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Biodiversity of shallow reef fish assemblages in Western Australia using a rapid censusing technique

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Abstract – A rapid assessment methodology was used to provide relative abundance data on selected families of Western Australian fishes. Twenty shallow water reef sites were surveyed covering the coastline between the Recherche Archipelago in the south east and the Kimberley in the north. Three groups of atolls located off the Kimberley coast were also included. Eighteen families that best represent the State's nearshore reef fish fauna were targeted. They are: Serranidae, Caesionidae, Lutjanidae, Haemulidae, Lethrinidae, Mullidae, Pempheridae, Kyphosidae, Girellidae, Scorpididae, Chaetodontidae, Pomacanthidae, Pomacentridae, Cheilodactylidae, Labridae, Odacidae, Acanthuridae, and Monacanthidae. Analysis of the dataset using a hierarchical classification technique indicates that four groups of reef fishes are present: a southwest assemblage, a northwest assemblage, an offshore atolls assemblage, and a Kimberley assemblage. The first assemblage is comprised mainly of temperate species, while the latter three are mostly tropical fishes; these two broader groupings narrowly overlap on the west coast between Kalbarri and the Houtman Abrolhos. Evidence of a wide zone of temperate/tropical overlap—as proposed by some previous studies—is not supported by this analysis, nor is the presence of a prominent subtropical fauna on the west coast. Ecological differences of the four assemblages are explored, as well as the impact by the Leeuwin Current on this arrangement.

INTRODUCTION

Western Australia occupies about 23 degrees of latitude (12–35°S) covering a large and varied aquatic ecosystem. Its fish fauna, at just over 3000 species, is recognised as possibly the most diverse in Australia (Hutchins, 2001). About 1500 of these are associated with shallow reefs (0–40 m), and make up the majority of fishes that best identify the Western Australian fauna. They range from diverse coral-dwelling fishes of the northern atolls to the cool water inhabitants of the State's southern rocky reefs. However, human impact on these fishes is increasing; reef fishes represent the core of recreational catches and their often gaudy colouration attracts the attention of swimmers and divers. Many are targeted by professional fishermen which has led to a reduction in numbers of some of the more popular species (e.g., coral trout). Because of this notoriety, demand for information on their biodiveristy has accelerated over the last two decades. Although contemporary studies of reef fish diversity have focussed attention on various regions of the State (e.g., Hutchins, 1990; Allen, 1993b), few have been able to examine large-scale spatial changes in the fauna. One recent study (Hutchins, 1994) looked at distributions along the western and southern coasts of the State, but could only provide a brief comparison with other more northern areas. The main stumbling block was the lack of reliable data from the more isolated parts of the Pilbara and Kimberley coasts. Subsequent investigations (e.g., Hutchins, 1995a, 1996b), however, have helped to overcome this deficiency. For the first time, an analysis of reef fish assemblages across the various marine regions of Western Australia is possible. The coverage is broad enough to allow a close examination of their biodiversity, although much of the present dataset is based on exploratory work and future efforts will doubtlessly lead to some changes in its interpretation.

Reef fish assemblages of shallow waters lend themselves to study because of their relatively easily accessible habitat, their familiarity to researchers, and the increasing comprehensiveness of taxonomic knowledge. In particular, many reef fish families are comprised of species that spend much of their time in the open and are generally easy for divers to record visually. Lately, surveys employing visual techniques have gained wider acceptance for estimating species diversity than the previous specimen collecting methodology

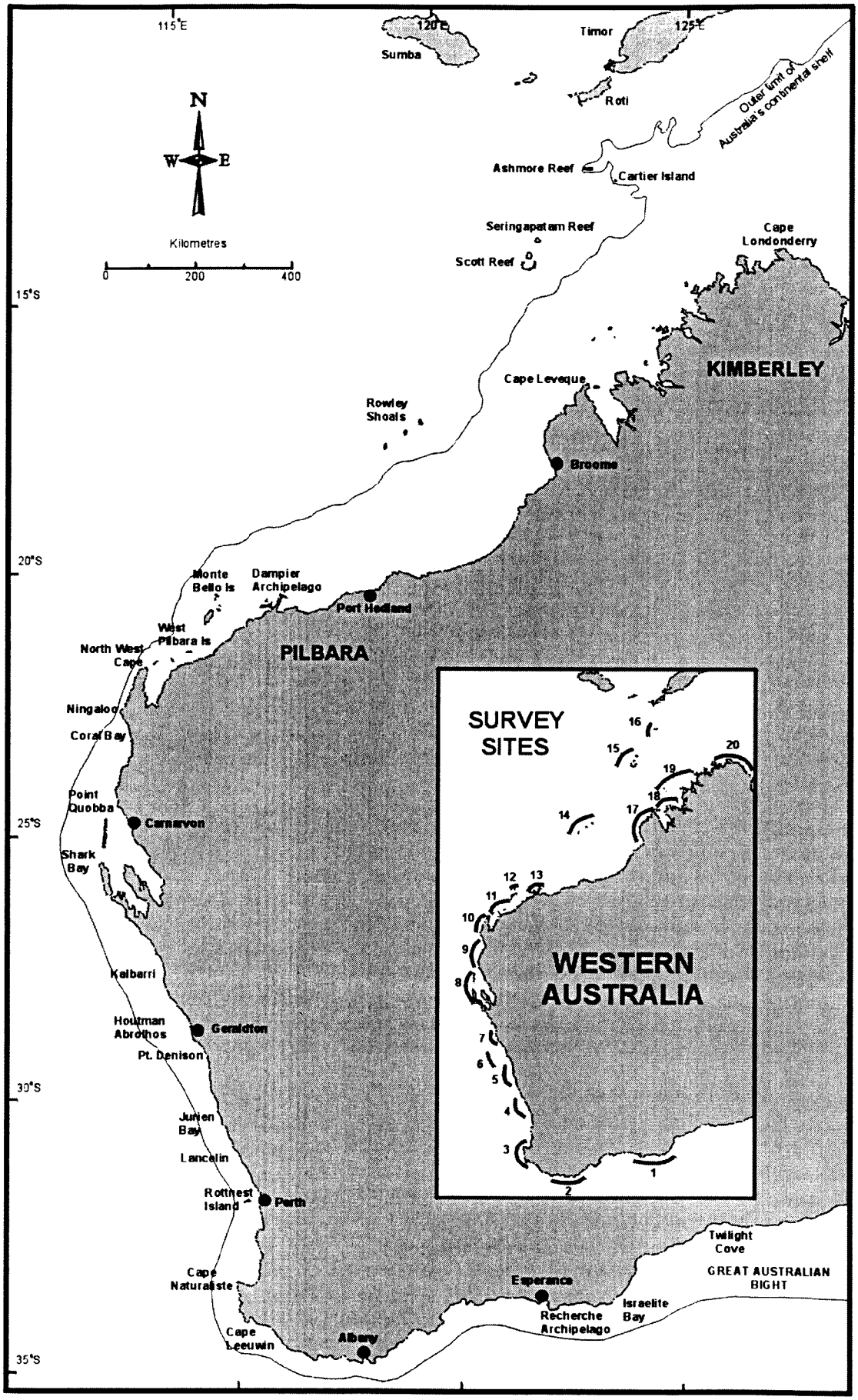

Figure 1 Map of Western Australia showing many of the localities mentioned in the text. Insert depicts the location and approximate range of each of the 20 survey sites as described in the Methods section.

(Anonymous, 1978). Nevertheless, a combination of the two is still necessary when preparing lists of biodiversity. Many cryptic species remain hidden in the reef structure and must be forcibly removed using a variety of collecting procedures. For analysis, however, the rapid assessment technique (Williams, 1982) incorporating visual surveys that target particular families has many benefits. This semiquantitative method can allow reasonably accurate comparisons to be made between various study sites (e.g., Newman *et al.*, 1997); it is also non-destructive, and involves less time and resources that more comprehensive investigations demand.

The present paper deals with the results of a series of surveys carried out at 20 major locations in Western Australia (Figure 1) by the author and colleagues from various institutions (see Acknowledgements for a list of participants). The surveys commenced in 1978 and have continued to the present. The data presented here were gathered using the rapid assessment methodology mentioned above and described more fully in the methods section below. Eighteen families were targeted (Table 1), six of which consist wholly of tropical species, four almost entirely of temperate species (two subtropical species are included) and eight with a mixture of tropical, subtropical and temperate species. Almost 500 species of shallow reef fishes are represented by these families in Western Australia, including many of the species that attract the attention of divers and are recognised as typical reef inhabitants. Apparent spatial variations of these taxa are easier to detect than changes to other less visible species, and therefore should be more representative of changes within the fish fauna as a whole. The dataset is presented in several ways, including a complete listing of species, data summaries in tabular form, and a hierarchical classification that indicates the degree of similarity of the various fish assemblages. The resulting spatial pattern is examined in the context of previous studies.

METHODS

The method of survey was based initially on the visual survey technique described in Wilson and Marsh (1979) but subsequently modified after Williams (1982). Fish were counted during a 45–60 minute swim in which the observer swam in a zigzag course around each survey location. Records were noted on underwater sheets that had previously been filled out with the names of species most likely to be found, and scored in a $\log_5$ scale of abundance (1=1 fish; 2=2–5; 3=6–25; 4=26–125; 5=126–625; 6=626–3125; 7=3126+). All identifiable species were recorded but particular emphasis was placed on the target families. Species not normally associated with shallow reefs (e.g., rare sightings of deepwater dwellers) are not covered here. However, seagrass and sandy bottom inhabitants that often enter the reef system are included. Most survey activity occurred in the depth range 0–20 m, but depths to 30 m were occasionally worked. The reader is also referred to Anonymous (1978) and Halford and Thompson (1994) for additional information on reef fish censusing.

The terminology used here follows Hutchins (1994). Biodiversity is usually defined as the number of species present (Helfman *et al.*, 1997), but is also employed here to infer geographic changes in diversity. Species referred to as endemic are those with breeding ranges restricted to Western Australia. The phylogenetic order and arrangement of the families follow Paxton *et al.* (1989). Much of the survey work has previously been reported in published and unpublished reports, all of which are listed in the bibliography at the rear of this paper (see Allen, 1977, 1992, 1993a–b, 1996; Allen and Russell, 1986; Allen and Swainston, 1988; Hutchins, 1977, 1978, 1979, 1990, 1994, 1995a–b, 1996a–b, 1997b–c, 1998, 1999; Hutchins and Swainston, 1986; Hutchins and Thompson, 1983; Hutchins *et al.*, 1995; and Morrison and Hutchins, 1997). In addition, a full list of species known for Western Australia with a comprehensive bibliography can be found in Hutchins (in press).

Sites

The sites selected for analysis are shown in Figure 1, and are briefly described below (grouped into seven approximate geographical regions). Additional information on sites along the west and south coasts can be found in Hutchins (1994).

South coast

Site 1 – Recherche Archipelago, from Israelite Bay to Esperance. Twilight Cove, which is located further to the east and was examined by Hutchins (1994), is not included in the present analysis due to the limited nature of its dataset.

Site 2 – Albany area, from Cheyne Beach to Walpole.

Site 3 – Capes area, from Cape Leeuwin to Cape Naturaliste, including Geographe Bay.

Lower west coast

Site 4 – Perth area, from Rockingham to Lancelin. Rottnest Island, which was treated as a separate site by Hutchins (1994), is included here.

Site 5 – Port Denison area, from Jurien Bay to Port Denison.

Central west coast

Site 6 – Houtman Abrolhos, including all offshore islands in the region.

Site 7 – Kalbarri area, from Port Gregory to Kalbarri.

Upper west coast

Site 8 – Shark Bay (western portion), from South Passage to Bernier Island.

Site 9 – Coral Bay area, from Point Quobba to Coral Bay.

Northwest coast

Site 10 – Ningaloo Reef, from Ningaloo to North West Cape.

Site 11 – West Pilbara islands, from Muiron Islands to Boodie Island, but not including Barrow Island or the Lowendahl Islands (data not available) (Hutchins [1994] included the offshore Muiron Islands with Ningaloo Reef).

Site 12 – Monte Bello Islands.

Site 13 – Dampier Archipelago, from Kendrew Island to Delambre Island, and including northern parts of the Burrup Peninsula.

Offshore atolls

Site 14 – Rowley Shoals (Imperieuse, Clerke, and Mermaid Reefs)

Site 15 – Scott and Seringapatam Reefs

Site 16 – Ashmore Reef and Cartier Island

Kimberley

Site 17 – Southwest Kimberley, from Broome to Cape Leveque, but not including the offshore Lacepede Islands (data not available).

Site 18 – North Kimberley (inshore), from the Buccaneer Archipelago to Montgomery Reef.

Site 19 – North Kimberley (offshore), from Churchill Reef, through the Bonaparte Archipelago to Cassini Island.

Site 20 – Northeast Kimberley, from Vansittart Bay to Cambridge Gulf.

Analysis

Sites were classified into groups by a hierarchical classification analysis employing the computer program NTSYSPC 2.0. Bray-Curtis similarity coefficients were used, and matrices clustered using the UPGMA clustering method. Log_5 abundances were determined for all species recorded during each individual survey swim, the means calculated for each site and then rounded to the nearest whole number, usually between 1 and 4 (a few mean values at sites 14, 15 and 16 were calculated as 5 but were still entered as 4). This simplistic approach was adopted for several reasons: 1. The survey effort was higher in some areas than others, and therefore is not directly comparable; 2. The times spent censusing fish were not standardised until the early 1990's; and 3. No single calculation can be expected to accurately describe abundance over the wide range of reef habitat that exists at each of the 20 survey sites. Therefore, the abundance data presented in Appendix 1 could be best described as broad estimates for each site that equate to the following: blank = not recorded; 1 = rare; 2 = occasional; 3 =

Table 1 Numbers of species per family recorded from 20 sites in Western Australia

Regions	South coast			Lower W coast		Central W coast		Upper W coast		NW coast				Atolls			Kimberley				Total
Sites	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Serranidae	6	7	8	12	10	16	9	20	21	23	24	18	21	25	29	24	11	12	15	6	59
Caesionidae								3	3	4	4	3	3	3	5	7	1	1	2	1	8
Lutjanidae						3	1	10	10	13	14	12	13	12	15	13	7	4	12	4	23
Haemulidae			1	2	1	3	2	4	5	7	7	7	7	2	3	4	4	5	6	3	10
Lethrinidae				2	1	4		6	6	10	8	9	8	8	11	12	4	1	4	2	19
Mullidae	1	1	3	3	4	6	3	9	6	11	9	8	6	6	8	9	2	2	2	2	14
Pempheridídae	4	4	4	6	5	6	3	6	4	5	6	4	4	2	2	2	1		1		10
Kyphosidae	1	1	2	2	2	2	2	2	2	2	3	2	2	2	3	3	1		1		5
Girellidae	2	2	2	2	2	1	1														2
Scorpididae	4	4	5	5	4	3	3	3	1	1	1										5
Chaetodontidae	1	1	2	8	5	15	8	16	18	23	23	17	19	25	31	30	4	6	10	6	43
Pomacanthidae						3		6	4	8	8	5	5	10	13	14	3	2	3		19
Pomacentridae	4	4	5	15	11	24	8	28	32	40	41	35	35	48	60	73	13	17	29	12	100
Cheilodactylidae	5	5	4	4	2	3	2	2	1												5
Labridae	13	15	15	32	22	50	15	45	44	59	59	38	46	58	65	65	13	11	29	8	116
Odacidae	4	4	4	4	4	1	2														4
Acanthuridae				4	2	6	2	12	11	17	22	12	13	20	21	28	4	1	6	1	31
Monacanthidae	9	8	9	11	8	6	1	6	3	7	5	4	4	7	5	6	1		1	1	20
Total: sites	54	56	64	112	83	152	62	178	171	230	234	174	186	228	271	290	69	62	121	46	
Total: regions	68			118		156		203		267				344			141				493

Table 2 Numbers of tropical, subtropical and temperate fishes per family recorded from 20 sites in Western Australia

	Tropical	Subtropical	Temperate
Serranidae	50	4	5
Caesionidae	8		
Lutjanidae	23		
Haemulidae	10		
Lethrinidae	19		
Mullidae	13		1
Pempheridae	6		4
Kyphosidae	3	1	1
Girellidae			2
Scorpididae		2	3
Chaetodontidae	41	1	1
Pomacanthidae	19		
Pomacentridae	94	2	4
Cheilodactylidae		2	3
Labridae	99	5	12
Odacidae			4
Acanthuridae	31		
Monacanthidae	11		9
Total	427	17	49

frequent; 4 = abundant. For comparative purposes, a second analysis of this dataset was performed using a presence-absence format only.

Results

A total of 493 species of reef-associated fishes were recorded for the 18 families examined during this investigation. These are listed by family in Appendix 1, together with estimates of their relative abundance at each of the twenty survey sites. Also, the latitudinal range of each species is indicated by one of three biogeographical descriptors (i.e., tropical, subtropical, or temperate), and species endemic to Western Australia are denoted by an asterisk. The following summaries of the dataset are presented in tabular form: species numbers per family (Table 1); species numbers per biogeographical category (Tables 2 and 3); numbers of endemic species per biogeographical category (Table 4), most abundant species at three or more sites (Table 5); and species numbers shared between the seven geographical regions (Table 6).

Regionally, the greatest number of taxa were recorded at the offshore atolls (344 species), the numbers decreasing southwards to the south coast (68 species) (Table 1). However, the Kimberley's unexpectedly low figure of 141 species places it between the central west coast (156 species) and the lower west coast (118). Ashmore Reef (290 species) had the highest species richness of the survey sites, followed by Scott/Seringapatam (271 species), West Pilbara islands (234), Ningaloo Reef (230), Rowley Shoals (228), Dampier Archipelago (186), Shark Bay (178), Monte Bello Islands (174), Coral Bay (171), and Houtman Abrolhos (152). All of these locations had predominantly tropical faunas, although two—

Table 3 Numbers of tropical, subtropical and temperate fishes recorded from 20 sites in Western Australia.

	South coast			Lower W coast		Central W coast		Upper W coast		NW coast				Atolls			Kimberley			
Sites	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Tropical		1	4	48	27	112	35	155	159	221	228	174	186	228	271	290	67	62	121	46
Subtropical	7	8	13	17	17	17	15	17	12	9	6									
Temperate	47	47	47	47	39	23	12	6												
Total	54	56	64	112	83	152	62	178	171	230	234	174	186	228	271	290	69	62	121	46

Table 4 Numbers of endemic tropical, subtropical and temperate fishes recorded from 20 sites in Western Australia.

	South coast			Lower W coast		Central W coast		Upper W coast		NW coast				Atolls			Kimberley			
Sites	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Tropical				1		3		5	5	5	5	5	5	2	2	1	4		2	
Subtropical	7	8	12	16	16	15	13	16	11	8	5									
Temperate	8	10	9	9	7	6	4													
Total Endemics	15	18	21	26	23	24	17	21	16	13	10	5	5	2	2	1	4		2	
% of Total Species from Site	28	32	33	23	28	16	27	12	10	6	5	3	3	0.9	0.7	0.3	6		2	

Table 5 Most abundant species at three or more sites (abundance estimates: 1 = rare; 2 = occasional; 3 = frequent; 4 = abundant)

	South coast			Lower W coast		Central W coast		Upper W coast		NW coast				Atolls			Kimberley			
Sites	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Lutjanidae																				
Lutjanus carponotatus								3	2	3	4	3	3				4	3	4	3
Kyphosidae																				
Kyphosus cornelii			2	4	4	4	4	4	2	1	1									
Pempheridae																				
Pempheris klunzingeri	4	4	4	4	2	1	1	1												
Pomacentridae																				
Abudefduf bengalensis				1	1	2	4	3	2	2	4	4	4				3	4	4	3
A. sexfasciatus				2	1	4	2	3	4	4	4	4	4			1				
Chromis klunzingeri	4	4	4	4	3	1														
Dascyllus aruanus						2		1	3	3	1	2		4	4	4				
Neopomacentrus azysron								3	2	3	4	4	4			1	1	3	3	1
Parma mccullochi	3	4	4	4	4	2	1													
Pomacentrus coelestis				1	1	2	1	3	4	4	4	4	3	3	2	3			3	1
P. milleri				2	4	4	4	3	2	3	4	4	4				4	4	4	3
P. moluccensis								2	3	4	4	3	2	3	4	2				
P. vaiuli								1	3	4	4	1		3	4	2				
Stegastes obreptus				3	2	3	1	4	4	3	4	3	3					1	3	
Labridae																				
Austrolabrus maculatus	4	3	4	4	4	3	3	1												
Choerodon cyanodus						1		1	1	2	4	3	4				3	4	4	4
Coris auricularis	1	3	4	4	4	4	4	3	1	1	1									
Halichoeres brownfieldi	2	3	4	4	4	4	4	4	1		1									
H. nebulosus						2	1	3	4	4	4	3	3			1			2	
Notolabrus parilus	4	4	4	4	4	3	4	2												
Ophthalmolepis lineolatus	4	4	4	3	3	1														
Pseudolabrus biserialis	4	4	4	4	3	1														
Stethojulis bandanensis				2	2	2	2	4	4	4	3	3	3	1	1	1				
Thalassoma lunare				2	3	4	2	4	4	4	4	3	4	1	3	3		1	2	1
T. lutescens				2	3	4	1	4	4	4	4	2	1							
Acanthuridae																				
Acanthurus grammoptilus					1	1	1	2	2	3	4	4	3				3	4	4	3

Shark Bay and Houtman Abrolhos—also had moderate numbers of subtropical and temperate species. The site with the lowest number of species was Northeast Kimberley (site 20), which at 46 species was slightly lower than the numbers found at the temperate sites along the State's south coast. The most speciose family was the Labridae with 116 species, followed by the Pomacentridae with 100 and the Serranidae with 59 (Table 1). These families are predominantly tropical but also include small numbers of subtropical and temperate species (Table 2).

Tropical species were found as far south as Albany (site 2), temperate species as far north as Shark Bay (site 8) and subtropical species between the Recherche Archipelago (site 1) and West Pilbara islands (site 11) (Table 3). A total of 427 tropical species (87% of the total) was recorded, whereas only 17 subtropical (3%) and 49 temperate species (10%) were found (Table 2). Most of the

Table 6 Number of species shared between seven regions of Western Australia (expressed as % of total species in each region)

Regions	S Coast	Lower W coast	Cen. W coast	Upper W coast	NW coast	Atolls	Kimberley	Total Species
South coast	100%	97%	66%	40%	20%	1%	0%	68
Lower West coast	56%	100%	79%	64%	55%	31%	25%	118
Central West coast	29%	60%	100%	66%	78%	49%	36%	156
Upper West coast	13%	37%	51%	100%	93%	60%	46%	203
North West coast	5%	24%	46%	71%	100%	64%	46%	267
Atolls	0%	10%	22%	35%	50%	100%	25%	344
Kimberley	0%	21%	40%	67%	88%	60%	100%	141

tropical species are wide-ranging Indo-West Pacific species; 15 species are known only from the northern Australian area and six of these are considered endemic to Western Australia (Appendix 1). The subtropical component had the highest number of endemic species (Table 4), with only one species also inhabiting other parts of Australia. Most of the temperate species range into other southern States, but 10 are confined to Western Australia. Furthermore, endemic species comprised 23–33% of the fauna at each of sites 1–5 and 7 in the south west, 10–16% at sites 6, 8 and 9, but had reduced to negligible proportions by site 10 in the north west. In terms of the number of individuals, the endemic species were also among the most numerous in the southern half but were poorly represented in the northern half (species abundance is covered in more detail below). The most widespread species was the tropical labrid *Thalassoma lunare* which was recorded from 16 sites. The species with the most restricted distribution was the temperate endemic labrid *Pictilabrus brauni* (one site).

The figures presented in Table 3 indicate a significant variation in species numbers occurred between some adjacent survey sites. In the Kimberley, the offshore islands (site 19) had almost double the number of species recorded for the more inshore areas. Along the northwest coast, Ningaloo Reef (site 10) and West Pilbara islands (site 11) had noticeably more diverse faunas than the Monte Bello Islands (site 12) and Dampier Archipelago (site 13). In the central west and lower west coastal regions, one site in each (sites 6 and 4 respectively) had considerably higher numbers than adjacent areas (sites 7 and 5 respectively). All of these variations are probably due to ecological differences which are discussed in more detail below.

Relationships

Apparent relationships in the dataset (Appendix 1) were explored using the hierarchical classification analysis described above in the Methods section. The dissimilarity dendrogram for faunal assemblages at the 20 survey sites is illustrated in Figure 2. Two main clusters are apparent at the 0.75 level of dissimilarity: the first includes all locations between the Recherche Archipelago (site 1) and Kalbarri (site 7), excluding the Houtman Abrolhos (site 6), and the second encompasses all locations from Shark Bay (site 8) northwards but including the Houtman Abrolhos.

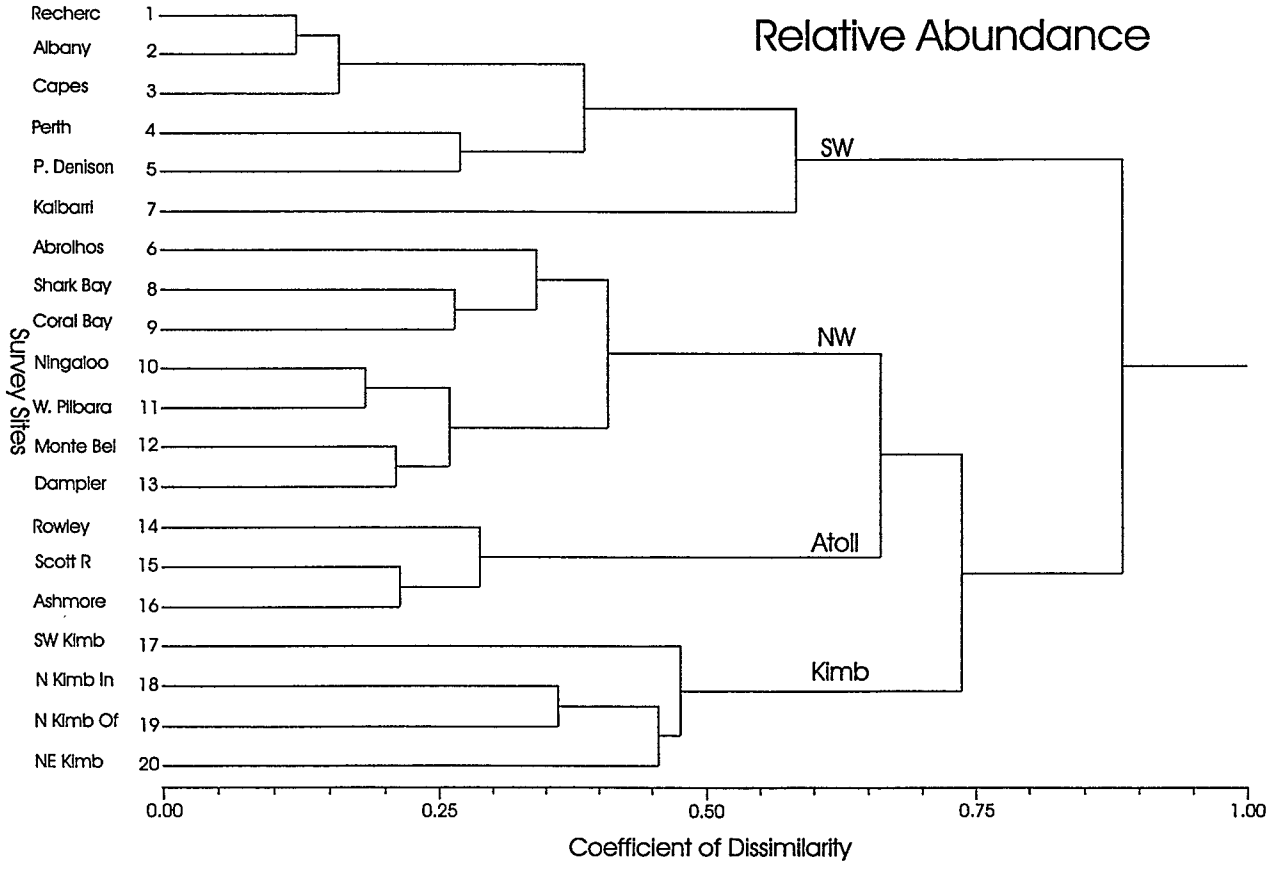

Figure 2 Classification of 20 sites from Western Australia based on relative abundance categories of 493 species of reef fishes (abbreviations: SW = southwest assemblage; NW = northwest assemblage; Atoll = offshore atolls assemblage; Kimb = Kimberley assemblage).

At a level of dissimilarity of approximately 0.7, the northern group forms two more clusters, one consisting of the Kimberley (sites 17–20) and the other comprising sites extending from the Houtman Abrolhos to Ashmore Reef (sites 6–16). The latter cluster can be further differentiated into two assemblages at a dissimilarity level of about 0.5, one consisting of the offshore atolls (sites 14–16) and the other of upper west coast and northwest coast sites (sites 8–13) but also including one site on the central west coast (site 6). This suggests that four major assemblages of shallow reef fishes (at the 0.65 level of dissimilarity) can be recognised in Western Australia (see Figure 2):

1. Southwest assemblage
2. Northwest assemblage
3. Offshore atolls assemblage
4. Kimberley assemblage

The southwest assemblage, which overlaps the northwest assemblage on the central west coast between the Houtman Abrolhos and Kalbarri (Fig. 2), consists mainly of temperate species whereas the other three assemblages are predominantly tropical (Table 3). The southwest assemblage can be further differentiated into two groups at a dissimilarity level of 0.55, one consisting of Kalbarri (site 7) and the other of the south coast and lower southwest sites. The latter can be further separated into two clusters at the 0.35 level, south coast (sites 1–3) and lower west coast (sites 4 and 5). The Kalbarri site is clearly differentiated from the other sites mainly because of a prominent reduction in temperate species (only 12 of 47 species were recorded for Kalbarri [Table 3]). The northwest assemblage can be separated into two groups at the 0.40 level, one consisting of a central to upper west coast cluster (sites 6, 8 and 9), the other of a northwest coast cluster (sites 10–13). The offshore atoll assemblage at a level of 0.25 consists of two groups, one comprising the Rowley Shoals and the other of Scott, Seringapatam and Ashmore Reefs. The Kimberley assemblage is composed of three groups at the 0.4 level; these correspond to the southwest, north and northeast regions of the Kimberley.

For comparison, Figure 3 presents a dendrogram based on presence-absence data only. Four main assemblages are still evident (at the 0.55 level of dissimilarity). The only major differences are in the

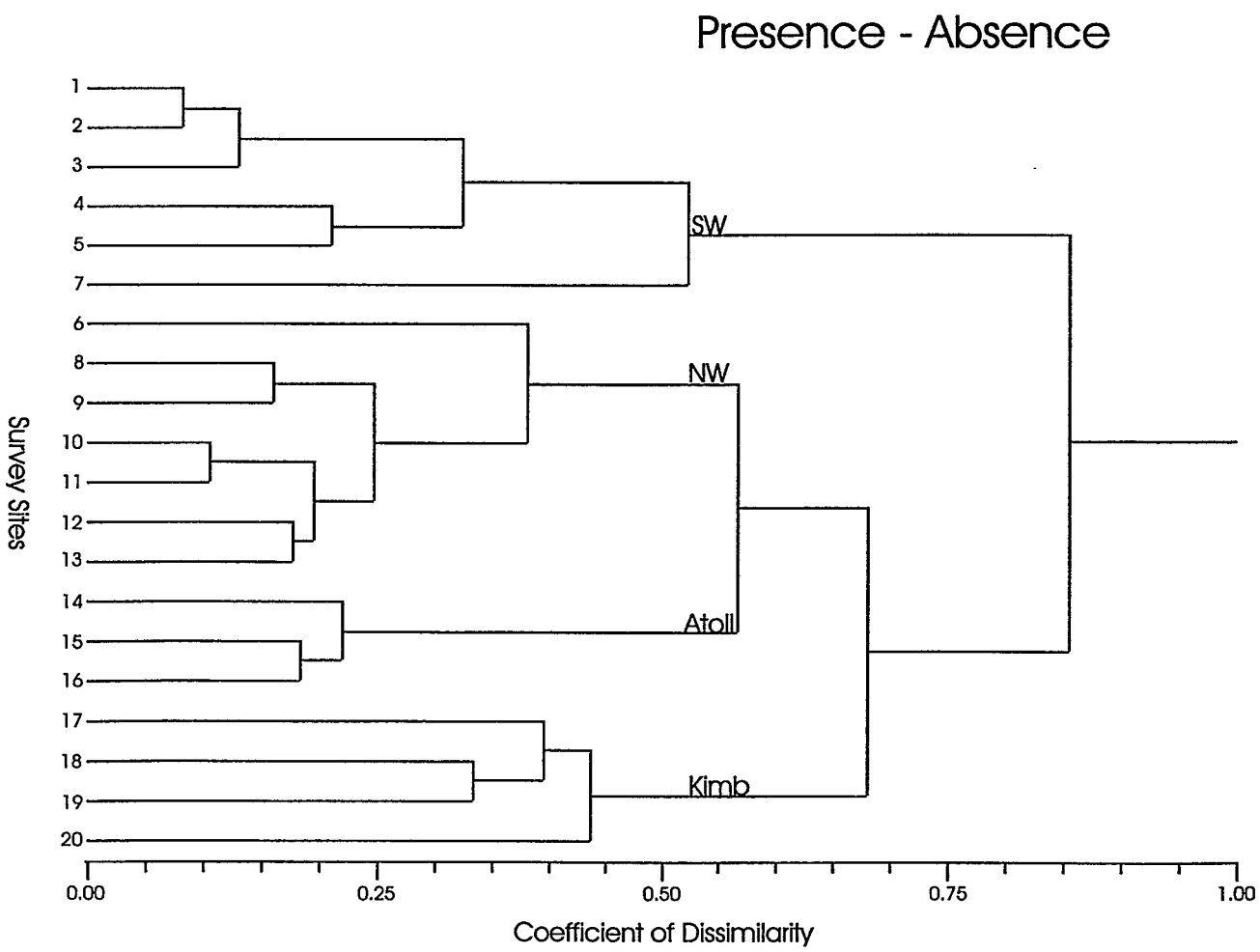

Figure 3 Classification of 20 sites from Western Australia based on presence-absence categories of 493 species of reef fishes (abbreviations as in Figure 2).

northwest and Kimberley assemblages. In the former, Houtman Abrolhos (site 6) clusters separately from the rest of the upper west and lower northwest coast sites (sites 8–13), instead of being grouped with Shark Bay (site 8) and Coral Bay (site 9) as in Figure 2. In the Kimberley assemblage, the north Kimberley (offshore) (site 19) is distinguished from a group of the other three Kimberley sites, whereas in Figure 2, the southwest Kimberley (site 17) clusters separately from the others. In addition, most clusters in Figure 3 are somewhat lower in dissimilarity than the same clusters in Figure 2 (i.e., utilising presence-absence data indicated a slight increase in similarity for each cluster when compared to data usage incorporating relative abundance).

Most abundant species

Within the four main assemblages described above, species-groups characterising the fauna of each site were identified. These are comprised of species that were usually observed in very large numbers and were also the most widespread at each site (Hutchins [1994] referred to these as representing the 'faunal signature' of an area). They provide a quick and reasonably accurate guide to the composition of the fishes at each site. These species-groups are described below, following the hierarchical arrangement depicted in Figure 2. Additional information on other species relevant to the site is also included.

Southwest Assemblage

Sites 1, 2 and 3 (Israelite Bay to Cape Naturaliste). The south coast consists mainly of temperate species with increasing numbers of subtropicals from east to west. The most abundant are the temperate endemic species such as the pomacentrids *Chromis klunzingeri* and *Parma mccullochi* and the labrids *Pseudolabarus biserialis* and *Dotalabrus alleni*. Non-endemic temperate species like the labrids *Austrolabarus maculatus, Notolabrus parilus* and *Ophthalmolepis lineolatus* are also abundant, as are the pempheridid *Pempheris klunzingeri* and scorpidid *Scorpis aequipinnis*. The endemic subtropical labrids *Coris auricularis* and *Halichoeres brownfieldi* become more numerous westwards. One temperate species, the non-endemic cheilodactylid *Cheilodactylus nigripes*, is in moderate numbers in eastern areas but these reduce westwards. A few tropical species were recorded, including the labrid *Anampses geographicus* at Albany, and the haemulid *Plectorhinchus flavomaculatus* and mullid *Parupeneus spilurus* from the capes area, but all were in low numbers.

Sites 4 and 5 (Perth to Port Denison). The lower west coast is dominated by a combination of subtropical and temperate species. The most abundant subtropicals, all of which are endemic, are the labrids *Coris auricularis* and *Halichoeres brownfieldi*, the pomacentrids *Chromis klunzingeri* and *Parma occidentalis*, the scorpidid *Neatypus obliquus* and the kyphosid *Kyphosus cornelii*. The pomacentrid *Parma mccullochi* and labrid *Pseudolabarus biserialis* (both temperate endemics) are equally abundant, as are the labrid *Notolabrus parilus*, kyphosid *Kyphosus sydneyanus*, and scorpidid *Scorpis aequipinnis* (all temperate non-endemics). The subtropical endemic labrid *Choerodon rubescens* becomes more numerous northwards. Tropical non-endemic species such as the mullid *Parupeneus spilurus*, the pomacentrids *Abudefduf vaigiensis, A. sexfasciatus, Pomacentrus milleri*, and *Stegastes obreptus*, and the labrids *Anampses geographicus, Thalassoma lunare* and *T. lutescens* also become more numerous northwards; they sometimes occur in prominent numbers seasonally, but none is abundant year round.

Site 7 (Port Gregory to Kalbarri). The central west coast (inshore) is characterised by subtropical endemics such as the pomacentrid *Parma occidentalis*, the kyphosid *Kyphosus cornelii*, and the labrids *Coris auricularis* and *Halichoeres brownfieldi*. The temperate non-endemic labrids *Notolabrus parilus* and *Austrolabrus maculatus* are also very numerous. Some tropical non-endemic species, such as the pomacentrids *Pomacentrus milleri* and *Abudefduf bengalensis* and the mullid *Parupeneus spilurus*, also were observed in high numbers; however, most of the other tropical species were recorded infrequently.

Northwest Assemblage

Site 6 (Houtman Abrolhos). The central west coast (offshore) is dominated by tropical non-endemic species, although a number of subtropical endemic species are also abundant. The most abundant tropical species are the pomacentrids *Pomacentrus milleri* and *Abudefduf sexfasciatus*, and the labrids *Stethojulis strigiventer, Thalassoma lunare, T. lutescens* and *Anampses geographicus*. The most numerous subtropical endemics are the labrids *Choerodon rubescens, Coris auricularis*, and *Halichoeres brownfieldi*, the pomacentrids *Chromis westaustralis* and *Parma occidentalis*, and the kyphosid *Kyphosus cornelii*. The temperate non-endemic kyphosid *Kyphosus sydneyanus* is also abundant. Many tropical species were recorded for the area but other than those mentioned above, most were observed in low to moderate numbers only.

Sites 8 and 9 (Shark Bay to Coral Bay). The fishes of the upper west coast are predominantly tropical but some of the most common species are subtropical, especially in the Shark Bay area. Tropical species that are abundant (all non-endemic) include the labrids *Thalassoma lunare, T. lutescens, Stethojulis bandanensis, Halichoeres nebulosus*, and *Anampses geographicus*, and the pomacentrids *Abudefduf sexfasciatus, A. vaigiensis,*

Chromis atripectoralis, Pomacentrus milleri, P. coelestis and *Stegastes obreptus*. The following endemic subtropicals are abundant in the Shark Bay area, their numbers reducing northwards: the pomacentrid *Chromis westaustralis*, the labrids *Halichoeres brownfieldi, Choerodon rubescens, Coris auricularis* and *Suezichthys cyanolaemus*, and the kyphosid *Kyphosus cornelii*.

Sites 10 and 11 (Ningaloo to West Pilbara islands). The lower northwest coast possesses a mainly tropical fauna (a few subtropical species occur here in low numbers). The most abundant species are the labrids *Thalassoma lunare, T. lutescens, Coris caudimacula, Halichoeres nebulosus* and *Stethojulis bandanensis*, the pomacentrids *Abudefduf sexfasciatus, Chromis atripectoralis, Neopomacentrus azysron, Pomacentrus coelestis, Pomacentrus molluccensis, P. milleri, P. vaiuli, Plectroglyphidodon lacrymatus*, the caesionids *Caesio cuning* and *Pterocaesio digramma*, and the acanthurid *Acanthurus grammoptilus*. This area has the most diverse fish fauna of mainland Western Australia, the richest areas being around offshore islands such as the Muiron and Serrurier Islands. However the diversity reduces significantly to the north east as the waters become more turbid.

Sites 12 and 13 (Monte Bello Islands and Dampier Archipelago). The central northwest coast has a tropical fauna, the most abundant species being the pomacentrids *Abudefduf bengalensis, A. sexfasciatus, Neopomacentrus azysron, N. cyanomos*, and *Pomacentrus milleri*, the labrids *Choerodon cyanodus* and *Thalassoma lunare*, the caesionid *Caesio cuning*, the chaetodontid *Chaetodon aureofasciatus*, and the acanthurid *Acanthurus grammoptilus*. Some species were common at the Dampier Archipelago but not at the Monte Bello Islands (the pomacentrid *Neopomacentrus filamentosus* and the labrid *Halichoeres nigrescens* for example).

Offshore Atolls Assemblage

Sites 14, 15 and 16 (Rowley Shoals to Ashmore Reef). Many fishes at the offshore atolls are in abundant numbers, the most numerous including the pomacentrids *Amblyglyphidodon curacao, Chromis ternatensis, C. margaritifer, C. viridis*, and *Dascyllus aruanus*, the labrid *Thalassoma amblycephalum*, the lethrinid *Monotaxis grandoculis*, and the acanthurid *Ctenochaetus striatus* (all non-endemic). However, only one – *Dascyllus aruanus* – is scored as abundant at all three sites. Some species are common at two of the sites but not the third. The lutjanid *Lutjanus gibbus*, the pomacentrids *Chrysiptera rex* and *Pomacentrus lepidogenys*, and the labrid *Halichoeres melanurus* are in prominent numbers at Scott/Seringapatam and Ashmore Reefs, whereas the lethrinid *Lethrinus erythropterus* and the pomacentrids *Pomacentrus adelus, P. moluccensis, P. philippinus* and *P. vaiuli* are more numerous at the Rowley Shoals and Scott/Seringapatam Reefs. Ashmore Reef has the most diverse fauna probably because of its close proximity to the Indonesian archipelago, but it also benefits by sharing some species with the Kimberley.

Kimberley Assemblage

Sites 17, 18, 19 and 20 (southwest Kimberley to northeast Kimberley). The Kimberley fishes are dominated by the pomacentrids *Abudefduf bengalensis, Acanthochromis polyacanthus, Dischistodus darwiniensis, Neopomacentrus azysron* and *Pomacentrus milleri*, the labrids *Choerodon cyanodus* and *Halichoeres nigrescens*, the lutjanid *Lutjanus carponotatus*, the chaetodontid *Chaetodon aureofasciatus*, and the acanthurid *Acanthurus grammoptilus* (all are non-endemic). The endemic serranid *Epinephelus bilobatus* and endemic labrid *Choerodon cauteroma* are also very numerous in the southwest Kimberley, but both were rarely found to the north of Cape Leveque. Some species like the pomacentrids *Pomacentrus coelestis* and *Stegastes obreptus*, the labrid *Labroides dimidiatus* and the serranid *Epinephelus fasciatus* are more numerous in the offshore north Kimberley (site 19), than the other more inshore sites.

The dominant family of these species-groups is the Pomacentridae with 28 species that are abundant (Appendix 1) in one or more areas. This is followed by the Labridae (21 species), Acanthuridae (4), and Caesionidae (3). The remaining families with abundant taxa (Serranidae, Lutjanidae, Lethrinidae, Scorpididae, Kyphosidae, Pempheridae, Chaetodontidae, and Odacidae) are represented by 1–2 species only. The most abundant species is the pomacentrid *Pomacentrus milleri* which was recorded in large numbers from 9 sites. Other species that were abundant at three or more sites are listed in Table 5. This spread includes 16 tropical, 3 subtropical, and 7 temperate species. Non-endemics account for 20 species and endemics for 6.

The numbers of species shared between each of the seven geographic regions is presented in Table 6 (expressed as a percentage of the species total for each region). Each line of data indicates a species diversity gradient for the region listed in the first column; this shows the percentage similarity between the relevant region and the other six. For example, 79% of the 118 species recorded for the lower west coast region are shared with the nearby central west coast but only 25% with the Kimberley. The most striking gradient concerns the offshore atolls. Only 50% of its 344 species reach mainland Western Australia (in the northwest coast region), and only 25% are shared with the nearby Kimberley. This suggests that many atoll species are unable either to tolerate the more inshore conditions of mainland waters (e.g., due to the higher turbidity) or to disperse across the gap separating

them. Another noteworthy gradient involves the upper west coast region. Here, only 51% of its 203 species were found at the adjacent central west coast region to the south, whereas 93% were recorded for the nearby northwest coast region to the north. This shows a prominent loss of species between the upper west coast and its neighbouring region to the south.

Discussion

Previous studies of the shallow reef fish fauna of Western Australia (Wilson and Allen, 1987; Hutchins, 1994) indicate a close similarity with the faunas of other parts of Australia. The tropical component shares many species with north-eastern Australia (as well as other parts of Southeast Asia and beyond) and the temperate component includes a prominent number of species that are found across the whole southern portion of Australia. The two components overlap on the west coast in an area often referred to by marine biogeographers as the "western overlap zone" (Wilson and Gillett 1971); this ranges approximately from Albany on the south coast to Shark Bay on the west coast. Here tropical species near the southern end of their ranges share reefs with temperate species that are approaching their northern limits. However, this region is also inhabited by another small group of fishes that is more subtropical in distribution. Comprising mainly endemic Western Australian species, the subtropical component provides many of the most abundant reef fishes in the region. Numerous temperate endemic species are also abundant here and together with the subtropical taxa, give a distinctive western character to the fauna. This caused Hutchins (1994) to determine that this region should be included in a separate southwest biogeographical zone named the Leeuwin Province (modified after Hatcher, 1991). This was essentially a western counterpart of the Peronian Province of eastern Australia, the latter region being referred to by Wilson and Gillett (1971) as the "eastern overlap zone".

Although the present investigation was confined to a subset of the reef fish fauna of Western Australia, any perceived distributional patterns of the 18 families studied here should reflect patterns of the fauna as a whole. The data in Table 3 clearly indicate that a prominent tropical fauna overlaps a smaller temperate fauna on the west coast, and that a still smaller subtropical component also shares this overlap zone. Furthermore Table 4 suggests that the southwest region (sites 1 to 7 but not including the Houtman Abrolhos, site 6) is inhabited by a fauna that has a relatively high proportion of endemics (range 23–33%). Sites 6, 8, and 9 have moderate numbers of endemics (10–16%), but from Ningaloo Reef (site 10) northwards, the indigenous species have relatively little impact (0–6%). The majority of these endemics belong to the subtropical component. However, the hierarchical analysis of the data suggests, at a level of dissimilarity of 0.75, that only two main groups of reef fishes are present, one a predominantly temperate fauna occupying the southwestern corner and the other a mostly tropical fauna in the northern two thirds of the State. There is no evidence of a separate subtropical cluster, or of a wide overlap zone on the west coast.

Working with molluscs, both Wilson and Gillett (1971) and Wells (1980) provided evidence that an extensive zone of intermixing between the tropical and temperate faunas exists along the west coast of Western Australia. This zone was also addressed in the more wide-ranging treatment of the marine fauna by Morgan and Wells (1991). All refer to the influence of the endemic species in this overlap zone. However, Veron and Marsh (1988), using a hierarchical classification similar to that employed in the present study showed only a narrow overlap of reefal (northern) corals and non-reefal (southern) corals in the central west coast area. There seems little doubt, therefore, that the method of analysis employed here is responsible for the apparently small size of the overlap zone. However, even though the general assumption of a two component reef fish fauna is favoured, the influence of the small subtropical element cannot be overlooked. It provides the majority of the endemic species in Western Australia, which also happen to be some of the most abundant.

Faunal divisions

Besides the partitioning of tropical and temperate components above, the hierarchical analysis of the dataset shows that the tropical fauna can be split into three major assemblages: offshore atolls, Kimberley coast and northwest coast. These divisions not only have a geographical basis, but ecological differences are also apparent.

The offshore atolls are surrounded by waters of very low turbidity, and have the best-developed coral reef communities in Western Australia (Wilson, 1994). They possess the highest fish diversity of any region, although a rather prominent species gradient occurs from north to south. Ashmore Reef, which is the northernmost, has 290 species, whereas Scott and Seringapatam Reefs possess 271 species, and the Rowley Shoals at the southern end of the atoll chain has 228 species. The fish faunas of all three are very similar, but the more northern sites have a higher proportion of species with Indonesian affinities. For example, the pomacentrids *Chrysiptera rex*, *Pomacentrus amboinensis* and *P. lepidogenys*, occur in large numbers at Ashmore Reef and Scott/Seringapatam Reefs, but were not found at the Rowley Shoals. These species also do not occur on mainland reefs, being some of the 150 atoll species that fail to cross

into mainland waters of the State. However, a number of transient visitors from the atolls have been recorded at Ningaloo Reef and the West Pilbara islands, possibly reaching these areas via the Leeuwin Current (described more fully below), and therefore helping to boost species numbers.

By comparison, coral communities in the Kimberley are far less extensive than at the offshore atolls. While moderate numbers of coral reef inhabitants were found in inshore waters where the turbidity was high, the greatest diversity occurred on the reefs surrounding the more offshore islands. The relatively clearer waters there allow a much stronger representation of reef fishes. A few transient visitors from the atolls were also found at these offshore islands but were always in low numbers. However, some Ashmore Reef species, such as the pomacanthid *Chaetodontoplus mesoleucus*, were reasonably numerous in parts of the Kimberley. In contrast, a number of species from the southwest Kimberley (e.g., the endemic serranid *Epinephelus bilobatus* and endemic labrid *Choerodon cauteroma*) were rarely found to the north of Cape Leveque.

Within the northwest assemblage, coral communities are also extensive, but generally decrease in diversity southwards. However, reef fish diversity at the Monte Bello Islands and the Dampier Archipelago was found to be considerably lower than that of Ningaloo Reef and the West Pilbara islands. Many of the additional species in the latter two areas are typical inhabitants of the offshore atolls, and possibly dispersed south via the Leeuwin Current. Furthermore, Hutchins (1994, 1999) suggested that water conditions at Ningaloo Reef are more oceanic than at the Monte Bellos and Dampier Archipelago, and this could account for the higher fish diversity at the former area. Ningaloo Reef certainly lies closer to the edge of the continental shelf than the other two, which would ensure that more current borne larvae would have a better chance of reaching its reefs. In addition, a 1996 survey conducted on the outer reefs of the West Pilbara islands (Hutchins, Mooi, and Gill, unpublished data) found additional atoll species that had not been recorded for mainland waters before.

The second group of the northwest assemblage – the central and upper west coast sites 6, 8 and 9 – show both a reduction in tropical reef fishes and an increase in subtropical and temperate species with increasing latitude. However, the fauna remains predominantly tropical and all sites have extensive coral communities. Nevertheless, at the Houtman Abrolhos (site 6), macroalgal communities are much more evident than further north, and compete successfully with corals for the available substrate (Hatcher, 1991), especially on the more exposed reefs along the western margin. This represents a significant divergence from a reef ecology dominated by corals, resulting in less favourable conditions for coral reef dwellers.

To the south of the Houtman Abrolhos, macroalgal communities dominate most shallow reefs and tropical reef fish diversity is much reduced. Notwithstanding, coral communities are rather prominent in some areas, particularly near Jurien Bay in site 5 and at Rottnest Island in site 4. They have noticeable populations of tropical reef fish, although numbers tend to fluctuate from year to year (Hutchins, 1994; Hutchins and Pearce, 1994). Furthermore, on the south coast, some prominent monospecific stands of tropical coral occur, but attract few tropical reef fishes.

Impact of Ocean Currents

Many papers over the last 20 years (e.g., Wilson and Allen, 1987; Pearce and Walker, 1991; Hutchins, 1994) have referred to the effects of ocean currents on the Western Australian biota, particularly the Leeuwin Current. This warm current has been implied as the vehicle for transporting fish larvae from northern waters southwards (Hutchins and Pearce, 1994; Hutchins, 1997a). There is little doubt that it affects the whole western coastline and is responsible for the spread of tropical species into temperate waters. Furthermore, recent studies (McGowran *et al.*, 1997; McNamara, 1999) suggest that this current–or an ancestral form of it–may have been affecting the State's coastal waters and its flora and fauna since the Eocene. Perhaps the present day patterns of biotic distribution reflect some of the evolutionary history of the Leeuwin Current.

The Leeuwin Current is a poleward flowing body of warm water in the eastern Indian Ocean. It originates as a southerly continuation of what has become known as the Indonesian throughflow, which in turn is sourced from the central Pacific Ocean. There, strong southeast trade winds force waters of the South Equatorial Current into the Indonesia region (Pearce *et al.*, 1997). These warm waters push through the island passages and eventually exit the Indonesian archipelago in the tropical Indian Ocean. Some of this water flows south along the western margin of Australia to form the Leeuwin Current. Depending on the atmospheric pressure gradient between the Pacific and Indian Oceans (which gives rise to the Southern Oscillation), conditions may favour either a strong or weak current (these are associated with phenomena known either as La Niña or El Niño respectively). The flow of this eastern boundary current becomes more pronounced in late summer to early autumn, continuing through winter before waning in spring. It tends to follow the edge of Western Australia's continental shelf, with gyres pushing across the shelf into coastal waters,

especially in the southern half. Off Cape Leeuwin in the States' south west, the current changes direction and heads east towards South Australia, sometimes reaching as far as Tasmania (as the East Bight Current [Pearce and Cresswell, 1985]). Therefore, this current has the potential to distribute propagules of marine organisms from Indonesia to north-western Australia, as well as picking up others from breeding populations along the State's northwest and west coasts for dispersal southwards and eastwards. The primary effect of the Leeuwin Current, like that of the East Australian Current and other poleward flowing boundary currents around the world (Hutchins, 1991), therefore, is to extend the range of the tropical fauna southwards, even into temperate areas. Furthermore, it also provides the means to disperse eggs and larvae of subtropical biota to the southern coastline of Australia. On the other hand, counter-currents flowing inshore of the Leeuwin Current are believed to be responsible for the dispersal of temperate and subtropical species to the north (Hutchins, 1994; Taylor and Pearce, 1999).

The Leeuwin Current is thought to have evolved in the middle Eocene when changes to current flow in the eastern Indian Ocean were caused by the accelerated opening of the oceanic gap between Australia and Antarctica (McGowran *et al.*, 1997). Furthermore, the flow since has been episodic rather than continuous, following the pattern of glacial and interglacial events. Thus the evolution of the marine fauna of Western Australia could have been influenced by this variation in current flow.

Many of the largest families of reef fishes (e.g., Pomacentridae and Labridae) are considered by some workers to have evolved in the tropical Tethys Sea, an ancient ocean that existed between the two supercontinents of Laurasia and Gondwana from the Cretaceous to the Miocene (Hopper *et al.*, 1996). The subsequent dispersal of these taxa is represented today by species diversity gradients from a central area of high diversity (e.g., Indonesia) to marginal areas (Briggs, 1999). In Western Australia, these families have contributed many of the endemic species in our waters, probably evolving into new forms as they spread southwards. These evolutionary events might be linked to fluctuations – "ebb and flow" events – of an ancient Leeuwin Current. During extended periods of strong flow, the conditions would have been more tropical and during periods of weak flow more temperate. Species inhabiting marginal areas therefore could have been isolated by a changing current regime. Repeated isolations of these taxa may have eventually allowed them to achieve reproductive isolation, and finally speciation. Many of the subtropical endemic species in Western Australia are apparently closely related to tropical taxa (e.g., the labrids *Thalassoma septemfasciata, Halichoeres brownfieldi* and *Choerodon rubescens* and the pomacentrid *Chromis westaustralis*), but others (e.g., the cheilodactylid *Cheilodactylus rubrolabiatus* and the pomacentrid *Parma occidentalis*) apparently have close temperate relatives, which suggests a different path in the evolutionary story. However, until phylogenetic studies of the families in question are completed and published, little can be said with confidence about such relationships, and therefore any associations with the flow of the Leeuwin Current are only conjectural.

Hatcher (1991) in his study of coral reefs in the Leeuwin Current summed up the mechanism of the Leeuwin Current influence by noting the importance of gradients in three areas: physical and biotic environments, species diversity, and habitat diversity. He believed the Leeuwin Current affected all three, and, with due consideration of past events, could be tied to the pattern of reef and biotic development found in Western Australia today.

In the present study, the results indicate a gradient in species diversity along the State's coastline that clearly has been impacted on by the Leeuwin Current. They demonstrate a connection between the Western Australian and Indonesian faunas, a relationship that commences in the northern offshore atolls (Allen, 1993b), and continues through a diminishing tropical fauna well into temperate seas. However, faunal differences between the offshore atolls and the mainland coasts, particularly in the Kimberley, suggest that gradients in the physical and biotic environments are acting as effective barriers to dispersal. Furthermore, the rather rapid southwards change in the reef habitat on the central west coast from one dominated by coral communities to one of increasing macroalgae is closely matched by a change in the reef fish fauna. The tropical fishes that held sway on the northern reefs now have to contend with a stronger temperate influence. In addition, a small though faunistically important group of subtropical endemic species is prominent there, and contributes much to the uniqueness of the area.

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Appendix 1

Abundance estimates of species recorded from 20 sites in Western Australia (abbreviations and symbol in second column: S = subtropical; T = temperate; blank = tropical; * = WA endemic) (abundance estimates: 1 = rare; 2 = occasional; 3 = frequent; 4 = abundant; see also Methods section)

		South coast			Lower W coast		Central W coast		Upper W coast		NW coast				Atolls			Kimberley			
Site No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
SERRANIDAE																					
Acanthistius pardalotus	S*				1	1	1	1	2	1											
A. serratus	T*	1	1	1	1		1														
Aetheloperca rogaa															1	2	2			1	
Anyperodon leucogrammicus										1	1	1		1	1	1	1			1	
Caesioperca rasor	T	2	1																		
Caesioscorpis theagenes	S*		1	2	2	2		2	2												
Cephalopholis argus															1	3	3				
C. boenak										1	2	1	2	2				2	1	2	1
C. cyanostigma							1			1	1	2	2	2					1	2	
C. leopardus															1	1	1			1	
C. miniata							1		2	1	2	2	1	2	1	1	1				
C. sexmaculata															1	1	1				
C. sonnerati									1	1	1										
C. spiloparaea															1						
C. urodeta											1	1		1	1	1	1				
Cromileptes altivelis									1	1	1	1	1	1			1	1	1	1	
Epinephelides armatus	S*	2	3	2	2	2	2	2	1												
Epinephelus bilobatus	*						1		2	2	2	3	3	2				3		1	
E. coioides				1	1	1	2	1	2	1	1	1	1	1				1	1	1	1
E. corallicola										1		1		1				1	1	1	1
E. cyanopodus												1									
E. fasciatus							1	1	2	3	3	4	3	3	1		1	1	1	3	
E. faveatus																1					
E. fuscoguttatus											1		1	1	1	1	1				
E. hexagonatus															1	1					
E. lanceolatus				1	1		1		1	1	1	1	1	1	1	1				1	
E. maculatus																1	1				
E. malabaricus											1	2	1	1				1	1		1
E. melanostigma															1		1				
E. merra															1	2	1				
E. multinotatus							1		1	1	1	2	2	1				1			
E. ongus															1	1			1	1	
E. polyphekadion									1			1	1	1	2	2	1		1		
E. quoyanus									1	2	2	1	1	2				2	2	1	1
E. rivulatus					1	1	2	1	2	2	2	2	2	1				1	1	1	
E. spilotoceps															1	1					
E. tauvina									1	1	1	1									
E. tukula									1	1	1	1	1	1	1	1					
Gracila albimarginata															1	1					
Hypoplectrodes cardinalis	S*	1			1	1	1	1	1												
H. nigrorubrum	T	2	2	2	2	1		1													
H. wilsoni	T*		1	1	1	1															
Othos dentex	T	2	1	2	1	1															
Plectropomus areolatus															3	2	1				
P. laevis															1	1	1				
P. leopardus						1	2			1	2	1	2	1		1	1				
P. maculatus					1		1	1	1	1	2	3	2	2				3	2	3	1
P. oligocanthus																2					
Pseudanthias cooperi							1		2	1	3	3									
P. dispar																1	1				
P. huchtii																2	1				
P. lori															1						
P. pleurotaenia																	1				
P. sheni															1	1					

	South coast			Lower W coast		Central W coast		Upper W coast		NW coast				Atolls			Kimberley			
Site No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
P. squamipinnis															1	1				
P. tuka														3	2	1				
Rainfordia opercularis										1	1	1	1							
Variola albimarginata															1	1				
Variola louti						1		1	1	1	1			1	1	1				
CAESIONIDAE																				
Caesio caerulaurea								2	1	3	3	3	2		2	3			1	
C. cuning								1	1	3	4	3	4		3	2	2	3	3	1
C. lunaris										2	1			2	1	1				
C. teres														2	1	1				
Pterocaesio digramma								2	1	3	4	3	4			1				
P. pisang															1					
P. tile														4		1				
P. trilineata																1				
LUTJANIDAE																				
Aphareus furca														1	1					
Aprion virescens								1	1	1				1	1	1				
Lutjanus argentimaculatus								1	1	2	1	1	1				1	1	1	1
L. biguttatus															1					
L. bohar								1	1	2	1	1	1	3	3	3			1	
L. carponotatus								3	2	3	4	3	3				4	3	4	3
L. decussatus													1	3	3	3			1	
L. fulviflamma						1	1	2	2	3	3	3	3			1	1		1	
L. fulvus															1	2				
L. gibbus											1			2	4	3				
L. kasmira											1			2	1	2				
L. lemniscatus								2	1	1	3	3	2				2	1	2	1
L. lutjanus										1			2						1	
L. monostigma								1		1	2	1	1	1	1	1				
L. quinquelineata						1		1	1	3	2	2	2	1		1				
L. rivulatus											1	1		1	1	1			1	
L. russelli						1		1	1	1	2	1	2		1	1	1	2	2	2
L. sebae										1	1	1	1						1	
L. vitta									1	1	2	1	1				1			
Macolor macularis														1	1	1				
M. niger														2	2	1			1	
Symphorichthys spilurus														1	1					
Symphorus nematophorus								1	1	1	2	2	2		1		1		1	
HAEMULIDAE																				
Diagramma labiosum						1		1	1	2	2	2	1				2		2	1
D. pictum																1				
Plectorhinchus chaetodonoides									1	1	2	2	1	1	1	1		1	1	
P. flavomaculatus			1	2	2	2	3	3	2	3	2	1	1							
P. gibbosus										1	1	1	1					1	1	1
P. lineatus															1	1				
P. multivittatum								2	1	2	3	1	2				3	2	1	1
P. orientalis														1	1	1				
P. polytaenia										1	2	1	1				1	1	1	
P. unicolor				1		1	1	2	1	2	2	2	2				2	2	1	
LETHRINIDAE																				
Gnathodentex aureolineatus														1	1	1				
Gymnocranius grandoculis											1	1			1	1				
Lethrinus atkinsoni						2		2	2	2	3	3	2		1	1			1	
L. erythracantus														1	1					
L. erythropterus														4	3	1				
L. genivittatus				1		2		1	1	1	1		1							
L. harak																1				

		South coast			Lower W coast		Central W coast		Upper W coast		NW coast				Atolls			Kimberley			
Site No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
L. hutchinsi	*								2	1	2	2	1	1				2			
L. laticaudis									1	1	1	2	2	1				2	3	1	1
L. lentjan													1	1				1			1
L. microdon																1	1				
L. miniatus							1		2	1	1										
L. nebulosus					1	1	2		2	2	2	3	3	1			1	2		1	
L. obsoletus															1	1	2				
L. olivaceus											1	1	1	1	1	1	1			1	
L. rubrioperculatus											1		1		1	1	1				
L. xanthochilus															1	1	1				
L. variegatus											1	1	1	1							
Monotaxis grandoculis											1				4	3	3				
MULLIDAE																					
Mulloidichthys flavolineatus									1		2	1			1	1	1				
M. vanicolensis									1		2	1		1	1		1				
Parupeneus barberinoides							1		1	1	3	3	3	1		1	1				
P. barberinus															1	1	1				
P. bifasciatus											1		1		1	1	1				
P. chrysopleuron				1	1	1	1	1	2	1	1		1								
P. cyclostomus							1		1	1	1	3	2		1	1	1				
P. heptacanthus												1	1								
P. indicus								1	2	1	3	3	3	2			1	2	1	2	1
P. multifasciatus											1	3	1	1	1	1	1				
P. pleurostigma							1		1	1	1	3				1					
P. spilurus				1	3	2	3	4	3	2	3	3	2	2							
Upeneichthys vlamingii	T	2	2	2	3	1	1														
Upeneus tragula						1			2		2			1		1	1	2	1	1	1
PEMPHERIDIDAE																					
Parapriacanthus elongatus	T	2	2	2	2	1	1														
P. ransonneti							1		2	1	2	2			1	2	3				
Pempheris analis						1	1	1	2	1	2	1	1	1							
P. klunzingeri	T	4	4	4	4	2	1	1	1												
P. multiradiata	T	3	3	3	2	1															
P. ornata	T	2	2	2	1	1															
P. oualensis												1			1	1	1			1	
P. schwenkii					2		2		3	2	3	3	2	2							
P. ypsilychnus									1		2	3	2	2				1			
P. species	*				2		2	2	3	2	2	2	2	2							
KYPHOSIDAE																					
Kyphosus bigibbus									3	2	3	3	3	2		1	1			1	
K. cinerascens															1	1	1				
K. cornelii	S*			2	4	4	4	4	4	2	1	1									
K. sydneyanus	T	3	4	3	4	3	3	2	2												
K. vaigiensis												1	1	1	1	1	1	1			
GIRELLIDAE																					
Girella tephraeops	T*	3	2	2	2	1	1	1													
Girella zebra	T	3	3	3	3	2															
SCORPIDIDAE																					
Microcanthus strigatus	S			1	2	2	3	3	3	1	1	1									
Neatypus obliquus	S*	2	3	2	4	3	1	2	1												
Scorpis aequipinnis	T	4	4	3	3				1												
S. georgianus	T	3	2	3	3	2	1	1													
Tilodon sexfasciatum	T	2	2	3	2	1															
CHAETODONTIDAE																					
Chaetodon adiergastos										1	1	1	1	1	1	2	2		2	2	1
C. assarius	S*			1	1	2	3		3	3	3	1									

		South coast			Lower W coast		Central W coast		Upper W coast		NW coast				Atolls			Kimberley			
Site No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
C. aureofasciatus							1	1	1	1	2	3	3	4				2	3	4	2
C. auriga					1		3	2	2	2	2	3	2	2	3	2	2		1	1	
C. baronessa																1	2				
C. bennetti															2	1	1				
C. citrinellus					1	1	1		1	1	2	2	1	1	1	1	1				
C. decussatus																	1				
C. ephippium											1		1	1	2	2	2				
C. kleinii							1				1	1			1	1	2				
C. lineolatus					1		1	1	1	1	2	2	2	2	1	1	1		2	1	
C. lunula					1		2	1	2	2	2	2	2	2	2	2	1			1	
C. lunulatus							1		1	1	2	2	3	1	3	3	3				
C. melannotus															1	2	2				
C. meyeri											1	1			1	2	2				
C. ocellicaudus																1	1				
C. octofasciatus																1					
C. ornatissimus										1	1	1			3	3	2				
C. oxycephalus																	1				
C. pelewensis																1					
C. plebeius					1		3	2	3	3	3	3	3	2							
C. punctatofasciatus										1	1	1			3	2	1				
C. rafflesi																1	1				
C. semeion															1	2	1				
C. speculum							1	1	1	1	1	1		1	1	1	1			1	
C. trifascialis							2		1	2	3	2	1	1	2	1	1			1	
C. ulietensis											1	1	2	1	3	3	2				
C. unimaculatus										1	1	2			2	1	1				
C. vababundus															1	1	2			1	1
Chelmon marginalis							1		2	1	2	2	2	2				2	2	2	1
C. muelleri														1							1
Chelmonops curiosus	T	2	2	2	2	2	2	3	1												
Coradion altivelis																1					
C. chrysozonus									1		1	1	1	1			2	1			
Forcipiger flavissimus									1	1	1	2	1		2	2	2				
F. longirostris																1					
Hemitaurichthys polylepis															1						
Heniochus acuminatus					1	1	1	1	2	1	2	2	2	2	1		1	1		1	
H. chrysostomus														1	1	1	2				
H. monoceros																1	1				
H. singularius									1	1	1	1	2	1	1	1					
H. varius												1			1	1	1				
Parachaetodon ocellatus						1	1						1	1					1		1
POMACANTHIDAE																					
Apolemichthys trimaculatus											1	1			1	1	1				
Centropyge bicolor															1	1	1				
C. bispinosus															1	1	1				
C. eibli											1	1			1	1					
C. flavicauda																1	1				
C. nox																1	1				
C. tibicen							1		1	1	2	3	2			1	1				
C. vroliki																1	1				
Chaetodontoplus duboulayi									1		1	1	1	2				3		2	
C. mesoleucus																	1		2	2	
C. personifer							1		1		1	1	1	1				1			
Genicanthus lamarck																	1				
G. melanospilos															1						
Pomacanthus imperator									1	1	1	1		1	1	1	1				
P. navarchus															1	1	1				
P. semicirculatus							1		2	1	2	3	2	2			1				
P. sexstriatus									1	1	2	2	2	2	1	1	1	3	2	2	

		South coast			Lower W coast		Central W coast		Upper W coast		NW coast				Atolls			Kimberley			
Site No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
P. xanthometopon															1	1					
Pygoplites diacanthus															1	1	1				
POMACENTRIDAE																					
Abudefduf bengalensis					1	1	2	4	3	2	2	4	4	4				3	4	4	3
A. septemfasciatus																	1				
A. sexfasciatus					2	1	4	2	3	4	4	4	4	4			1				
A. sordidus					1		1		1	1	1	1	2	2			1	1		1	1
A. vaigiensis					2	1	3	1	3	2	3	2	2	2	3	2	2	1		1	
Acanthochromis polyacanthus																	3	1	4	3	3
Amblyglyphidodon aureus															2	2	1				
A. batunai														1					3	1	
A. curacao											2	1	2	1	4	4	3				
A. leucogaster																2	2				
Amphiprion clarkii							3		2	1	2	1	1	1	1	1	1	1		1	
A. frenatus																	1				
A. melanopus																	1				
A. ocellaris																1	1		1	1	
A. perideraion											1	1	1	1	1	1	1				
A. rubrocinctus										1	2	2	2	2				2	2	2	2
A. sandaracinos											1	1			1	1	1			1	
Cheiloprion labiatus											1			1						1	
Chromis alpha															1	1	1				
C. amboinensis															3	1	1				
C. analis															1						
C. atripectoralis							1		1	4	4	3	3	3	1	1	1			2	
C. atripes															3	2	1				
C. caudalis																	1				
C. cinerascens									1		1	2	2	3					1	3	
C. elerae															1						
C. fumea											1	3	3	2							
C. klunzingeri	T*	4	4	4	4	3	1														
C. lepidolepis												1			1	2	1				
C. lineata																1					
C. margaritifer							1		1	1	2	3	1	1	4	3	3				
C. opercularis																	1				
C. retrofasciata																1	1				
C. ternatensis															4	4	3				
C. vanderbilti																1					
C. viridis							1		1	1	2	2		1	3	4	3			1	
C. weberi									1	1	3	3		1	3	3	3				
C. westaustralis	S*				3	2	4		4	1	1										
C. xanthochira																	1				
C. xanthura															3	3	1				
Chrysiptera biocellata															2	1	1				
C. caeruleolineata															1						
C. cyanea															1	1	1				
C. glauca															1		1				
C. hemicyanea															3	3	3				
C. leucopoma															1	1	1				
C. rex																3	3				
C. rollandi																	1			2	
C. talboti																1	3				
Dascyllus aruanus							2		1	3	3	1	2		4	4	4				
D. melanurus																	1				
D. reticulatus							1		2	3	3	3	3	2	1	1	1			1	
D. trimaculatus							2		2	2	2	2	3	2	1	2	2			1	
Dischistodus chrysopoecilus																	1				
D. darwiniensis												1		1				1	4	2	2
D. perspicillatus															2	2	2				

		South coast			Lower W coast		Central W coast		Upper W coast		NW coast				Atolls			Kimberley			
Site No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
D. prosopotaenia										2	1	1	2	1	2	1	1		1	1	1
Hemiglyphidodon plagiometopon												1	1		2	2	2		1		
Lepidozygus tapeinosoma																	1				
Neoglyphidodon melas										2	2	2	2	2		1	2	1	2	2	1
N. nigroris											2	2	2	2		2	2			2	
N. oxyodon																	1				
Neopomacentrus azysron									3	2	3	4	4	4			1	1	3	3	1
N. cyanomos									2	1	1	4	3	4						1	
N. filamentosus									3		2	3	1	4				4	3	3	1
Parma bicolor	T*	2	2	1	1																
P. mccullochi	T*	3	4	4	4	4	2	1													
P. occidentalis	S*			1	4	3	3	4	2	2	1										
P. victoriae	T	4	3	2	1	1															
Plectroglyphidodon dickii							1		2	1	2	2		1	2	2	2				
P. imparipennis																1					
P. johnstonianus							1		1	1	2	2			1	1	1				
P. lacrymatus					1		1		2	4	4	3	2		1	3	3				
P. leucozonus					1		2		3	3	3	2	2	1		1	1				
Pomacentrus adelus															3	4	2		3	2	
P. alexanderae															1	1	2				
P. amboinensis																3	3				
P. bankanensis															1	1	2				
P. chrysurus																1	1				
P. coelestis					1	1	2	1	3	4	4	4	4	3	3	2	3			3	1
P. grammorhynchus															2		1				
P. lepidogenys																4	3				
P. littoralis													1					1	2	2	2
P. milleri					2	4	4	4	3	2	3	4	4	4				4	4	4	3
P. moluccensis									2	3	4	4	3	2	3	4	2				
P. nagasakiensis									1	1	3	4	3	3	1	1	1	1			
P. nigromarginatus															1	1					
P. nigromanus												1	2	2					2	3	
P. pavo															3	2	1				
P. philippinus															3	4	2				
P. reidi																1	1				
P. stigma																	1				
P. vaiuli									1	3	4	4	1		3	4	2				
Pomachromis richardsoni															2	1					
Premnas biaculeatus																1	1				
Stegastes albifasciatus																1	1				
S. fasciolatus							1			2	2	2	1		1	1	1				
S. lividus										1	2	1	1	1	1	1	1				
S. nigricans							1			1	2	1	1	1	1	1	1				
S. obreptus					3	2	3	1	4	4	3	4	3	3					1	3	
CHEILODACTYLIDAE																					
Cheilodactylus gibbosus	S*	1	1	2	2	1	1	2	2												
C. nigripes	T	3	1																		
C. rubrolabiatus	S*	1	2	2	3	2	2	2	2	1											
Dactylophora nigricans	T	2	2	2	2		1														
Nemadactylus valenciennesi	T	3	3	2	1																
LABRIDAE																					
Achoerodus gouldii	T	3	2	2	2	1	1														
Anampses caeruleopunctatus					1		1		2	1	3	2	1	2	1		1				
A. geographicus			1		2	2	4	1	3	3	4	3		2	1	1					
A. lennardi	*								1	1	1	2	1	2				2		1	
A. melanurus																1					
A. meleagrides						1			1	2	2	2	1	1		1	1				

		South coast			Lower W coast		Central W coast		Upper W coast		NW coast				Atolls			Kimberley			
Site No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A. neoguinaicus															1						
A. twistii															1	1	1				
Austrolabrus maculatus	T	4	3	4	4	4	3	3	1												
Bodianus anthioides																1	1				
B. axillaris							1		2	1	2	2	2	2	1	1	1		1	1	
B. bilunulatus							1		1	1	1	2									
B. diana												1		1	1	1	1			1	
B. frenchii	T	3	2	3	3	2	2	1													
B. mesothorax																1	1			1	
B. perditio							1						1								
Cheilinus bimaculatus									1		1					1					
C. celebicus															1	1	1				
C. chlorurus							1		1	2	3	2	3	3	1	1	2		2	2	
C. diagrammus															2	2	1				
C. fasciatus							1								2	2	2	1	1	2	
C. oxycephalus															1	1					
C. trilobatus							1		1	2	2	2		1	1	1	2			2	
C. undulatus															2	1	1				
C. unifasciatus										1	1	1			2	1	1				
Cheilio inermis					1		1		1	2	3	1	2	2	1	1	1				
Choerodon cauteroma	*						1		4	2	3	3	2	2				3			
C. cephalotes									1		1	1	1					2		1	
C. cyanodus							1		1	1	2	4	3	4				3	4	4	4
C. rubescens	S*			1	2	3	4	3	3	3	1										
C. schoenleini							1		2	2	2	3	3	3				4	2	2	1
C. vitta														1				3		1	
Cirrhilabrus cyanopleura															1	1	1				
C. exquisitus															2	2	2				
C. randalli	*														1	2	2				
C. temminckii							1		2	1	2	2	2				1				
Conniella apterygia	*														1	1					
Coris auricularis	S*	1	3	4	4	4	4	4	3	1	1	1									
Coris aygula					1		1		2	2	3	2	2	1	2	1	1	1			
C. batuensis																2	3				
C. caudimacula							1		2	2	3	4	2	2				1			
C. dorsomacula																	1				
C. gaimard											1	1		1	2	1	1				
C. pictoides												1	2	1				1			
Cymolutes praetextatus											1	1	1		1	1	1				
Diproctacanthus xanthurus																	1			2	
Dotalabrus alleni	T*	3	3	4	4	1	1														
Dotalabrus aurantiacus	T	1		1	1																
Epibulus insidiator							1			3	2	1	2	1	2	2	1				
Eupetrichthys angustipes	T	1	2	2	2	1	1														
Gomphosus varius					1		1		1	3	3	2	2	2	3	2	2			1	
Halichoeres biocellatus											1	2			1	1					
Halichoeres brownfieldi	S*	2	3	4	4	4	4	4	4	1		1									
H. chrysus																1	1				
H. hartzfeldii															1		1			1	
H. hortulanus											2	1			2	2	2			1	
H. margaritaceus															1	1	1				
H. marginatus									2	2	2	3	2	2	1	1	1	1		2	1
H. melanochir											3	3	3	3			1	2	1	1	
H. melanurus																4	4		3	3	
H. melasmopomus															2						
H. nebulosus							2	1	3	4	4	4	3	3			1			2	
H. nigrescens												1		3				2	4	3	4
H. ornatissimus																	1				
H. prosopeion																2	1				

		South coast			Lower W coast		Central W coast		Upper W coast		NW coast				Atolls			Kimberley			
Site No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
H. purpurescens																				1	
H. scapularis														1		1	1				
H. trimaculatus							1			1	2	1	1	1	2	2	1				
Hemigymnus fasciatus					1		3		1	2	2	2	2	3	2	1	1			1	
H. melapterus							1		1	3	2	2	2	3	2	2	2		2	3	1
Hologymnosus annulatus							1		1	1	2	2	1	2							
H. doliatus											1			1		1	1				
Labrichthys unilineatus							1		1	2	2	2	1		3	2	2				
Labroides bicolor							1			1	2	1		1	2	2	2				
L. dimidiatus					1		3	1	3	3	3	3	3	3	2	3	3			3	1
L. pectoralis															1	1	1				
Labropsis manabei															1	1					
L. xanthonota															1	1					
Leptojulis cyanopleura											2	2	1	1							
Macropharyngodon meleagris															1	1	1				
M. negrosensis											1	2				1		1			
M. ornatus									1	1	1	1	1	1	1		1				
Notolabrus parilus	T	4	4	4	4	4	3	4	2												
Novaculichthys taeniourus										1	1	1		1	1	1	1				
Ophthalmolepis lineolatus	T	4	4	4	3	3	1														
Paracheilinus flavianalis																1					
Pictilabrus brauni	T*		1																		
P. laticlavius	T	2	2	3	2	2	1														
P. viridis	T*	3	3	3	3	1															
Pseudocheilinus evanidus											1				3	2	1				
P. hexataenia											2	1		1	2	2	3			1	
P. octotaenia															1	1	1				
Pseudocoris yamashiroi															1	1	1				
Pseudodax moluccanus															1	1	1				
Pseudolabrus biserialis	T*	4	4	4	4	3	1														
Pseudojuloides elongatus							1		2	1	2	1	1	1							
Pteragogus enneacanthus							1	1	2		2	1	2	2							
P. cryptus															1						
Stethojulis bandanensis					2	2	2	2	4	4	4	3	3	3	1	1	1				
S. interrupta					1		1		2	4	3	3	2	3			1			2	1
S. strigiventer					1	1	4		2	3	3	2	2	3	3	2	2				
S. trilineata																	1				
Suezichthys cyanolaemus	S*		1	1	2	1	3	1	3	2	1	1									
Thalassoma amblycephalum					1		1		1	1	3	3	1	2	3	3	4			1	
T. hardwicke					1		1		1	1	1	2		2	3	3	3			1	
T. janseni									1			1				1	2				
T. lunare					2	3	4	2	4	4	4	4	3	4	1	3	3		1	2	1
T. lutescens					2	3	4	1	4	4	4	4	2	1							
T. purpureum					2	2	2		1	2	2	1		2		1					
T. quinquevittatum											1	1			2	2	2				
T. septemfasciata	S*				2	3	2	2	2	2	1										
T. trilobatum					1		1		1		1	1			1	1					
Wetmorella albofasciata															2		1				
W. nigropinnata												1			1	1	1				
Xenojulis margaritaceus											1			1							
Xyrichtys species										1	1	1	1		1						
ODACIDAE																					
Odax acroptilus	T	3	2	2	2	1	1	1													
O. cyanomelas	T	3	3	3	2	1		1													
Siphonognathus beddomei	T	4	4	3	2	1															
S. caninis	T	3	2	2	1	1															
ACANTHURIDAE																					
Acanthurus bariene																	1				

		South coast			Lower W coast		Central W coast		Upper W coast		NW coast				Atolls			Kimberley			
Site No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A. blochii															1	1	1				
A. dussumieri									2	2	3	4	3	1	1	1	1				
A. grammoptilus						1	1	1	2	2	3	4	4	3				3	4	4	3
A. lineatus											2	1		1	1	1	2				
A. mata									1		1	1		1			1				
A. nigricans											1	2	1	1	1	2	1			1	
A. nigricaudus												1			1		2				
A. nigrofuscus					1	1			1	1	2	3	2	1	1	1	1				
A. olivaceus									1		2	2	1	1	1	1	1				
A. pyroferus																1	2				
A. thompsoni												1			1	1					
A. triostegus					2		3	1	2	2	4	3	2	2	1	1	1	1			
A. xanthopterus												1			1	1	2				
Ctenochaetus binotatus												1			1	2	2				
C. striatus											3	3	2	1	3	4	3	1		1	
C. strigosus										2	2	1	1	1	1	1	1				
Naso annulatus												1		1			1				
N. brachycentron																1	1				
N. brevirostris											2	1	1		1	2	2				
N. fageni							1		1	1	1	2									
N. hexacanthus															1	2	1				
N. lituratus									1	1	2	2		1	3	3	2			1	
N. maculatus																	1				
N. thorpei																	1				
N. thynnoides																	1				
N. tuberosus									1	1	1	1					1				
N. unicornis					1		1		1	2	2	3	2	2	1	1	2	1		1	
N. vlamingii															2	1	1				
Zebrasoma scopas							1		1	2	2	2	2		3	3	3			1	
Z. veliferum					1		1		1	1	1	1	1		2	2	2				
MONACANTHIDAE																					
Acanthaluteres brownii	T	2	2	2	1	1															
A. vittiger	T	1	2	2	2																
Acreichthys radiatus															1						
Aluterus scriptus							1				1				1	1					
Amanses scopas															1		1				
Brachaluteres jacksonianus	T	1	1	2	1																
Cantherhines dumerilii											1				1	1	1				
C. fronticinctus									1		1	1									
C. pardalis					1				2	1	2	2	2	1	1	1	1				
Eubalichthys cyanoura	T	1	1	1	1	1															
E. mosaicus	T	1		1	2	1															
Meuschenia galii	T	3	3	2	3	1															
M. flavolineata	T	3	3	2	2	1															
M. hippocrepis	T	3	2	2	3	1	1														
Monacanthus chinensis					1	1	2	1	1		1	1	1	1				1		1	1
Oxymonacanthus longirostris							1		2	2	2	1	1	1	1	1	1				
Paraluteres prionurus															1	1	1				
Pervagor janthinosoma							1		1	1	1	2	1	1							
P. melanocephalus																	1				
Scobinichthys granulatus	T	1	2	2	1	1	1		1												