca waigensis	Sand Bass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	1	0	0	0	0	7
Stegastes obreptus	Western Gregory	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	1	7
Odax acroptilus	Rainbow Cale	2	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	6
Achoerodus gouldii	Western Blue Groper	0	0	0	1	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	5
Anoplocapros lenticularis	White-barred Boxfish	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0	5
Chaetodon assarius	Western Butterflyfish	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1	5
Meuschenia flavolineata	Yellow-striped Leatherjacket	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	5
Suezichthys cyanolaemus	Blue-throated rainbow Wrasse	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Apogon victoriae	Red-striped Cardinalfish	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	4
Cirripectes sp.	Black Blenny	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3
Glaucosoma hebraicum	West Australian Jewfish	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Melambaphes zebra	Zebra Fish	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3
Pomacentrus coelestis	Neon Damsel	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Trachurus novaezelandiae	Yellotail Scad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	3
Torquigener pleurogramma	Banded Toadfish	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2
Anoplocapros amygdaloides	Western smooth Boxfish	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	3
Apogon cyanosoma	Blue-striped Cardinalfish	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Chromis klunzingeri	Blackheaded Puller	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Ellerkeldia maccullochi	Half Banded Seaperch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Ellerkeldia wilsoni	Spotty Seaperch	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Girella tephraeops	Western rock Blackfish	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Microcanthus strigatus	Stripey	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Othos dentex	Harlequin Fish	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Penicipelta vittiger	Toothbrush Leatherjacket	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Pentapodus vitta	Western Australia Butterfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Plagiotremus rhinorhynchos	Blue-lined Sabretooth Blenny	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Scarus ghobban	Blue-barred orange Parrotfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Siphonognathus caninus	Sharp-nosed Weed Whiting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Urolophus sp.	Striped Stingaree	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Total Species		20	14	26	25	28	15	17	26	30	21	21	15	18	26	29	29	23	20	22	20	18	25	21	25	31	

Table 3. Fish abundance totals per site recorded during surveys at Jurien Bay in October 2000.

Species	Common name / Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total
Coris auricularis	Western king Wrasse	128	55	51	78	133	60	92	168	175	154	5	36	36	137	93	129	29	63	66	69	46	108	145	58	230	2344
Parma mccullochi	McCulloch's scalyfin	30	22	68	36	23	40	46	105	113	29	16	99	38	54	49	85	33	5	19	71	14	141	34	80	69	1319
Notolabrus parilus	Brown-spotted Wrasse	63	40	29	20	22	14	37	57	52	20	37	88	64	62	28	57	24	106	35	83	36	63	32	60	50	1179
Kyphosus cornelii	Western Buffalo Bream	3	7	4	33	38	12	19	157	139	12	48	0	0	200	1	0	73	0	17	15	0	21	0	106	159	1064
Halichoeres brownfeldi	Brownfield's Wrasse	84	34	6	13	15	45	13	2	1	14	71	56	38	61	12	60	6	21	23	18	79	41	11	8	3	735
Thalassoma lutescens	Green moon Wrasse	0	0	24	9	4	14	6	50	50	9	0	1	0	3	17	0	0	0	1	1	0	21	0	4	22	236
Ophthalmolepis lineolatus	Maori Wrasse	0	0	1	31	0	14	48	0	0	32	3	0	1	2	4	22	4	0	13	0	10	8	41	0	0	234
Parma occidentalis	Western scalyfin	4	1	0	3	0	1	0	32	49	0	1	3	2	14	6	4	0	34	3	17	4	18	0	21	9	226
Kyphosus sydneyanus	Silver Drummer	5	0	21	9	34	0	3	0	0	13	1	0	16	33	10	0	1	0	0	12	0	36	0	0	0	194
Thalassoma lunare	Moon Wrasse	0	0	11	0	0	1	1	70	50	0	0	0	0	2	9	0	0	0	0	0	0	14	0	0	24	182
Pictilabrus viridis	False Senator Wrasse	4	0	10	4	1	1	3	0	0	3	8	17	2	0	3	6	13	0	14	25	0	25	14	1	9	163
Schuettea woodwardi	Woodward's Pomfret	0	0	0	0	116	0	0	0	0	0	0	0	0	0	44	0	0	0	0	0	0	1	1	0	0	162
Scorpis georgianus	Banded sweep	4	6	2	32	2	1	1	0	0	5	5	2	14	0	9	11	14	13	6	16	0	7	0	1	0	151
Parupeneus signatus	Blackspot Goatfish	1	0	0	0	5	4	6	33	33	4	0	0	3	13	0	1	0	0	2	12	0	4	0	0	11	132
Odax cyanomelas	Herring Cale	1	0	8	18	1	5	10	0	0	7	0	1	3	0	5	0	20	0	24	0	0	14	0	0	0	117
Anampses geographicus	Scribbled Chisel-toothed Wrasse	0	0	0	0	6	0	0	12	53	1	0	0	0	0	0	2	0	0	8	0	0	8	0	0	17	107
Austrolabrus maculatus	Black-spotted wrasse	3	1	1	0	3	5	2	6	16	5	0	0	14	0	9	9	1	10	0	0	4	0	3	4	3	100
Neatypus obliquus	Footballer sweep	0	0	0	9	0	0	1	0	5	10	0	0	0	0	23	0	25	0	0	0	0	0	0	0	0	73
Pomacentrus milleri	Miller's Damsel	0	0	0	0	0	2	0	14	18	0	0	0	0	14	5	0	0	0	0	0	0	0	0	0	14	67
Pseudolabrus biserialis	Red-banded Wrasse	0	0	7	7	5	1	1	10	9	2	0	0	0	0	4	8	0	0	0	0	0	1	0	4	0	59
Pempheris klunzingeri	Rough Bullseye	1	0	0	0	0	0	0	0	15	0	0	9	0	0	0	13	0	0	0	0	0	7	0	0	0	45
Stegastes obreptus	Western Gregory	0	0	0	0	1	1	0	1	2	0	0	1	0	4	1	0	0	0	0	0	0	0	0	0	30	41
Plectorhinchus flavomaculatus	Blue-lined Sabretooth Blenny	7	4	0	0	0	0	0	3	2	0	0	0	0	1	0	5	1	4	1	0	0	0	1	0	7	36
Epinephelides armatus	Breaksea Cod	0	0	0	0	2	0	5	0	5	3	0	0	0	1	0	3	0	2	0	2	2	4	0	2	0	31
Pictilabrus laticlavius	Senator Wrasse	1	0	3	4	1	0	2	0	0	6	0	1	0	0	2	0	1	0	2	0	0	0	1	0	0	24
Chelmonops curiosus	Western talma	3	3	0	0	0	0	0	1	1	0	0	0	0	0	3	1	1	1	0	1	1	0	2	0	2	20
Enoplosus armatus	Old Wife	0	0	0	6	1	0	0	2	2	0	0	0	0	0	3	1	0	0	0	0	1	1	0	0	1	18
Siphonognathus caninus	Sharp-nosed Weed Whiting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	18
Rhabdosargus sarba	Tarwhine	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17
Choerodon rubescens	Baldchin Groper	0	0	0	0	1	0	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	2	13
Cheilodactylus rubrolabiatus	Red-lipped Morwong	0	0	0	0	1	1	1	1	1	0	0	0	0	1	0	0	1	2	1	0	0	1	0	0	1	12
Apogon victoriae	Red-striped Cardinalfish	6	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	10
Dotalabrus alleni	Little rainbow Wrasse	0	0	0	6	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	10
Scorpis aequipinnis	Sea sweep	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	5	1	10
Thalassoma septemfasciata	Seven-banded Wrasse	0	0	0	0	0	2	1	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3	9
Labracinus lineata	Lined Dottyback	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	1	0	1	1	0	0	7
Torquigener pleurogramma	Banded Toadfish	0	0	0	0	0	0	0	0	0	0	3	0	1	0	2	0	0	0	0	0	0	0	0	0	0	6
Anoplocapros amygdaloides	Western smooth Boxfish	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	0	0	0	5
Chaetodon assarius	Western Butterflyfish	0	3	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	5
Dactylophora nigricans	Dusky Morwong	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	5

Table 3. Fish abundance totals per site recorded during surveys at Jurien Bay in October 2000 (continued).

Species	Common name / Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total
Labroides dimidiatus	Cleaner fish	0	0	0	1	0	1	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Arripis georgianus	Tommy Rough	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	4
Caranx dentex	Silver Trevally	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	1	0	0	0	0	4
Pempheris multiradiatus	Common Bullseye	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	4
Sphyraena obtusata	Striped Seapike	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	4
Bodianus frenchi	Western Foxfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	3
Odax acroptilus	Rainbow Cale	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3
Seriola lalandi	Yellowtail Kingfish	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	3
Achoerodus gouldii	Western Blue Groper	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2
Chromis klunzingeri	Blackheaded puller	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Hypoplectrodes nigrorubrum	Black-banded Seaperch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	2
Pentapodus vitta	Western Australia Butterfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
Anampses caeruleopunctatus	Diamond wrasse	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Chromis westaustralis	West Australian puller	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Melambaphes zebra	Zebra Fish	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Octopus sp.	Octopus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Othos dentex	Harlequin Fish	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Parupeneus chrysopleuron	Yellow-striped Goatfish	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Psammoperca waigensis	Sand Bass	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Scarus ghobban	Blue-barred orange Parrotfish	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Sepia apama	Giant Cuttle	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Seriola hippos	Samsonfish	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Stethojulius bandanensis	Redspot Wrasse	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Suezichthys cyanolaemus	Blue-throated rainbow Wrasse	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Urolophus sp. (striped stingaree)	Striped Stingaree	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Total Species		19	13	15	21	22	22	22	24	27	21	13	14	17	21	25	20	17	13	19	16	14	25	16	18	27	

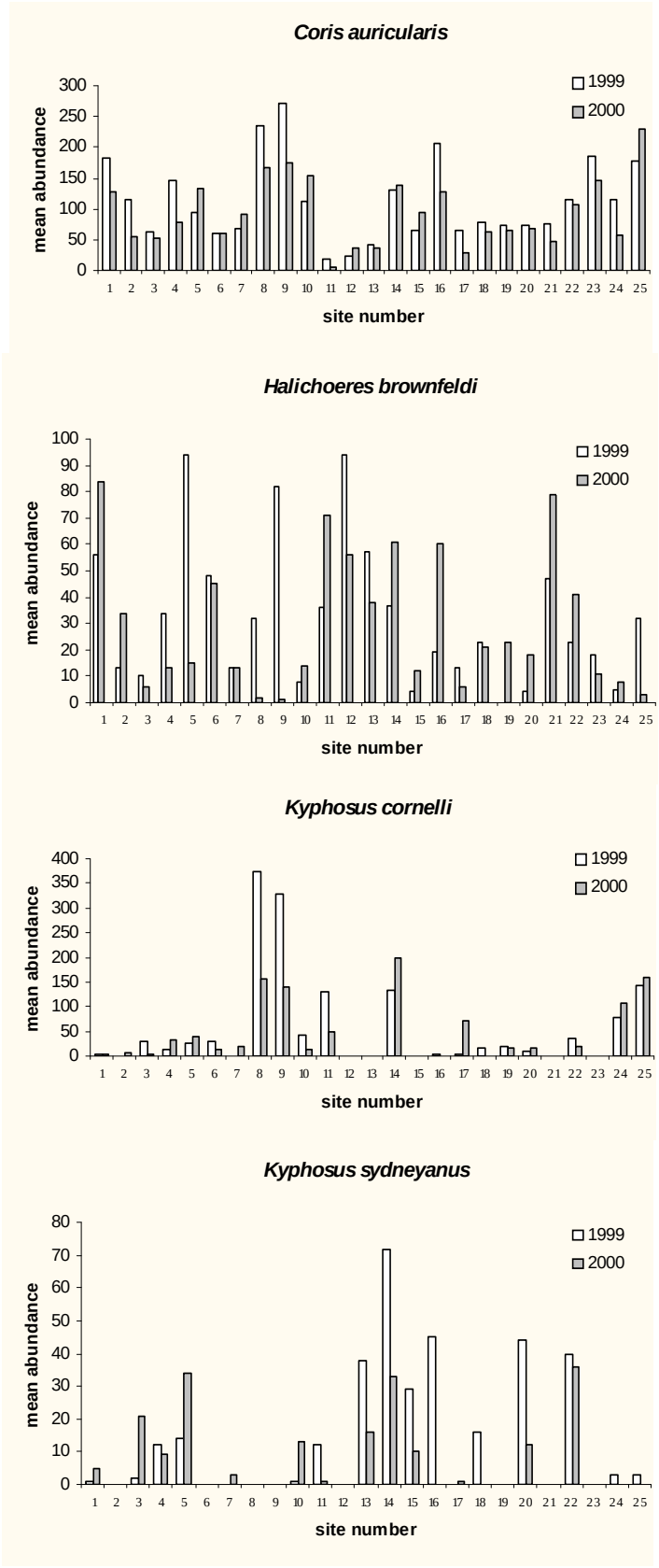

Figure 4. Abundance of common fish species encountered during surveys at Jurien Bay in October 1999 and 2000.

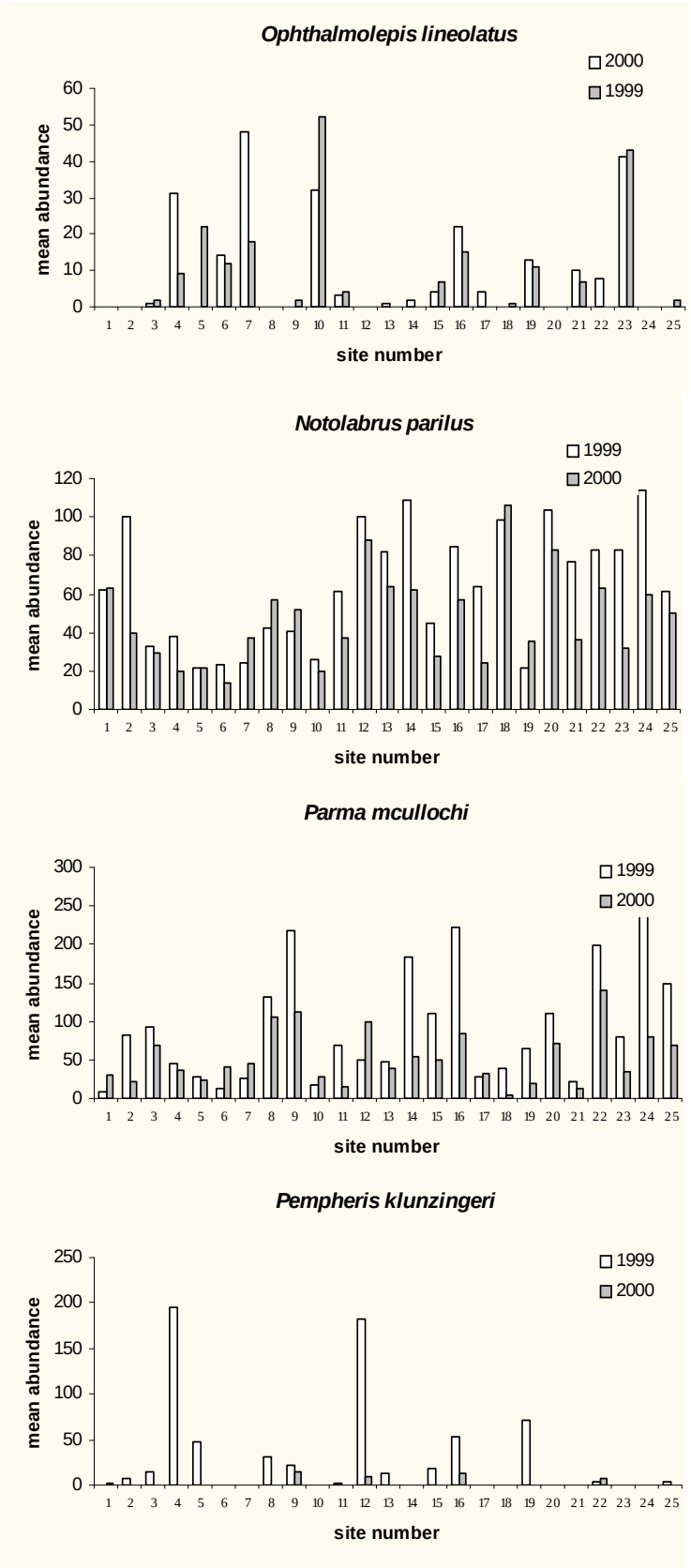

Figure 4 (Cont.). Abundance of common fish species encountered during surveys at Jurien Bay in October 1999 and 2000.

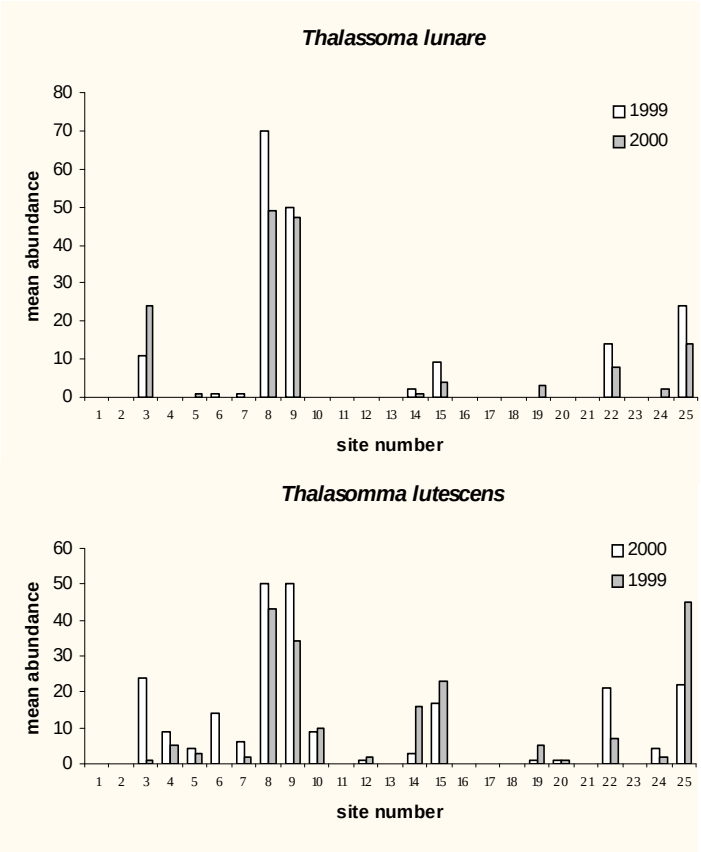

Figure 4 (Cont.). Abundance of common fish species encountered during surveys at Jurien Bay in October 1999 and 2000.

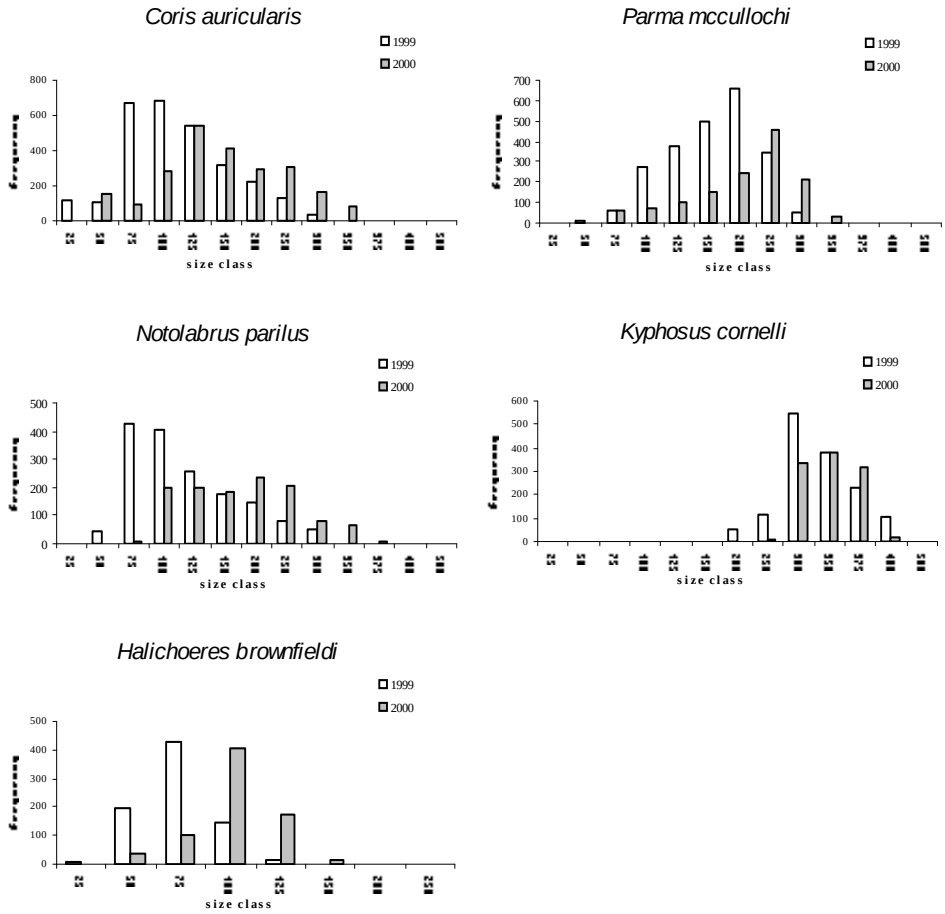

Figure 5. Observed size distribution of common fishes encountered during dive surveys at Jurien Bay in October 1999 and 2000. Sizes are in mm.

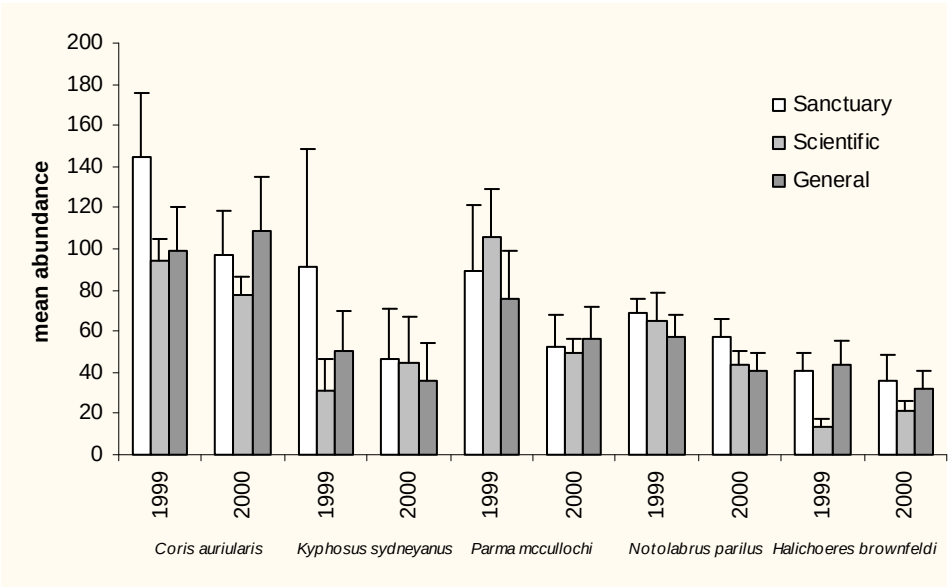

Figure 6. Distribution of common fish species between zones within the proposed Jurien Bay Marine Park. Based on site totals from 8-9 sites within each zone.

Invertebrates

Within the habitats surveyed the most common large mobile invertebrates included the molluscs *Campanila symbolicum, Turbo torquatus, T. pulchra* and *Thais orbita,* the echinoderms *Heliocidaris erythrogramma, Phyllacanthus irregularis*, and *Commanthus trichoptera,* hermit crabs (a number of unidentified species) and rock lobsters (*Panulirus cygnus*). While most of the common species were found over a wide range of sites (Tables 4 & 5), several sites displayed notable variation from this pattern including sites 9 & 10 (Fisherman's Islands) where *Campanile* was absent and hermit crabs were abundant.

A comparison of the inter-annual and inter site abundances of the most common invertebrates (Fig. 7) indicates that the patterns of abundance are relatively stable in space and time over this period. This observation is not surprising given that most of these species are relatively long-lived and are likely to be permanent residents of their home reef. An exception to this pattern was *Panulirus cygnus,* a highly mobile species and one with a population of mostly juvenile animals in the survey area. The abundance of this species was highly variable between years.

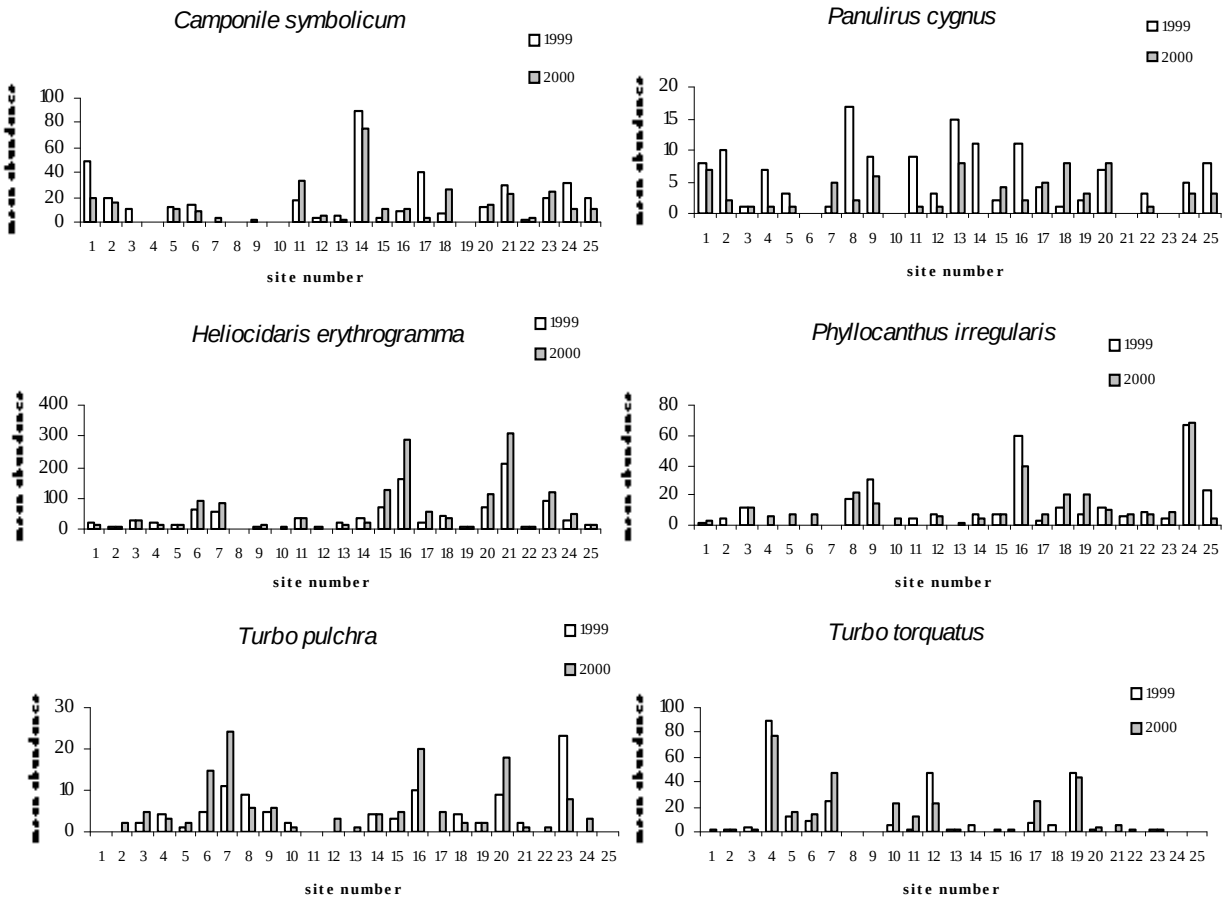

Figure 7. Abundance of common megafaunal invertebrate species encountered during surveys at Jurien Bay in October 1999 and 2000.

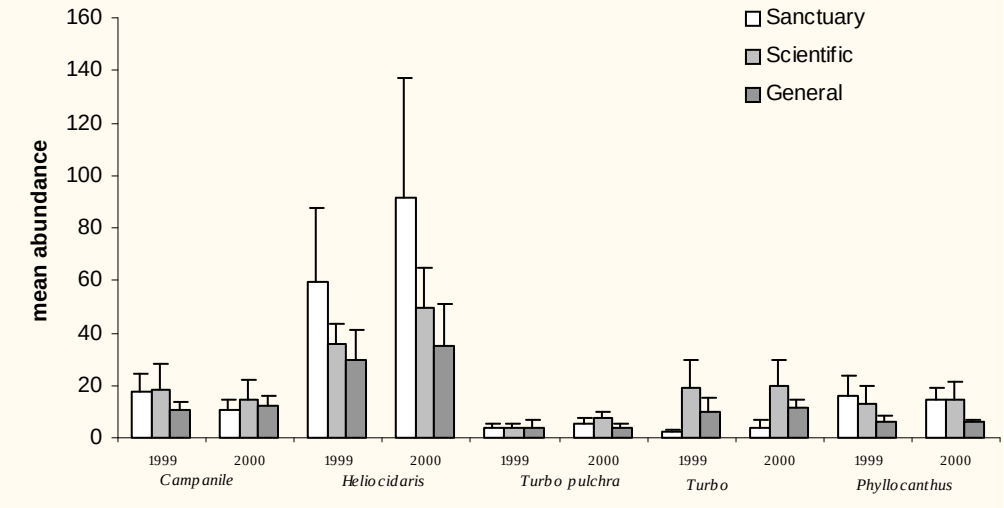

Figure 8. Abundance of common invertebrate species encountered during surveys at Jurien Bay in October 1999 and 2000 with respect to their distribution between proposed management zones.

For most of the common invertebrates abundances usually varied less than 50% percent between years, indicating that their populations are not only relatively stable over these time periods but that the survey techniques used adequately described the abundance of each of these species at each location. The distribution of all invertebrates and cryptic fishes encountered during the surveys is given in Tables 4 & 5.

Examination of the distribution of the more common invertebrate species with respect to the three main zoning types within the proposed MPA indicated a broad similarity between zones (Fig. 8), however one notable exception was *Heliocidaris erythrogramma,* the most common large invertebrate within the survey area, which was approximately twice as abundant within the sanctuary zone compared to the scientific reference and general use zones. This difference was stable between years and showed no obvious correlation with other biological factors investigated.

Algae

The algal percentage cover data derived during the two surveys (Tables 6 & 7) needs to be interpreted with consideration for the biases involved in species recognition by individual divers involved with the algal census. The brown and green algae consist primarily of a relatively small set of readily identified and widely distributed species that would have been recognised at the species level by both Dr Graham Edgar (the marine botanist for the1999 survey) and Dr John Huissman (the marine botanist for the 2000 survey). The red algae have substantially more species and a large proportion of species that are not widespread throughout temperate Australia. As John Huissman is a macrophycologist with specialist experience in the red algae of Western Australia his species list is not suprisingly more comprehensive than Graham Edgars. In the 1999 survey there was a substantial proportion of unidentified species and these were reduced to the genus level or to two broader categories of unidentified thallose or fillamentous red algae.

Table 4. Large mobile invertebrate and cryptic fish abundance totals per site recorded during surveys at Jurien Bay in October 1999.

Species	Common names/ Sites	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total
Cryptic fish																											
Anoplocapros lenticularis	White-barred boxfish	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Apogon cyanosoma	Blue-striped Cardinalfish	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Apogon victoriae	Red-striped Cardinalfish	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	0	0	0	1	0	0	0	1	6
Gymnothorax prasinus	Green moray	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Hypoplectrodes wilsoni	Spotty seaperch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	3
Parascyllium variolatum	Varied catshark	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	5
Perryena leucometopon	Whitenose pigfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Pterois volitans	Red firefish	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Threpterius maculosus	Silver spot	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Torquigener pleurogramma	Banded Toadfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Urolophus sp.	Striped stingaree	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	2
Molluscs																											
Aplysia dactylomela	Sea hare	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Campanile	Lighthouse shell	49	20	11	0	12	14	0	0	1	0	17	3	6	90	3	8	40	7	0	12	29	1	19	31	20	393
Charonia powelli	Trumpet shell	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Charonia rubicunda	Trumpet shell	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Haliotis emma	Emma's abalone	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	2	0	0	7
Melo miltonis	Southern bailer	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	4
Octopus sp.	Octopus	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2
Ranella australasia	Australian rock whelk	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	4
Scutus antipodes	Elephant snail	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	2	1	1	0	0	7
Thais orbita	Dog whelk	0	0	0	4	1	1	3	2	8	0	4	0	2	0	1	3	0	4	8	5	6	0	2	1	4	59
Turbo jordani	Turban shell	0	1	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	5
Turbo pulchra	Turban shell	0	0	2	4	1	5	11	9	5	2	0	0	0	4	3	10	0	4	2	9	2	0	23	0	0	96
Turbo torquatus	Turban shell	0	1	3	90	12	8	25	0	0	6	1	48	2	5	0	1	7	6	47	1	0	1	2	0	0	266
Echinoderms																											
Amblypneustes leucoglobus	Short-spined urchin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
Amblypneustes pachistus	Short-spined urchin	0	0	0	0	0	0	4	0	0	1	4	7	1	0	0	0	1	9	4	5	0	3	3	0	1	43
Anthaster valvulatus	Seastar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Centrostephanus tenuispinus	Long-spine urchin	0	0	3	0	1	0	0	0	0	0	0	0	0	0	4	1	0	0	2	0	0	1	0	0	1	13
Comanthus trichoptera	Feather star	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	30	14	0	23	24	0	2	77	0	192
Coscinasterias muricata	Eleven armed seastar	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	3
Echinaster varicolor	Seastar	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2
Fromia polypora	Spotted seastar	0	0	8	0	0	0	2	0	0	1	0	0	0	0	3	7	0	2	0	0	0	0	0	0	0	23
Heliocidaris erythrogramma	Common Urchin	20	9	27	23	13	65	53	0	4	2	36	4	24	32	69	158	19	41	7	70	210	8	93	29	17	1033
Holopneustes porossimus	Short-spined Urchin	0	4	0	0	2	0	11	0	0	1	2	1	0	0	3	0	0	2	1	0	0	0	0	0	0	27
Pentagonaster dubeni	Firebrick seastar	1	1	1	0	0	0	0	0	0	0	0	0	5	5	0	1	0	2	0	0	0	1	3	5	0	25
Petricia vernicina	Velvet star	1	1	6	0	1	0	1	0	0	1	0	0	0	0	4	0	0	2	1	0	0	3	2	5	0	28
Phyllacanthus irregularis	Western slate urchin	1	5	12	0	0	0	0	18	30	0	4	7	0	8	8	60	3	11	7	11	6	9	5	67	23	295

Table 4. Large mobile invertebrate and cryptic fish abundance totals per site recorded during surveys at Jurien Bay in October 1999 (continued).

Species	Common names/ Sites	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total
Pseudoboletia indiana	Short-spined urchin	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Stichopus mollis	Sea cucumber	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0	0	1	1	0	0	1	0	0	5	4	16
Tosia australis	Biscuit star	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Crustaceans																											
Hermit u/i	Hermit crab	2	1	0	0	2	1	0	2	19	0	4	7	1	12	8	19	8	24	2	8	1	4	4	13	10	152
Pagurid (grey)	Hermit crab	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Panulirus cygnus	Western rock lobster	8	10	1	7	3	0	1	17	9	0	9	3	15	11	2	11	4	1	2	7	0	3	0	5	8	137
Total Species		10	11	12	8	12	7	11	9	11	7	12	10	10	11	14	15	12	15	15	11	11	12	15	10	12	

Table 5. Large mobile invertebrate and cryptic fish abundance totals per site recorded during surveys at Jurien Bay in October 2000.

Species	Common names / Sites	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total
Cryptic fish																											
Aetapcus maculatus	Warty prowfish	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Apogon victoriae	Red-striped cardinalfish	1	0	0	0	0	0	0	6	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	10
Callogobius mucosus	Goby	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Orectolobus maculatus	Spotted wobbegong	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Paraplesiops meleagris	Western blue devil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Parascyllium variolatum	Varied catshark	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Urolophus paucimaculatus	Sparsely spotted stingaree	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Urolophus sp.	Striped stingaree	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Molluscs																											
Aplysia sp.	Sea hare	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4
Campanile	Lighthouse shell	19	15	0	0	11	8	4	0	0	0	34	5	2	75	11	11	3	26	0	14	22	3	25	11	10	309
Charonia powelli	Trumpet shell	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Haliotis emma	Abalone	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	2	3	1	0	0	0	0	4	1	0	14
Melo miltonis	Southern bailer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Octopus sp.	Octopus	1	0	0	0	0	0	0	3	0	1	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	8
Ranella australis	Rock whelk	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Scutus antipodes	Elephant snail	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	3	0	3	1	0	0	0	0	10
Thais orbita	Whelk	1	0	2	3	4	4	3	8	20	0	1	0	0	0	2	2	3	0	8	5	4	4	4	2	3	83
Turbo jordani	Turban shell	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Turbo pulchra	Turban shell	0	2	5	3	2	15	24	6	6	1	0	3	1	4	5	20	5	2	2	18	1	1	8	3	0	137
Turbo torquatus	Turban shell	1	1	2	78	15	14	48	0	0	23	12	23	1	0	1	0	25	0	44	3	5	0	2	0	0	298
Echinoderms																											
Amblypneustes leucoglobus	Short-spined urchin	0	0	0	0	2	0	0	0	0	0	4	0	0	0	0	0	0	2	4	0	0	3	0	0	0	15
Centrostephanus tenuispinus	Long-spine urchin	0	0	6	0	0	0	4	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	12
Comanthus trichoptera	Feather star	2	0	0	0	0	4	0	0	0	0	0	0	0	0	0	10	1	32	0	35	46	0	3	53	0	186
Coscinasterias muricata	Seastar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	3
Fromia polypora	Seastar	0	0	0	0	0	0	6	0	0	1	0	0	0	0	4	5	1	0	0	0	0	0	2	0	0	19
Heliocidaris erythrogramma	Common urchin	15	5	30	16	13	91	82	3	12	5	33	2	16	23	124	289	57	33	4	112	307	9	116	47	14	1458
Holopneustes inflatus	Short-spined urchin	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Holopneustes porossimus	Short-spined urchin	1	0	2	2	0	1	5	0	0	1	0	6	3	0	1	0	3	0	1	0	0	0	0	0	0	26
Holopneustes sp. 1	Short-spined urchin	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18
Pentagonaster dubeni	Firebrick star	0	1	0	0	1	3	0	0	0	0	0	0	2	3	2	0	0	0	0	0	0	0	0	1	0	13
Petricia vernicina	Velvet star	1	0	6	1	3	0	1	0	0	0	0	1	0	1	4	0	4	0	0	4	0	2	0	11	0	39
Phyllacanthus irregularis	Western slate urchin	3	0	11	6	7	7	0	22	15	4	0	6	2	5	8	39	7	21	21	10	8	8	9	69	5	293
Stichopus mollis	Sea cucumber	0	0	0	0	0	1	0	1	0	0	0	0	0	3	0	0	1	3	1	0	0	0	0	0	2	12
Crustaceans																											
Hermit u/i	Hermit crab	5	2	1	0	1	2	0	31	46	1	0	5	5	15	2	4	2	5	2	1	8	1	3	2	1	145
Pagurid (grey)	Hermit crab (grey)	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	5
Paguristes purpureantennatus	Hermit crab	0	0	0	0	0	0	0	2	6	0	0	1	0	5	1	2	0	3	0	1	0	1	0	1	0	23
Panulirus cygnus	Western rock lobster	7	2	1	1	1	0	5	2	6	0	1	1	8	0	4	2	5	8	3	8	0	1	0	3	3	72
Plagusia chabrus	Red bait crab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Trizopagurus strigimanus	Hermit crab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	4
Total Species		14	8	12	10	13	13	11	11	10	8	8	11	10	9	14	11	16	13	12	15	10	12	10	12	11	

Direct comparison between the two datasets is therefore not possible for the red algae other than for species shared between the two or for the pooled total value. Within the brown algae the dominant species were *Ecklonia radiata, Scytothalia dorycarpa* and *Sargassum* species (Fig. 8). While no one particular *Sargassum* species was abundant at a wide range of sites, *Sargassum* species in general formed a major component of the flora at most locations. At most sites the brown algae formed a conspicuous canopy or overstorey, with a wide variety of red algae forming an understorey of more than 50% cover.

The green algae usually only formed a very minor component of the flora. Some notable variants from the average were Site 12 which had a high (20%) cover of the seagrass *Amphibolis antarctica* indicating that the transect at this location overlapped some seagrass beds, and the two sites at the Fisherman's Islands (8 & 9) that had a strong influence of coral cover (5-10 %). The latter two site were visibly conspicuous sites due to the abundance of coral cover present and the physical structure that the coral provided.

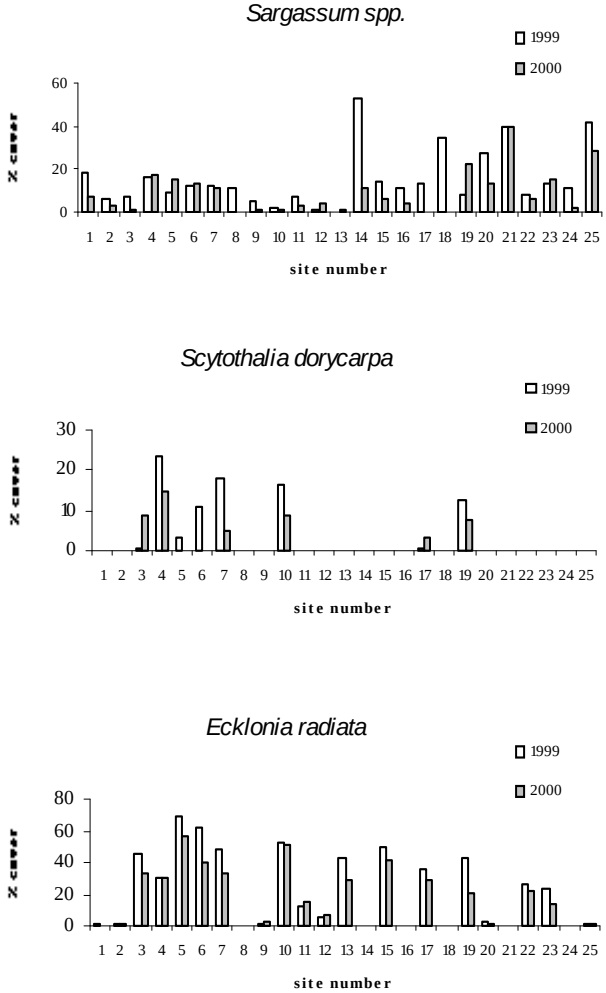

Figure 8. Abundance of dominant algal species encountered during surveys at Jurien Bay in October 1999 and 2000.

Comparison of the dominant cover forming algae between treatments and years (Fig. 9) indicates that patterns between treatments are relatively constant over time and that for *Ecklonia* the average percentage cover is significantly less within the sanctuary sites than within the general use zone. This suggests that on average the sanctuary zone sites may be slightly more sheltered than the sites within the other zones. *Sargassum* species generally replace *Ecklonia* as wave exposure decreases and there is a slight trend here, with *Sargassum* species being more abundant in the sanctuary sites than the general use sites.

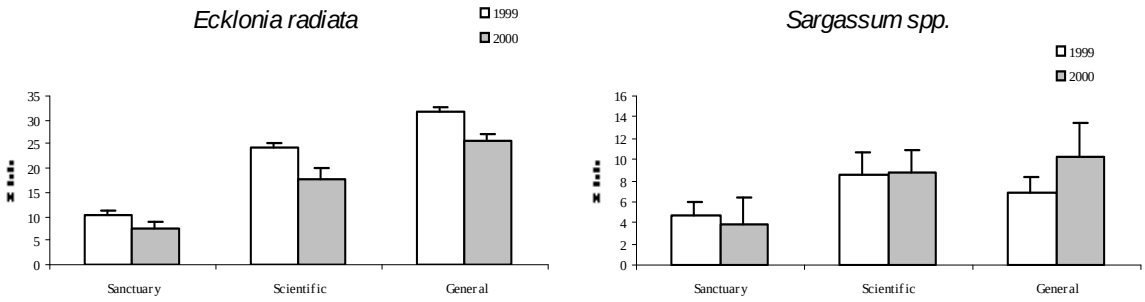

Figure 9. Abundance of common macroalgal species encountered during surveys at Jurien Bay in October 1999 and 2000 with respect to their distribution between proposed management zones.

Discussion

The surveys of Jurien Bay in 1999 and 2000 have provided a comprehensive description of the resident reef fishes, large mobile invertebrates and cover forming plants and animals on the moderately sheltered inshore reefs of the region. While examination of deeper and more exposed outer reefs would have been desirable, these habitats were not represented in the sanctuary zones and were also logistically difficult to survey, thus they were not included in the experimental design. Examination of patterns of inter-site and inter-annual variation of the dominant species suggest that the data collected provides an adequate description of each location for use in subsequent analysis of change through time. Comparison of the overall relationship between sites based on assemblage data indicates that while there is some degree of variation between sites within each protection category, the categories broadly overlap and therefore future comparison between categories is valid using the current sites and experimental design.

The selection of between 8 – 9 sites within each treatment should be sufficient to detect biologically meaningful change within the species examined. From the results of the Tasmanian MPA study (Edgar and Barrett 1997, 1999) and a workshop examining MPA monitoring techniques (Barrett & Buxton 2002), it appears that where the abundance of each species is adequately described at each site, six sites would be the accepted minimum number of “replicates” per treatment for an effective monitoring program. By surveying a wide range of species the experimental design should have sufficient power to detect ecosystem shifts as well as changes in the abundance of target species following the protection of some areas from fishing.

Table 6. Percentage cover of algal species and cover forming invertebrates recorded during surveys of Jurien Bay in 1999.

Species / Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	% Cover
Brown algae																										
Cliftonaea pectinata	0	1.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.05
Colpomenia sinuosa	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0.1	0.1	0.02
Dictyopteris ?gracilis	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01
Dictyopteris australis	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0.1	0	0	0	0	0	0	0	0	0	0.03
Dictyopteris muelleri	0	0	0	0	0	0	0	0	0	0.1	0.1	0	0	0	0.2	0	0	0.1	0	0	0	0	0	0	0	0.02
Dictyopteris sp. 1	0	0	0	0	0	0	0.4	0	0	0.4	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.04
Dictyota sp.1	0	0	0	0	0	0	0	0	0	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01
Dictyota sp. 2	0	0	0	0.8	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0.1	0	0	1.8	0	0	0	0	0.12
Dictyota dichotoma	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0.3	0	0.2	0	0.2	0	0	0	1	0.1	0	0.08
Dictyota sp. 3	0	0	0	0	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01
Dictyota naevosa	0	0	0	0	0	0.5	0	0	0	0	0.2	0	0.3	0	0	0	0	0	0.1	0	0.5	0	0.7	0	0	0.09
Ecklonia radiata	1.7	2	45.1	31	69.4	61.9	48.6	0.5	2	52.3	12.9	6.2	42.4	0	49.1	0.4	35.4	0	42.6	2.3	0	26.4	23	0.1	1	22.25
Homeostrichus sinclairii	0	0	0	0	0	0	0	0.4	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.04
Hydroclathrus clathratus	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0.4	0	0.1	0	0	0	0	0	0	0	0.03
Lobophora variegata	1.3	0.4	2	0	0	0.6	0	0.6	1.4	0	0	0.9	0	0.5	0	0.6	1	0.7	0.2	0.1	0.4	0	0	0	0.9	0.46
Lobospira bicuspidata	0	0	1.5	0	0.8	0	0	0	0	0.4	0	0	0.2	0.1	0	0.8	0.2	0.1	0	0.1	0	0.1	0.1	0	1.5	0.24
Myriodesma serrulatum	0	0	0	11.6	0.2	0	3	0	0	0	0	0.9	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0.64
Myriodesma sp.	0	3.4	0	0	0	0	0	0	0	0	3.2	0	0.2	0	0	0	0	0.5	0	0	11.6	0	0.8	0	0	0.79
Pachydictyon paniculatum	0	1.3	0	5.3	0	0.1	1.4	0	0	0.8	0.6	0	0	0.5	0	0.5	0.4	0	0	0	1	0.5	0.2	0	0	0.50
Padina sp.	0.2	0.1	0	0	0	0	0	0.6	0.3	0	0	0.1	0	0	0	0.2	0	0	0	0.3	0.2	0	0	0.2	0	0.09
Palythoa ?densa	0	0	0	0	0	0	0	8.6	4.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.52
Platythalia angustifolia	0	2	0	0.2	0	0	7.3	0	0	0	0	0	0	0	0	0	0	0	3.9	1.2	0	0	0	0	0	0.58
Sargassum distichum	4.2	0	0	0	0	0	0	0	0	0	0	0	0	16.4	0	0	0	0	0	1.2	0.6	0	0	0	30.6	2.12
Sargassum heteromorphum	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0.02
Sargassum linearifolium	8.7	0	0	0	0	0	2.4	0	0	0	0	0	0	1.2	0	1.5	0	29.7	0	0	16	0.5	0	3.2	1.7	2.60
Sargassum paradoxum	0	0	0	0	0	0	0	5.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.23
Sargassum podacanthum	2.7	1.3	0	2.4	0	0	0	0	0	0	0	0	0	18	0	2.4	2.5	0.9	0	4.5	4.8	0	2.3	0.8	6	1.94
Sargassum spinuligerum	0	0	0	0	0	0	0	5.8	0	0	0	0	0	15.6	1	3	0	0.3	0.9	0	9.4	0	0	5.5	0	1.66
Sargassum spp.	3.2	4.4	7.1	13.8	9.4	12.2	10.2	0	5.1	1.8	7.5	1	0.3	0.8	13.4	4.05	11.1	3.8	7.6	21.8	9.2	7.4	11.3	2	3.4	6.87
Scaberia agardhii	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0.01
Scytothalia dorycarpa	0	0	0.4	23.3	3.1	10.8	17.8	0	0	16.1	0	0	0	0	0	0	0.8	0	12.3	0	0	0	0	0	0	3.38
Sporochnus sp.	0.2	0	0	0	0	0	0	0	0	0	0.2	0	0.1	0	0	0.2	0.1	0	0	0.6	0	0	0.2	0	0	0.06
Turbinaria sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.7	0	0	0	0	0	0	0	0	0	0	0.03
Zonaria turneriana	0	0	0	0	0	0	0	0	0	0	0.1	0	0.2	0	0	0	0.5	0	0.4	0	0	0	0	0	0	0.05

Table 6. Percentage cover of algal species and cover forming invertebrates recorded during surveys of Jurien Bay in 1999(cont.).

Species / Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	% Cover
Green algae																										
Bryopsis foliosa	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
Bryopsis sp.	0	0	0	0.3	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0.2	0	0	0	0.03
Caulerpa brownii	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01
Caulerpa cactoides	0	0.7	0	0	0	0	0	0	0	0	0	0	1.4	0.2	0	0	0.1	0	0	0.4	0.2	0	0.1	0.1	0	0.13
Caulerpa crispata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0.3	0	0.3	0.3	0	0.9	0	0	0	0.08
Caulerpa flexilis var. muelleri	0.3	1.4	0	0	0	0	0	0	0	0	2.6	2.4	3.2	0	2	0.1	0	0	0	1.6	0	5.2	4.2	0	0	0.92
Caulerpa obscura	0	0.2	3.8	0	0	0	0	0.5	0.5	1.3	3.1	0.3	1.8	1.3	1.8	1.1	4	0.1	0	0.3	0	0.6	0.8	19.1	1.1	1.67
Caulerpa racemosa	0	0.4	0	0	0	0	0	0.3	0	0	0	0	0	0.2	0	0.2	0.3	0	0	0	0	0	0.1	0	0.2	0.07
Caulerpa scalpelliformis	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.3	0	0	0.5	0	0.04
Caulerpa simplisciuscula	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0.1	0	0	0	0.6	0.06
Chaetomorpha sp.	0	0	0	0	0	0	0	0.4	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02
Chlanidophora microphylla	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01
Cladophora rugulosa	0	0	0	0	0	0	0	0	0	0	0	0	1.4	0	0	0	0	0	0	0	0	0	0	0	0	0.06
Cladophora spp.	1.6	0.3	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.09
Codium galeatum	0	0	0.7	0	0.3	0	0	0	0.3	0.2	0	0.3	0	0	0	0.4	1.6	2.4	0	2.6	0	0	0.4	0	0	0.37
Codium spongiosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0.00
Struvea plumosa	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0.01
Ulva spp.	2	0	1	0.1	1.3	4.1	0.2	0.7	0.3	0.1	0	1.1	0.6	0.3	0.1	0.1	0.3	0	0.4	0	0	2.9	0	0	3.4	0.76
Red algae																										
Asparagopsis spp.	0	0.2	2.3	0	0	0.5	0	0	1.1	0	0	1.1	0	0	0.5	0	0	0	0	0	0	1	1.5	0.7	0.9	0.39
Botrocladia obovata	0	2.3	0	0.3	0	0	0	0.5	0.6	0	0.4	0.2	0.1	0.6	0	1.1	0.3	2	0	2	2.5	0.5	1	0.6	0.2	0.61
Botryocystis browni	0	0	0	0	0	0	0	0	0	0.4	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02
Callophycis costatus	0	0	5.3	1.3	7.7	9	3	1.1	0	12	1.6	3.4	2.5	0	13.8	0	6.5	1	10.6	0	0.6	6.3	4.3	0.6	0.3	3.64
Callophycus	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02
Callophycus dorsiferus	0	0.9	0.4	0	0	0	0	0	0	0	0	0	2.2	0	0	0	0.7	0	0	0.6	0	1.8	0.2	0	0	0.27
Callophycus harveyana	0	0	1.1	0.3	0	0	0	0	0	0	1.6	0.4	2.3	0.2	0.2	0	0.5	0	0	0	0	0	0	0	0	0.26
Callophycus oppositifolius	0.5	0.7	2.5	7.2	8.5	1.1	3.8	0	0	4.1	1.8	0	0.3	0	1.1	0	3.3	0	4.7	0.2	0.2	0	0.9	0	0	1.64
Callophyllis rangiferinus	0	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01
Delisea spp.	0	0	0.1	0	0	0	0.2	0	0	0	0.7	0.5	2.9	0	0.7	0	0.3	0	0	0.4	0	0	0.3	0	0	0.24
Erythremenia minuta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0.1	0	0.1	0	0	0	0	0	0	0.02
Filamentous red algae	17	22.1	15.1	4.7	9.9	1.6	5.1	58	56.5	6.2	10.4	21.4	6.1	23.9	12.6	23.4	4.4	10.5	13.5	26.4	7.4	28.5	11.8	47.4	24.6	18.74
Galaxaura obtusata	0	0	0.1	0	0.2	0	0.1	0.3	0	0	0.2	0	0	0	0	0.2	0	0	0	0.1	0	0	0	0	0	0.05
Galaxaura speciosa	0	0	1.1	0.8	0	0	0	0	0	0	0	0	0	0.7	0	3.3	1.3	0.4	0	1.8	0	0.6	0	0	0	0.40
Gelinaria ulvoidea	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0.6	0	0	0.2	0	0	0.06
Gracilaria ramulosa	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01
Gracilaria secundata	0.7	1.9	4.4	2	6.2	0.7	0.7	3.9	2	1.3	0.5	0.8	0	1.2	2.7	1.4	2.7	0.2	1.4	1.6	1.4	2.4	1.5	0.4	3.5	1.82
Gracillaria flagelliformis	0	0	0	0	0	0	0	0	0	0	0.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03
Halimeda cuneata	0	0.1	0	0	0	0	0	0.2	0.2	0	0	0	0.1	0.2	0.1	0.3	0.4	0	0.1	0	0.2	0.1	0.1	0.1	0	0.09

Table 6. Percentage cover of algal species and cover forming invertebrates recorded during surveys of Jurien Bay in 1999 (continued).

Species / Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	% Cover
Herdmania momus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.9	0	0	0	0	0	0	0	7.3	0	0.33
Hypnea ramentacea	0	0	0	0	0	0	0	0	0	0	0	0	0.7	0	0	0	0	0	0.6	0	0	0	0	0	0	0.05
Jania spp.	0	1.6	0.4	0.1	0	0	0	1.8	1.1	0	0.4	0.2	0	0	0.3	0	0	0.1	0	0	0	0.5	0.1	0	0.9	0.30
Kallymenia cribrosa	0	0	0	0	0	0	0	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0.02
Laurencia brongniartii	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01
Laurencia spp.	1.5	5	0.2	0.4	0.4	0	1.4	1.1	0.6	1.1	2.7	3.9	2.1	2.4	1.3	10	1.5	3.6	0	3.3	5.3	1.6	5.3	3	2.1	2.39
Lenormandia sp.	0.5	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.04
Martensia australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0.02
Metagoniolithon	6.6	0.7	0	0.4	0	0	0	0	1	0	0	6.3	0	0.3	0	0.1	1.5	0.9	0.7	7.7	0	1.1	0.5	0.2	0	1.12
Metamastophora flabellata	0.5	9.2	14.1	3.3	5.1	1.3	0.9	1.7	0.5	0.6	0	3.5	14	0.7	10.8	0.7	5.5	0.1	1.1	7.1	0.4	14.7	6.4	0.6	2.6	4.22
Neurymenia fraxinifolia	1.6	0	0	0	0	0.4	0	0	0	0	0.5	0.3	0	0	0.3	28.1	2.4	50.9	0.1	1.4	1.9	0	1.8	0	0.5	3.61
Osmundaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.7	0	0	0	0	0.5	0	0	0	0	0.05
Peyssonelia novaehollandiae	2	7.2	5.7	0.4	2.3	0.2	0.9	0.3	1	2.9	7.7	5.2	5.9	1.7	4.6	3	4.1	2.1	1.5	5.3	6.8	6.5	5.2	1.4	1.6	3.42
Phacelocarpus alatus	0	0	0	0	0	0	0	0	0	0.2	1.5	0.2	0	0	0	0	0.2	0	0	0	0	0.4	0	0	0	0.10
Phacelocarpus sp.	0	0.5	0	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03
Plocamium pressianum	0	0.8	0	0.5	0.7	0.1	1.4	0	0	3.2	0.5	0.4	0.3	0	0.6	0	0.8	0	0.3	0	0.1	0.2	2.4	0	0	0.49
Rhodomenia sp.	0	0	0	0	0	1	0.7	0	0	0.2	0	0	0.4	0	0	0	0	0	0	0	0	0	0	0	0	0.09
Rhodopeltis australis	0	0	0.9	1.5	1.3	0.2	0.5	0	0	0.9	0.1	0	0.3	0	0.5	0	0.5	0	0.4	0.1	0	0	0.8	0	0	0.32
Sporolithon durum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.4	0	0.06
Thuretia quercifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.9	0	0.2	0	0	0.04
Unidentified thallous red alga	5.1	25.6	18.7	12	11.2	8.9	10.2	2.2	1.3	13.8	18.9	12.6	24	7.8	10.3	6.7	12.1	3.8	14.4	16.4	8.8	13.7	8.7	3.7	4	11.00
Seagrass																										
Amphibolis antarctica	9.7	6.4	0	3	0.1	0	0	0	0	0	0	36.9	0	0.7	0	4	0	1.1	0	0	3.2	0	0	0.3	0	2.62
Amphibolis griffithi	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.6	0	0	0	0	1.10
Halophila australis	0.6	0	0	0	0	0	0	1.2	3.5	0	0	0	0	0	0	0	0	0	0	0	1.4	0	0	0	1.5	0.33
Heterozostera tasmanica	0.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02
Posidonia australis	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0.10
Posidonia sinuosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0.16
Syringodium isoetifolium	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02
Sponges																										
Chondrilla sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0	0.02
Other sponges	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.9	4.9	0	0.23
Corals (c) and Zooanthids (z)																										
Goniastrea sp (c)	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0	0.2	0.3	0.03
Goniopora sp. (c)	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
Montipora sp. (c)	0	0.2	1.1	0	0	0	0	0	5.7	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0.2	0.6	0.33
Pocillopora damicornis (c)	0	0	0	0	0	0	0	0.6	0.1	0	0	0	0	0.5	0.2	0	0.7	0	0	0	0	0	0	0	0.4	0.10
Vidalia sp.	6.8	20.9	1.2	1.8	0.8	0.1	1.1	0	0	0	29	2.8	13.6	0.9	1.6	1.3	0	0.8	0	4.4	26.4	8	13.8	4.5	0	5.59
Zoanthus praelongus (z)	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.04
Total cover	29	38	28	28	22	21	27	26	26	24	30	30	30	31	31	36	37	27	25	32	33	30	36	30	28	

Table 7. Percentage cover of algal species and cover forming invertebrates recorded during surveys of Jurien Bay in 2000.

Species / Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	% Cover
Brown algae																										
Caulocustis uvifera	0	0	0	0	0	0	0	0	0	0	0	2.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0.12
Cladosiphon filum	0	0	0	0	0	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01
Cliftonaea pectinata	0	0	0	0	0	0	0	0	0	0	0	0.9	0	2.8	0	0	0	0	0	0	0.4	0	0	0	0	0.16
Colpomenia sinuosa	0.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03
Colpomenia spp.	0	0	0	0	0	0.2	0	0.1	0	0	0	0	0	0.2	0.1	0.3	0	0	0	0	0	0	0	0	0	0.04
Cystophora spp.	0	0	0	0	0	0	0	0	0	0	0	0.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03
Cystoseira trinodis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0	0	0	0.02
Dasya sp.	1.2	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0.07
Dictyopteris australis	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02
Dictyopteris plagiogramma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.6	0.2	0	0	0	0	1.3	0	0.4	0	0	0.10
Dictyopteris spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0.3	0	0	0	0	0	0	0	0.03
Dictyota sp. 1 (fine)	1.3	0.2	1.2	0.3	0	0.4	0	0	0.4	0	0	0	0.4	0	0	1.7	0.4	0.1	0	0	1.6	0.8	0.3	0.4	0.1	0.38
Dictyota ciliolata	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02
Echinothamnion mallardiae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.1	0	0	0	0	0.04
Ecklonia radiata	0	0.9	32.9	30	56.4	39.4	32.7	0	2.2	51.2	15.3	7.1	28.5	0	41.2	0	28.5	0	20.6	1.9	0	21.4	14	0	0.8	17.00
Hincksia spp.	0	0	0	0	0	0	0	0.1	1	0	0	0.1	0	0	0	0	0	0	0.6	0	0	0	0	3.2	0	0.20
Hormophysa cuneiformis	0	0	0	0	0	0	0	0	0	0	0	0.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0.04
Hydroclathrus clathratus	0	0	0	0.3	0	0	0	0.1	0	0	0	0	0	0.3	0	0	0	0	0	0.2	0	0	0	1.7	0.45	0.12
Lobophora variegata	3.6	0.1	0	0.2	0.8	1.7	0.2	0.4	0.8	0	0.1	4.1	0	3.2	0.1	0.3	0	0	0	0	0.3	0.5	0.1	0	0.4	0.68
Lobospira bicuspidata	0	0	0.3	0	0.6	0	0.2	0	0	0.2	0	0	0	0	2.4	0	0.5	0	0	2.4	0	0.3	0.4	0	2.3	0.38
Myriodesma serrulatum	0.6	0	0	4	0	0	0	0	0	0	1.65	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0.26
Myriodesma sp. 1	0	2.2	0	0.9	0	0	2	0	0	0	0	0	0.4	0	0	0	0	0	0	0.8	2.1	0	0	0	0	0.34
Pachydictyon paniculatum	0.5	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0.02
Pachydictyon spp.	0	0	0	0	0	0	0	0	0	0.2	0.5	0	0	0	0	1.4	0.5	0.1	0	1.2	0	0.6	0	0	0	0.18
Padina fraseri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0.2	0.01
Padina sp.	0.2	0	0	0	0	0	0	0.1	0.4	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0.1	0.04
Platythalia angustifolia	1.2	3.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.2	0	0	0	0	0	0	0.41
Sargassum decurrens	0.2	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02
Sargassum linearifolium	2.4	0	0	3.7	0.5	0.4	0	0	0	0	0	0	0	0	0	0	0	0	2.2	0	4.8	2.6	0	0	1	0.70
Sargassum sonderi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14.9	0	0	0	0	0.60
Sargassum spp.	4.4	3	1.3	13.7	14.9	12.4	10.9	0.5	1.15	1.1	2.65	4.2	1.3	11.1	5.8	4	0	0.1	20.2	13.2	20.1	3.3	15.7	1.8	27.4	7.77
Scytothalia dorycarpa	0	0	9	14.5	0	0	5	0	0	8.7	0	0	0	0	0	0	3.2	0	7.6	0	0	0	0	0	0	1.92
Zonaria turneriana	0.3	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0.4	0	0	0	0	0.2	0	0	0	0.05

Table 7. Percentage cover of algal species and cover forming invertebrates recorded during surveys of Jurien Bay in 2000 (cont.).

Species / Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	%Cover
Green algae																										
Apjohnia laetevirens	0	0	0	0	0	0	0	0	0	0	0	0.1	0.9	0	0	0	0	0	0	0	0	0	0	0	0	0.04
Caulerpa cactoides	0	1.5	0	0	0	0	0	0	0.1	0	0.3	0	3.5	0.7	0.15	0	0	0.4	0	0	2.6	0	0.8	0	0.7	0.43
Caulerpa distichophylla	0.1	0	0	0	0	0.3	0.4	0	0	0	0	0.2	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0.05
Caulerpa flexilis	0	1.5	0	0	0	0	0	0	0	0	0.3	0	2	0	0	0.1	0	0	0	0	0	0	1.7	4.3	0	0.40
Caulerpa geminata	0	0.1	0	0	0	0	0	0.3	0	0	0	0.2	0	0.6	0	0	0	0	0	0	0	0	0.4	0.3	0	0.08
Caulerpa longifolia	0	0.3	0	0	0	0	0	0	0	0	0	0	2.3	0	0.2	0.4	0.8	0	0	0.2	0	0.15	0	0	0.1	0.18
Caulerpa obscura	0	0.5	0	0	0	0	0	0	0	0	0	0.4	0	0	1.1	1.2	0	0	0	0	0	0.2	0	10.4	0	0.55
Caulerpa racemosa	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01
Caulerpa scalpelliformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0.2	0.4	0	0.4	0	0	0.04
Caulerpa simpliciuscula	0.1	0.1	0	0	0	0	0.4	0.4	0.6	0	0.7	0	0	0.2	0	0	0	0	0	0	0	0	0	0.5	1.2	0.17
Cladophora spp.	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0	3.7	0	0	0	0	0	0	0	0.4	0	0.17
Codium galeatum	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0.6	3.5	0.1	0	0.9	0.9	0	3.4	0	0	0.39
Codium laminalidides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0.00
Codium spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0.15	0	0	0	0.1	0	0	0	0.2	0	0.4	0.1	0.04
Enteromorpha sp.	0	0	0	0	0	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01
Ulva spp.	0.9	0	0.8	0	0.4	1.4	0	1.2	2.1	0	0	0.1	0	0	1.4	0.5	0.1	0	0.4	0	0	1.5	0	0	2	0.51
Red algae																										
Amphiroa gracilis	0.5	0.4	0	0.3	0	0	0	0.4	0.4	0	0.4	4.4	0	1.1	0	0	0	0.5	0	2.05	0.7	0.5	0.4	0	0.3	0.49
Asparagopsis armata	0	0	0	0	0	0	0	0	0	0	0.6	0	0	0	2.4	0	0.2	0.1	0	0	0.3	0	2.1	0	0	0.23
Asparagopsis taxiformis	0	0	2.15	1.2	0	0.4	0	0	0	0	0	0	0	0	1.7	0	0	0	0	0	0	0	0	0	0.8	0.25
Betaphycus speciosum	0	0.5	0.5	0.1	0	0	0.8	0	0	0	0.9	0	0	0	0	0	0	0	0	1	0	0	0	0	0.1	0.16
Bornetia binderiana	0.1	0	0	0	0	0	0	0	0	0	0	0.4	0.3	0	0	2.2	0	0	0	1.2	3	1.1	0	0	0	0.33
Botryocladia leptopoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0.02
Botryocladia sonderi	0.9	0.3	0	0.4	0	0	0	0	0	0	0.2	0.5	0.1	2.9	0.5	0.4	0.7	0.6	0	1.9	3.1	0.8	1.3	0	0.2	0.59
Callophycus dorsiferus	0	0.4	0	0	0	0	0	0	0	0	0.2	0	0	0	0.8	0	0.4	0	0	0	0.1	0	0	0	0	0.08
Callophycus harveyana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.6	0	0	0	0	0	0.02
Callophycus oppositifolius	0	0	0	7.5	5.3	0.6	3.7	0	0	4	0	0.8	0.1	0.1	0	0.2	1.8	0	9.5	1	0.7	1	2.6	0	0	1.56
Champia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.1	0	0	0	0	0.04
Champia viridis	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01
Champia zostericola	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01
Chauviniella coriifolia	0	0	0	0	0	1.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.05
Claviclonium ovatum	0	0	0	0	0	0	0	0	0	0	0.1	0	0.8	0	0	0	0	0	0	0	0.4	0	0.2	0	0	0.06
Corallines	0.2	0	4.3	17.5	12.3	12.4	0	0	0	0	0	0	0.5	0.4	3	0	3.5	0	2.2	0	0	0	2	0	0	2.33
Cryptonemia kallymenioides	0	0	0	0	0	0	0	0	0	0	0	0.7	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0.04
Curdiea irvineae	0.9	3	1.9	1	13.4	3.9	2.8	0	0	8.5	4.6	5.8	5.8	2.7	8.2	2.2	2.7	1.8	1.5	4.8	2.2	6.8	6	0.7	1.6	3.71
Curdiea obesa	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02
Dasyclonium incisum	0	0	0	0	0	0	0	0	0	0	0	0	0.7	0	0	0	0	0	0	0	0	0	0	0	0	0.03
Delisea spp.	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0.4	0	0	0.04

Table 7. Percentage cover of algal species and cover forming invertebrates recorded during surveys of Jurien Bay in 2000 (cont.).

Species / Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	%Cover
Dictymenia sonderi	0.7	7.1	0	0	0	0	0	0	0	0	12.1	3.8	9	1.5	0	8.3	3.5	0.8	0	9.8	0	0	8.7	0	0	2.61
Euptilota articulata	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0.08
Galaxaura marginata	0	0	0	0	0.2	0.1	0	0	0	0	0	0	0	0	0.15	0	0	0	0	0	0	0.3	0	0	0	0.03
Galaxaura rugosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0.02
Gigartina disticha	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01
Gliosaccion brownii	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.2	0	0	0	0	0	0	0	0	0.02
Glossophora nigricans	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0	0	0	0.8	0	0	0	0	0	0	0	0	0.04
Gracilaria secundata	1.8	0.4	2.4	0.9	6.4	1.6	3.7	4.9	5.1	2	1.1	0.3	0.2	1.5	3.5	0.2	1.3	0	0	4.2	1	6.3	4.8	1.5	3.7	2.35
Gracillaria preissiana	0.7	0.4	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0.06
Halimeda cuneata	0.1	0	0	0	0	0	0	0	0.1	0	0	0	0	0.1	0	0	0	0	0	0	0	0.4	0	0	0	0.03
Haliptalon roseum	0.4	0	0	0.8	0	0.1	0	0	0	0	0	0.3	0	0	0	0	0	0	5	0	0	0.4	0	0	0	0.28
Haplognema preissii	0	0.2	0	0	0	0	0	0	0	0	0	0	0.4	0	0.3	0	0	0	0	0	0.3	0	0	0	0	0.05
Hennedya crispa	0	0.3	2.4	0.3	1.5	0.6	5	0	0	1.85	2.8	1.4	8.6	0	2.3	0	5.7	0	1.9	0	0	0.1	0.6	0	0.4	1.43
Heterosiphonia muelleri	0.9	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0.5	0	0.9	0	0	0	0	0	0	0	0.11
Hypnea pannosa	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02
Hypnea ramentacea	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0	0	0	0	0.02
Hypnea sp.	5.6	15.4	22.6	2.9	3.3	3.1	15.2	25	16.8	15.5	14.5	17.9	12.4	7.5	11.9	7.4	12.9	7.9	4	11.5	2.5	35.5	14.8	21.5	32.5	13.60
Hypnea valentiae	0	0	0	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01
Jania spp.	0	0	0	0	0	0	0	0.1	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0.3	0	0.02
Kuetzingia angustata	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
Kuetzingia canaliculata	0.4	0.4	0.2	1	0	0	1.7	0	0	0	1.8	0.5	1.7	0	0	0	1.7	0	1.8	1.1	0.5	0.1	0	0	0	0.52
Laurencia brongniartii	0	0	0	0	0	0.2	0	0	0	0	0	0.6	0	0.3	0	0	0	0	0	0	0	0	0.4	0	0	0.06
Laurencia elata	0	0	0	0	1.2	0	0	0	0	0	0	0	0.6	0	0.2	0	0	0	0	0	0	0	0.3	0	0	0.09
Laurencia filiformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9.1	0	4.9	0	0	0.56
Laurencia spp.	5	11.1	0	0.5	0.3	0.3	1.3	8.7	4.8	0.8	11.8	4.8	2.6	9.7	1.9	15.8	1.6	7.1	0.2	3	1.3	1.6	0.7	2.4	3.6	4.04
Lenormandia spectabilis	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01
Metagoniolithon radiatum	0	0	0.1	0	0	0	0	0	0	0	0	0.2	0	1	11	0	0	0	0	0	0	0	0	0	0	0.49
Metamastophora flabellata	0.7	2.7	8.3	7.5	17.8	2.3	2.6	0	0.6	0.9	5.8	0.6	7.6	0.4	0	0.4	3.9	0.5	0	4.7	0.3	10	7.7	0	4.2	3.58
Neurymenia fraxinifolia	0.3	0.35	0	0	0	2	0	0	0	0	1.4	1.1	0	0	0	19.6	5.6	56.5	0	5.8	1.4	0.4	0	0	0.6	3.80
Osmundaria prolifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.3	0	0	0	0	0	0	0	0.05
Osmundaria spiralis	2.3	1.1	0	0	0	0.2	0	0	0	0	1.8	0.3	0	0.8	0.2	0.6	0	1.2	0	1.2	0.8	0	0	0.4	0	0.44
Peyssonelia novaehollandiae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0.7	0	0	0	0	0	0	0	0	0.04
Peyssonnelia sp.	0	0.1	1.3	0.3	0.4	0.2	0	0.1	0	0.1	0	0	0	0.1	0.6	0	0.4	0	0.8	0	0	0	0	0	0	0.18
Phacelocarpus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0.6	0	0	0	0.04
Plocamium angustum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.6	0	0	0	0	0	0	0	0	0.06
Plocamium preissianum	0	0	0	1	0	0	0	0	0	0.6	0	0.4	0	0	4.5	0	1.1	0	0.2	0	0	0	8.1	0	0	0.64
Polysiphonia sp.	1.5	0	0	0	0	0	0	0	0	0	0	4.2	0	11.7	0	1	0	1	0	0.6	2.4	0	0.8	0	0	0.93
Protokuetzingia australasica	1.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.04
Pterocladia lucida	0.2	0	3.4	3.5	5.9	7.6	2.6	0	0	17.6	1.4	0.6	0.8	0.1	2.6	0.1	1.9	0.4	9.1	0.2	0	2.2	0.8	0.3	0.2	2.46

Table 7. Percentage cover of algal species and cover forming invertebrates recorded during surveys of Jurien Bay in 2000 (cont.)

Species / Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	%Cover
Ptilophora prolifera	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02
Rhodopeltis australis	0.1	0	0	0	0	0.3	1.8	0	0	1.3	0	0	0	0	0.2	0	0.1	0	0.5	0	0	0	0.4	0	0	0.19
Rhodymenia sonderi	0	0.1	0	0	0	1.2	0	0	0	0.2	0	0	0.9	0	0.1	0	0.2	0	0.4	0	0	0	0.6	0	0	0.15
Sarcomenia delesseriodes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0.01
Scinaia tsinglanensis	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
Solieria robusta	0.7	0.4	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0.3	0	0.1	0	0	0	0	0	0	0	0.06
Thuretia quercifolia	0.4	0	0	0	0	0	0	0	0	0	0.7	0	0	0	0	0	0	0	0	0	0.4	0	0.6	0	0	0.08
Tolypiocladia glomerulata	0	0	0	1	0	0	0	2.3	6.8	0	0	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0.42
Unidentified thallous red alga	2.3	7.1	2.5	5.6	1.65	6.9	6.3	2.2	3	13.4	10.7	5.6	3	5.7	5.1	5.7	9.3	9.7	4.5	9.9	4.7	9.1	3.7	2.9	4.1	5.79
Unidentified filamentous red algae	0	5.3	6.5	6	2.5	4.6	4.55	22.3	31.7	0.5	0.7	2	1	3.8	5.2	0.8	2.2	0	1.9	6.8	0.5	3.4	2.2	23.1	4	5.66
Seagrass																										0.00
Amphibolis antarctica	0	16.4	0	0	0	0	0	0	0	0	3.4	20	0	6.6	0	0	0	2.7	9.8	0	3.9	0	0.8	0	0.4	2.56
Amphibolis griffithi	21.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.8	0	0	0	0	2.5	0	0	0	0	1.02
Halophila australis	2.8	0	0	0	0	0	0	1.2	0	0	0	0	0	0	0	4.8	0	0	0	0	0	0	0	5	0	0.55
Halophila ovalis	0	0	0	0	0	0	0	0.7	0	0	0	0	0	2	0	1.8	0	0	0	0	1.8	0	0	5.3	0	0.46
Heterozostera tasmanica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0.01
Syringodium isoetifolium	0.9	0	0	0	0	0	0	1.2	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0	1.5	0	0.16
Thallasodendron pachyrhizum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.6	0.7	0	0	0	0	0	0	0	0.05
Corals, sponges & sand																										0.00
Sponges	0	0	0	0	0	0.4	0	0	0.1	0	0	0	0	0.1	0	0	0.3	0.5	0	2.2	0.8	0	0.4	1	0	0.23
Coral (other than plate)	0	0	0	0	0	0	0	5.2	0	0	0.2	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0.22
Alcyonarians (Octocorals)	0.2	0	0	0	0	0	4	0	0.1	0	0	0.4	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0.19
Plate coral	0	0	3	0	0	0	0	2.9	7.4	0	0	0	0	0	1.1	0	0	0	0	0.8	0	0	0	0	0	0.61
Pocillopora damicornis	0	0.5	0	0	0	0	0	0.2	4.4	0	0	0	0	1.1	0	0	0	0	0	0	0	0	0	0	0.5	0.27
Sand	5	0	0	0	0	0	0	0	0	0	0	0	0	0	4.6	0	0	0	0	0	0	4.7	0	0	0	0.57
Total cover	52	36	21	29	20	33	23	27	22	20	35	39	37	40	35	35	38	28	23	31	42	30	39	23	30	

Ideally the surveys would be repeated a number of times in the years following the declaration of the MPA and enforcement of the fishing restrictions to obtain a time-series of date to follow trends in the change in abundance of species of interest. It is recommended that as a minimum requirement at least one survey be conducted in the year prior or following declaration as a reference point for the time of divergance, and that subsequent surveys be conducted at five year intervals as this is the time frame that biologically meaningful changes may be expect to occur and be detected.

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