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Fisheries Long Term Monitoring Program

Benthic Marine Fauna Composition in the Queensland Scallop Fishery Area in 2000 and 2002

October 2004

Queensland Government
Department of Primary Industries and Fisheries

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Acronyms

BRD	Bycatch Reduction Device
CAAB	Code for Australian Aquatic Biota
CFISH	Commercial Fishery Information System
DPI&F	Department of Primary Industries and Fisheries
LTMP	Long Term Monitoring Program
MDS	Multi-dimensional Scaling
SRA	Scallop Replenishment Area
TED	Turtle Excluder Device

LTMP Background

The Department of Primary Industries and Fisheries (DPI&F) manages the harvest of Queensland's fish, mollusc and crustacean species and the habitats in which they live. Inherent in this responsibility is a commitment to monitoring the condition and trends in fish populations and their associated habitats. This information is used to assess the effectiveness of fisheries management strategies and contributes to ensuring that the fisheries remain ecologically sustainable.

In 1999 the Department of Primary Industries and Fisheries initiated a statewide Long Term Monitoring Program (LTMP) in response to this identified need for the collection of long term trend data for the stock assessment of Queensland's fisheries. The LTMP is managed centrally by a steering committee comprising the General Manager Policy and Sustainability, Principal Fisheries Scientist Assessment and Monitoring and North and South Regional Managers. Operational aspects of the program are managed regionally from the Southern and Northern Fisheries Centres, located at Deception Bay and Cairns respectively. The regional teams are responsible for organising and undertaking the collection of data to be used for the stock assessment of key commercial and recreational species and for the preparation of data summaries and preliminary assessments.

The identification of key species for inclusion in the LTMP occurred through a series of stock assessment workshops. These workshops evaluated the suitability of various species and fisheries for inclusion in the program against several criteria, including, but not restricted to:

a) the need for stock assessment

b) the suitability of existing data sets

c) whether agreement had been reached on appropriate indicators of resource status; and

d) the ability to collect suitable data.

Species selected as priorities for the LTMP included saucer scallops, spanner crabs, spotted mackerel, stout whiting, mullet and tailor in southern Queensland, and tiger prawns, coral trout and Spanish mackerel in northern Queensland. Species with a statewide distribution — for example, mud crabs, barramundi and freshwater fishes — are being sampled by both North and South Long Term Monitoring teams.

Various sampling methodologies are used to monitor each resource. Fishery-independent techniques are preferred where feasible, and combinations of fishery-dependent and fishery-independent techniques are used where they are not. Where a species distribution overlaps the areas of responsibility of each team, comparable methodologies are used to ensure a consistent approach to data collection. Data collected by the monitoring teams is collated in a central database maintained within the Assessment and Monitoring work unit in Brisbane.

The primary aim of the LTMP is the collection of data for stock assessment and management strategy evaluation. The real value in the developing data sets for each of the species and associated habitats lies in the time series generated by several years of uninterrupted sampling. Saucer scallops, spanner crabs, stout whiting, spotted mackerel and Spanish mackerel are five species for which formal stock assessment models have already been developed and management recommendations have been made. In conjunction with these management strategy evaluations are recommendations for future monitoring, so that we can better address improvements to fisheries stock assessments. Without compromising the integrity of the data gathered from existing monitoring programs, recommendations for improving the monitoring strategies for the previously mentioned resources are currently being implemented. Through this process of analysing the data and the subsequent refinement of the monitoring and assessment protocols, continuing improvements in the assessments and hence sustainable management of Queensland's fisheries resources will be achieved.

Introduction

Since 1997, the Department of Primary Industries and Fisheries (DPI&F) has monitored the saucer scallop *Amusium japonicum balloti* stock in southern Queensland. This is a commercially important species worth about $18 million annually. Catch rates observed in the early part of the 1996–1997 scallop season were at about one-third of average levels since 1988. The then Queensland Fisheries Management Authority, acting on the basis of precautionary management, embarked on a two-pronged approach to ensure the sustainability of the fishery. The first was the creation of three Scallop Replenishment Areas (SRA), closed to trawling. These areas were historically highly productive and were closed as a means of maintaining spawning stock levels for the coming winter spawning season. The second was the implementation of an annual fishery-independent trawl survey that would measure the density and abundance of scallops before they recruit to the fishery as an indicator of likely catch levels the following season (Jebreen *et al*., 2003). In 2000 and 2002, samples of benthos were collected from the main scallop fishing grounds from Yeppoon to Hervey Bay as part of the saucer scallop survey.

Objectives

- To describe the benthic faunal community that exists in the main scallop fishing grounds, off Yeppoon, Bustard Head and Hervey Bay.
- To investigate differences in benthos between closure and non-closure areas.
- To determine if any temporal variation occurred in the benthic species composition.
- To assess the feasibility of monitoring benthos using these survey techniques.

Methods

Survey design

Samples of benthos were collected as part of the DPI&F Long Term Monitoring Program (LTMP) Scallop surveys of 2000 and 2002. The stratified random trawl surveys were based on the 30' Queensland Commercial Fishery Information System (CFISH) grid system covering the main scallop trawl grounds between 22°30'S and 25°S (Figure 1, Figure 2) (Jebreen *et al*, 2003 provides details of the Scallop Fishery survey protocol). The area swept by the scallop fishery in 2000 and 2002 was estimated to be 20 500 km^2 and 6500 km^2 respectively (Appendix 1).

Four commercial trawlers were chartered for the 2000 survey and two trawlers for the 2002 survey. Surveys were conducted in the period between the new and full moon, centering on neap tides, to minimise the effects of tidal flow on the ability to catch scallop. Surveys were undertaken in October to maximise the catch prior to the peak fishing period beginning in November. Vessels used standard prawn trawl nets (2.25 inch mesh) to increase the catch rate of small scallops. Trawls were 20 minutes in duration and conducted in darkness, from 6 pm to 6 am.

In 2000, benthos sampling was undertaken on all four vessels at every third shot. In 2002, benthos sampling was undertaken on both vessels for every shot. In 2000 benthos was collected from the port or starboard net, chosen at random, and in 2002 it was recovered from the middle net. Benthos was obtained only from the middle net in 2002, due to the inclusion of Turtle Excluder Devices (TEDs) and Bycatch Reduction Devices (BRDs) in both port and starboard nets. Total benthos weight was obtained and sub-samples of approximately 10 kg were boxed and frozen for later analysis. In 2000 most of the sampling occurred in non-closure areas while in 2002 most of the sampling took place inside the closures as a consequence of a change in objectives in the Scallop survey. Note that target and by-product species data is not published here as it forms the basis of an additional LTMP report (Jebreen *et al*, 2003).

Shot characteristics recorded included: start and finish latitude and longitude, distance of trawl, trawl speed, bearing, depth, trawl duration and net configuration. Additional comments were recorded regarding factors that may have influenced the swept area or efficiency of a particular trawl for example, nets choked with weed or nets dredging or broken nets. Nets where catch rate was obviously affected by extraneous circumstances were excluded from the analyses.

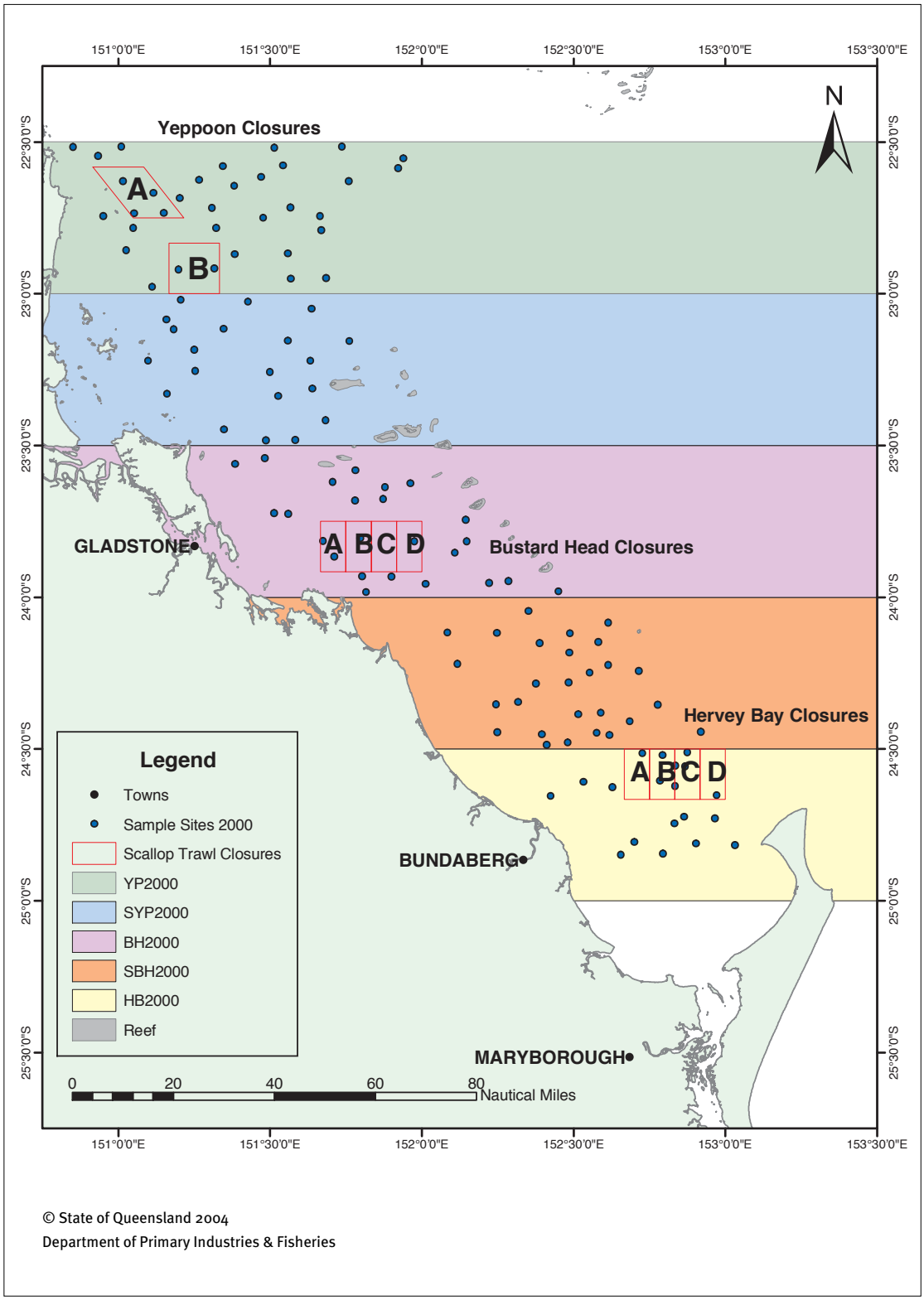


Figure 1. Scallop replenishment areas (SRA), analysis regions and sampling sites for 2000.

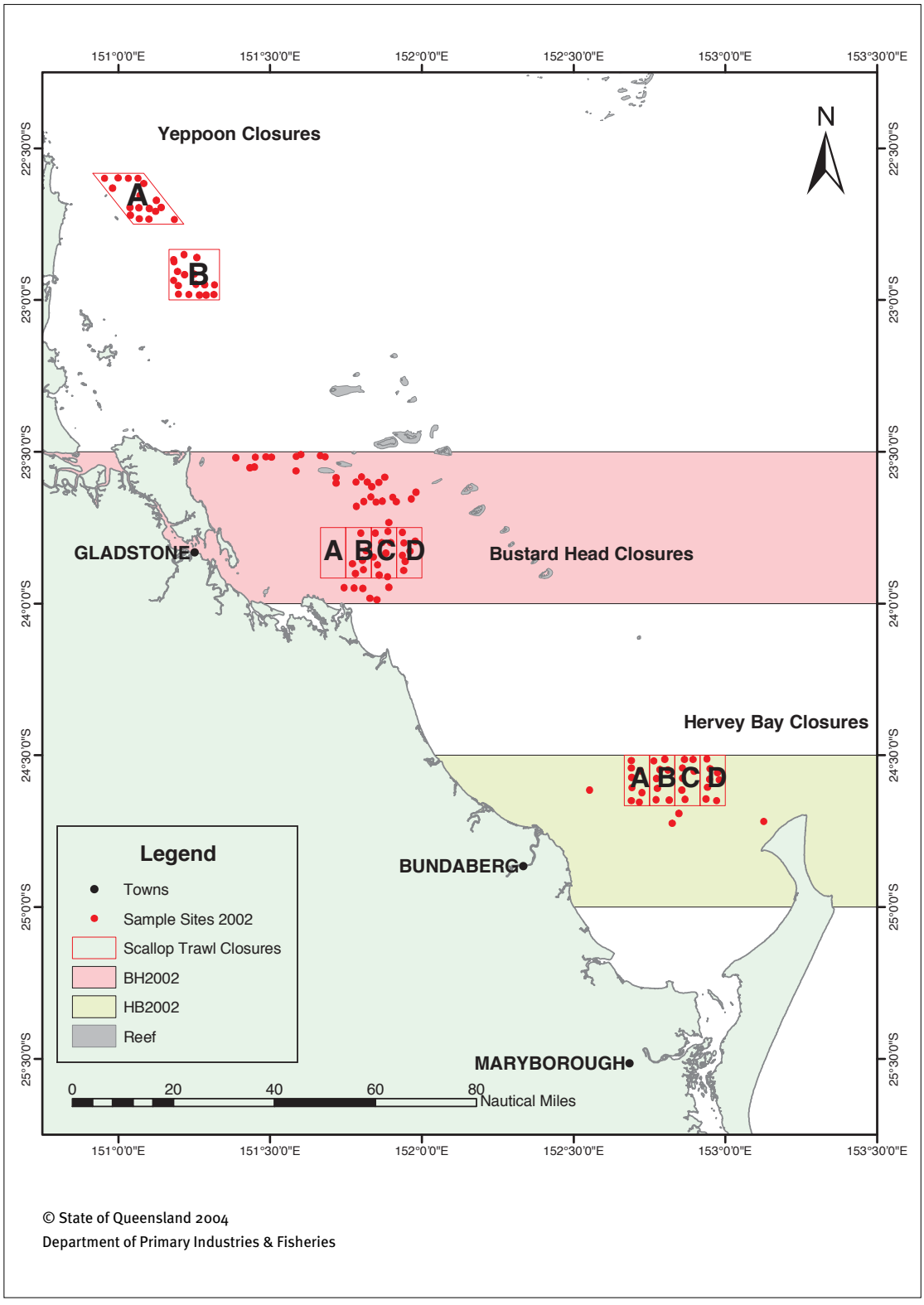


Figure 2. Scallop replenishment areas (SRA), analysis regions and sampling sites for 2002.

Species identification

In the laboratory, benthic specimens were identified down to species level. Total counts, lengths and weights were recorded. Samples were identified to species level using suitable identification guides (Sainsbury *et al*., 1985, Carpenter and Niem, 2001). When more than 20 individuals of a species were present, 20 individuals were chosen at random and measured. When a species could not be readily identified it was recorded under a descriptive name and a specimen of optimal condition was labelled and frozen until the correct name could be assigned. Species that could not be identified using published taxonomic keys were sent to the Queensland Museum for identification.

Standardisation of catch rates

The raw catch and weight data was standardised to produce an observed catch rate for each species at each site in grams per square metre (g m^{-2}) so that comparisons could be made across all sites, sub-regions and years.

The weight of each species in each sub-sample was converted to a weight for the entire net in the equation:

weight [sp X] at site Y (g) = weight [sp X] in sub-sample (g)/weight of sub-sample (g) x total weight benthos at site Y (g)

Note that some sub-samples constituted the entire benthos sample from the given site. In these cases the above transformation was not needed. To distinguish between these samples and true sub-samples the weight of each sub-sample was compared with the total recorded benthos weight. Where the sub-sample weight was within the range: total benthos weight ± 1 kg, the sub-sample weight was taken to be the total benthos sample for that site.

The swept area of the net was calculated as:

swept area at site Y (m^2) = headrope length of benthos net (m) x trawl distance at site Y (m) x gear spread (%)

where gear spread was recorded at time of sampling and was the skipper's perceived efficiency of the gear as a percentage of the maximum spread of the headrope.

Finally, the standardised catch value was calculated as:

observed catch rate [sp X] at site Y (g m^{-2}) = weight [sp X] at site Y (g)/swept area at site Y (m^2)

The resultant standardised data was then collated by sub-region, to minimise the effect of latitudinal differences in species composition, and then analysed.

Data analysis

Patterns in the benthos species composition were investigated using cluster analysis and multidimensional scaling (MDS), methods that are commonly used to examine variation in the structure of aquatic faunal communities (Clarke and Green, 1988; Watson and Goedon, 1989; Gray *et al*., 1990; Watson *et al*., 1990; Clarke. 1993; Clarke and Ainsworth, 1993). PRIMER software (Plymouth Routines in Multivariate Ecological Research) by Clarke and Warwick (1994) was used to analyse the data. Square-root transformed catch rate data and Presence-absence data were used. Catch rate data was used to identify important species based on composition and abundance, while presence/absence data was used to identify important species based on composition only. The Bray-Curtis similarity index (Bray-Curtis, 1957) was used to examine the similarity between species groups based on catch rates of individual species in each sample (number of individuals m^{-2}). Clustering was examined using a dendogram; this compared the similarity of the sub-regions. MDS ordination plots were used to provide a visual representation of the relationship between the individual sites. These plots were only carried out on species present in >5% of all samples across all regions and years to avoid the species-sample table being dominated by zeros.

For each sub-region (where significant differences occurred), SIMPER (similarity percentages) analyses in PRIMER were carried out using two types of data: (1) square-root transformed catch rate (abundance data), and (2) presence/absence (binary) data. These analyses yielded values (%) of average similarity and dissimilarity within and between each sub-region respectively. Only those species contributing to the upper 50% of the measured similarity/dissimilarity for the catch rate data and only the species contributing to the upper 10% of similarity/dissimilarity are reported. Note that these limits are arbitrary and were set to focus attention on the main species only. Generalised Linear Models (GLMs) were generated to factor in the effect of depth on the abundance and presence/absence of those species accounting for the between-group dissimilarity detected by SIMPER. The models were run using GENSTAT® statistical package (Genstat, 2003).

Results

Summary of survey results 2000 and 2002

There was a dominance of teleosts between Yeppoon and Hervey Bay across both survey years (Table 1). These samples were dominated, in terms of species composition, by 'one offs' (rare species), with nearly 300 species occurring in less than 5% of samples. During both of the survey years 547 species were identified in total, of which 151 species from 61 taxa occurred in >5% of all samples. In 2000 there were 425 different species identified, of which 134 species from 58 taxa occurred in >5% of all samples. In 2002 there were 318 species identified, of which 136 species from 60 taxa occurred in >5% of all samples (Table 2). Fishes from the family Synodontidae (grinners) constituted the majority of the total benthic sample weight (13%) in both survey years. More Lethrinids and Pomacentrids were detected in 2002 than in 2000, while there were fewer Monacanthidae and Tetraodontidae (by weight) observed in 2002 than 2000 (Table 3). Synodontidae and Nemipteridae landings were consistent between survey years.

	Contribution to total benthos (%)	
Taxa	**2000**	**2002**
Teleosts (bony fishes)	76	83
Crustaceans	10	9
Echinoderms (stars, urchins)	4	1
Algae	2	1
Coral (soft and hard)	2	2
Cephalopods (cuttlefish, octopus, squid)	2	3
Porifera (sponges)	2	1
Bivalves	2	1

Table 1. Taxa present in benthic samples collected in the 2000 and 2002 Scallop Surveys and their percentage of total benthos weight.

Year	No. species (total)	No. species (>5% of samples)	No. taxa (>5% of total samples)
2000	425	134	58
2002	318	136	60
Total	547	151	61

Table 2. The number of species found in benthic samples from 2000 and 2002 Scallop Surveys.

Family	Contribution to total benthos 2000 (%)	Contribution to total benthos 2002 (%)
Synodontidae	13	13
Lethrinidae	11	11
Monacanthidae	10	7
Nemiteridae	9	10
Pomacentridae		9
Tetraodontidae	8	

Table 3. The five most numerically dominant families and their contribution to total benthos for 2000 and 2002 surveys.

Regional results and comparisons

A total of 249 benthic samples were collected and analysed (124 samples in 2000 and 125 in 2002). The sample size range across sub-regions in 2000 varied from n = 3 (Bustard Head Closure 2000) to n = 35 (Bustard Head Region 2000). In 2002 sub-regional sample sizes ranged from n = 3 (Hervey Bay Region 2002) to n = 17 (Yeppoon Closure B 2002). There were large differences in the size[1] of the sampled sub-regions (from 170 to 4500 km^2) and the area sampled (swept area) in them (0.0467 to 0.4395 km^2). Mean sampled depth ranged from 24 to 53 m and the average standardised weight of benthos yielded ranged from 0.9 to 1.9 g m^{-2} overall (Table 4).

A continued increase in the number of species being recorded with the number of samples taken was observed in all sub-regions (Figure 3). No asymptotes were observed. This result has major implications for survey design if temporal changes in diverity of by-catch are to be detected with any confidence.

Cluster analysis of the 249 samples displayed three major groupings, with an arbitrary similarity level of 54% (Figure 4). The first grouping of sites were: (1) samples from 2000, excluding Yeppoon (YP and YP2000); (2) samples from 2002; and (3) samples from 2000 (YP and YP2000). In the 2000 data, South of Yeppoon and Bustard Head (non-closure area) were the most similar sub-regions and in 2002 Bustard Head Closure Areas C and D formed the most similar pair of sub-regions. More discreet and predictable clustering occurred for the 2002 data than for the 2000 data. The classification is based on the standardised catch rate of 151 species (square-root transformed) from the 2000 and 2002 surveys.

Sub-region	Description			Survey			
		latitude (degrees)	approx. area (mill. of m^2)	n	swept area (mill. of m^2)	mean depth (m)	mean bycatch (g m^{-2})
YP	Yeppoon Closure 2000	*	340	4	0.0469	45.8	0.9
YP2000	Yeppoon Region 2000	22.5–23.0 S	4500	30	0.3629	53.0	0.9
YPA	Yeppoon Closure A 2002	*	340	16	0.2129	45.3	1.2
YPB	Yeppoon Closure B 2002	*	340	17	0.2168	40.2	1.3
SYP2000	Region south of Yeppoon 2000	23.0–23.5 S	4500	20	0.2374	31.9	1.5
BH	Bustard Head Closure 2000	*	340	3	0.0467	31.0	1.8
BH2000	Bustard Head Region 2000	23.5–24.0 S	4500	21	0.3245	35.3	1.6
BHB	Bustard Head Closure B 2002	*	170	6	0.0632	33.7	1.7
BHC	Bustard Head Closure C 2002	*	170	9	0.0924	35.3	1.3
BHD	Bustard Head Closure D 2002	*	170	7	0.0738	36.9	1.4
BH2002	Bustard Head Region 2002	23.5–24.0 S	4500	35	0.4395	32.7	1.9
SBH2000	Region south of Bustard Head 2000	24.0–24.5 S	4500	27	0.3750	29.3	1.7
HB	Hervey Bay Closure 2000	*	340	6	0.0701	34.7	1.1
HB2000	Hervey Bay Region 2000	24.5–25.0 S	3000	13	0.1537	23.8	1.2
HBA	Hervey Bay Closure A 2002	*	170	8	0.0813	27.4	1.0
HBB	Hervey Bay Closure B 2002	*	170	8	0.0852	33.3	1.5
HBC	Hervey Bay Closure C 2002	*	170	8	0.0932	32.9	1.4
HBD	Hervey Bay Closure D 2002	*	170	8	0.0835	30.9	1.2
HB2002	Hervey Bay Region 2002	24.5–25.0 S	3000	3	0.0350	25.3	1.3

* See Appendix 2

Table 4. Information on each sub-region. n refers to the number of benthic samples collected.

Footnote [1] note that 'millions of m^2' is equivalent to km^2

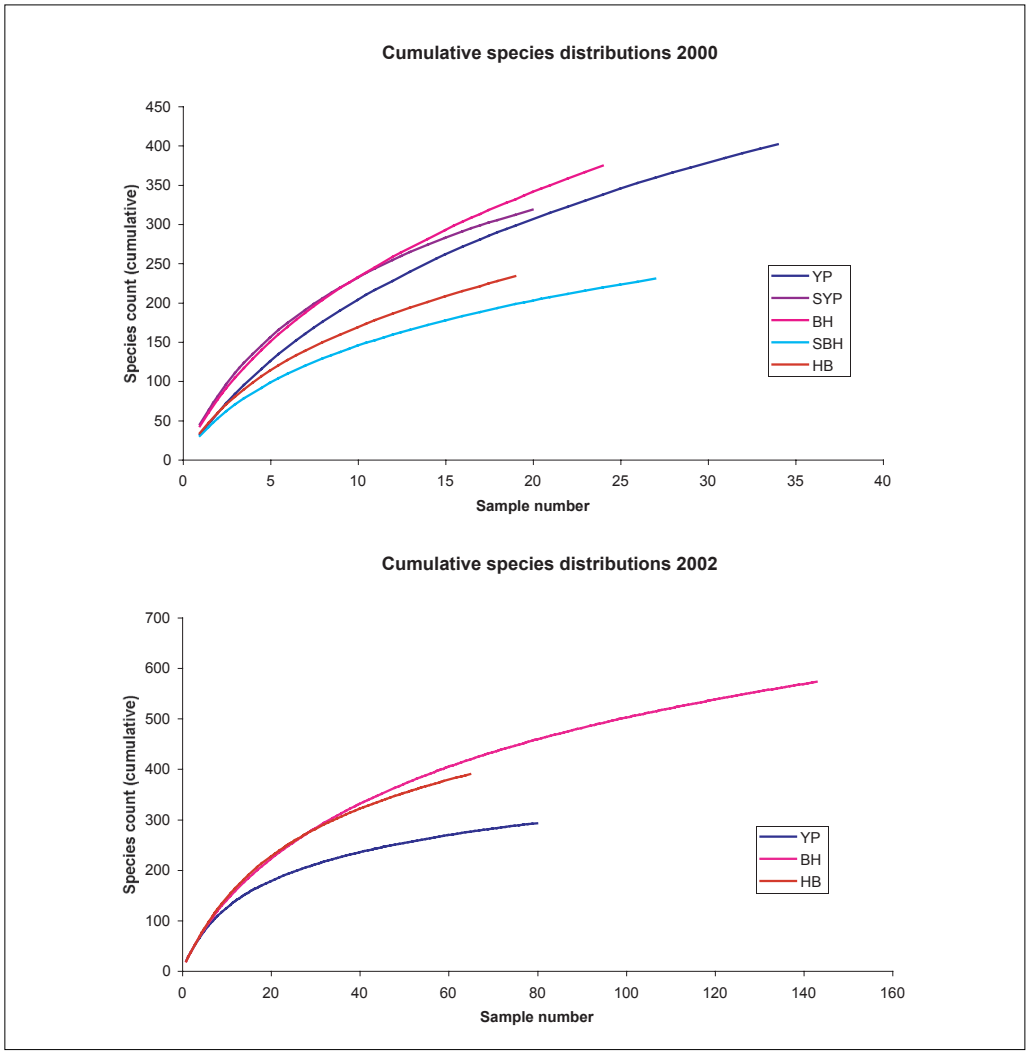


Figure 3. Relationship between sub-region sample number (n) and the number of species detected in the sub-region.

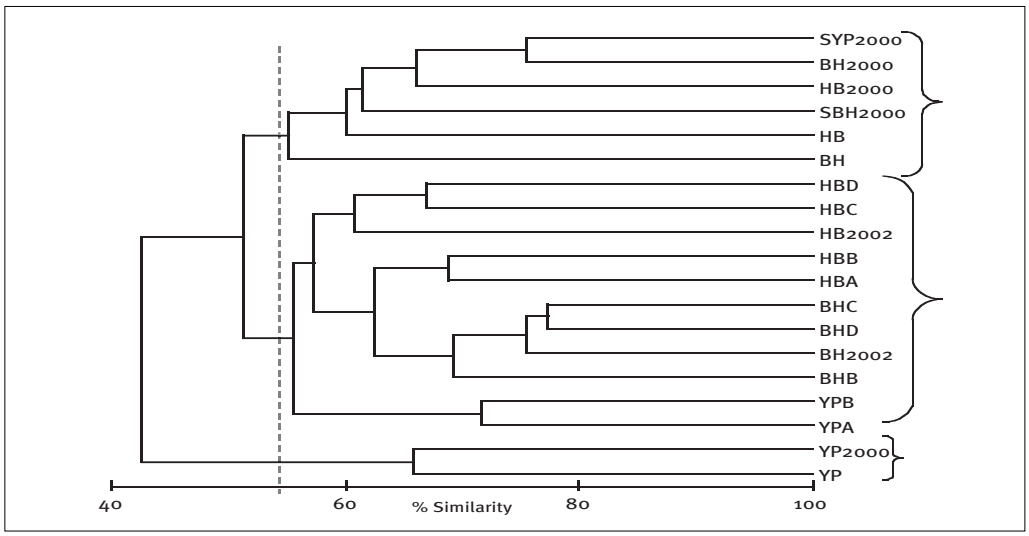


Figure 4. Dendogram showing classification of 249 benthic samples grouped by 19 sub-regions between Yeppoon and Hervey Bay. Classification is based on standardised catch rate of 151 species (square-root transformations) from 2000 and 2002 Scallop Surveys. Three majors groupings are distinguished at an arbitrary similarity level of 54% (X-axis).

Yeppoon Region ordination plot

MDS was carried out for the Yeppoon region using 87 sub-samples. The resulting stress value was 0.16. The low within sub-region similarity of the 2000 samples is indicated by the high degree of spatial separation of individual samples in the plot, although general clustering of the 2000 sub-regions is evident. There was also some overlap in similarity between samples from Yeppoon (YP2000) and those south of Yeppoon (SYP2000). The 2002 samples exhibited greater within sub-region similarity and more discrete clustering than those of 2000 and the 2002 closure areas appeared to be more similar to one another than to any of the 2000 sub-regions (Figure 5).

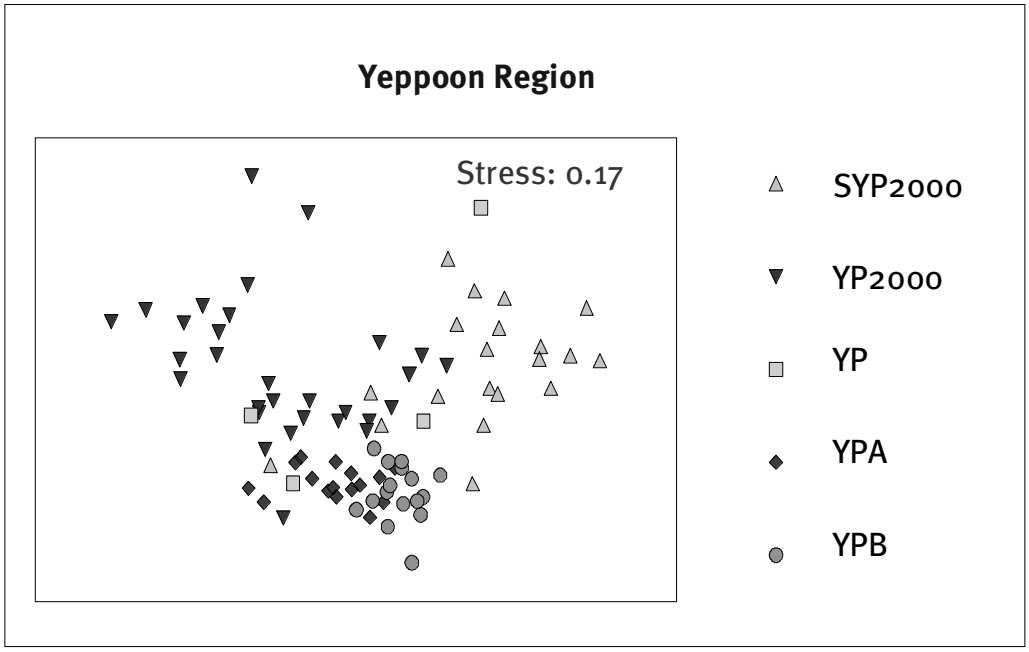


Figure 5. Multi-dimensional scaling of benthic fauna samples from the Yeppoon Region (YP2000, YP, YPA, YPB) (n = 67) and south Yeppoon Region (SYP2000) (n = 20).

Yeppoon Region similarity summaries

Yeppoon Region 2000

The samples from Yeppoon (YP and YP2000) exhibited low within sub-region similarity (~30%) in 2000. Overall, much of the similarity was attributable to a high abundance of *Nemipterus theodorei* and *Paramonacanthus filicauda*. The samples of the Yeppoon Closure in 2000 (YP) were further characterised by a moderate abundance of *Pseudorhombus dupliciocellatus*. The non-closure area (YP2000) was characterised by an abundance of *Metapenaeopsis palmensis* (Figure 6 and Figure 7).

Region south of Yeppoon 2000

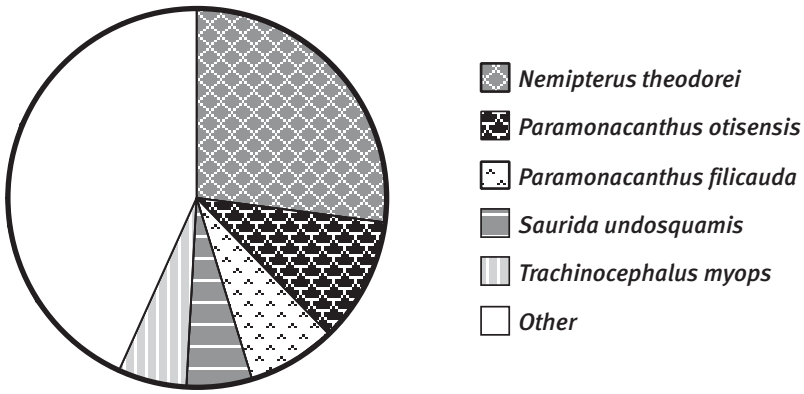
Samples of the region south of Yeppoon in 2000 (SYP2000) exhibited low similarity (~40%). The samples were characterised by the moderately abundant *Lethrinus genivittatus*, *Saurida undosquamis*, *Pentapodus nagasakiensis* and *Pristotis jerdoni*. (abundance data). Much similarity (both data types) was also accounted for by a moderate abundance of *Portunus rubromarginatus* and *Torquigener pallimaculatus* (Figure 8).

Yeppoon Region 2002

The 2002 samples from Yeppoon (YPA and YPB) exhibited greater within sub-region similarity than did those of 2000 (~55%). High abundances of *Saurida undosquamis*, *Nemipteris theodorei* and *Trachinocephalus myops* (abundance data) and a moderate abundance of *Pseudorhombus dupliciocellatus* (both data types) in both sub-regions explained much of the observed similarity. In Yeppoon Closure A, moderately abundant *Upeneus asymmetricus* and *Pristotis jerdoni* characterised the samples (Figure 9). Yeppoon Closure B (YPB) was characterised by *Paramonacanthus otisensis* and *Torquigener pallimaculatus* (Figure 10).

YP

(a)



Group YP

(b)

Average similarity: 32.84

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Nemipterus theodorei	0.260	8.830	2.00	26.90	26.90
Pseudorhombus dupliciocellatus	0.060	4.150	4.12	12.64	39.53
Lepidotrigla argus	0.050	2.440	0.77	7.43	46.96
Paramonacanthus filicauda	0.070	2.400	0.41	7.32	54.28

Group YP

(c)

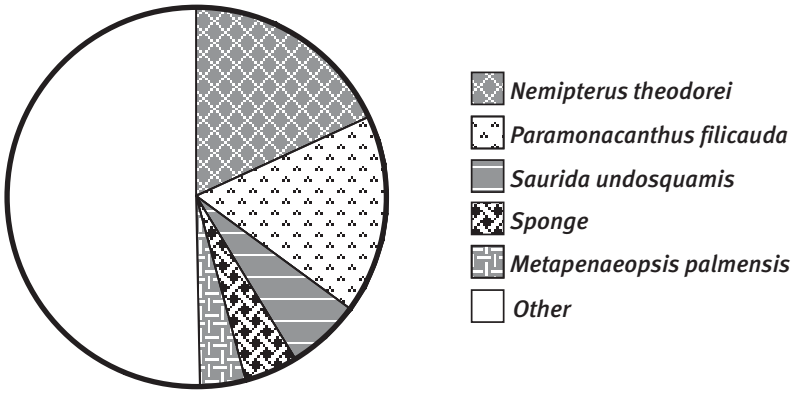
Average similarity: 41.15

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Pseudorhombus dupliciocellatus	0.060	4.710	3.43	11.44	11.44

Figure 6. Yeppoon Closure 2000 (a) five most abundant species; (b) average similarity value and species contributing to the upper 50% (catch rate data); (c) average similarity value and species contributing to the upper 10% of similarity (presence/absence data).

YP2000

(a)



Group YP2000

(b)

Average similarity: 33.17

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Nemipterus theodorei	0.150	7.870	2.02	23.72	23.72
Saurida undosquamis	0.050	3.420	1.05	10.32	34.04
Metapenaeopsis palmensis	0.030	3.170	2.39	9.55	43.59
Paramonacanthus filicauda	0.140	3.000	0.55	9.04	52.63

Group YP2000

(c)

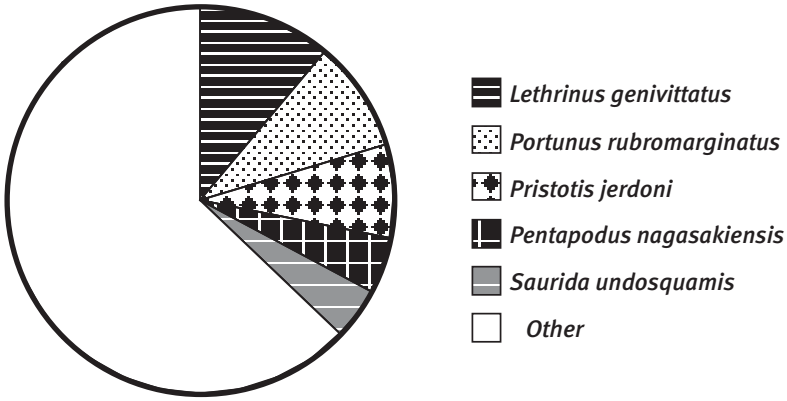
Average similarity: 38.36

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Metapenaeopsis palmensis	0.030	4.510	2.77	11.76	11.76

Figure 7. Yeppoon Region 2000 (a) five most abundant species; (b) average similarity value and species contributing to the upper 50% (catch rate data); (c) average similarity value and species contributing to the upper 10% (presence/absence data).

SYP2000

(a)



Group SYP2000

(b)

Average similarity: 36.19

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Lethrinus genivittatus	0.120	2.860	0.91	7.89	7.89
Torquigener pallimaculatus	0.030	2.720	2.64	7.52	15.41
Portunus rubromarginatus	0.100	2.720	1.23	7.51	22.92
Pristotis jerdoni	0.090	2.670	1.26	7.38	30.30
Metapenaeopsis palmensis	0.040	2.120	1.21	5.86	36.16
Saurida undosquamis	0.050	1.760	0.89	4.86	41.02
Upeneus tragula	0.030	1.560	0.92	4.30	45.33
Paramonacanthus otisensis	0.020	1.520	1.43	4.21	49.53
Pentapodus nagasakiensis	0.050	1.390	0.59	3.83	53.36

Group SYP2000

(c)

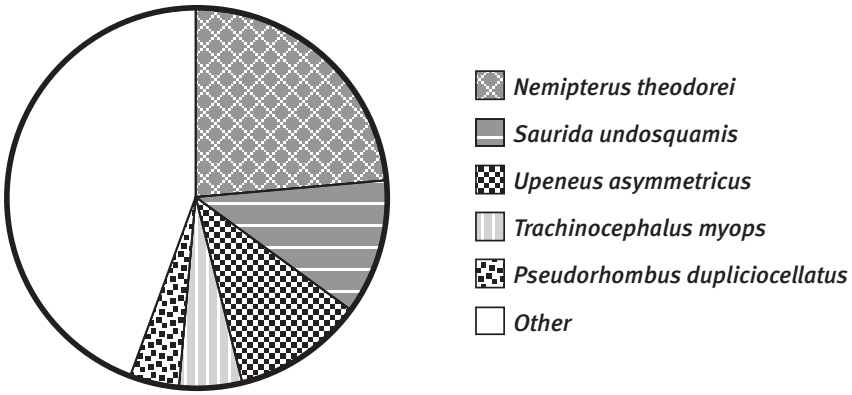
Average similarity: 47.44

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Torquigener pallimaculatus	0.030	2.850	5.84	6.00	6.00
Portunus rubromarginatus	0.100	2.570	2.62	5.41	11.41

Figure 8. Region south of Yeppoon 2000 (a) five most abundant species; (b) average similarity value and species contributing to the upper 50% (catch rate data); (c) average similarity value and species contributing to the upper 10% of similarity (presence/absence data).

YPA

(a)



Group YPA

(b)

Average similarity: 52.70

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Nemipterus theodorei	0.280	9.780	3.69	18.55	18.55
Saurida undosquamis	0.140	6.790	5.28	12.88	31.44
Pseudorhombus dupliciocellatus	0.050	3.400	2.89	6.45	37.89
Pristotis jerdoni	0.040	2.300	2.04	4.37	42.25
Trachinocephalus myops	0.070	2.270	1.05	4.30	46.56
Upeneus asymmetricus	0.130	1.970	0.84	3.74	50.29

Group YPA

(c)

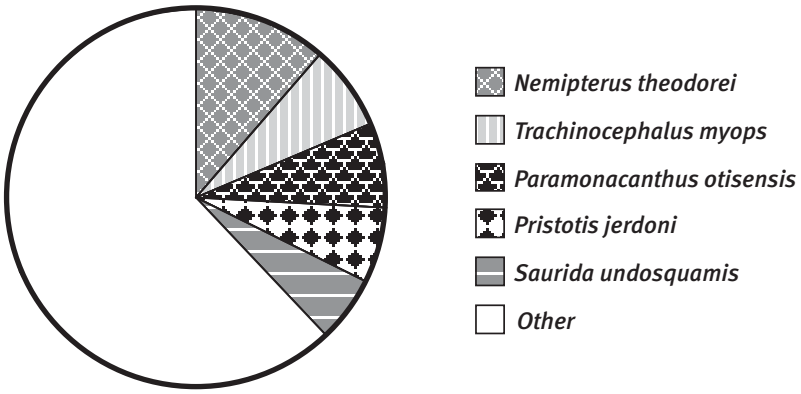
Average similarity: 61.02

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Pristotis jerdoni	0.040	2.830	10.10	4.63	4.63
Pseudorhombus dupliciocellatus	0.050	2.830	10.10	4.63	9.27
Saurida undosquamis	0.140	2.830	10.10	4.63	13.90

Figure 9. Yeppoon Closure A 2002 (a) five most abundant species; (b) average similarity value and species contributing to the upper 50% (catch rate data); (c) average similarity value and species contributing to the upper 10% of similarity (presence/absence data).

YPB

(a)



Group YPB

(b)

Average similarity: 57.01

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Trachinocephalus myops	0.090	4.620	3.72	8.10	8.10
Paramonacanthus otisensis	0.090	4.570	6.41	8.03	16.12
Nemipterus theodorei	0.140	3.480	1.48	6.11	22.23
Torquigener pallimaculatus	0.050	3.040	3.82	5.34	27.57
Engyprosopon grandisquama	0.060	2.910	1.66	5.10	32.67
Paramonacanthus lowei	0.050	2.640	2.09	4.62	37.30
Pseudorhombus dupliciocellatus	0.030	2.530	3.71	4.43	41.73
Saurida undosquamis	0.070	2.150	0.96	3.78	45.50
Grammatobothus polyophthalmus	0.030	2.110	2.77	3.71	49.21
Lethrinus genivittatus	0.060	2.010	1.49	3.53	52.75

Group YPB

(c)

Average similarity: 62.93

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Torquigener pallimaculatus	0.050	2.230	7.15	3.54	3.54
Trachinocephalus myops	0.090	2.230	7.15	3.54	7.08
Pseudorhombus dupliciocellatus	0.030	2.230	7.15	3.54	10.62

Figure 10. Yeppoon Closure B 2002 (a) five most abundant species; (b) average similarity value and species contributing to the upper 50% (catch rate data); (c) average similarity value and species contributing to the upper 10% (presence/absence data).

Yeppoon Region dissimilarity summaries

Yeppoon Region 2000 sub-regional dissimilarity

There was moderately high dissimilarity (~60%) between the Yeppoon samples from the closure (YP) and those from the non-closure (YP2000) in 2000. Many species of moderate to high abundance in each sub-region accounted for the dissimilarity detected in the abundance data, few of which exhibited any significant difference. The main source of dissimilarity between the closure area and the non-closure areas were *Pseudorhombus dupliciocellatus* and *Amusium pleuronectes*. Although *Metapenaeopsis palmensis* was previously identified as an important contributor to similarity of Yeppoon non-Closure samples the abundance in these samples was not significantly different to that in the Yeppoon Closure samples (Table 5).

Yeppoon Region 2002 sub-regional dissimilarity

Moderate dissimilarity (~50%) was exhibited between the Yeppoon samples in the sub-regions of 2002 (YPA and YPB). Some dissimilarity was accounted for by *Lethrinus genivittatus* in both data types and was detected in a significantly greater quantity in Closure B. Many other species were recognised as contributing to the dissimilarity between the sub-regions and most of these species exhibited a significant difference in abundance between the sub-regions (Table 6). Species accounting for dissimilarity (abundance data) — and in significantly greater abundance in Closure A than Closure B — that were previously identified as important contributors to similarity of Closure A samples include *Upeneus asymmetricus* and *Saurida undosquamis*.

(a)

Groups YP2000 and YP

Average dissimilarity = 58.76

Species	YP2000 Av.Abund.	YP Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Upeneus asymmetricus	0.000	0.000	1.31	0.89	2.23	2.23
Engyprosopon grandisquama	0.000	0.010	1.23	1.03	2.09	4.32
Apogon ellioti	0.000	0.000	1.22	0.89	2.07	6.39
Amusium pleuronectes	0.010	0.010	1.20	0.90	2.04	8.43*
Portunus argentatus	0.000	0.000	1.19	0.89	2.02	10.45

(b)

Groups YP2000 and YP

Average dissimilarity = 58.76

Species	YP2000 Av.Abund.	YP Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Upeneus asymmetricus	0.000	0.000	1.31	0.89	2.23	2.23
Engyprosopon grandisquama	0.000	0.010	1.23	1.03	2.09	4.32
Apogon ellioti	0.000	0.000	1.22	0.89	2.07	6.39
Amusium pleuronectes	0.010	0.010	1.20	0.90	2.04	8.43*
Portunus argentatus	0.000	0.000	1.19	0.89	2.02	10.45

Table 5. (a) Average dissimilarity value and species contributing to the upper 50% (catch rate data); (b) average dissimilarity value and species contributing to the upper 10% (presence/absence data) in the Yeppoon Region and Yeppoon Closure in 2000.
*** denotes a significant differences between the groups detected.**

(a)

Groups YPA and YPB

Average dissimilarity = 53.51

Species	YPA Av.Abund.	YPB Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Nemipterus theodorei	0.280	0.140	2.69	1.47	5.02	5.02
Paramonacanthus otisensis	0.010	0.090	2.26	2.31	4.23	9.25*
Upeneus asymmetricus	0.130	0.020	2.03	1.02	3.79	13.04*
Saurida undosquamis	0.140	0.070	1.84	1.37	3.44	16.48*
Lethrinus genivittatus	0.000	0.060	1.76	1.32	3.30	19.78*
Pristotis jerdoni	0.040	0.080	1.74	1.26	3.25	23.02
Torquigener pallimaculatus	0.020	0.050	1.64	1.84	3.07	26.10*
Trachinocephalus myops	0.070	0.090	1.59	1.18	2.97	29.07
Lepidotrigla argus	0.040	0.040	1.33	1.29	2.48	31.55
Engyprosopon grandisquama	0.020	0.060	1.30	1.40	2.42	33.97
Paramonacanthus lowei	0.020	0.050	1.22	1.48	2.28	36.25*
Portunus sanguinolentus	0.010	0.030	1.15	1.11	2.16	38.41*
Apistus carinatus	0.020	0.040	1.07	1.30	2.00	40.40
Parapercis nebulosa	0.020	0.020	1.04	1.50	1.94	42.34
Lepidotrigla grandis	0.020	0.010	1.03	1.00	1.92	44.27*
Upeneus tragula	0.020	0.010	1.02	1.11	1.91	46.18
Pseudorhombus spinosus	0.020	0.020	1.00	1.38	1.87	48.04
Grammatobothus polyophthalmus	0.020	0.030	0.90	1.34	1.68	49.72*
Amusium pleuronectes	0.020	0.000	0.85	0.73	1.59	51.31*

(b)

Groups YPA and YPB

Average dissimilarity = 44.17

Species	YPA Av.Abund.	YPB Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%*
Lethrinus genivittatus	0.000	0.060	0.98	1.79	2.22	2.22*
Ichthyscopus sannio	0.000	0.000	0.85	1.45	1.92	4.13*
Sepia smithi	0.010	0.000	0.80	1.31	1.80	5.93*
Rhynchostracion nasus	0.010	0.000	0.78	1.28	1.77	7.70*
Apogon ellioti	0.000	0.000	0.78	1.28	1.76	9.47*
Sepia plangon	0.000	0.010	0.76	1.19	1.72	11.18

Table 6. (a) Average dissimilarity value and species contributing to the upper 50% (catch rate data); (b) average dissimilarity value and species contributing to the upper 10% (presence/absence data) in Yeppoon Closure A and Yeppoon Closure B in 2002.
*** denotes a significant difference between groups detected.**

Bustard Head Region ordination plot

The ordination plot of the samples collected in the Bustard Head Region is a poor representation of the data in 2-dimensions (stress = 0.21). Low within sub-region similarity is evident from the high degree of spatial separation between the samples, especially for those collected in 2000. There also appears to be a general distinction between the samples of 2000 and those collected in 2002. Some overlap in sample similarity is apparent in the 2000 samples (SYP2000, BH2000 and SBH2000) while the 2002 non-closure area samples (BH2002) appear to overlap with the closure samples of the same year (BHB, BHC, BHD), with little overlap exhibited between the closure samples themselves (Figure 11).

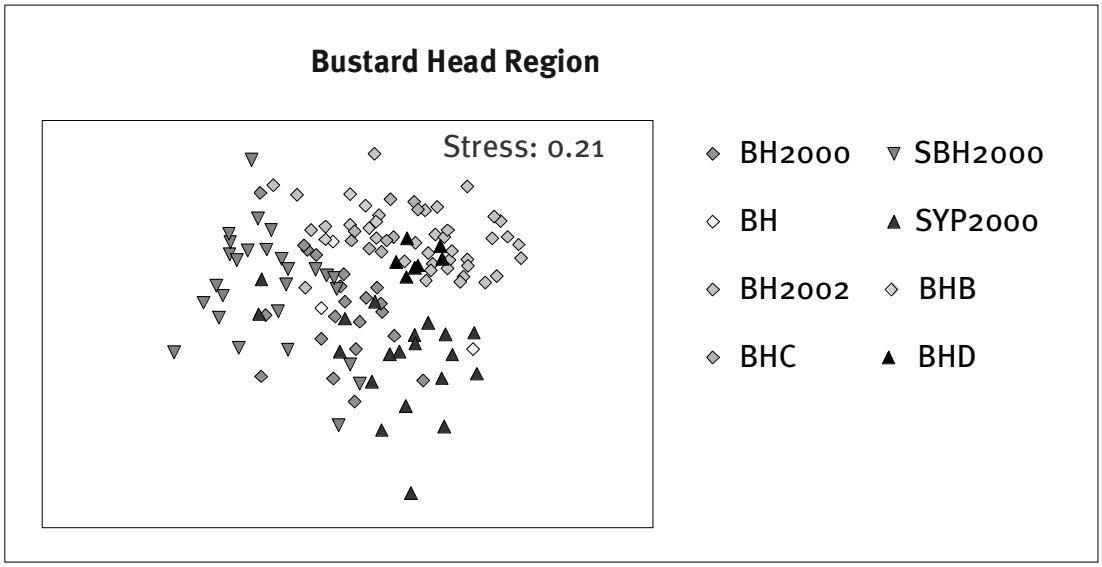


Figure 11. Multi-dimensional scaling of benthic samples from the Bustard Head Region (BH2000, BH, BH2002, BHB, BHC, BHD) (n = 81), region south of Yeppoon (SYP2000) (n = 20) and region south of Bustard Head (SBH2000) (n = 27).

Bustard Head Region similarity summaries

Bustard Head Region 2000

Bustard Head samples (BH and BH2000) exhibited low within sub-region similarity (~40%) in 2000. The moderate abundance of *Saurida undosquamis* and *Torquigener pallimaculatus* accounted for one of the larger individual contributions to similarity for both data types in both sub-regions. The moderate abundance of *Lethrinus genivittatus* in both sub-regions also influenced the similarity (abundance data) in both sub-regions. The moderate abundance of *Pristotis jerdoni* in the closure (BH) and *Portunus rubromarginatus* in the non-closure area (BH2002) further contributed to the sample similarity in each region (abundance data) (Figure 12 and Figure 13).

Region south of Bustard Head 2000

The samples from the region south of Bustard Head in 2000 (SBH2000) exhibited low similarity (~45%). These samples were characterised by a high abundance of *Saurida undosquamis* and a moderate abundance of *Portunus rubromarginatus*, both of which accounted for the largest individual contributions to similarity for both data types. Other species, including *Paramonacanthus otisensis*, *Torquigener pallimaculatus* and *Upeneus asymmetricus,* made important contributions to the sample compositions and similarity (abundance data) (Figure 14).

Bustard Head Closures 2002

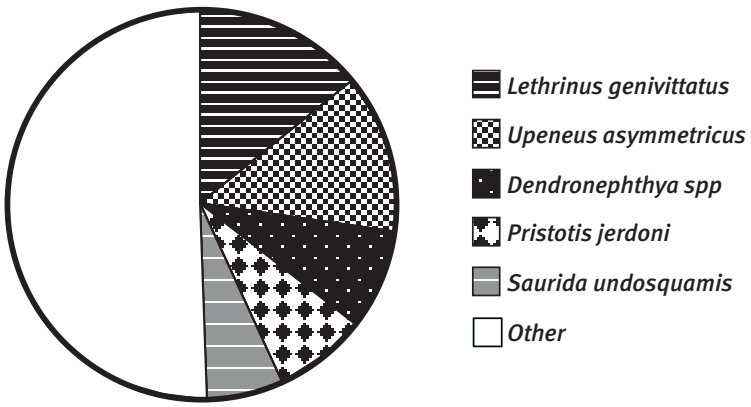
Three species in moderate to high abundance: *Saurida undosquamis, Pristotis jerdoni* (esp. BHC) and *Lethrinus genivittatus* contributed to the moderate similarity (~60%) of each of the Bustard Head Closures (BHB, BHC, BHD) in 2002 (abundance data). *Torquigener pallimaculatus* (esp. BHC and BHD) and *Sepia plangon* were also identified as important contributors to the observed similarity in each sub-region (binary data). *Upeneus asymmetricus* and *Nemipterus theodorei* were important contributors to similarity in BHB and BHC (abundance data), while *Upeneus tragula* was important in BHD (both data types) (Figure 15, Figure 16 and Figure 17).

Bustard Head non-Closure area 2002

The samples collected in the Bustard Head non-Closure (BH2002) in 2002 exhibited low similarity (~40%). All species in high abundance (*Portunus rubromarginatus*, *Pentapodus nagasakiensis*, *Saurida undosquamis*, *Pristotis jerdoni* and *Lethrinus genivittatus*) appeared to contribute to similarity, especially *Pristotis jerdoni* and *Lethrinus genivittatus*: found to be of importance to the similarity in both data types. The moderately abundant *Inimicus caledonicus* was also found to be an important contributor to similarity in both data types (Figure 18).

BH

(a)



Group BH

(b)

Average similarity: 37.82

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Torquigener pallimaculatus	0.040	3.030	5.72	8.00	8.00
Saurida undosquamis	0.110	3.030	5.72	8.00	16.00

Group BH

(c)

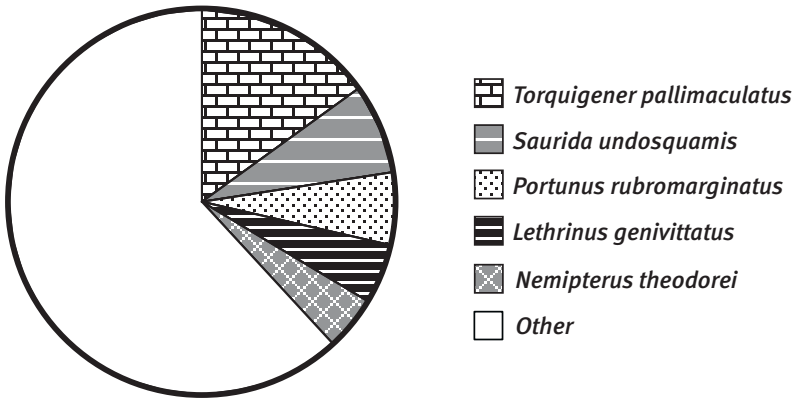
Average similarity: 34.95

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Lethrinus genivittatus	0.240	5.460	2.21	15.63	15.63
Saurida undosquamis	0.110	4.740	2.16	13.57	29.20
Paramonacanthus otisensis	0.060	3.300	5.39	9.43	38.64
Torquigener pallimaculatus	0.040	2.480	8.12	7.09	45.72
Pristotis jerdoni	0.130	2.320	0.58	6.64	52.36

Figure 12. Bustard Head Closure 2000 (a) five most abundant species; (b) average similarity value and species contributing to the upper 50% (catch rate data); (c) average similarity value and species contributing to the upper 10% (presence/absence data).

BH2000

(a)



Group BH2000

(b)

Average similarity: 40.41

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Saurida undosquamis	0.120	4.600	3.41	11.38	11.38
Torquigener pallimaculatus	0.250	3.900	2.64	9.65	21.03
Portunus rubromarginatus	0.100	3.460	1.56	8.57	29.59
Lethrinus genivittatus	0.080	2.920	1.60	7.23	36.82
Trachinocephalus myops	0.070	2.060	1.10	5.09	41.92
Paramonacanthus otisensis	0.040	2.020	1.57	4.99	46.90
Metapenaeopsis palmensis	0.040	1.780	1.25	4.42	51.32

Group BH2000

(c)

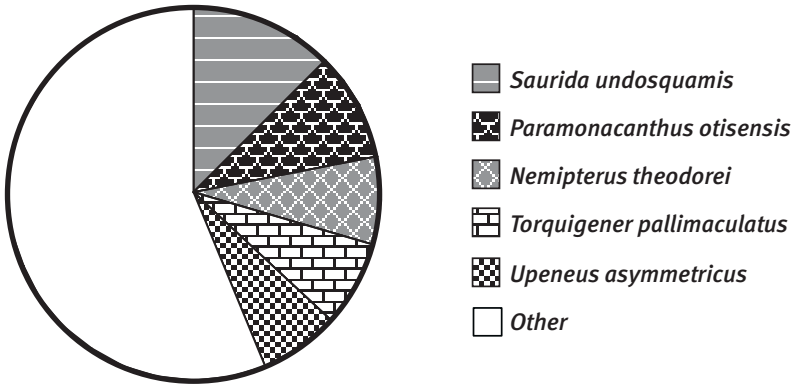
Average similarity: 49.76

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Torquigener pallimaculatus	0.250	2.810	6.36	5.64	5.64
Saurida undosquamis	0.120	2.810	6.36	5.64	11.28

Figure 13. Bustard Head Region 2000 (a) five most abundant species; (b) average similarity value and species contributing to the upper 50% (catch rate data); (c) average similarity value and species contributing to the upper 10% (presence/absence data).

SBH2000

(a)



Group SBH2000

(b)

Average similarity: 41.52

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Saurida undosquamis	0.240	6.400	2.65	15.42	15.42
Paramonacanthus otisensis	0.180	4.730	2.07	11.40	26.83
Portunus rubromarginatus	0.130	4.600	2.02	11.07	37.90
Torquigener pallimaculatus	0.140	3.050	1.80	7.35	45.24
Upeneus asymmetricus	0.130	2.450	0.88	5.89	51.14

Group SBH2000

(c)

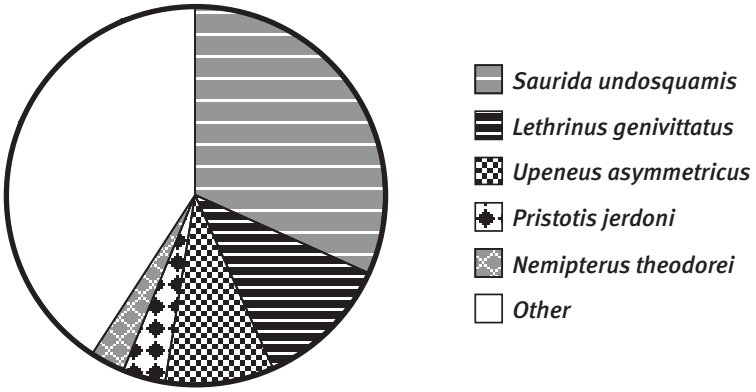
Average similarity: 51.67

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Saurida undosquamis	0.240	4.150	4.92	8.04	8.04
Portunus rubromarginatus	0.130	4.150	4.92	8.04	16.07

Figure 14. Region South Bustard Head 2000 (a) five most abundant species; (b) average similarity value and species contributing to the upper 50% (catch rate data); (c) average similarity value and species contributing to the upper 10% (presence/absence data).

BHB

(a)



Group BHB

(b)

Average similarity: 55.74

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Saurida undosquamis	0.530	6.230	4.69	11.17	11.17
Upeneus asymmetricus	0.150	5.690	3.98	10.21	21.38
Lethrinus genivittatus	0.190	5.320	14.56	9.55	30.93
Nemipterus theodorei	0.050	3.270	4.47	5.87	36.80
Apistus carinatus	0.040	2.860	5.55	5.12	41.93
Pristotis jerdoni	0.060	2.460	1.68	4.42	46.34
Engyprosopon grandisquama	0.040	2.360	3.27	4.24	50.59

Group BHB

(c)

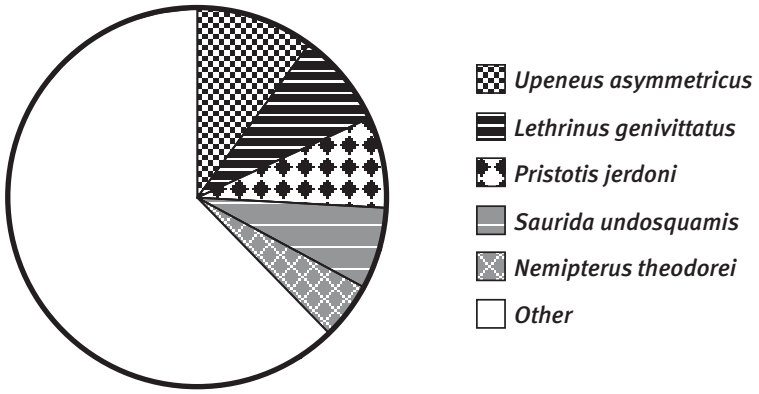
Average similarity: 62.58

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Torquigener pallimaculatus	0.020	2.440	9.59	3.90	3.90
Upeneus asymmetricus	0.150	2.440	9.59	3.90	7.81
Sepia plangon	0.020	2.440	9.59	3.90	11.71

Figure 15. Bustard Head Closure B 2002 (a) five most abundant species; (b) average similarity value and species contributing to the upper 50% (catch rate data); (c) average similarity value and species contributing to the upper 10% (presence/absence data).

BHC

(a)



Group BHC

(b)

Average similarity: 54.83

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Lethrinus genivittatus	0.110	3.650	2.82	6.65	6.65
Pristotis jerdoni	0.100	3.350	3.07	6.11	12.76
Upeneus asymmetricus	0.130	3.260	1.59	5.95	18.71
Portunus rubromarginatus	0.050	3.170	4.80	5.79	24.49
Torquigener pallimaculatus	0.040	3.050	3.49	5.56	30.06
Sepia plangon	0.040	2.810	4.64	5.12	35.18
Saurida undosquamis	0.090	2.700	1.22	4.93	40.11
Nemipterus theodorei	0.070	2.460	1.65	4.49	44.60
Ambiserrula jugosa	0.030	2.400	3.72	4.38	48.98
Engyprosopon grandisquama	0.020	1.970	3.85	3.59	52.57

Group BHC

(c)

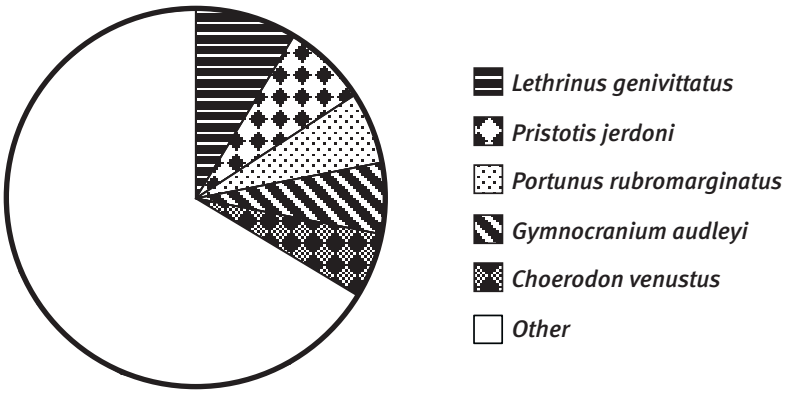
Average similarity: 62.38

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Torquigener pallimaculatus	0.040	2.050	11.64	3.28	3.28
Upeneus asymmetricus	0.130	2.050	11.64	3.28	6.56
Sepia plangon	0.040	2.050	11.64	3.28	9.84
Pristotis jerdoni	0.100	2.050	11.64	3.28	13.12

Figure 16. Bustard Head Closure C 2002 (a) five most abundant species; (b) average similarity value and species contributing to the upper 50% (catch rate data); (c) average similarity value and species contributing to the upper 10% (presence/absence data).

BHD

(a)



Group BHD

(b)

Average similarity: 59.02

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Lethrinus genivittatus	0.180	5.860	5.36	9.94	9.94
Pristotis jerdoni	0.150	4.990	3.22	8.46	18.39
Portunus rubromarginatus	0.120	4.560	3.05	7.72	26.11
Pentapodus nagasakiensis	0.070	3.740	3.83	6.33	32.44
Torquigener pallimaculatus	0.060	3.590	5.34	6.09	38.53
Saurida undosquamis	0.090	3.170	1.36	5.38	43.91
Sepia plangon	0.050	3.110	3.66	5.27	49.18
Upeneus tragula	0.060	3.020	2.93	5.11	54.29

Group BHD

(c)

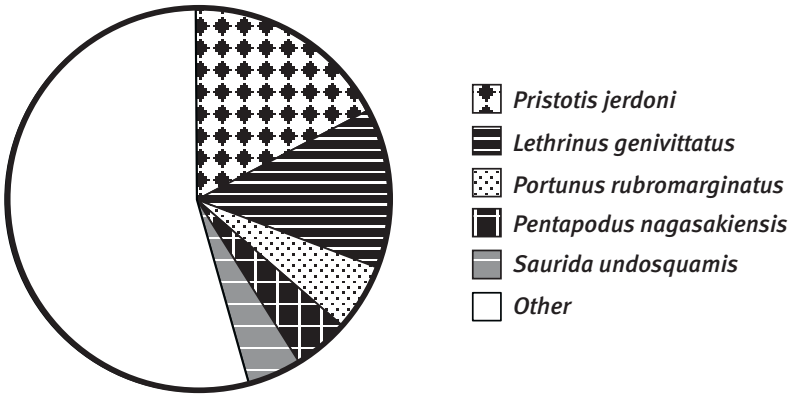
Average similarity: 59.72

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Torquigener pallimaculatus	0.060	2.300	10.65	3.85	3.85
Upeneus tragula	0.060	2.300	10.65	3.85	7.70
Sepia plangon	0.050	2.300	10.65	3.85	11.55

Figure 17. Bustard Head Closure D 2002 (a) five most abundant species; (b) average similarity value and species contributing to the upper 50% (catch rate data); (c) average similarity value and species contributing to the upper 10% (presence/absence data).

BH2002

(a)



Group BH2002

(b)

Average similarity: 42.06

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Lethrinus genivittatus	0.240	5.560	2.11	13.21	13.21
Pristotis jerdoni	0.320	4.020	1.20	9.57	22.78
Portunus rubromarginatus	0.100	2.930	1.56	6.97	29.74
Torquigener pallimaculatus	0.030	1.830	1.82	4.34	34.08
Inimicus caledonicus	0.040	1.650	1.27	3.92	38.00
Pentapodus nagasakiensis	0.090	1.480	0.62	3.52	41.52
Pentapodus paradiseus	0.050	1.330	0.82	3.17	44.69
Saurida undosquamis	0.080	1.140	0.48	2.71	47.40
Trachinocephalus myops	0.030	1.080	0.76	2.56	49.95
Gymnocranium audleyi	0.070	1.030	0.61	2.46	52.41

BH2002

(c)

Average similarity: 52.60

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Pristotis jerdoni	0.320	2.380	3.34	4.53	4.53
Lethrinus genivittatus	0.240	2.380	3.36	4.52	9.04
Inimicus caledonicus	0.040	2.090	2.07	3.97	13.01

Figure 18. Bustard Head Region 2002 (a) five most abundant species; (b) average similarity value and species contributing to the upper 50% (catch rate data); (c) average similarity value and species contributing to the upper 10% (presence/absence data).

Bustard Head Region dissimilarity summaries

Bustard Head Region 2000

Moderate dissimilarity (~60%) was observed between the sub-regions of 2000 (BH and BH2000). Two species identified in the similarity data, *Portunus rubromarginatus* and *Pristotis jerdoni*, contributed to the dissimilarity, but no significant difference was detected for either species between sub-regions in Bustard Head in 2000. *Pseudomancanthus peroni*, *Chaetodermis penicilligera* and *Pentapodus paradiseus* were all significantly more abundant in the closure. *Trachinocephalus myops* (also recognised in similarity data in BH2000) made an important contribution to the observed dissimilarity for both data types in the non-closure area (Table 7).

Bustard Head Region 2002

Moderate dissimilarity (~55%) was observed between the non-closure samples (BH2002) and the closure samples (BHB, BHC, BHD) of 2002 (Table 8, Table 9 and Table 10). *Saurida undosquamis* and *Upeneus asymmetricus* were more abundant in all closure areas compared with non-closure areas. *Nemipterus theodorei* was a significant cause of dissimilarity within closures BHB and BHC. *Pentapodus nagasakiensis* was signiciantly more abundant in the non-closure areas (BH2002) compared with all closures (BHB, BHC, BHD).

Bustard Head Closures 2002

Low dissimilarity (~45%) was observed between the Bustard Head Closures B and C (BHB, BHC) in 2002. *Parapercis nebulosa* contributed to dissimilarity for both data types and was significantly more abundant in Closure C than B. *Torquigener pallimaculatus* and *Sepia plangon* also contributed to dissimilarity (abundance data), consistent with the similarity data, but no significant difference between the sub-regions was detected. Moderate dissimilarity (~50%) between Closure D and the other closures (B and C) of Bustard Head was observed. Significantly more *Pentapodus nagasakiensis* and *Upeneus asymmetricus* were detected in the D closure than the others and accounted for an important amount of dissimilarity for both data types. Significantly more *Apistus carinatus* and *Nemipterus theodorei* were present in Closures B and C than in Closure D, accounting for further dissimilarity (abundance data). The significantly lower abundance of *Gymnocranium audleyi* in Closures B and C than in Closure D also accounted for some dissimilarity (abundance data) (Table 11, Table 12 and Table 13).

Bustard Head Region 2000 and 2002

The species recognised as important contributors to sample similarity in Bustard Head in 2000 and 2002 also contributed to the detected dissimilarity between years. *Saurida undosquamis* and *Torquigener pallimaculatus* were significant contributors to dissimilarity, being more abundant in 2000. *Pristotis jerdoni*, *Lenthrinus genivittatus*, *Pentapodus nagasakiensis*, *Inimicus caledonicus*, *Gymnocranius audleyi Metapenaeopsis palmensis*, *Ambiserrula jugosa* and *Inegocia japonica* were all significantly more abundant in 2002 than in 2000 (Table 14).

(a)

Groups BH2000 & BH

Average dissimilarity = 63.42

Species	BH2000 Av.Abund.	BH Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Upeneus asymmetricus	0.050	0.230	2.84	0.87	4.48	4.48
Lethrinus genivittatus	0.080	0.240	2.32	1.43	3.66	8.14
Dendronephthya spp	0.020	0.140	2.27	1.08	3.57	11.71*
Pristotis jerdoni	0.050	0.130	2.13	1.70	3.36	15.08
Torquigener pallimaculatus	0.250	0.040	1.72	0.70	2.71	17.78
Trachinocephalus myops	0.070	0.000	1.65	1.26	2.60	20.38*
Nemipterus theodorei	0.070	0.050	1.58	1.29	2.49	22.87
Portunus rubromarginatus	0.100	0.020	1.57	1.51	2.48	25.35
Inimicus sinensis	0.030	0.060	1.57	1.52	2.47	27.82
Pentapodus paradiseus	0.010	0.060	1.52	1.28	2.40	30.22*
Chaetodermis penicilligera	0.000	0.030	1.23	1.22	1.94	32.16*
Inegocia japonica	0.020	0.040	1.22	1.34	1.93	34.09
Sponge	0.050	0.010	1.22	0.77	1.93	36.02
Pseudomonacanthus peroni	0.000	0.040	1.20	0.97	1.90	37.91*
Choerodon venustus	0.010	0.050	1.10	0.74	1.73	39.64*
Saurida undosquamis	0.120	0.110	1.08	1.40	1.71	41.35
Pentaceraster sp.	0.030	0.000	1.03	0.97	1.63	42.99
Parapercis nebulosa	0.030	0.020	1.03	1.43	1.62	44.60
Annachlamys flabellata	0.030	0.000	1.02	0.92	1.60	46.20
Paramonacanthus otisensis	0.040	0.060	0.99	1.36	1.57	47.77
Siganus fuscescens	0.030	0.010	0.94	0.87	1.48	49.26
Metapenaeopsis palmensis	0.040	0.010	0.92	1.27	1.45	50.71

(b)

Groups BH2000 & BH

Average dissimilarity = 55.75

Species	BH2000 Av.Abund.	BH Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Pseudomonacanthus peroni	0.000	0.040	1.03	1.32	1.84	1.84*
Callionymus japonicus	0.010	0.010	0.97	1.23	1.73	3.57*
Trachinocephalus myops	0.070	0.000	0.94	1.19	1.68	5.25*
Chaetodermis penicilligera	0.000	0.030	0.91	1.30	1.64	6.89*
Pentapodus paradiseus	0.010	0.060	0.91	1.15	1.63	8.51*
Sorsogona tuberculata	0.000	0.010	0.85	1.14	1.52	10.04

Table 7. (a) Average dissimilarity value and species contributing to the upper 50% (catch rate data); (b) average dissimilarity value and species contributing to the upper 10% (presence/absence data) in the Bustard Head Region and Bustard Head Closure in 2000.
*** denotes a significant difference between groups detected.**

(a)

Groups BH2002 & BHB

Average dissimilarity = 59.45

Species	BH2002 B Av.Abund.	HB Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Saurida undosquamis	0.080	0.530	3.95	1.06	6.65	6.65*
Upeneus asymmetricus	0.050	0.150	2.66	2.19	4.48	11.13*
Pristotis jerdoni	0.320	0.060	2.64	1.04	4.43	15.56
Lethrinus genivittatus	0.240	0.190	1.78	1.27	3.00	18.57
Pentapodus nagasakiensis	0.090	0.000	1.75	0.97	2.94	21.51*
Nemipterus theodorei	0.050	0.050	1.53	1.59	2.58	24.09*
Portunus rubromarginatus	0.100	0.030	1.42	1.31	2.38	26.47
Gymnocranius audleyi	0.070	0.010	1.37	0.97	2.30	28.77*
Apistus carinatus	0.010	0.040	1.34	1.99	2.26	31.03*
Pseudorhombus spinosus	0.010	0.040	1.26	1.36	2.13	33.16*
Pentapodus paradiseus	0.050	0.020	1.19	1.02	2.00	35.16
Annachlamys flabellata	0.030	0.020	1.04	1.16	1.76	36.92
Acropora sp.	0.070	0.000	1.02	0.57	1.71	38.63*
Trachinocephalus myops	0.030	0.020	0.99	1.33	1.66	40.29
Inimicus caledonicus	0.040	0.030	0.96	1.42	1.61	41.90
Siganus fuscescens	0.030	0.010	0.96	1.04	1.61	43.51
Dasyatis kuhlii	0.010	0.020	0.94	0.96	1.58	45.09*
Paramonacanthus lowei	0.010	0.020	0.91	1.29	1.53	46.62
Callionymus japonicus	0.010	0.020	0.90	1.48	1.52	48.14*
Engyprosopon grandisquama	0.010	0.040	0.87	1.56	1.47	49.61*
Parapercis nebulosa	0.020	0.000	0.78	1.31	1.32	50.93*

(b)

Groups BH2002 & BHB

Average dissimilarity = 49.37

Species	BH2002 Av.Abund.	BHB Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Sargassum sp.	0.010	0.000	0.93	1.77	1.88	1.88*
Lepidotrigla argus	0.010	0.010	0.81	1.36	1.64	3.52
Apistus carinatus	0.010	0.040	0.80	1.26	1.61	5.13*
Sorsogona tuberculata	0.000	0.010	0.79	1.30	1.61	6.74*
Onigocia spinosa	0.010	0.000	0.79	1.35	1.59	8.33*
Lobophora variegata	0.020	0.000	0.78	1.36	1.58	9.92*
Metapenaeopsis lamellata	0.010	0.000	0.78	1.35	1.57	11.49*

Table 8. (a) Average dissimilarity value and species contributing to the upper 50% (catch rate data); (b) average dissimilarity value and species contributing to the upper 10% (presence/absence data) in the Bustard Head Region and Bustard Head Closure B in 2002.
*** denotes a significant difference between groups detected.**

(a)

Groups BH2002 & BHC

Average dissimilarity = 56.07

Species	BH2002 Av.Abund.	BHC Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Pristotis jerdoni	0.320	0.100	2.50	1.04	4.46	4.46
Upeneus asymmetricus	0.050	0.130	2.30	1.45	4.10	8.57*
Saurida undosquamis	0.080	0.090	1.94	1.45	3.46	12.03*
Lethrinus genivittatus	0.240	0.110	1.83	1.21	3.26	15.29
Pentapodus nagasakiensis	0.090	0.010	1.68	1.02	2.99	18.28*
Nemipterus theodorei	0.050	0.070	1.65	1.43	2.94	21.22*
Gymnocranius audleyi	0.070	0.030	1.46	1.12	2.60	23.82
Pentapodus paradiseus	0.050	0.020	1.31	1.00	2.34	26.16
Portunus rubromarginatus	0.100	0.050	1.16	1.14	2.07	28.23
Trachinocephalus myops	0.030	0.030	1.15	1.20	2.06	30.29
Annachlamys flabellata	0.030	0.030	1.13	1.19	2.02	32.30
Acropora sp.	0.070	0.000	1.00	0.57	1.78	34.08*
Inimicus caledonicus	0.040	0.040	0.97	1.36	1.74	35.82
Apistus carinatus	0.010	0.020	0.94	1.46	1.68	37.50*
Siganus fuscescens	0.030	0.010	0.91	1.00	1.63	39.13
Sepia plangon	0.020	0.040	0.90	1.49	1.60	40.73*
Paramonacanthus lowei	0.010	0.020	0.84	1.23	1.50	42.23
Ambiserrula jugosa	0.020	0.030	0.83	1.27	1.48	43.71*
Synodus sageneus	0.020	0.010	0.81	0.95	1.45	45.16
Choerodon venustus	0.020	0.010	0.81	0.86	1.44	46.60
Grammatobothus polyophthalmus	0.000	0.020	0.81	1.58	1.44	48.04*
Sepia papuensis	0.020	0.020	0.80	1.54	1.43	49.46*
Chaetodermis penicilligera	0.010	0.020	0.78	0.89	1.39	50.86

(b)

Groups BH2002 & BHC

Average dissimilarity = 46.98

Species	BH2002 Av.Abund.	BHC Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Sargassum sp.	0.010	0.000	0.78	1.53	1.67	1.67*
Lepidotrigla argus	0.010	0.010	0.73	1.29	1.55	3.22
Sicyonia lancifera	0.000	0.000	0.72	1.25	1.52	4.74*
Lobophora variegata	0.020	0.000	0.71	1.36	1.52	6.26*
Udotea sp.	0.000	0.000	0.70	1.28	1.49	7.75*
Apistus carinatus	0.010	0.020	0.69	1.20	1.46	9.21*
Dactylopus dactylopus	0.000	0.000	0.68	1.21	1.45	10.66

Table 9. (a) Average dissimilarity value and species contributing to the upper 50% (catch rate data); (b) average dissimilarity value and species contributing to the upper 10% (presence/absence data) in the Bustard Head Region and Bustard Head Closure C in 2002.
*** denotes a significant difference between groups detected.**

(a)

Groups BH2002 & BHD

Average dissimilarity = 53.18

Species	BH2002 Av.Abund.	BHD Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Pristotis jerdoni	0.320	0.150	2.47	1.17	4.65	4.65
Saurida undosquamis	0.080	0.090	1.98	1.60	3.72	8.37*
Gymnocranius audleyi	0.070	0.100	1.96	1.46	3.68	12.04*
Pentapodus nagasakiensis	0.090	0.070	1.73	1.79	3.25	15.29*
Lethrinus genivittatus	0.240	0.180	1.56	1.30	2.94	18.23
Portunus rubromarginatus	0.100	0.120	1.44	1.20	2.71	20.94
Nemipterus theodorei	0.050	0.020	1.32	0.99	2.49	23.43
Choerodon venustus	0.020	0.050	1.25	0.84	2.36	25.78
Upeneus tragula	0.020	0.060	1.24	1.56	2.33	28.12*
Pentapodus paradiseus	0.050	0.010	1.18	0.99	2.23	30.34
Sepia plangon	0.020	0.050	1.09	1.53	2.05	32.39*
Upeneus asymmetricus	0.050	0.000	1.08	0.67	2.03	34.42
Trachinocephalus myops	0.030	0.020	1.01	1.26	1.91	36.32
Acropora sp.	0.070	0.000	1.01	0.58	1.89	38.22*
Siganus fuscescens	0.030	0.020	0.97	1.20	1.83	40.05
Torquigener pallimaculatus	0.030	0.060	0.97	1.40	1.82	41.87
Inimicus caledonicus	0.040	0.040	0.90	1.47	1.69	43.56
Annachlamys flabellata	0.030	0.010	0.89	1.22	1.68	45.24
Grammatobothus polyophthalmus	0.000	0.020	0.85	1.17	1.60	46.84
Parapercis nebulosa	0.020	0.030	0.85	1.37	1.59	48.43*
Sepia papuensis	0.020	0.020	0.85	1.33	1.59	50.02

(b)

Groups BH2002 & BHD

Average dissimilarity = 46.22

Species	BH2002 Av.Abund.	BHD Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Sargassum sp.	0.010	0.000	0.82	1.47	1.77	1.77*
Udotea sp.	0.000	0.000	0.74	1.27	1.61	3.38*
Abalistes stellaris	0.000	0.000	0.69	1.12	1.49	4.88*
Parapriacanthus ransonneti	0.000	0.000	0.68	1.08	1.48	6.36*
Acropora sp.	0.070	0.000	0.67	1.13	1.45	7.81*
Liocranium praepositum	0.010	0.010	0.65	1.07	1.41	9.22
Rogadius patriciae	0.000	0.010	0.64	1.10	1.39	10.61*

Table 10. (a) Average dissimilarity value and species contributing to the upper 50% (catch rate data); (b) average dissimilarity value and species contributing to the upper 10% (presence/absence data) in the Bustard Head Region and Bustard Head Closure D in 2002.
*** denotes a significant difference between groups detected.**

(a)

Groups BHB & BHC

Average dissimilarity = 46.58

Species	BHB Av.Abund.	BHC Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Saurida undosquamis	0.530	0.090	3.02	0.78	6.48	6.48
Upeneus asymmetricus	0.150	0.130	1.44	1.27	3.09	9.57
Lethrinus genivittatus	0.190	0.110	1.39	0.98	2.99	12.56
Pristotis jerdoni	0.060	0.100	1.20	1.38	2.57	15.13
Pseudorhombus spinosus	0.040	0.010	1.13	1.43	2.43	17.56
Annachlamys flabellata	0.020	0.030	1.05	1.19	2.25	19.81
Trachinocephalus myops	0.020	0.030	1.00	1.36	2.15	21.96
Pentapodus paradiseus	0.020	0.020	0.96	1.36	2.07	24.03
Gymnocranius audleyi	0.010	0.030	0.96	1.31	2.06	26.09
Nemipterus theodorei	0.050	0.070	0.94	1.56	2.02	28.11
Dasyatis kuhlii	0.020	0.010	0.93	1.05	1.99	30.10
Paramonacanthus lowei	0.020	0.020	0.87	1.30	1.88	31.98
Parapercis nebulosa	0.000	0.020	0.87	2.06	1.86	33.84*
Inimicus caledonicus	0.030	0.040	0.86	1.55	1.84	35.68
Torquigener pallimaculatus	0.020	0.040	0.86	1.89	1.84	37.52
Sepia papuensis	0.000	0.020	0.81	2.01	1.73	39.25*
Apistus carinatus	0.040	0.020	0.79	1.39	1.70	40.96
Chaetodermis penicilligera	0.010	0.020	0.77	0.94	1.65	42.61
Portunus rubromarginatus	0.030	0.050	0.76	1.65	1.64	44.24
Liocranium praepositum	0.000	0.020	0.72	1.13	1.55	45.80*
Upeneus tragula	0.000	0.020	0.72	1.36	1.55	47.34
Callionymus japonicus	0.020	0.010	0.71	1.40	1.53	48.87
Sepia plangon	0.020	0.040	0.69	1.60	1.47	50.35

(b)

Groups BHB & BHC

Average dissimilarity = 38.50

Species	BHB Av.Abund.	BHC Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Dactylopus dactylopus	0.000	0.000	0.76	1.44	1.97	1.97*
Parapercis nebulosa	0.000	0.020	0.75	1.38	1.95	3.92*
Sicyonia lancifera	0.000	0.000	0.69	1.22	1.80	5.72*
Batrachomoeus dubius	0.000	0.000	0.69	1.22	1.79	7.51*
Upeneus tragula	0.000	0.020	0.66	1.18	1.72	9.23
Metapenaeopsis lamellata	0.000	0.000	0.63	1.10	1.63	10.86

Table 11. (a) Average dissimilarity value and species contributing to the upper 50% (catch rate data); (b) average dissimilarity value and species contributing to the upper 10% (presence/absence data) in Bustard Head Closure B and Bustard Head Closure C in 2002.
*** denotes a significant difference between groups detected.**

(a)

Groups BHB & BHD

Average dissimilarity = 54.64

Species	BHB Av.Abund.	BHD Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Upeneus asymmetricus	0.150	0.000	3.09	3.30	5.65	5.65*
Saurida undosquamis	0.530	0.090	2.92	0.77	5.34	10.99
Pentapodus nagasakiensis	0.000	0.070	2.27	3.13	4.16	15.14*
Gymnocranius audleyi	0.010	0.100	1.87	1.40	3.43	18.58*
Upeneus tragula	0.000	0.060	1.70	2.27	3.11	21.69*
Portunus rubromarginatus	0.030	0.120	1.62	1.62	2.96	24.65
Pristotis jerdoni	0.060	0.150	1.48	1.43	2.72	27.37
Pseudorhombus spinosus	0.040	0.000	1.31	1.43	2.39	29.76*
Parapercis nebulosa	0.000	0.030	1.29	2.56	2.35	32.11*
Apistus carinatus	0.040	0.010	1.27	1.96	2.32	34.43*
Nemipterus theodorei	0.050	0.020	1.25	1.58	2.29	36.72*
Lethrinus genivittatus	0.190	0.180	1.22	1.06	2.24	38.96
Torquigener pallimaculatus	0.020	0.060	1.10	1.83	2.01	40.97
Choerodon venustus	0.010	0.050	1.09	0.72	1.99	42.95
Dasyatis kuhlii	0.020	0.020	0.99	1.12	1.82	44.77
Callionymus japonicus	0.020	0.000	0.87	1.53	1.59	46.37*
Paramonacanthus lowei	0.020	0.010	0.87	1.28	1.59	47.96
Sepia plangon	0.020	0.050	0.86	1.48	1.58	49.53
Engyprosopon grandisquama	0.040	0.010	0.83	1.54	1.51	51.04

(b)

Groups BHB & BHD

Average dissimilarity = 45.66

Species	BHB Av.Abund.	BHD Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Pentapodus nagasa kiensis	0.000	0.070	1.19	8.93	2.60	2.60*
Upeneus asymmetricus	0.150	0.000	1.03	2.32	2.26	4.86*
Sorsogona tuberculata	0.010	0.000	0.88	1.62	1.94	6.79*
Lobophora variegata	0.000	0.000	0.85	1.53	1.87	8.67*
Onigocia spinosa	0.000	0.010	0.84	1.53	1.84	10.50*

Table 12. (a) Average dissimilarity value and species contributing to the upper 50% (catch rate data); (b) average dissimilarity value and species contributing to the upper 10% (presence/absence data) in Bustard Head Closure B and Bustard Head Closure D in.
*** denotes a significant difference between groups detected.**

(a)

Groups BHC & BHD

Average dissimilarity = 47.00

Species	BHC Av.Abund.	BHD Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Upeneus asymmetricus	0.130	0.000	2.48	1.60	5.27	5.27*
Pentapodus nagasakiensis	0.010	0.070	1.92	2.05	4.09	9.36*
Gymnocranius audleyi	0.030	0.100	1.67	1.28	3.55	12.91*
Nemipterus theodorei	0.070	0.020	1.40	1.41	2.98	15.89*
Saurida undosquamis	0.090	0.090	1.31	1.13	2.78	18.67
Lethrinus genivittatus	0.110	0.180	1.30	1.17	2.77	21.44
Pristotis jerdoni	0.100	0.150	1.27	1.25	2.71	24.15
Upeneus tragula	0.020	0.060	1.17	1.37	2.49	26.64
Portunus rubromarginatus	0.050	0.120	1.13	1.34	2.41	29.05
Choerodon venustus	0.010	0.050	1.11	0.79	2.36	31.41
Trachinocephalus myops	0.030	0.020	1.02	1.28	2.17	33.58
Apistus carinatus	0.020	0.010	0.90	1.46	1.92	35.50
Annachlamys flabellata	0.030	0.010	0.89	1.18	1.90	37.40
Pentapodus paradiseus	0.020	0.010	0.88	1.49	1.88	39.28
Dasyatis kuhlii	0.010	0.020	0.86	0.97	1.83	41.12
Grammatobothus polyophthalmus	0.020	0.020	0.84	1.40	1.79	42.91
Paramonacanthus lowei	0.020	0.010	0.81	1.23	1.71	44.62
Inimicus caledonicus	0.040	0.040	0.78	1.44	1.66	46.28
Rogadius patriciae	0.010	0.010	0.75	1.19	1.59	47.87*
Chaetodermis penicilligera	0.020	0.010	0.73	0.89	1.55	49.43
Liocranium praepositum	0.020	0.010	0.68	1.22	1.45	50.88

(b)

Groups BHC & BHD

Average dissimilarity = 40.28

Species	BHC Av.Abund.	BHD Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Upeneus asymmetricus	0.130	0.000	0.94	2.36	2.33	2.33*
Lobophora variegata	0.000	0.000	0.78	1.54	1.94	4.27*
Pentapodus nagasakiensis	0.010	0.070	0.73	1.38	1.81	6.07*
Lepidotrigla argus	0.010	0.000	0.68	1.25	1.68	7.76*
Erosa erosa	0.000	0.000	0.62	1.13	1.55	9.31
Apistus carinatus	0.020	0.010	0.59	1.10	1.47	10.78

Table 13. (a) Average dissimilarity value and species contributing to the upper 50% (catch rate data); (b) average dissimilarity value and species contributing to the upper 10% (presence/absence data) in Bustard Head Closure C and Bustard Head Closure D in 2002.
*** denotes a significant difference between groups detected.**

(a)

Groups BH2000 & BH2002

Average dissimilarity = 68.00

Species	BH2000 Av.Abund.	BH2002 Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%*
Pristotis jerdoni	0.050	0.320	2.96	1.05	4.35	4.35*
Lethrinus genivittatus	0.080	0.240	2.25	1.28	3.31	7.66*
Saurida undosquamis	0.120	0.080	2.20	1.76	3.23	10.89*
Torquigener pallimaculatus	0.250	0.030	1.91	0.76	2.80	13.69*
Pentapodus nagasakiensis	0.040	0.090	1.89	1.10	2.78	16.48
Nemipterus theodorei	0.070	0.050	1.70	1.10	2.51	18.98
Portunus rubromarginatus	0.100	0.100	1.57	1.19	2.31	21.29
Upeneus asymmetricus	0.050	0.050	1.49	0.83	2.19	23.48*
Gymnocranius audleyi	0.000	0.070	1.46	0.85	2.15	25.63
Trachinocephalus myops	0.070	0.030	1.45	1.21	2.13	27.75*
Inimicus caledonicus	0.000	0.040	1.43	1.52	2.10	29.85*
Pentapodus paradiseus	0.010	0.050	1.39	0.97	2.04	31.89*
Metapenaeopsis palmensis	0.040	0.010	1.36	1.33	2.00	33.88
Siganus fuscescens	0.030	0.030	1.22	0.95	1.79	35.67
Annachlamys flabellata	0.030	0.030	1.21	1.14	1.78	37.45*
Sponge	0.050	0.010	1.16	0.67	1.70	39.15*
Paramonacanthus otisensis	0.040	0.020	1.05	1.38	1.55	40.70*
Acropora sp.	0.000	0.070	1.05	0.57	1.55	42.25*
Pentaceraster sp.	0.030	0.000	1.00	0.86	1.48	43.72*
Inimicus sinensis	0.030	0.000	1.00	0.98	1.47	45.19*
Ambiserrula jugosa	0.000	0.020	0.96	1.21	1.41	46.60
Parapercis nebulosa	0.030	0.020	0.93	1.36	1.37	47.97
Dendronephthya spp	0.020	0.010	0.92	0.82	1.35	49.32*
Inegocia japonica	0.020	0.000	0.89	1.14	1.32	50.63

(b)

Groups BH2000 & BH2002

Average dissimilarity = 60.41

Species	BH2000 Av.Abund.	BH2002 Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Inimicus caledonicus	0.000	0.040	1.21	2.83	2.00	2.00*
Metapenaeopsis mogiensis	0.000	0.010	1.03	1.89	1.71	3.72*
Ambiserrula jugosa	0.000	0.020	0.92	1.52	1.53	5.24*
Synodus tectus	0.000	0.010	0.91	1.53	1.51	6.75*
Metapenaeopsis palmensis	0.040	0.010	0.91	1.38	1.50	8.25*
Gymnocranius audleyi	0.000	0.070	0.88	1.33	1.46	9.71*
Inegocia japonica	0.020	0.000	0.86	1.36	1.43	11.14*

Table 14. (a) Average dissimilarity value contributing to the upper 50% (catch rate data); (b) average dissimilarity value contributing to the upper 10% (presence/absence data) in the Bustard Head Region in 2000 and Bustard Head Region in 2002.
*** denotes a significant difference between groups detected.**

Hervey Bay Region ordination plot

The ordination plot of samples from the Hervey Bay Region is a good representation of the similarity matrix data used to produce it (Stress = 0.17). More discrete clustering occurred for 2002 sub-regions than those of 2000. All the 2002 sub-regions are more similar to other 2002 sub-regions than to any 2000 sub-region. Some overlap exists between samples from Hervey Bay (HB2000) and south Bustard Head samples (SBH200) from 2000. One outlier from Hervey Bay Closure A (HBA) in 2002 is unlike any other sample from the region (Figure 19).

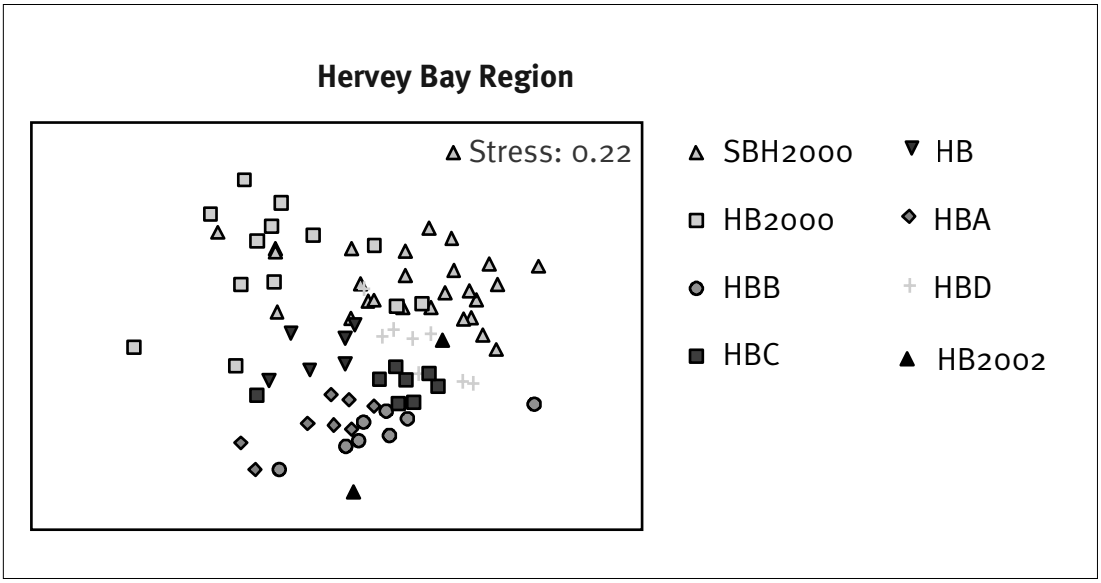


Figure 19. Multi-dimensional scaling of benthic fauna samples from Hervey Bay Region (HB, HB2000, HBA, HBB, HBC, HBD, HB2002) (n = 54) and south Bustard Head Region (SBH2000) (n = 27).

Hervey Bay Region similarity summaries

Hervey Bay Region 2000

The most important contributor to overall similarity (~45%) in Hervey Bay in 2000 for the closure and non-closure alike (HB and HB2000 respectively) was the moderately abundant *Saurida undosquamis* (both data types). *Portunus rubromarginatus* also contributed to detected similarity in the closure and the non-closure (both data types). Two other species, *Torquigener pallimaculatus* (more so in closure) and *Paramonacanthus otisensis* (more so in non-closure), also contributed to similarity in each sub-region (both data types). The moderate abundance of *Annachlamys flabellata* and *Inimicus sinensis* further characterised closure samples while the moderately abundant *Lethrinus genivittatus* was characteristic of the non-closure samples (Figure 20 and Figure 21).

Hervey Bay Closures 2002

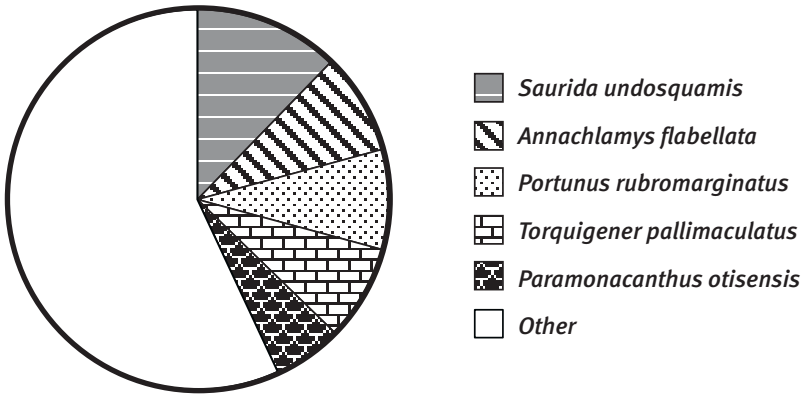
The samples from the closures of Hervey Bay in 2002 (HBA, HBB, HBC, HBD) exhibited low to moderately high within sub-region similarity (~40-65%). A large portion of this similarity in each closure was accounted for by moderate abundances of *Portunus rubromarginatus* and *Saurida undosquamis* (abundance data). Moderate to low abundances of *Paramonacanthus otisensis* and *Engyprosopon grandisquama* also contributed to similarity (abundance data) in all closures. In Closures A and B the low abundance of *Inimicus caledonicus* and *Pristotis jerdoni* (abundance data) and the presence of *Sepia papuensis* and sponge (binary data) were identified as important contributors to sample similarity.
In Closures B and C it was *Torquigener pallimaculatus* in moderate abundance contributing further to sample similarity (binary data). In Closure D the high abundance of *Upeneus asymmetricus* and moderate abundance of *Saurida undosquamis* accounted for much similarity in both data types (Figure 22, Figure 23, Figure 24 and Figure 25).

Hervey Bay Region 2002

Moderate similarity between samples (~50%) was observed in the Hervey Bay non-closure region (HB2002) in 2002. Moderate abundances of *Nemipterus theodorei*, *Portunus rubromarginatus*, *Paramonacanthus otisensis* (abundance data) and lower abundances of *Pristotis jerdoni* (both data types) accounted for much of the observed similarity of samples in this sub-region (Figure 26).

HB

(a)



Group HB

Average similarity: 50.04

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Saurida undosquamis	0.130	5.750	2.73	11.48	11.48
Torquigener pallimaculatus	0.090	5.340	3.59	10.67	22.15
Portunus rubromarginatus	0.090	4.760	5.08	9.52	31.67
Paramonacanthus otisensis	0.060	3.830	1.94	7.66	39.32
Annachlamys flabellata	0.090	3.260	2.06	6.51	45.83
Inimicus sinensis	0.050	3.030	5.34	6.06	51.88

Group HB

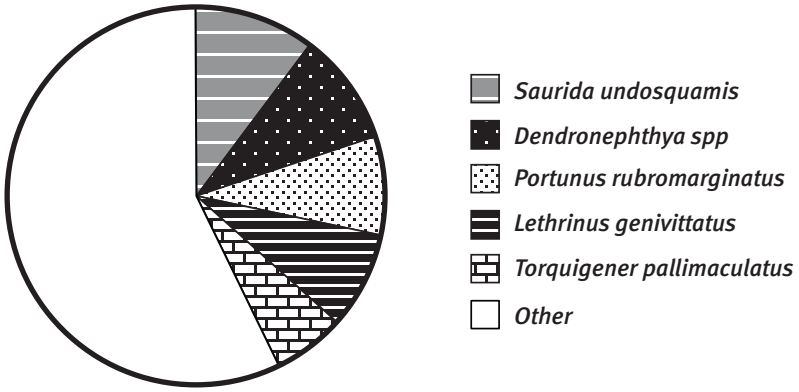
Average similarity: 55.83

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Torquigener pallimaculatus	0.090	2.920	8.80	5.23	5.23
Saurida undosquamis	0.130	2.920	8.80	5.23	10.45

Figure 20. Hervey Bay Closure 2000 (a) five most abundant species (b) average similarity value and species contributing to the upper 50% (catch rate data); (b) average similarity value and species contributing to the upper 10% (presence/absence data).

HB2000

(a)



Group HB2000

Average similarity: 37.49

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Saurida undosquamis	0.110	5.910	1.80	15.76	15.76
Lethrinus genivittatus	0.090	5.110	1.53	13.64	29.40
Torquigener pallimaculatus	0.070	3.290	1.77	8.79	38.18
Portunus rubromarginatus	0.090	3.140	1.46	8.38	46.56
Paramonacanthus otisensis	0.070	2.980	2.31	7.95	54.51

Group HB2000

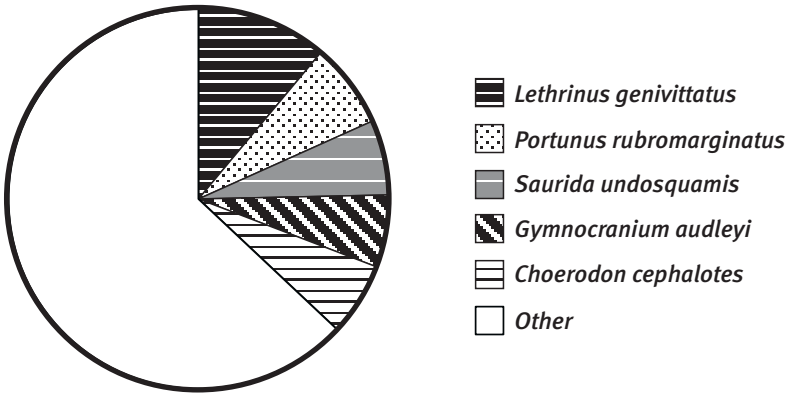
Average similarity: 45.88

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Paramonacanthus otisensis	0.070	3.950	5.34	8.62	8.62
Saurida undosquamis	0.110	3.370	2.09	7.36	15.98

Figure 21. Hervey Bay Region 2000 (a) five most abundant species; (b) average similarity value and species contributing to the upper 50% (catch rate data); (c) average similarity value and species contributing to the upper 10% (presence/absence data).

HBA

(a)



Group HBA

Average similarity: 40.66

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Portunus rubromarginatus	0.070	2.850	1.55	7.01	7.01
Torquigener pallimaculatus	0.050	2.460	1.41	6.04	13.06
Sponge B	0.030	2.270	2.49	5.59	18.65
Saurida undosquamis	0.060	2.270	0.90	5.59	24.24
Inimicus caledonicus	0.040	2.250	1.43	5.52	29.76
Ambiserrula jugosa	0.020	2.070	1.61	5.09	34.85
Pristotis jerdoni	0.020	1.990	1.33	4.89	39.74
Paramonacanthus otisensis	0.030	1.820	1.16	4.47	44.21
Engyprosopon grandisquama	0.020	1.750	1.49	4.31	48.52
Lethrinus genivittatus	0.110	1.670	0.95	4.12	52.64

Group HBA

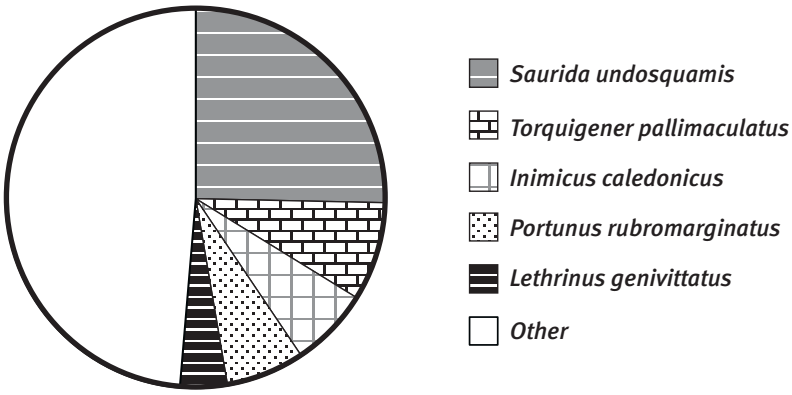
Average similarity: 51.14

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Sponge B	0.030	3.200	3.47	6.26	6.26
Sepia papuensis	0.020	2.430	1.47	4.76	11.02

Figure 22. Hervey Bay Closure A 2002 (a) five most abundant species; (b) average similarity value and species contributing to the upper 50% (catch rate data); (c) average similarity value and species contributing to the upper 10% (presence/absence data).

HBB

(a)



Group HBB

Average similarity: 52.31

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Saurida undosquamis	0.380	4.260	1.34	8.14	8.14
Inimicus caledonicus	0.100	3.250	2.45	6.22	14.36
Portunus rubromarginatus	0.100	3.170	2.02	6.07	20.42
Torquigener pallimaculatus	0.130	2.750	1.60	5.26	25.69
Nemipterus theodorei	0.050	2.720	4.42	5.21	30.89
Paramonacanthus otisensis	0.030	2.540	2.91	4.86	35.75
Engyprosopon grandisquama	0.040	2.470	2.64	4.73	40.48
Metapenaeopsis mogiensis	0.050	2.290	3.29	4.37	44.85
Annachlamys flabellata	0.030	1.960	1.55	3.74	48.59
Pristotis jerdoni	0.020	1.750	2.72	3.35	51.94

Group HBB

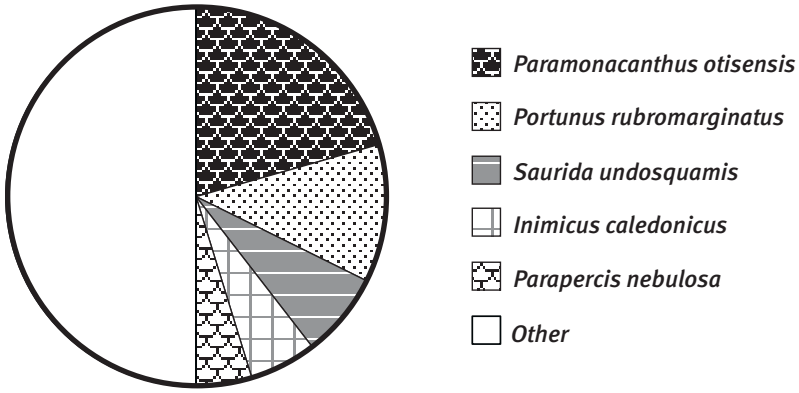
Average similarity: 64.50

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Torquigener pallimaculatus	0.130	2.540	11.84	3.94	3.94
Sepia papuensis	0.010	2.540	11.84	3.94	7.88
Sponge B	0.010	2.540	11.84	3.94	11.82

Figure 23. Hervey Bay Closure B 2002 (a) five most abundant species; (b) average similarity value and species contributing to the upper 50% (catch rate data); (c) average similarity value and species contributing to the upper 10% (presence/absence data).

HBC

(a)



Group HBC

Average similarity: 64.11

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Paramonacanthus otisensis	0.300	9.460	6.04	14.76	14.76
Portunus rubromarginatus	0.170	6.180	2.48	9.64	24.40
Saurida undosquamis	0.110	5.020	4.13	7.83	32.23
Inimicus caledonicus	0.080	4.200	3.93	6.55	38.79
Engyprosopon grandisquama	0.050	3.620	7.25	5.65	44.44
Torquigener pallimaculatus	0.070	3.580	5.35	5.58	50.02

Group HBC

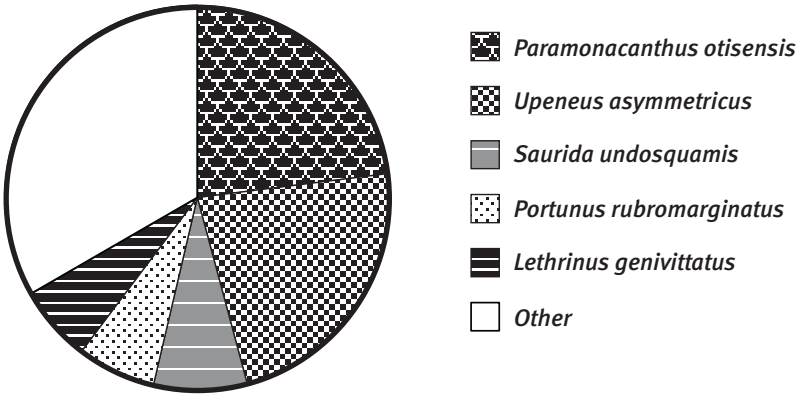
Average similarity: 68.51

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Torquigener pallimaculatus	0.070	3.210	9.58	4.68	4.68
Torquigener perlevis	0.060	3.210	9.58	4.68	9.37
Sorsogona tuberculata	0.010	3.210	9.58	4.68	14.05

Figure 24. Hervey Bay Closure C 2002 (a) five most abundant species; (b) average similarity value and species contributing to the upper 50% (catch rate data); (c) average similarity value and species contributing to the upper 10% of the similarity (presence/absence data).

HBD

(a)



Group HBD

Average similarity: 54.46

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Paramonacanthus otisensis	0.260	11.110	3.84	20.40	20.40
Upeneus asymmetricus	0.260	5.940	1.19	10.90	31.30
Portunus rubromarginatus	0.080	5.660	3.42	10.40	41.70
Engyprosopon grandisquama	0.030	3.830	6.09	7.03	48.73
Saurida undosquamis	0.090	3.490	2.90	6.41	55.14

Group HBD

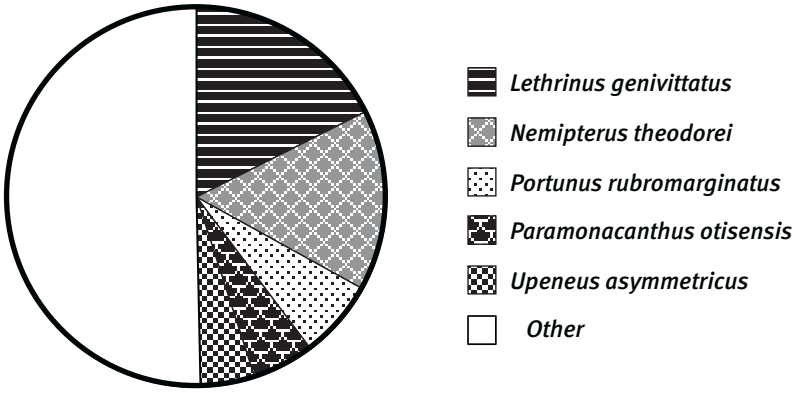
Average similarity: 58.75

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Upeneus asymmetricus	0.260	4.210	6.25	7.16	7.16
Saurida undosquamis	0.090	4.210	6.25	7.16	14.32

Figure 25. Hervey Bay Closure D 2002 (a) five most abundant species; (b) average similarity value and species contributing to the upper 50% (catch rate data); (c) average similarity value and species contributing to the upper 10% (presence/absence data).

HB2002

(a)



Group HB2002

Average similarity: 47.17

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Nemipterus theodorei	0.170	7.850	12.75	16.64	16.64
Paramonacanthus otisensis	0.060	3.950	2.46	8.39	25.02
Engyprosopon grandisquama	0.030	3.580	11.69	7.58	32.61
Callionymus japonicus	0.030	3.480	9.68	7.37	39.98
Portunus rubromarginatus	0.070	2.700	1.27	5.73	45.71
Pristotis jerdoni	0.020	1.980	3.64	4.20	49.91
Grammatobothus polyophthalmus	0.010	1.940	2.06	4.11	54.02

Group HB2002

Average similarity: 58.77

Species	Av.Abund.	Av.Sim.	Sim./SD	Contrib.%	Cum.%
Pristotis jerdoni	0.020	3.090	42.01	5.26	5.26
Saurida undosquamis	0.030	3.090	42.01	5.26	10.53

Figure 26. Hervey Bay region 2002 (a) five most abundant species; (b) average similarity value and species contributing to the upper 50% (catch rate data); (c) average similarity value and species contributing to the upper 10% (presence/absence data).

Hervey Bay Region dissimilarity summaries

Hervey Bay Region 2000

There was high dissimilarity (~65%) observed between samples from Hervey Bay closure and non-closure areas (HB and HB2000) in 2000. The dissimilarity (both data types) was attributable to the significantly greater abundance of *Choerodon cephalotes* and *Siganus fuscescens* in the non-closure area. *Annachlymus flabellata*, *Chaetodermis pencilligera*, *Inimicus caledonicus*, *Lepidotrigla* cf. *japonica* and *Grammatobothus polyophthalmus* in the closure HB compared to non-closure HB2000. *Upeneus asymmetricus* and *Lethrinus genivittatus* were more abundant in the non-closure area (HB2000) (Table 15).

Hervey Bay Region 2002

Moderate dissimilarity (~55%) was detected between the Hervey Bay non-closure (HB2002) and closure areas (HBA, HBB, HBC and HBD) in 2002. Across all closures *Nemipterus theodorei* accounted for much dissimilarity (abundance data) and occurred in significantly higher abundance in the non-closure area than any closure area. Closures A, B and C exhibited dissimilarity (binary data) to the non-closure, attributable to the (significant) presence of *Batrachomoeus dubius* in these closures and the absence of *Choerodon sugillatum* from them. Closures A and D were further dissimilar from the non-closure on account of the significantly lower abundance of dragonet *Callionymus japonicus* inside the closures. Significantly more *Sepia papuensis* inside Closures A and B further defined the dissimilarity observed between these closures and the non-closure area (binary data), while *Sepia plangon* was significantly more plentiful in Closures B and C and further defined the dissimilarity (both data types) between these closures and the non-closure. Closure D was further dissimilar (both data types) from the non-closure on account of significant differences in the abundance of *Callionymus limceps* (more in closure) and *Pristotis jerdoni* (more in non-closure) (Table 16, Table 17, Table 18 and Table 19).

Hervey Bay Closures 2002

Dissimilarity was detected between each of the closures in Hervey Bay in 2002 (HBA, HBB, HBC, HBD) (50–67%) (Table 20, Table 21, Table 22, Table 23, Table 24 and Table 25). This was attributable to significantly more *Upeneues asymmetricus* in Closure D than B and significantly more abundant *Pristotis jerdoni* and *Annachlamys flabellata* in Closure B than D. Greater abundance of *Inimicus caledonicus*, *Lepidotrigla argus* and *Torquigener perlevis* caused dissimilarity between HBC and HBD.

Hervey Bay Region 2000 and 2002

High dissimilarity was observed between HB2000 and HB2002 at 69%. *Nemipterus theoderei*, *Callionmyus japonica*, *Sepia whitleyana*, *Ambiserrula jugosa*, *Inimicus caledonicus* were all significantly more abundant in 2002 than in 2000 (Table 26).

(a)

Groups HB & HB2000

Average dissimilarity = 64.49

Species	HB Av.Abund.	HB2000 Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Annachlamys flabellata	0.090	0.020	2.78	1.51	4.32	4.32*
Lethrinus genivittatus	0.020	0.090	2.45	1.60	3.80	8.12*
Siganus fuscescens	0.000	0.060	2.06	0.98	3.19	11.31*
Portunus rubromarginatus	0.090	0.090	1.96	1.36	3.04	14.36
Torquigener pallimaculatus	0.090	0.070	1.91	1.64	2.96	17.31
Saurida undosquamis	0.130	0.110	1.85	1.22	2.86	20.18
Paramonacanthus otisensis	0.060	0.070	1.84	1.92	2.85	23.03
Chaetodermis penicilligera	0.040	0.020	1.83	1.54	2.83	25.86*
Inimicus sinensis	0.050	0.020	1.82	1.62	2.82	28.68*
Lepidotrigla argus	0.040	0.000	1.64	1.11	2.54	31.22*
Grammatobothus polyophthalmus	0.020	0.000	1.63	3.21	2.52	33.74*
Sepia opipara	0.050	0.000	1.61	0.95	2.50	36.24
Choerodon cephalotes	0.000	0.040	1.46	0.92	2.26	38.50*
Algae	0.000	0.040	1.40	0.68	2.17	40.67
Nemipterus theodorei	0.030	0.010	1.34	1.01	2.07	42.74
Torquigener perlevis	0.020	0.010	1.25	1.17	1.94	44.68*
Inegocia harrisii	0.020	0.000	1.22	1.04	1.89	46.57*
Lepidotrigla cf japonica	0.030	0.000	1.20	0.52	1.87	48.44*
Upeneus asymmetricus	0.000	0.030	1.16	0.81	1.80	50.23*

(b)

Groups HB & HB2000

Average dissimilarity = 55.48

Species	HB Av.Abund.	HB2000 Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Grammatobothus polyophthalmus	0.020	0.000	1.46	2.18	2.64	2.64*
Apogon nigripinnis	0.000	0.000	1.23	1.44	2.21	4.84*
Choerodon cephalotes	0.000	0.040	1.16	1.39	2.10	6.94*
Lepidotrigla argus	0.040	0.000	1.09	1.29	1.97	8.91*
Siganus fuscescens	0.000	0.060	1.09	1.25	1.96	10.87*

Table 15. (a) Average dissimilarity value and species contributing to the upper 50% (catch rate data); (b) Average dissimilarity value and species contributing to the upper 10% (presence/absence data) in the Hervey Bay Closure and Hervey Bay region in 2000.
*** denotes a significant difference between groups detected.**

(a)

Groups HBA & HB2002

Average dissimilarity = 62.92

Species	HBA Av.Abund.	HB2002 Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Nemipterus theodorei	0.010	0.170	4.03	2.10	6.41	6.41*
Lethrinus genivittatus	0.110	0.190	3.50	1.01	5.57	11.97
Portunus rubromarginatus	0.070	0.070	1.98	1.17	3.15	15.12
Saurida undosquamis	0.060	0.030	1.84	1.34	2.92	18.04
Upeneus asymmetricus	0.000	0.050	1.77	1.00	2.82	20.86*
Sponge B	0.030	0.000	1.66	2.31	2.64	23.50*
Callionymus japonicus	0.000	0.030	1.65	1.85	2.63	26.13*
Sepia whitleyana	0.000	0.030	1.65	1.09	2.62	28.75*
Choerodon cephalotes	0.060	0.010	1.60	1.00	2.54	31.28
Metapenaeopsis mogiensis	0.050	0.000	1.58	1.12	2.51	33.79*
Torquigener pallimaculatus	0.050	0.020	1.54	1.25	2.45	36.25
Gymnocranius audleyi	0.060	0.010	1.54	0.79	2.44	38.69
Paramonacanthus otisensis	0.030	0.060	1.51	0.97	2.40	41.09
Torquigener perlevis	0.040	0.010	1.44	1.24	2.30	43.39
Choerodon venustus	0.000	0.030	1.34	0.72	2.13	45.51
Sepia papuensis	0.020	0.000	1.34	1.54	2.12	47.64*
Inimicus caledonicus	0.040	0.020	1.27	1.21	2.02	49.66
Pentapodus paradiseus	0.010	0.020	1.27	1.06	2.02	51.68

(b)

Groups HBA & HB2002

Average dissimilarity = 52.90

Species	HBA Av.Abund.	HB2002 Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Sponge B	0.030	0.000	1.59	3.93	3.01	3.01*
Choerodon sugillatum	0.000	0.010	1.59	3.93	3.01	6.02*
Sepia papuensis	0.020	0.000	1.41	2.08	2.66	8.67*
Batrachomoeus dubius	0.010	0.000	1.41	2.08	2.66	11.33*

Table 16. (a) Average dissimilarity value and species contributing to the upper 50% (catch rate data); (b) Average dissimilarity value and species contributing to the upper 10% (presence/absence data) in Hervey Bay Closure A and Hervey Bay Region 2002.
*** denotes a significant difference between groups detected.**

(a)

Groups HBB & HB2002

Average dissimilarity = 57.52

Species	HBB Av.Abund.	HB2002 Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Saurida undosquamis	0.380	0.030	3.69	1.01	6.42	6.42
Lethrinus genivittatus	0.060	0.190	2.91	1.10	5.07	11.49
Torquigener pallimaculatus	0.130	0.020	2.12	1.12	3.69	15.18
Nemipterus theodorei	0.050	0.170	2.09	1.76	3.63	18.80
Inimicus caledonicus	0.100	0.020	1.77	1.41	3.07	21.88
Portunus rubromarginatus	0.100	0.070	1.70	1.10	2.96	24.84
Sepia whitleyana	0.050	0.030	1.63	1.38	2.83	27.67
Upeneus asymmetricus	0.000	0.050	1.55	1.05	2.70	30.36*
Metapenaeopsis mogiensis	0.050	0.000	1.48	1.30	2.58	32.94*
Sepia plangon	0.030	0.000	1.34	1.51	2.33	35.27*
Paramonacanthus lowei	0.030	0.000	1.33	1.50	2.31	37.59*
Upeneus luzonius	0.000	0.020	1.25	1.35	2.17	39.76*
Annachlamys flabellata	0.030	0.000	1.23	2.01	2.14	41.90
Chaetodermis penicilligera	0.030	0.000	1.17	0.94	2.04	43.93*
Choerodon venustus	0.000	0.030	1.11	0.76	1.93	45.86
Pseudorhombus spinosus	0.020	0.020	1.10	1.09	1.92	47.78
Ambiserrula jugosa	0.030	0.020	1.09	1.46	1.90	49.67
Torquigener perlevis	0.030	0.010	1.07	1.25	1.86	51.53

(b)

Groups HBB & HB2002

Average dissimilarity = 47.15

Species	HBB Av.Abund.	HB2002 Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Sepia papuensis	0.010	0.000	1.40	13.81	2.96	2.96*
Sponge B	0.010	0.000	1.40	13.81	2.96	5.92*
Batrachomoeus dubius	0.010	0.000	1.40	13.81	2.96	8.89*
Choerodon sugillatum	0.000	0.010	1.40	13.81	2.96	11.85*

Table 17. (a) Average dissimilarity value and species contributing to the upper 50% (catch rate data); (b) Average dissimilarity value and species contributing to the upper 10% (presence/absence data) in Hervey Bay Closure B and the Hervey Bay Region 2002.
*** denotes a significant difference between groups detected.**

(a)

Groups HBC & HB2002

Average dissimilarity = 53.94

Species	HBC Av.Abund.	HB2002 Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Paramonacanthus otisensis	0.300	0.060	3.19	2.96	5.91	5.91
Lethrinus genivittatus	0.010	0.190	2.58	0.96	4.78	10.70
Portunus rubromarginatus	0.170	0.070	2.12	1.38	3.93	14.63
Nemipterus theodorei	0.050	0.170	2.11	1.70	3.90	18.53*
Lepidotrigla argus	0.060	0.010	1.88	1.58	3.48	22.00
Upeneus asymmetricus	0.070	0.050	1.87	1.31	3.46	25.47
Saurida undosquamis	0.110	0.030	1.76	1.69	3.27	28.74
Inimicus caledonicus	0.080	0.020	1.64	1.70	3.04	31.78*
Parapercis nebulosa	0.070	0.020	1.60	1.62	2.97	34.75
Torquigener pallimaculatus	0.070	0.020	1.53	1.34	2.84	37.58
Torquigener perlevis	0.060	0.010	1.44	1.06	2.68	40.26*
Sepia whitleyana	0.000	0.030	1.40	1.19	2.60	42.86*
Pseudorhombus spinosus	0.020	0.020	1.32	1.68	2.44	45.30
Sepia plangon	0.020	0.000	1.29	1.69	2.39	47.69*
Upeneus luzonius	0.000	0.020	1.26	1.37	2.34	50.02*

(b)

Groups HBC & HB2002

Average dissimilarity = 43.24

Species	HBC Av.Abund.	HB2002 Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Batrachomoeus dubius	0.010	0.000	1.58	12.54	3.65	3.65*
Choerodon sugillatum	0.000	0.010	1.58	12.54	3.65	7.29*
Sepia plangon	0.020	0.000	1.40	2.54	3.24	10.53*

Table 18. (a) Average dissimilarity value and species contributing to the upper 50% (catch rate data); (b) Average dissimilarity value and species contributing to the upper 10% (presence/absence data) in Hervey Bay Closure C and Hervey Bay Region 2002.
*** denotes a significant difference between groups detected.**

(a)

Groups HBD & HB2002

Average dissimilarity = 59.71

SSpecies	HBD Av.Abund.	HB2002 Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Nemipterus theodorei	0.010	0.170	4.41	3.63	7.39	7.39*
Upeneus asymmetricus	0.260	0.050	4.06	1.07	6.79	14.18
Lethrinus genivittatus	0.070	0.190	3.60	1.43	6.03	20.21
Paramonacanthus otisensis	0.260	0.060	3.27	1.60	5.48	25.69
Callionymus japonicus	0.000	0.030	1.72	2.27	2.89	28.57*
Callionymus limiceps	0.020	0.000	1.71	4.91	2.86	31.44*
Saurida undosquamis	0.090	0.030	1.66	0.95	2.78	34.22
Portunus rubromarginatus	0.080	0.070	1.65	1.48	2.77	36.98
Sepia whitleyana	0.000	0.030	1.65	1.22	2.76	39.74*
Pseudorhombus spinosus	0.030	0.020	1.64	1.86	2.75	42.50
Pentaceraster sp.	0.040	0.020	1.62	0.97	2.72	45.21
Pristotis jerdoni	0.000	0.020	1.57	2.42	2.64	47.85*
Upeneus luzonius	0.000	0.020	1.49	1.37	2.50	50.35*

(b)

Groups HBD & HB2002

Average dissimilarity = 50.02

Species	HBD Av.Abund.	HB2002 Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Callionymus limiceps	0.020	0.000	1.78	9.67	3.56	3.56*
Pristotis jerdoni	0.000	0.020	1.60	2.52	3.19	6.76*
Grammatobothus polyophthalmus	0.000	0.010	1.55	2.48	3.09	9.85*
Callionymus japonicus	0.000	0.030	1.40	1.68	2.80	12.65*

Table 19. (a) Average dissimilarity value and species contribuing to the upper 50% (catch rate data); (b) Average dissimilarity value and species contributing to the upper 10% (presence/absence data) in Hervey Bay Closure D and Hervey Bay Region 2002.
*** denotes a significant difference between groups detected.**

(a)

Groups HBA & HBB

Average dissimilarity = 56.00

Species	HBA Av.Abund.	HBB Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Saurida undosquamis	0.060	0.380	3.86	0.91	6.90	6.90
Lethrinus genivittatus	0.110	0.060	2.43	0.94	4.34	11.24
Torquigener pallimaculatus	0.050	0.130	2.18	1.07	3.89	15.14
Portunus rubromarginatus	0.070	0.100	1.86	0.82	3.33	18.46
Inimicus caledonicus	0.040	0.100	1.82	1.11	3.24	21.70
Sepia whitleyana	0.000	0.050	1.62	0.89	2.90	24.61*
Choerodon cephalotes	0.060	0.020	1.59	1.04	2.84	27.45
Metapenaeopsis mogiensis	0.050	0.050	1.57	1.10	2.80	30.25
Nemipterus theodorei	0.010	0.050	1.56	1.42	2.79	33.04
Torquigener perlevis	0.040	0.030	1.51	1.19	2.70	35.74
Paramonacanthus lowei	0.000	0.030	1.48	1.32	2.64	38.38*
Annachlamys flabellata	0.000	0.030	1.39	1.60	2.48	40.86*
Chaetodermis penicilligera	0.020	0.030	1.32	1.04	2.35	43.21
Gymnocranius audleyi	0.060	0.000	1.17	0.59	2.10	45.31*
Paramonacanthus otisensis	0.030	0.030	1.09	1.14	1.95	47.26
Engyprosopon grandisquama	0.020	0.040	1.08	1.02	1.94	49.19
Ambiserrula jugosa	0.020	0.030	1.07	1.17	1.91	51.10

(b)

Groups HBA & HBB

Average dissimilarity = 44.03

Species	HBA Av.Abund.	HBB Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Sorsogona tuberculata	0.000	0.010	0.89	1.21	2.02	2.02
Erosa erosa	0.000	0.010	0.89	1.20	2.02	4.04*
Paramonacanthus lowei	0.000	0.030	0.89	1.20	2.01	6.05*
Parapercis nebulosa	0.010	0.020	0.82	1.07	1.86	7.91
Lepidotrigla argus	0.000	0.010	0.81	1.14	1.85	9.76
Nemipterus theodorei	0.010	0.050	0.77	0.93	1.76	11.52

Table 20. (a) Average dissimilarity value and species contributing to the upper 50% (catch rate data); (b) Average dissimilarity value and species contributing to the upper 10% (presence/absence data) in Hervey Bay Closure A and Hervey Bay Closure B in 2002.
*** denotes a significant difference between groups detected.**

(a)

Groups HBA & HBC

Average dissimilarity = 59.99

Species	HBA Av.Abund.	HBC Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Paramonacanthus otisensis	0.030	0.300	4.44	1.89	7.41	7.41*
Portunus rubromarginatus	0.070	0.170	2.63	1.13	4.39	11.80*
Lepidotrigla argus	0.000	0.060	2.47	1.82	4.12	15.92*
Upeneus asymmetricus	0.000	0.070	2.31	1.20	3.85	19.77*
Parapercis nebulosa	0.010	0.070	2.20	1.60	3.67	23.44*
Saurida undosquamis	0.060	0.110	1.92	1.07	3.19	26.64
Lethrinus genivittatus	0.110	0.010	1.91	0.85	3.19	29.82
Torquigener perlevis	0.040	0.060	1.84	1.08	3.06	32.88*
Nemipterus theodorei	0.010	0.050	1.69	1.34	2.82	35.70
Choerodon cephalotes	0.060	0.010	1.64	1.07	2.74	38.44*
Inimicus caledonicus	0.040	0.080	1.60	1.04	2.67	41.11*
Torquigener pallimaculatus	0.050	0.070	1.51	1.08	2.52	43.63
Metapenaeopsis mogiensis	0.050	0.000	1.50	1.11	2.50	46.13
Sponge B	0.030	0.000	1.29	1.87	2.16	48.29*
Pseudorhombus spinosus	0.000	0.020	1.24	1.33	2.06	50.35*

(b)

Groups HBA & HBC

Average dissimilarity = 49.95

Species	HBA H Av.Abund.	BC Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Lepidotrigla argus	0.000	0.060	1.43	2.02	2.86	2.86*
Sorsogona tuberculata	0.000	0.010	1.27	1.48	2.54	5.40*
Upeneus asymmetricus	0.000	0.070	1.13	1.31	2.26	7.66*
Parapercis nebulosa	0.010	0.070	1.10	1.15	2.20	9.86*
Metapenaeopsis lamellata	0.000	0.000	1.10	1.69	2.20	12.05*

Table 21. (a) Average dissimilarity value and species contributing to the upper 50% (catch rate data); (b) Average dissimilarity value and species contributing to the upper 10% (presence/absence data) in Hervey Bay Closure A and Hervey Bay Closure C in 2002.
*** denotes a significant difference between groups detected.**

(a)

Groups HBA & HBD

Average dissimilarity = 67.66

Species	HBA Av.Abund.	HBD Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Upeneus asymmetricus	0.000	0.260	5.42	1.02	8.02	8.02*
Paramonacanthus otisensis	0.030	0.260	4.95	1.30	7.32	15.34*
Lethrinus genivittatus	0.110	0.070	3.07	1.12	4.54	19.87
Saurida undosquamis	0.060	0.090	2.49	1.20	3.69	23.56
Choerodon cephalotes	0.060	0.020	2.06	1.11	3.05	26.61
Portunus rubromarginatus	0.070	0.080	2.04	0.91	3.01	29.62
Metapenaeopsis mogiensis	0.050	0.000	1.87	1.16	2.76	32.39*
Callionymus limiceps	0.000	0.020	1.80	2.10	2.65	35.04*
Pseudorhombus spinosus	0.000	0.030	1.73	1.46	2.56	37.60*
Inimicus caledonicus	0.040	0.010	1.67	1.49	2.47	40.07*
Pentaceraster sp.	0.010	0.040	1.67	0.82	2.46	42.53
Sponge B	0.030	0.000	1.64	2.07	2.43	44.96*
Torquigener perlevis	0.040	0.010	1.64	1.31	2.43	47.38
Torquigener pallimaculatus	0.050	0.020	1.63	1.20	2.41	49.80
Pristotis jerdoni	0.020	0.000	1.56	1.71	2.31	52.10*

(b)

Groups HBA & HBD

Average dissimilarity = 58.72

Species	HBA Av.Abund.	HBD Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Upeneus asymmetricus	0.000	0.260	1.68	1.86	2.86	2.86*
Callionymus limiceps	0.000	0.020	1.68	1.86	2.86	5.72*
Sepia papuensis	0.020	0.000	1.51	1.48	2.57	8.29*
Pristotis jerdoni	0.020	0.000	1.51	1.48	2.57	10.86*

Table 22. (a) Average dissimilarity value and species contributing to the upper 50% (catch rate data); (b) Average dissimilarity value and species contributing to the upper 10% (presence/absence data) in Hervey Bay Closure A and Hervey Bay Closure D in 2002.
*** denotes a significant difference between groups detected.**

(a)

Groups HBB & HBC

Average dissimilarity = 51.46

Species	HBB Av.Abund.	HBC Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Paramonacanthus otisensis	0.030	0.300	3.48	2.94	6.76	6.76*
Saurida undosquamis	0.380	0.110	2.80	0.92	5.43	12.20
Portunus rubromarginatus	0.100	0.170	2.10	1.80	4.08	16.28
Upeneus asymmetricus	0.000	0.070	2.04	1.31	3.96	20.24*
Torquigener pallimaculatus	0.130	0.070	1.77	1.36	3.45	23.68
Lepidotrigla argus	0.010	0.060	1.65	1.47	3.21	26.89*
Torquigener perlevis	0.030	0.060	1.55	1.23	3.01	29.91*
Parapercis nebulosa	0.020	0.070	1.51	1.41	2.93	32.84*
Metapenaeopsis mogiensis	0.050	0.000	1.50	1.40	2.91	35.74*
Lethrinus genivittatus	0.060	0.010	1.48	0.96	2.88	38.62
Sepia whitleyana	0.050	0.000	1.42	0.94	2.77	41.39*
Inimicus caledonicus	0.100	0.080	1.37	1.47	2.66	44.06
Paramonacanthus lowei	0.030	0.000	1.33	1.51	2.59	46.65*
Chaetodermis penicilligera	0.030	0.000	1.10	1.01	2.14	48.78*
Annachlamys flabellata	0.030	0.010	1.09	1.59	2.12	50.91*

(b)

Groups HBB & HBC

Average dissimilarity = 40.53

Species	HBB Av.Abund.	HBC Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Metapenaeopsis lamellata	0.000	0.000	1.06	1.68	2.62	2.62*
Upeneus asymmetricus	0.000	0.070	1.06	1.68	2.61	5.23*
Paramonacanthus lowei	0.030	0.000	0.95	1.45	2.34	9.94*
Erosa erosa	0.010	0.000	0.87	1.26	2.15	12.09*

Table 23. (a) Average dissimilarity value and species contributing to the upper 50% (catch rate data); (b) Average dissimilarity value and species contributing to the upper 10% (presence/absence data) in the Hervey Bay Closure B and Hervey Bay Closure C in 2002.
*** denotes a significant difference between groups detected.**

(a)

Groups HBB & HBD

Average dissimilarity = 63.60

Species	HBB Av.Abund.	HBD Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Upeneus asymmetricus	0.000	0.260	4.55	1.19	7.16	7.16*
Saurida undosquamis	0.380	0.090	3.98	1.03	6.26	13.42
Paramonacanthus otisensis	0.030	0.260	3.62	1.77	5.69	19.11*
Inimicus caledonicus	0.100	0.010	2.42	1.62	3.81	22.92*
Lethrinus genivittatus	0.060	0.070	2.35	1.28	3.70	26.62
Torquigener pallimaculatus	0.130	0.020	2.17	1.08	3.41	30.02*
Metapenaeopsis mogiensis	0.050	0.000	1.89	1.50	2.97	32.99*
Nemipterus theodorei	0.050	0.010	1.85	2.11	2.90	35.89*
Annachlamys flabellata	0.030	0.000	1.72	2.16	2.71	38.60*
Sepia whitleyana	0.050	0.000	1.67	0.97	2.63	41.23*
Portunus rubromarginatus	0.100	0.080	1.60	1.04	2.51	43.74
Paramonacanthus lowei	0.030	0.010	1.46	1.47	2.29	46.03*
Grammatobothus polyophthalmus	0.020	0.000	1.41	1.94	2.22	48.25*
Pristotis jerdoni	0.020	0.000	1.36	1.97	2.14	50.39*

(b)

Groups HBB & HBD

Average dissimilarity = 53.62

Species	HBB Av.Abund.	HBD Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Upeneus asymmetricus	0.000	0.260	1.59	8.33	2.96	2.96*
Sepia papuensis	0.010	0.000	1.42	2.51	2.64	5.60*
Pristotis jerdoni	0.020	0.000	1.42	2.51	2.64	8.24*
Annachlamys flabellata	0.030	0.000	1.37	2.50	2.55	10.79*

Table 24. (a) Average dissimilarity value and species contributing to the upper 50% (catch rate data); (b) Average dissimilarity value and species contributing to the upper 10% (presence/absence data) in Hervey Bay Closure B and Hervey Bay Closure D in 2002.
*** denotes a significant difference between groups detected.**

(a)

Groups HBC & HBD

Average dissimilarity = 50.03

Species	HBC Av.Abund.	HBD Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Upeneus asymmetricus	0.070	0.260	3.51	1.17	7.02	7.02
Inimicus caledonicus	0.080	0.010	2.47	2.26	4.93	11.95*
Lepidotrigla argus	0.060	0.010	2.23	1.76	4.46	16.41*
Saurida undosquamis	0.110	0.090	2.03	1.73	4.07	20.48
Lethrinus genivittatus	0.010	0.070	2.03	1.54	4.05	24.53
Torquigener perlevis	0.060	0.010	1.95	1.31	3.90	28.43*
Portunus rubromarginatus	0.170	0.080	1.93	1.46	3.86	32.29
Nemipterus theodorei	0.050	0.010	1.91	1.67	3.83	36.12*
Paramonacanthus otisensis	0.300	0.260	1.58	1.61	3.17	39.29
Parapercis nebulosa	0.070	0.020	1.57	1.60	3.14	42.43
Torquigener pallimaculatus	0.070	0.020	1.52	1.33	3.03	45.46*
Pentaceraster sp.	0.000	0.040	1.29	0.76	2.58	48.04*
Choerodon cephalotes	0.010	0.020	1.19	1.06	2.37	50.41

(b)

Groups HBC & HBD

Average dissimilarity = 42.37

Species	HBC Av.Abund.	HBD Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Pristotis jerdoni	0.010	0.000	1.63	2.48	3.86	3.86*
Callionymus japonicus	0.010	0.000	1.29	1.44	3.05	6.90*
Upeneus tragula	0.020	0.000	1.23	1.44	2.91	9.82*
Batrachomoeus dubius	0.010	0.000	1.19	1.26	2.82	12.63*

Table 25. (a) Average dissimilarity value and species contributing to the upper 50% (catch rate data); (b) Average dissimilarity value and species contributing to the upper 10% (presence/absence data) in Hervey Bay Closure C and Hervey Bay Closure D Regions in 2002.
*** denotes a significant difference between groups detected.**

(a)

Groups HB2000 & HB2002

Average dissimilarity = 69.13

Species	HB2000 Av.Abund.	HB2002 Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Nemipterus theodorei	0.010	0.170	4.35	2.74	6.29	6.29*
Lethrinus genivittatus	0.090	0.190	3.63	1.86	5.24	11.54
Saurida undosquamis	0.110	0.030	2.28	1.62	3.30	14.84
Siganus fuscescens	0.060	0.020	2.08	1.03	3.01	17.85
Portunus rubromarginatus	0.090	0.070	2.07	1.41	2.99	20.84
Upeneus asymmetricus	0.030	0.050	1.95	1.27	2.82	23.66
Callionymus japonicus	0.000	0.030	1.95	3.10	2.81	26.48*
Paramonacanthus otisensis	0.070	0.060	1.67	1.69	2.42	28.90
Sepia whitleyana	0.000	0.030	1.67	1.21	2.41	31.31*
Torquigener pallimaculatus	0.070	0.020	1.61	1.16	2.34	33.64
Ambiserrula jugosa	0.000	0.020	1.57	1.32	2.28	35.92*
Upeneus luzonius	0.020	0.020	1.52	1.31	2.20	38.12
Pentapodus paradiseus	0.020	0.020	1.51	1.06	2.18	40.30
Engyprosopon grandisquama	0.010	0.030	1.49	1.98	2.15	42.46*
Inimicus caledonicus	0.000	0.020	1.47	1.54	2.13	44.59*
Choerodon cephalotes	0.040	0.010	1.35	0.97	1.96	46.54
Choerodon venustus	0.000	0.030	1.34	0.74	1.94	48.49
Pentaceraster sp.	0.020	0.020	1.34	1.32	1.94	50.43

(b)

Groups HB2000 & HB2002

Average dissimilarity = 59.90

Species	HB2000 Av.Abund.	HB2002 Av.Abund.	Av.Diss.	Diss./SD	Contrib.%	Cum.%
Inimicus caledonicus	0.000	0.020	1.74	8.20	2.90	2.90*
Choerodon sugillatum	0.000	0.010	1.74	8.20	2.90	5.79*
Callionymus japonicus	0.000	0.030	1.62	3.15	2.71	8.50*
Grammatobothus polyophthalmus	0.000	0.010	1.51	2.23	2.52	11.02*

Table 26. (a) Average dissimilarity value and species contributing to the upper 50% 9catch rate data); (b) Average dissimilarity value and species contributing to the upper 10% (presence/absence data) in the Hervey Bay Region in 2000 and the Hervey Bay Region in 2002.
*** denotes a significant difference between groups detected.**

Discussion

The main objective of this LTMP study was to provide a description of the benthic community composition in the Queensland scallop grounds, off Yeppoon, Bustard Head and Hervey Bay. In both survey years, 2000 and 2002, teleosts (bony fishes) were found to be the dominant taxa. Synodontidae (lizardfish) were the most abundant family across both years in terms of benthos weight. The survey was successful in detecting a large number of benthic species. Over both survey years 547 species were indentified, of which 151 species from 61 taxa occurred in › 5% of all samples.

Data analysis allowed the determination of relationships within the large amount of data collected and identified. One of the objectives was to determine if differences existed in species composition between scallop closure (SRAs) and non-closure areas. For ease of discussion and interpretation, only the dissimilarity results are reviewed. In the Yeppoon region the main contributor to dissimilarity in 2000 between closure and non-closure area, was the high abundance of *Pseudorhombus dupliocellatus* in the closure area (YP). Both closure areas of 2002 (YPA, YPB) showed higher similarity, with high abundances of *Nemipterus theodorei*, *Saurida undosquamis* and *Trachinocephalus myops* in both regions. Moderate dissimilarity was also detected between closures (YPA, YPB) (catch rate data) explained by the species *Lethrinis genivittatus*, *Upeneus asymmetricus* and *Saurida undosquamis*.

In the Bustard Head Region the fish species *Pentapodus paradiseus*, *Chaetodermis pencilligera*, *Peusomoncanthus peroni* and *Choerodon venustus* contributed to significant dissimilarity in the closure areas in 2000 (BH) when compared with non-closure area (BH2000). In 2002, *Saurida undosquamis* and *Upeneus asymmetricus*, contributed to dissimilarity in all closure areas (BHB, BHC, BHD) when compared with the non-closure areas (BH2002). *Nemipterus theodorei* was more significantly more abundant in some of the closure areas, BHB and BHC (catch rate data). *Sepia plangon* was more abundant in closures BHC and BHD (catch rate data). *Pentapodus nagasakiensis* and *Acropora* spp. were significantly more abundant in the non-closure areas (BH2002) than in the closure areas in 2002 (BHB, BHC, BHD).

In Hervey Bay there were differences in species composition between closure (HB) and non-closure areas (HB2000). Some species that explain this dissimilarity and that were statistically more abundant (catch rate data) in the closure areas (HB) were *Annachlymus flabellata*, *Chaetodermis pencilligera*, *Inimicus caledonicus*, *Lepidotrigla* cf. *japonica* and *Grammatobothus polyophthalmus*. *Upeneus asymmetricus* and *Lethrinus genivittatus* were more abundant in the non-closure area (HB2000). *Callionmyus japonicus* and *Sepia whitleyana* were significantly more abundant in the closure areas. In 2002, with four closure areas (HBA, HBB, HBC, HBD) there were many differences in species composition between closure and non-closure areas (HB2002). *Nemipterus theodorei* was significantly different (more abundant, catch rate data) in the non-closure area in 2002 (HB2002) when compared with each of the closure areas. Each closure area in turn had various species that contributed to the dissimilarity with the non-closure area. The species contributing most to the dissimilarity were *Metapernaeopsis mogiensis*, *Sepia papuensi*s (HBA); *Sepia plangon*, *Torquigener perlevis* (HBB); *Inimicus caledonicus*, *Torquigener perlevis* and *Sepia plangon* (HBC).

In conclusion, differences existed in the benthic species composition in each of the sub- regions sampled. Differences exist between closure and non-closure areas and differences exist within the closures themselves. Natural spatial variation in species composition and differences in habitat type may explain these variations.

The possibility of temporal variation in species composition was also explored. The initial clustering of the data in the form of a dendogram allowed simplistic visualisation of similar groupings. Three main groupings were seen: samples from 2000; samples from 2002 and the Yeppoon 2000 Closure and non-Closure area. Multidimensional scaling (MDS) confirmed the existence of these groups. In the Bustard Head Region, *Pristostis jerdoni*, *Lethrinus genivittatus*, *Inimicus caledonicus* were all found to be significantly more abundant in 2002 compared with 2000. In contrast, *Saurida undosquamis* and *Torquigener pallimaculatus* were all significantly more abundant in 2000 than 2002. In the Hervey Bay Region, *Nemipterus theodorei, Callionymus japonicus* and *Sepia whitleyana* were all more abundant in 2002 compared with 2000. *Saurida undosquamis* was again more abundant in 2000 compared with 2002. This species was one of the most abundant species in Hervey Bay in 2000. However, a marked difference was seen in Hervey Bay non-Closure region in 2002. In 2002 this species did not feature in the list of the five most abundant species. A previous study, which assessed the sustainability of Australian northern prawn bycatch species, identified *Saurida undosquamis* as one of the least sustainable species to trawling (Stobutzki *et al*., 2001). In this study, sustainability ranking was assigned to each bycatch species. This ranking was based on two overriding characteristics: their susceptibility to capture and mortality due to trawling; and their ability to recover after depletion. No inference should be made in relation to the results of these LTMP surveys since the sampling gear used in the surveys (prawn trawl nets) differs significantly to the predominant commercial fishing gear used in this region (scallop trawl nets).

The final objective was to explore the limitations of the data and to assess the feasibility of monitoring changes in benthos using these survey techniques. Primarily, the collection of benthos was inexpensive as it was incorporated into the protocols of the LTMP scallop survey. The methods used were found to be unsuitable for sampling sponges, algae, coral, infauna and other sessile organisms. In terms of survey design, a non-asymptoting relationship was observed between the number of samples collected in each sub-region and the number of species caught. This result has critical implications, indicating that even with a huge increase in sampling effort all benthic species may not be collected. In both survey years, the swept area was a very low proportion of the approximate area of each sub-region. Also, in some of the sub-regions actual sample numbers were less than five, these being Yeppoon Closure 2000 (YP), Bustard Head Closure 2000 (BH) and the Hervey Bay Region 2002 (HB2002). Data analysis only included species that occurred in >5% of all samples across all years. Therefore, most species were excluded from consideration. In total across both survey years, only 27% of species detected were included in the data analysis. This LTMP study provides an incomplete description of the benthic composition of areas from Yeppoon south to Hervey Bay in 2000 and 2002.

An advantage of this type of survey is that it can provide biological information on otherwise unstudied species. For example, the LTMP benthic surveys of 2000 and 2002 have provided the most detailed information to date on pipehorse *Solegnathus* cf. *hardwickii* catch rates and distribution in Queensland. The information obtained has been used to investigate the distribution of pipehorses within the scallop grounds, suggesting differences in distributions according to depth (Courtney *et al*., 2003).

Recommendations

It is unlikely that the description of the benthic fauna captured in this survey represents comprehensive coverage of the entire benthic faunal community of the areas sampled. Future attempts to monitor benthic trawl communities should have clearly defined objectives. Numbers of common species may be large enough to support robust statistical analysis. However, since such a large proportion of the species collected are represented in less than 5% of samples much of this work will be restricted to descriptive applications without increasing the sampling intensity to unrealistic, highly destructive and costly levels.

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Appendix 1. The data and formulae used to calculate the swept area in the Queensland Scallop Fishery.

Data	Value	Source
Nights fished in 2000	15 756	CFISH compulsory logbook database (saucer scallop only)
Nights fished in 2002	4870	CFISH compulsory logbook database (saucer scallop only)
Trawl speed (km)	2.48	2003 lower 95% confidence limit from CFISH compulsory log book database (saucer scallop only)
Head rope (Fth)	22.68	2003 lower 95% confidence limit from CFISH compulsory log book database (saucer scallop only)
Gear spread (%)	67	observed efficiency of gear from 2000 and 2002 scallop fishery surveys
Hours per night	10	conservative estimate based on 14 available hours per night less time for sorting, setting and hauling

Formula for estimating swept area of fishery (saucer scallop only)

= trawl speed (m h^{-1}) x head rope length (m) x spread (%) x nights fished (nights) x hours fished per night (h night-1)

estimate of total swept area of the 340 boats in 2000

= [2.48 (n.m. h^{-1}) x 1852 (m $n.m.^{-1}$)] x [22.68 (Fth) x 1.88 (m Fth^{-1})] x 67% x 15756 (nights) x 10 (h $night^{-1}$)

= 20 673 515 665 m^2

= 20 674 km^2

estimate of bycatch in 2000 based on value of 1 g m^{-2}

= 20 673 515 665 g

= 20 674 tonnes

estimate of total swept area of the 170 boats in 2002

= [2.48 (n.m. h^{-1}) x 1852 (m $n.m.^{-1}$)] x [22.68 (Fth) x 1.88 (m Fth^{-1})] x 67% x 4870 (nights) x 10 (h $night^{-1}$)

= 6 389 948 038 m^2

= 6390 km^2

estimate of bycatch in 2002 based on value of 1 g m^{-2}

= 6 389 948 038 g

= 6390 tonnes

n.m. = nautical miles

Appendix 2. The coordinates and closure periods of the Queensland Scallop Replenishment Areas. Notes also included.

Closures 2000		Lat.	Long.	Term of Closure	Notes
Yeppoon	from	−22.750	151.050	Closed from 1997 to 1 Feb 01	Superceded by area A
	to	−22.750	151.217	Expires on 1 Feb 01	
	to	−22.583	151.083		
	to	−22.583	150.917		
	to	−22.750	151.050		
Bustard Head	from	−23.750	151.750	Closed from 1997 to 1 Feb 01	Superceded by areas B and C
	to	−22.917	151.750	Expires on 1 Feb 01	Lower boundary not parallel to upper
	to	−24.000	151.917		
	to	−23.750	151.917		
	to	−23.750	151.750		
Hervey Bay	from	−24.500	152.750	Closed from 1997 to 1 Feb 01	Superceded by areas B and C
	to	−24.667	152.750	Expires on 1 Feb 01	
	to	−24.667	152.917		
	to	−24.500	152.917		
	to	−24.500	152.750		

Closures 2002		Lat.	Long.	Term of Closure	Notes
Yeppoon	from	−22.750	151.050	Closed from 20 Sep 01 to 1 Jan 03	Closure as per Yeppoon above
Area A	to	−22.750	151.217	then from 20 Sep 03 to 1 Jan 05	2-year closure
(YPA)	to	−22.583	151.083	then from 20 Sep 05 to 1 Jan 07	
	to	−22.583	150.917	then from 20 Sep 07 to 1 Jan 09	
	to	−22.750	151.050	Expires on 1 Jan 09	
Yeppoon	from	−23.000	151.167	Closed from 1 Feb 01 to 1 Jan 02	New closure south-east of original closure
Area B	to	−23.000	151.333	then from 20 Sep 02 to 1 Jan 04	2-year closure
(YPB)	to	−22.833	151.333	then from 20 Sep 04 to 1 Jan 06	
	to	−22.833	151.167	then from 20 Sep 06 to 1 Jan 08	
	to	−23.000	151.167	from 20 Sep 08 until Plan expires	
Bustard Head	from	−23.917	151.667	Closed from 1 Feb 01 to 1 Jan 02	Additional area west of original closure
Area A	to	−23.917	151.750	then from 20 Sep 03 to 1 Jan 05	Adjoins western boundary of BH area B
(BHA)	to	−23.750	151.750	then from 20 Sep 06 to 1 Jan 08	Half original area of BH closure
	to	−23.750	151.667	Expires on 1 Jan 08	2-year closure
	to	−23.917	151.667		
Bustard Head	from	−23.917	151.750	Closed from 1 Feb 01 to 1 Jan 03	Approx. western half of original closure
Area B	to	−23.917	151.833	then from 20 Sep 03 to 1 Jan 06	Lower boundary parallel to upper
(BHB)	to	−23.750	151.833	then from 20 Sep 06 to 1 Jan 09	3-year closure
	to	−23.750	151.750	Expires on 1 Jan 09	
	to	−23.917	151.750		
Bustard Head	from	−23.917	151.833	Closed from 20 Sep 01 to 1 Jan 04	Approx. eastern half of original closure
Area C	to	−23.917	151.917	then from 20 Sep 04 to 1 Jan 07	Lower boundary parallel to upper
(BHC)	to	−23.750	151.917	from 20 Sep 07 until Plan expires	3-year closure
	to	−23.750	151.833		
	to	−23.917	151.833		
Bustard Head	from	−23.917	151.917	Closed from 20 Sep 02 to 1 Jan 04	Additional area east of original closure
Area D	to	−23.917	152.000	then from 20 Sep 05 to 1 Jan 07	Adjoins eastern boundary of BH area C
(BHD)	to	−23.750	152.000	from 20 Sep 08 until Plan expires	Half original area of BH closure
	to	−23.750	151.917		2-year closure
	to	−23.917	151.917		
Hervey Bay	from	−24.667	152.667	Closed from 1 Feb 01 to 1 Jan 02	Additional area west of original closure
Area A	to	−24.667	152.750	then from 20 Sep 03 to 1 Jan 05	Adjoins western boundary of HB area B
(HBA)	to	−24.500	152.750	then from 20 Sep 06 to 1 Jan 08	Half original area of HB closure
	to	−24.500	152.667	Expires on 1 Jan 08	2-year closure
	to	−24.667	152.667		
Hervey Bay	from	−24.667	152.750	Closed from 1 Feb 01 to 1 Jan 03	Western half of original closure
Area B	to	−24.667	152.833	then from 20 Sep 03 to 1 Jan 06	3-year closure
(HBB)	to	−24.500	152.833	then from 20 Sep 06 to 1 Jan 09	
	to	−24.500	152.750	Expires on 1 Jan 09	
	to	−24.667	152.750		
Hervey Bay	from	−24.667	152.833	Closed from 20 Sep 01 to 1 Jan 04	Eastern half of original closure
Area C	to	−24.667	152.917	then from 20 Sep 04 to 1 Jan 07	3-year closure
(HBC)	to	−24.500	152.917	from 20 Sep 07 until Plan expires	
	to	−24.500	152.833		
	to	−24.667	152.833		
Hervey Bay	from	−24.667	152.917	Closed from 20 Sep 02 to 1 Jan 04	Additional area east of original closure
Area D	to	−24.667	153.000	then from 20 Sep 05 to 1 Jan 07	Adjoins eastern boundary of HB area C
(HBD)	to	−24.500	153.000	from 20 Sep 08 until Plan expires	Half original area of HB closure
	to	−24.500	152.917		2-year closure
	to	−24.667	152.917		

Appendix 3. Species list, Family name, Common name, Code of Australia Aquatic Biota (CAAB) for species occurring in >5% of all samples across both years.

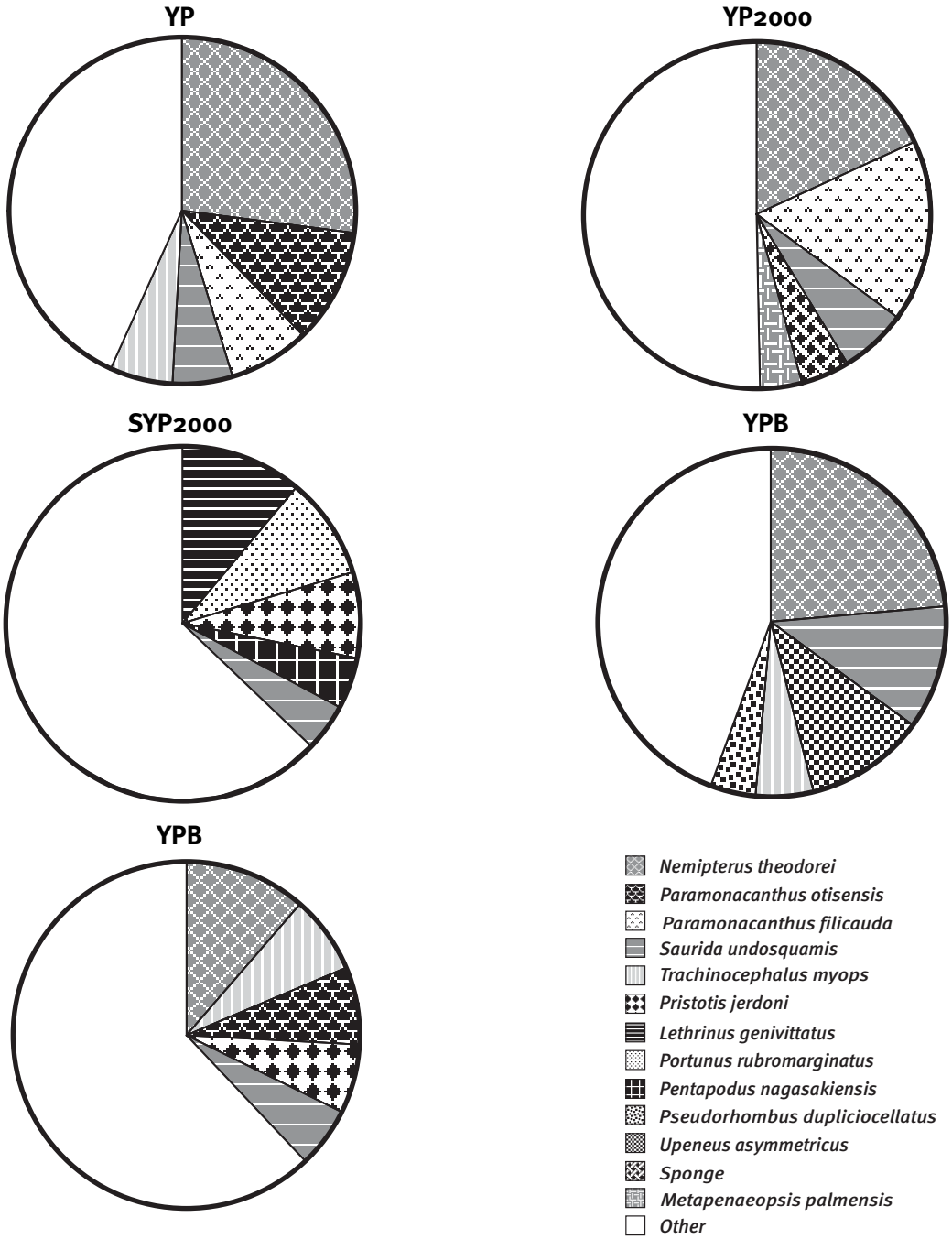
Species	FAO Family	Common Name	CAAB
Abalistes stellaris	Balistidae	starry triggerfish	37465011
Acropora sp	Acroporidae	hard coral	
Ambiserrula jugosa	Platycephalidae	mud flathead	37296041
Amusium balloti	Pectinidae	saucer scallop	23270001
Amusium pleuronectes	Pectinidae	northern saucer scallop	23270003
Annachlymys flabellata	Pectinidae	leopard scallop	23270004
Apistus carinatus	Scorpaenidae	ocellated waspfish	37287011
Apogon ellioti	Apogonidae	(flag-fin cardinalfish)	37327013
Apogon nigripinnis	Apogonidae	(two-eyed cardinalfish)	37327009
Batrachomoeus dubius	Batrachoididae	blotchtail toadfish	37205008
Callionymus japonicus	Callionymidae	longtailed dragonet	37427008
Callionymus limiceps	Callionymidae	rough headed dragonet	37427012
Chaetodermis penicilligera	Monocanthidae	prickly leatherjacket	37465013
Choerodon cephalotes	Labridae	purple tuskfish	37384004
Choerodon sugillatum	Labridae	(wedge tailed wrasse)	37384009
Choerodon venustus	Labridae	(venus tuskfish)	37384042
Dactylopus dactylopus	Callionymidae	fingered dragonet	37427005
Dasyatis kuhlii	Dasyatidaeblue	spotted stingray	37035004
Dendronephthya spp.	Nephtheidae	purple/orange soft coral	
Engyprosopon grandisquama	Bothidae	largescale flounder	37460012
Erosa erosa	Scorpaenidae	pitted stonefish	37287022
Grammatobothus polyophthalmus	Bothidae	manyeyed flounder	37460010
Gymnocranius audleyi	Lethrinidae	collared large-eye bream	37351018l
chthyscopus sannio	Uranoscopidae	spotcheck stargazer	37400022
Inegocia harrisi	Platycephalidae	Harriss flathead	37296010
Inegocia japonica	Platycephalidae	japanese flathead	37296029
Inimicus caledonicus	Scorpaenidae	caledonian stinger	37287055
Inimicus sinensis	Scorpaenidae	spotted stonefish	37287020
Lepidotrigla argus	Triglidae	(long-finned gurnard)	37288032
Lepidotrigla cf japonica	Triglidae	(blue-fringed gurnard)	37288010
Lepidotrigla grandis	Triglidae	(supreme gurnard)	37288033
Lethrinus genivittatus	Lethrinidae	longspine emperor	37351002
Liocranium praepositum	Tetrarogidae	blackspot waspfish	37287015
Lobophora variegata	Dictyotaceae	flat brown weed	54025006
Metapenaeopsis lamellata	Penaeidae	hunchback prawn	28711013
Metapenaeopsis mogiensis	Penaeidae	Mogi velvet prawn	28711015
Metapenaeopsis palmensis	Penaeidae	southern velvet prawn	28711017
Nemipterus theodorei	Nemipteridae	theodore's threadfin bream	37347036
Onigocia spinosa	Platycephalidae	large scaled spiny flathead	37296022

Appendix 3. (Continued). Species list, family name, common name and CAAB indicated.

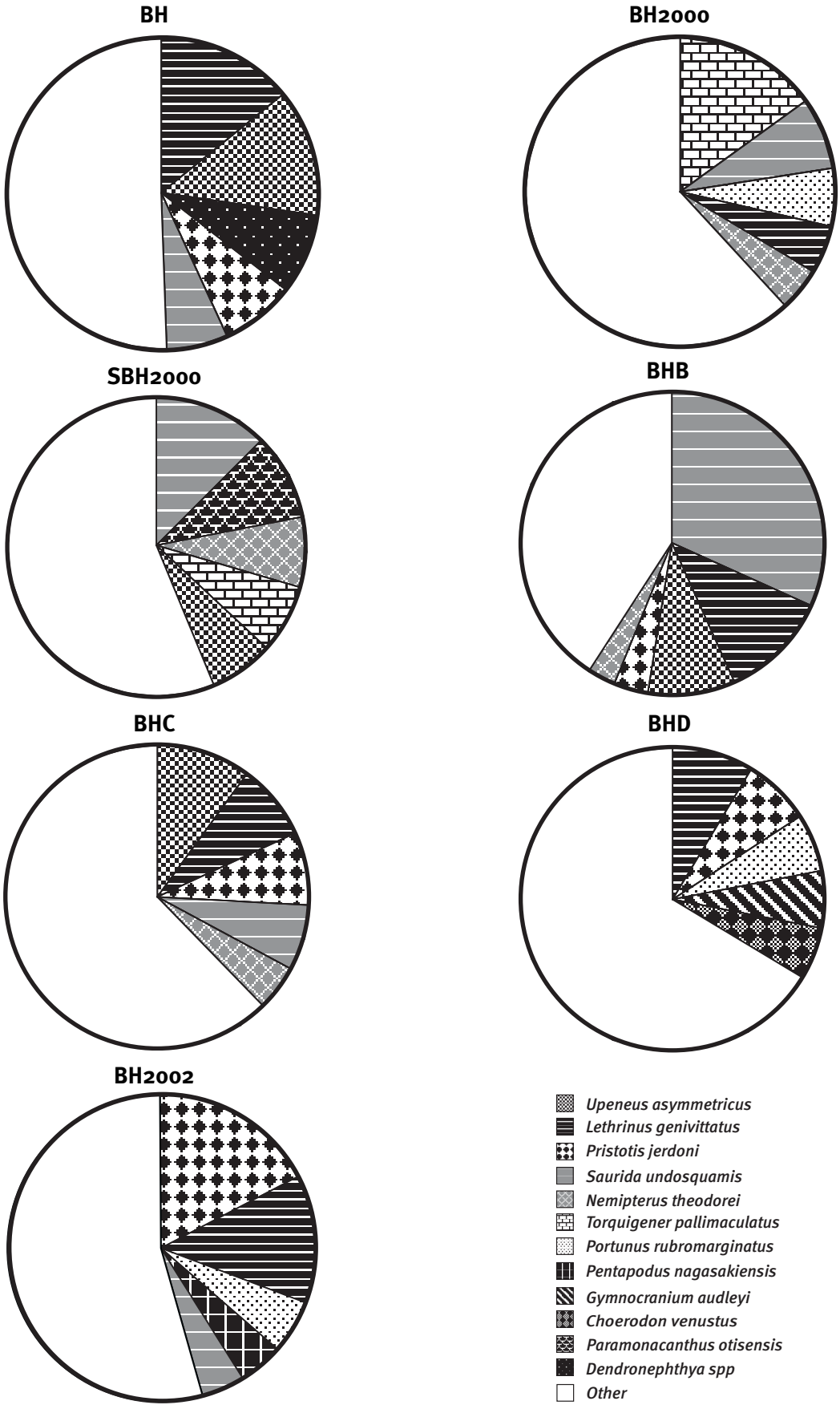
Species	FAO Family	Common Name	CAAB
Paramonacanthus filicauda	Monacanthidae	threadfin leatherjacket	37465024
Paramonacanthus lowei	Monacanthidae	lowe's leatherjacket	37465085
Paramonacanthus otisensi	Monacanthidae	dusky leatherjacket	37465065
Parapercis nebulosa	Pinguipedidae	barred sandperch	37390005
Parapriacanthus ransonneti	Pempheridae	(rosy sweep)	37357004
Pentaceraster sp.	Oreasteridae	starfish	
Pentapodus nagasakiensis	Nemipteridae	japanese whiptail	37347012
Pentapodus paradiseus	Nemipteridae	paradise whiptail	37347028
Portunus argentatus	Portunidae	swimming crab	28911032
Portunus rubromarginatus	Portunidae	red margined crab	28911026
Portunus sanguinolentus	Portunidae	three spot swimming crab	28911006
Pristotis jerdoni	Pomacentridae	(green puller)	
Pseudomonacanthus peroni	Monacanthidae	potbellied leatherjacket	37465020
Pseudorhombus dupliciocellatus	Paralichthyidae	sand flounder	37460004
Pseudorhombus spinosus	Paralichthyidae	spiny flounder	37460011
Pseudorhombus dupliciocellatus	Paralichthyidae	sand flounder	37460004
Pseudorhombus spinosus	Paralichthyidae	spiny flounder	37460011
Rhynchostracion nasus	Ostraciidae	(small nosed boxfish)	37466005
Rogadius patriciae	Platycephalidae	black banded flathead	37296008
Sargassum sp.	Sargassaceae	brown seaweed	
Saurida undosquamis	Synodontidae	brush tooth lizardfish	37118001
Sepia opipara	Sepiidae	staregaze cuttlefish	23607006
Sepia papuensis	Sepiidae	papuan cuttlefish	23607007
Sepia plangon	Sepiidae	mourning cuttlefish	23607012
Sepia smithi	Sepiidae	Smith's cuttlefish	23607013
Sepia whitleyana	Sepiidae	Whitley's cuttlefish	23607011
Sicyonia lancifera	Sicyoniidaek	night rock shrimp	28715001
Siganus fuscescens	Siganidae	mottled spinefoot	37438000
Sorsogona tuberculata	Platycephalidae	tuberculated flathead	37296030
Sponge B		finger sponge	
Synodus sageneus	Synodontidae	speartoothed grinner	37118004
Synodus tectus	Synodontidae	tectus lizardfish	37118026
Torquigener pallimaculatus	Tetraodontdidae	(orange-spotted pufferfish)	37467009
Torquigener perlevis	Tetraodontdidae	smooth brown toadfish	37467060
Trachinocephalus myops	Synodontidae	bluntnose lizardfish	37118002
Udotea sp.	Udoteaceae	calcified green weed	
Upeneus asymmetricus	Mullidae	(gold-band orange-barred goatfish)	37355010
Upeneus luzonius	Mullidae	(dark barred goatfish)	37355009
Upeneus tragula	Mullidae	freckled goatfish	37355014

Common names (Carpenter and Niem, 2001), common names in parentheses (Sainsbury *et al.*, 1985).

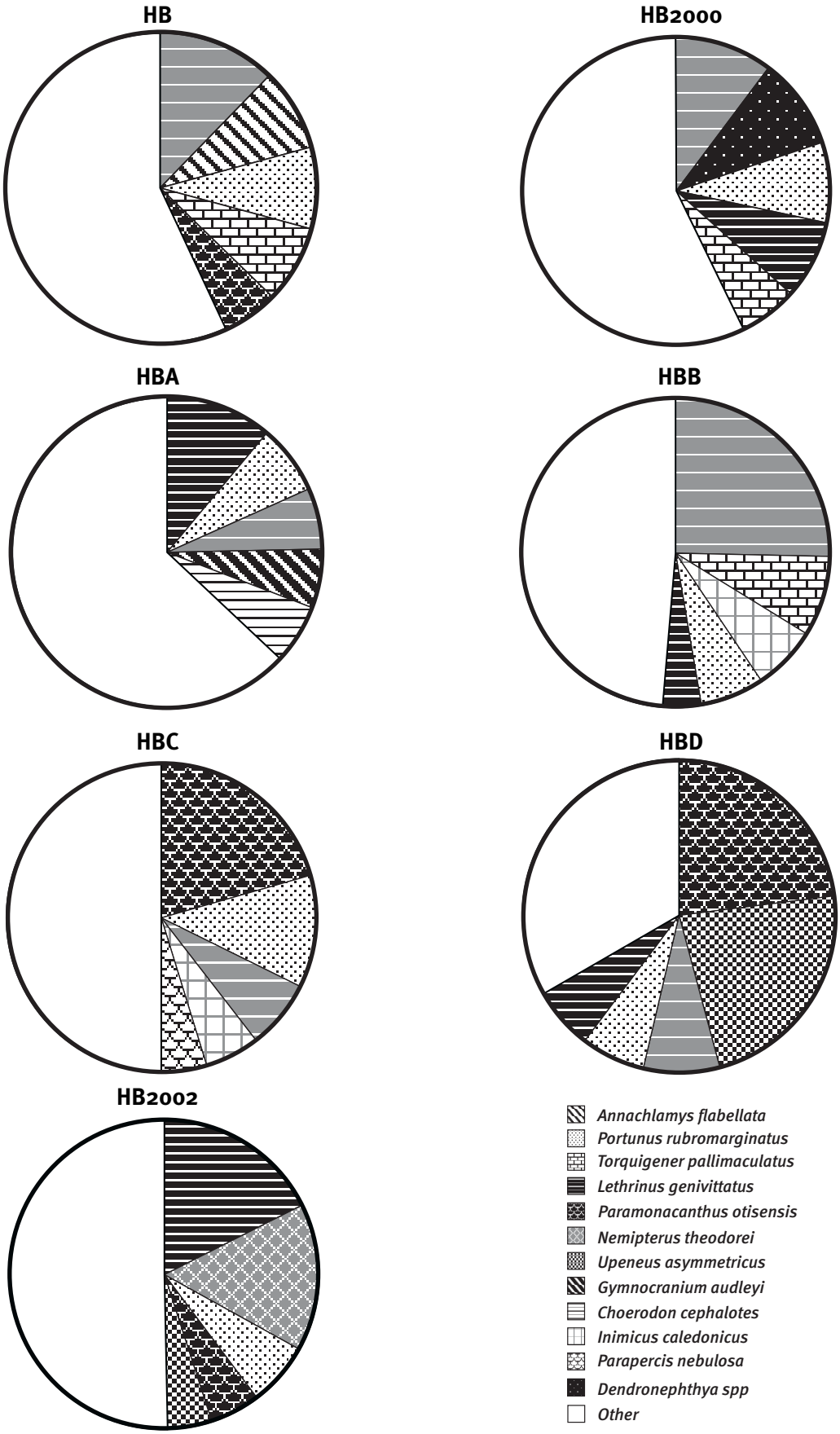
Appendix 4. Yeppoon Region 2000 and 2002. Five most abundant species.



Appendix 5. Bustard Head Region 2000 and 2002. The five most abundant species.



Appendix 6. Hervey Bay Region 2000 and 2002. The five most abundant species.



Appendix 7. Indicative list of species captured throughout the two years of surveys and numbers of individual specimens.

Scientific Name	2000	2002	Total
Abalistes stellaris	6	71	77
Acropora spp.	0	26	26
Actinopyga miliaris	11	2	13
Actinotrichia fragilis	0	1	1
Adventor elongatus	0	36	36
Aesopia cornuta	1	0	1
Albunea occultus	1	0	1
Alepes sp.	3	0	3
Aliaporcellana suluensis	1	0	1
Ambiserrula jugosa	2	385	387
Amblygobius sp.	0	1	1
Amphiprion sp.	0	1	1
Amusium balloti	241	391	632
Amusium pleuronectes	318	403	721
Anchisomus multistriatus	3	2	5
Annachlamys flabellata	611	562	1173
Antennarius hispidus	1	11	12
Antennarius striatus	5	4	9
Anthenea spp.	19	6	25
Apistus carinatus	579	684	1263
Aploactis aspera	18	10	28
Aplysia dactylomela	0	2	2
Apogon brevicaudata	21	105	126
Apogon capricornis	54	185	239
Apogon cardinalis	0	3	3
Apogon carinatus	0	4	4
Apogon cavitiensis	16	17	33
Apogon cf semilineatus	151	2	153
Apogon cf timorensis	31	57	88
Apogon coccineus	1	0	1
Apogon ellioti	52	70	122
Apogon fasciatus	40	2	42
Apogon timorensis	0	221	221
Apogon kiensis	49	0	49
Apogon limenus	2	0	2
Apogon nigripinnis	148	147	295
Apogon poecilopterus	202	0	202
Apogon semilineatus	0	7	7
Apogon septemstriatus	52	49	101
Apogon spp.	22	1	23
Apogon thermalis	61	0	61
Aptychotrema rostrata	3	2	5
Arcania spp.	2	0	2
Arcanis elongata	2	0	2
Argyrops spinifer	0	4	4
Arnoglossus fisoni	61	0	61
Arnoglossus intermedius	104	248	352
Arnoglossus waitei	62	0	62
Arothron stellatus	3	2	5
Aseraggodes melanostictus	8	23	31
Astele speciosum	2	0	2
Astropecten spp.	2	3	5
Atelomycterus macleayi	0	1	1
Atergatopsis inskipensis	1	0	1
Atherinomorus vaigiensis	1	0	1
Aulostomus chinensis	1	0	1
Bathypilummus pugilator	13	2	15

(continued...)

Scientific Name	2000	2002	Total
Bathypilumnus nigrispinnifer	2	0	2
Batrachomoeus dubius	101	206	307
Bodianus vulpinus	2	0	2
Bohadschia marmorata	6	4	10
Brachaluteres taylori	29	35	64
Callionymus belcheri	58	0	58
Callionymus japonicus	69	365	434
Callionymus limiceps	637	121	758
Callionymus moretonensis	23	0	23
Callionymus spp.	5	0	5
Callionymus sublaevis	0	42	42
Caluactaea tumida	1	0	1
Cantheschenia grandisquamis	0	2	2
Carangoides malabaricus	8	0	8
Carangoides spp.	2	0	2
Carangoides talamparoides	11	0	11
Carinosquilla australiensis	10	1	11
Carpilius convexus	0	2	2
Catostylus mosaicus	1	0	1
Caulerpa sertularioides	0	4	4
Caulerpa spp.	1	2	3
Centriscus scutatus	2	59	61
Centrogenys vaigiensis	0	2	2
Centropogon sp.	1	0	1
Cephalopholis boenak	0	1	1
Chaetodermis penicilligera	53	43	96
Chaetodontoplus duboulayi	1	5	6
Chaetodontoplus meredithi	4	18	22
Chaetodontoplus personifer	7	0	7
Charybdis bimaculata	1	0	1
Charybdis jaubertensis	16	19	35
Charybdis miles	2	0	2
Charybdis natator	3	6	9
Charybdis spp.	1	1	2
Charybdis truncata	3	11	14
Charybdis yaldwyni	1	0	1
Cheilopogon angusticeps	0	15	15
Cheilopogon spp.	7	0	7
Chiloscyllium punctatum	0	1	1
Chlamys senatoria	0	7	7
Chlamys spp.	0	5	5
Choerodon cauteroma	0	5	5
Choerodon cephalotes	107	128	235
Choerodon cf frenatus	3	0	3
Choerodon jordani	0	1	1
Choerodon monostigma	2	0	2
Choerodon sp.	0	1	1
Choerodon sugillatum	11	41	52
Choerodon venustus	7	73	80
Choerodon zamboangae	2	0	2
Chromis fumea	0	3	3
Chromis nitida	0	2	2
Cirrhitichthys aprinus	3	0	3
Clathria spp.	0	3	3
Cociella punctata	2	0	2
Coradion chrysozonus	3	13	16
Coris caudimacula	7	0	7
Cottapistus cottoides	58	121	179
Crossorhombus azureus	11	0	11
Cryptopodia dorsalis	1	0	1

(continued...)

Scientific Name	2000	2002	Total
Cryptopodia spatulifrons	1	0	1
Cyclichthys jaculiferus	3	0	3
Cymbacephalus nematophthalmus	1	1	2
Cynoglossus bilineatus	1	0	1
Cynoglossus spp.	38	61	99
Dactyloptena macracanthus	28	0	28
Dactyloptena papilio	34	63	97
Dactylopus dactylopus	56	76	132
Dardanus imbricatus	1	4	5
Dardanus spp.	0	22	22
Dascyllus trimaculata	0	2	2
Dasyatis kuhlii	9	13	22
Dasyatis leylandi	5	11	16
Decapterus russelli	6	6	12
Dendrochirus brachypterus	16	5	21
Dendrochirus zebra	1	0	1
Dendronephthya spp.	26	47	73
Diadema spp.	11	1	12
Diagramma pictum	8	19	27
Didemnidae sp.	1	0	1
Diodon holocanthus	1	5	6
Diploprion bifasciatum	6	0	6
Dorippe quadridens	1	0	1
Dromidiopsis australiensis	2	0	2
Elates ransonnetii	56	6	62
Engraulis australis	2	0	2
Engyprosopon grandisquama	978	2286	3264
Engyprosopon maldivensis	109	105	214
Engyprosopon spp.	122	0	122
Epinephelus sexfasciatus	3	0	3
Epinephelus undulostriatus	1	0	1
Erosa erosa	55	126	181
Etrumeus teres	1	0	1
Euprymna tasmanica	149	81	230
Euretaster insignis	1	0	1
Euristhmus nudiceps	11	0	11
Euristhmus spp.	0	24	24
Eurypegasus draconis	1	2	3
Fistularia commersonii	0	1	1
Fistularia petimba	4	2	6
Foa brachygramma	5	0	5
Fowleria spp.	8	0	8
Fraudella carassiops	2	0	2
Fungia spp.	23	8	31
Gaillardielus ruepelli	1	0	1
Galearctus timidus	19	0	19
Unidentified gastropod	0	1	1
Gloripallium pallium	0	2	2
Glossanodon australis	1	0	1
Gnathophis sp.	1	0	1
Goniasteridae spp.	2	0	2
Gonodactylaceus graphurus	2	1	3
Gorgonian spp.	11	6	17
Grammatobothus polyophthalmus	163	332	495
Gymnocranius audleyi	0	449	449
Gymnocranius elongatus	171	0	171
Gymnothorax cribroris	0	1	1
Halimeda discoidea	0	1	1
Halimeda platydisca	1	0	1
Halimeda spp.	10	2	12

(continued...)

Scientific Name	2000	2002	Total
Halophila ovalus	1	0	1
Halophila spinulosa	11	7	18
Halophryne ocellatus	12	0	12
Hapalochlaena lunulata	1	0	1
Harrouia sp.	1	0	1
Hemigaleus cf microstoma	0	4	4
Hemiramphid	0	4	4
Herklotsichthys lippa	1	3	4
Holothuria ocellatus	15	5	20
Holothurian spp.	4	16	1
Hyastenus campbelli	5	1	6
Hyastenus diacanthus	11	36	47
Hyastenus sp.	1	0	1
Hydatina physis	1	0	1
Unidentified Hydroid	12	8	20
Hypodistoma sp.	1	0	1
Ibacus brucei	2	0	2
Ichthyscopus insperatus	1	0	1
Ichthyscopus sannio	0	40	40
Inegocia harrisii	93	0	93
Inegocia japonica	149	1	150
Inimicus caledonicus	218	470	688
Ircinia spp.	0	5	5
Izanami inermis	153	4	157
Jonas leuteanus	14	1	15
Kanekonia queenslandica	2	3	5
Lactoria cornuta	4	1	5
Lagocephalus sceleratus	4	8	12
Leiognathus aureus	8	0	8
Leiognathus bindus	6	0	6
Leiognathus moretoniensis	1	0	1
Lepidotrigla argus	512	876	1388
Lepidotrigla asymmetricus	0	27	27
Lepidotrigla callodactyla	1	0	1
Lepidotrigla cf japonica	236	54	290
Lepidotrigla grandis	19	304	323
Lepidotrigla umbrosa	55	10	65
Lethrinus genivittatus	1524	1566	3090
Lethrinus laticaudis	21	0	21
Lethrinus nebulosus	5	0	5
Leucosia ocellata	4	0	4
Liocarcinus corrugatus	1	0	1
Liocranium praepositum	24	135	159
Lobophora sp.	0	1	1
Lobophora variegata	22	45	67
Lophopilumnus globosus	2	0	2
Lophopilumnus sp.	1	0	1
Luidia maculata	3	0	3
Lupocyclus phillipinensis	2	0	2
Lupocyclus rotundatus	11	10	21
Lutjanus adetii	3	12	15
Lutjanus malabaricus	4	0	4
Lutjanus quinquelineatus	0	1	1
Lutjanus sebae	3	0	3
Lutjanus spp.	10	46	56
Lutjanus vitta	10	4	14
Matuta granulosa	5	0	5
Matuta spp.	0	4	4
Meiacanthus luteus	0	4	4
Metapenaeopsis lamellata	303	301	604

(continued...)

Scientific Name	2000	2002	Total
Metapenaeopsis mogiensis	0	3240	3240
Metapenaeopsis palmensis	4691	730	5421
Metapenaeopsis rosea	0	865	865
Metapenaeopsis spp.	3	0	3
Metapenaeus ensis	1	1	2
Metasepia pfefferi	16	27	43
Micippa sp.	1	0	1
Microcanthus strigatus	1	0	1
Mimachlymus gloriosa	3	0	3
Minous trachycephalus	2	12	14
Minous versicolor	1	5	6
Monacanthus chinensis	3	2	5
Nemipterus furcosus	3	2	5
Nemipterus hexodon	41	0	41
Nemipterus peronii	0	3	3
Nemipterus sp.	0	1	1
Nemipterus theodorei	851	1791	2642
Nephthya spp.	0	3	3
Octopus exannulatus	0	138	138
Octopus spp.	43	0	43
Odontodactylus sp	1	0	1
Onigocia macrolepis	0	33	33
Onigocia pedimacula	0	1	1
Onigocia spinosa	97	230	327
Ophiuroid spp.	18	8	26
Oratosquillina inornata	1	0	1
Oratosquillina interupta	1	0	1
Oratosquillina quinquedentata	7	12	19
Ostracion nasus	5	42	47
Ostreid spp.	0	13	13
Oxycheilinus bimaculatus	0	3	3
Paracentropogon longispinus	6	3	9
Paracentropogon zonatus	0	7	7
Parachaetodon ocellatus	0	2	2
Paramonacanthus filicauda	1785	0	1785
Paramonacanthus lowei	52	464	516
Paramonacanthus otisensis	2380	3164	5544
Parapenaeus longipes	3	0	3
Parapercis clathrata	1	0	1
Parapercis nebulosa	281	403	684
Parapercis xanthoszona	0	1	1
Paraplagusia bilineata	1	8	9
Parapriacanthus ransonetti	1	0	1
Parapriacanthus ransonneti	223	28	251
Parascorpaena picta	3	0	3
Parastromateus niger	1	0	1
Pardachirus pavoninus	0	1	1
Parupeneus barberinoides	0	3	3
Parupeneus barberinus	3	1	4
Parupeneus heptacanthus	0	9	9
Parupeneus pleurospilos	5	0	5
Parupeneus sp.	1	0	1
Pegasus volitans	7	0	7
Pelates quadrilineatus	0	28	28
Penaeus esculentus	2	0	2
Penaeus latisulcatus	1	13	14
Penaeus longistylus	42	2	44
Penaeus plebejus	41	20	61
Pentaceraster regularis	2	0	2
Pentaceraster spp.	110	23	133

(continued...)

Scientific Name	2000	2002	Total
Pentacta anceps	1	0	1
Pentapodus nagasakiensis	690	968	1658
Pentapodus paradiseus	89	194	283
Pentapodus porosus	5	0	5
Pentaprion longimanus	9	0	9
Peristrominous dolosus	4	3	7
Peronella spp.	25	8	33
Peronella spp.	30	0	30
Pervagor janthinosoma	0	1	1
Petroscirtes lupus	4	8	12
Petroscirtes sp.	0	1	1
Phalangipus australiensis	3	0	3
Philine angasi	1	0	1
Photololigo spp.	9	0	9
Picrocerus armatus	2	0	2
Pilumnus semilanatus	1	0	1
Platax batavianus	0	1	1
Platycephalus arenarius	17	14	31
Platycephalus endrachtensis	1	0	1
Plotosus lineatus	23	8	31
Pomacentrus milleri	0	2	2
Pomacentrus nagasakiensis	1	0	1
Pomadasys maculatus	2	0	2
Pontocaris orientalis	1	0	1
Portunus argentatus	286	50	336
Portunus gracilimanus	35	4	39
Portunus haanii	27	0	27
Portunus orbitosinus	2	10	12
Portunus pelagicus	1	16	17
Portunus rubromarginatus	2018	3260	5278
Portunus rugosus	2	0	2
Portunus sanguinolentus	7	47	54
Portunus spp.	10	0	10
Portunus tenuipes	39	137	176
Priacanthus hamrur	4	0	4
Priacanthus macracanthus	18	2	20
Priacanthus tayenus	0	8	8
Pristotis jerdoni	2443	5683	8126
Psettina gigantea	14	0	14
Pseudochromis quinquedentatus	6	0	6
Pseudocolochirus axiologus	0	2	2
Pseudomonacanthus elongatus	3	14	17
Pseudomonacanthus peroni	19	18	37
Pseudopataecus taenianotus	5	9	14
Pseudorhombus argus	1	0	1
Pseudorhombus arsius	7	0	7
Pseudorhombus diplospilus	20	8	28
Pseudorhombus dupliciocellatus	154	300	454
Pseudorhombus elevatus	48	43	91
Pseudorhombus jenynsii	17	5	22
Pseudorhombus quinquocellatus	2	0	2
Pseudorhombus spinosus	116	285	401
Pteragogus amboinensis	2	0	2
Pteria lata	0	32	32
Pterocaesio digramma	9	3	12
Pteroeides spp.	2	1	3
Pterois volitans	1	7	8
Pterygotrigla hemisticta	3	0	3
Quallastria gonypetes	2	0	2
Rastrelliger brachysoma	1	0	1

(continued...)

Scientific Name	2000	2002	Total
Rhabdamia gracilis	1	0	1
Rhinobatos typus	1	0	1
Rhodophyta spp.	5	0	5
Rhynchoconger cf ectenurus	4	0	4
Rogadius patriciae	24	72	96
Samaris cristatus	0	5	5
Samaris macrolepis	4	1	5
Sargassum racamosa	2	0	2
Sargassum spp.	14	52	66
Sargocentron rubrum	13	3	16
Saurida argentea	1	0	1
Saurida filamentosa	5	0	5
Saurida grandisquamis	672	632	1304
Scaeochlamys livida	0	1	1
Scolopsis spp.	0	1	1
Scolopsis taenioptera	1	6	7
Scorpaena cardinalis	0	14	14
Scorpaenid – round headed red	0	1	1
Scorpaenodes smithi	3	0	3
Scorpaenodes varipinnis	1	0	1
Scorpaenopsis venosa	1	0	1
Scyllarus demani	33	81	114
Scyllarus granulosus	0	1	1
Scyllarus rugosus	0	3	3
Scyllarus spp.	9	0	9
Sea Urchin 11 (CSIRO)	1	0	1
Sea Urchin 3 (CSIRO)	46	21	67
Sea Urchin 6 (CSIRO)	16	4	20
Sebastapistes strongia	12	15	27
Selar boops	0	4	4
Selaroides leptolepis	14	17	31
Sepia mestus	3	0	3
Sepia opipara	193	0	193
Sepia papuensis	105	402	507
Sepia plangon	112	552	664
Sepia smithi	27	25	52
Sepia spp.	4	0	4
Sepia whitleyana	8	15	23
Sepiadarium austrinium	4	0	4
Sepiadarium kochii	12	16	28
Sepioloidea lineolata	4	1	5
Sepioteuthis lessoniana	2	0	2
Seriolina nigrofasciata	0	1	1
Sicyonia cristata	37	0	37
Sicyonia lancifera	0	37	37
Sicyonia rectirostris	1	0	1
Siganus fuscescens	678	204	882
Sillago ciliata	0	2	2
Sillago ingenuua	74	0	74
Sillago maculata	0	4	4
Sillago robusta	47	97	144
Sillago sihama	0	78	78
Sirembo imberbis	23	11	34
Soleichthys heterorhinos	11	28	39
Solenocera pectinata	40	0	40
Sorsogona tuberculata	201	401	602
Spatangoida spp.	106	0	106
Sphenopus marsupialis	3	18	21
Stellaster equestris	17	2	19
Stellaster spp.	2	0	2

(continued...)

Scientific Name	2000	2002	Total
Stichopus spp.	23	0	23
Stolephorus spp.	4	0	4
Strabozebrias cancellatus	4	0	4
Suezichthys devisi	2	0	2
Suezichthys gracilis	2	10	12
Suggrundus macracanthus	59	3	62
Synchiropus rameus	73	146	219
Synodus doaki	0	6	6
Synodus hoshinonis	55	0	55
Synodus indicus	20	0	20
Synodus sageneus	75	84	159
Synodus tectus	0	126	126
Synodus variegatus	10	0	10
Tamaria spp.	6	0	6
Tathicarpus butleri	12	8	20
Temnopleurus spp.	2	0	2
Terapon theraps	7	0	7
Tetrosomus concatenatus	78	0	78
Tetrosomus gibbosus	11	0	11
Tetrosomus reipublicae	0	26	26
Thalamita intermedia	32	17	49
Thalamita oculea	2	0	2
Thalamita sima	12	0	12
Thenus indicus	3	1	4
Thenus orientalis	1	2	3
Torquigener altipinnis	15	0	15
Torquigener pallimaculatus	2237	1600	3837
Torquigener perlevis	274	159	433
Torquigener whitleyi	14	0	14
Trachinocephalus myops	459	651	1110
Trachypenaeus anchoralis	26	0	26
Trachypenaeus curvirostris	1179	384	1563
Trachypenaeus granulosus	208	210	418
Trachyrhamphus bicoarctatus	0	1	1
Tragulichthys jaculiferus	0	4	4
Triphyllozoon spp.	0	23	23
Trixiphichthys weberi	16	16	32
Trygonoptera testacea	1	0	1
Udotea spp.	5	23	28
Upeneichthys lineatus	1	0	1
Upeneus asymmetricus	1092	2287	3379
Upeneus filifer	0	68	68
Upeneus luzonius	36	76	112
Upeneus moluccensis	14	0	14
Upeneus tragula	666	702	1368
Uranoscopus cognatus	3	0	3
Uranoscopus terraereginae	18	0	18
Valenciennea spp.	5	0	5
Zabidius novaemaculeatus	1	0	1
Zebrias craticula	26	48	74
Zebrias quagga	2	0	2
Grand Totals	**36 325**	**44 913**	**81 219**

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