CRC REEF RESEARCH TECHNICAL REPORT

FISHES OF THE YONGALA HISTORIC SHIPWRECK

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FOREWORD

The wreck of the S.S. Yongala is a truly spectacular dive. Some claim it to be one of the top ten dives in the world. The Yongala's size, structural integrity and proximity to Townsville alone make it exceptional locally, but it is unique because of the fish community that makes the Yongala its home base. The sheer abundance, variety and large size of predators (especially snappers, cods and trevallies) is extraordinary on the Great Barrier Reef. Like the authors, I have seen nothing like it elsewhere.

This joint study by the Department of Environment and Heritage and the Australian Institute of Marine Science clearly measures the uniqueness of the Yongala fish community by comparison to "similar" shoals in the area. It also shows the attachment of fish to the wreck by documenting the stability of fish numbers and composition over a significant period. In doing so, the report confirms the value of the wreck and "no fish" Marine Park B zone for 500m around it as a significant fish refuge.

The relative stability of the Yongala fish community over the study period and the similarity of this community to that reported in 1981 suggests that the management of the site is effective for fish protection - despite thousands of diver days documented on the wreck each year. Observations of resident fish with obvious damage from fishermen suggest there is no cause for complacency, however.

This study provides a crucial baseline against which to monitor the Yongala fish community in the future. It addresses recommendations of a management planning study of the Yongala Historic Shipwreck (eg. research to assess human effects on the shipwreck and associated communities, interpretive and educational material to be produced to promote understanding of the value of the Yongala). In its completeness and clarity of presentation, the report stands as an excellent example of what can be done to promote understanding of the condition and value of other major dive sites on the Great Barrier Reef.

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EXECUTIVE SUMMARY

The Yongala shipwreck, located near Cape Bowling Green, south of Townsville, is an important historic and recreational site. It is currently protected under Marine Park zoning (Marine National Park B) and Historic Shipwreck legislation. The main users at this time are recreational divers who predominantly visit the wreck to view and swim amongst the abundant fish species. Little documented information exists on the fish community, from which effective protocols to manage an increasingly popular resource can be formulated.

This report represents the results of a collaborative project between the Queensland Department of Environment and Heritage, and the Australian Institute of Marine Science, undertaken to accurately describe the Yongala fish community and provide some assessment of it's uniqueness and temporal variability. This was to be achieved by addressing the following questions: 1) How many fish species inhabit the wreck? 2) How different is the Yongala fish community from nearby deepwater shoal communities? 3) How abundant are the various Yongala fish species and how does this abundance vary over time?

Visual censuses using a log5 counting technique were used to assess the numbers and species richness of fishes on the Yongala on five occasions over a 15-month period. For comparison, two deepwater shoals at comparable depth and in the region of the Yongala were similarly surveyed but only on one occasion.

The Yongala was found to support a uniquely structured fish community containing at least 122 different species. Nearby deepwater shoals (at comparable depths to the Yongala) held markedly different fish communities that more closely resembled those of shallower off-shore coral reefs. An unusually large number and diversity of schooling, commercially and recreationally significant, adult sea-perch species (Lutjanidae) visually dominated the Yongala community. Other large predators (Carangidae and Serranidae) were also prevalent. Herbivorous fishes and specialist benthic invertebrate feeders, abundant at the deepwater shoals, were generally conspicuous by their low abundance while planktivorous fishes were extremely abundant.

The Yongala fish community structure was remarkably stable through the 15 months of this study, suggesting a high degree of residency amongst its constituent species. The unusual trophic structure of the Yongala fish community is probably being maintained by a combination of the wreck's inshore location (in a high current regime within a vast expanse of

relatively featureless lagoon habitat), topographic complexity and protected status.

Two major management issues arise from this study: 1) Given the unusually large number and variety of adult (and presumably highly fecund) commercially and recreationally significant species, and their apparent fidelity to the site, the continued protection of the wreck from fishing pressure is important. 2) Whilst diving trips to the wreck are a positive process in promoting the understanding and enjoyment of a protected marine environment, care should be taken to ensure that increasing numbers of divers do not have a detrimental effect on fish behaviour and residency.

1. INTRODUCTION

1.1 Background

The Yongala was a steel passenger and freight ship, launched in 1903. She was 363 feet in length, 30 feet deep, and had a 46 foot beam. The Yongala was servicing the east coast run from Melbourne to Cairns in late March 1911 when she steamed into the heart of a cyclone and was sunk between Bowen and Townsville (Gleeson & Elliott 1987). This occurred toward the end of an era when passenger ships were a common mode of travel but did not have modern navigation and weather aids. The Yongala did not even have ship to shore radio communications to warn them of the cyclone. All 121 people on board were lost. Positive identification of the final resting-place of the Yongala was made only in 1958 (47 years after she was lost) by members of the Queensland Underwater Research Group.

The shipwreck is located about 25 km east from Cape Bowling Green (Figure 1) offshore from seagrass nursery grounds and complex estuaries in Bowling Green and Upstart Bay. A large current gyre occurs in the area (authors pers.obs.) and the shipwreck itself is subject to strong currents. The Yongala lies on it's starboard side in a depth of about 30m with the highest part of the vessel about 16m below the surface at the lowest tides. The deck side of the wreck has the highest structural complexity and fish abundance. The exposed port side of the shipwreck has less topography and is primarily inhabited by small demersal fish. The hull structure is still relatively intact after 87 years on the seafloor and provides a hard and structurally complex habitat for marine life. This type of habitat is uncommon within the vast expanse of the Great Barrier Reef lagoon in this region and particularly so close to the coast. The predominant substrate in this area is sand.

Clearly the Yongala has cultural and historical significance but she is also economically important as an internationally recognised dive location. This reputation is largely built on the overwhelming abundance of fish which now inhabit the wreck (Cuthill 1996). To protect the Yongala site, the Great Barrier Reef Marine Park Authority has zoned a radius of 500m around the wreck as Marine National Park B, which prohibits any fishing. The Yongala is also protected under Historic Shipwreck legislation that requires anyone anchoring within 500m of the Shipwreck to have a permit from the Queensland Museum. A management planning study for the Yongala Historic Shipwreck has been undertaken (Cuthill 1996). This included recommendations that:

?? Research be undertaken to assess human effects on the shipwreck and associated marine life, and to determine sustainable levels of use.

?? Interpretive and educational material be produced to promote understanding of the values of the Yongala.

An understanding of the fish community on the wreck is a necessary step towards achieving the above recommendations.

The fish community associated with the Yongala appears unusually rich and differs markedly from fish communities found in the shallow waters (to 15m) of nearby coral reefs (Williams 1981). Of particular interest, the shipwreck supports large and diverse adult populations of commercially significant species of sea-perch (Lutjanidae) and cod (Serranidae). The significance of these animals as breeding stock for the region, their size at recruitment to the shipwreck and their fidelity to the Yongala site are all unknown. Prior to this study and apart from anecdotal accounts from dive operators who regularly visit the location, little was known about the true abundance and number of species inhabiting the shipwreck and how their numbers vary temporally. Williams (1981) conducted a survey of the shipwreck and recorded about 70 species but suggested the real number would be over 100. Obviously the depth of the shipwreck (16-30m) and it's artificial nature must have some influence on the fish community.

Visual census surveys had not previously been undertaken on nearby deep water shoals (open to fishing) at comparable depths to the Yongala, and the fish communities inhabiting those shoals have not been described. As such, the true uniqueness of the Yongala fish community could not be ascertained.

1.2 Objectives

The main aim of this study was to provide some assessment of the uniqueness and/or significance of the Yongala Shipwreck in its role as a fish refuge in this inshore region of the Great Barrier Reef.

To achieve this aim the objectives of this project were to:

1) compile an accurate species list of fishes associated with the Yongala Shipwreck.
2) compare the fish community found on the Yongala with those found on nearby deep water shoals.
3) assess constancy of the Yongala fish community by comparing results from regular visits, thus building up a picture of the relative abundance of the different fish species and temporal changes in abundance.

Relevant management issues related to results of this study are discussed.

2. METHODS

2.1 Yongala Shipwreck

The location of the Yongala is shown in Figure 1. Time on the shipwreck is often very restricted due to the exposed nature of the anchorage and the depth of the shipwreck, which limits underwater time on SCUBA. Furthermore, accurate counts cannot be easily made due to the large numbers of fish, and the size of the shipwreck. To obtain useful community level results, visual censuses using Log5 abundance estimates (Williams 1982) were used to compare relative fish abundance and community structure through time.

Using this technique, numbers of all species present are placed into categories based on multiples of 5 as per Table 1.

Table 1. Abundance categories used in visual surveys.

Log5 abundance category	Number of individuals
1	1
2	2 — 5
3	6 — 25
4	26 — 125
5	126 — 625
6	625 — 3125
7	>3125

Although this method is only semi-quantitative, it has the advantage of being fast, allowing large areas to be sampled in a given time period while providing a good indication of the community structure for non-cryptic species. It also provides a better indication of abundance for aggregating species than do more quantitative methods, such as replicated belt transects.

Two dives were conducted during each visit to the Yongala. It was possible to survey the length of the wreck during one dive and also count back the length of the shipwreck during a slow angled ascent. The bottom of the shipwreck was surveyed during the first dive and midway down the shipwreck was surveyed on the second dive. The second dive built on the estimates and species recorded during the first dive. For each visit a total time of 45 minutes was spent estimating the abundance of all fish species sighted. The relative abundance category for each species was increased as required (i.e. as more fish within a species were

observed) during each swim. The authors were already familiar with most of the fish species observed. Other species were identified using visible characteristics (Randall *et. al.* 1990).

Five visits were made to the shipwreck between April 1996 and September 1997. Three trained observers were used in the course of the study. During each visit, notes were also made on habitat type, environmental conditions (particularly water visibility and current), presence of other vessels with divers, and fish behaviour. All dives were made between 1100 hours and 1400 hours.

A pilot survey to record actual counts and length estimates for selected species was undertaken on 23 December 1998. Lengths were estimated visually and when possible with the aid of a tape measure held adjacent to individual fish.

2.2 Deepwater Shoals

The initial intention was to make comparative fish counts at small shoals lying a similar distance off the coast and in the same depth range as the Yongala. Bathymetric charts of the region revealed that the only available shoals were located a little farther offshore and were larger than the Yongala. Even so, they offered the best source of comparison and like the Yongala were located in the inshore channel (or Great Barrier Reef lagoon) and isolated from the shallower off-shore reefs. In early May 1997 immediately after conducting a Yongala survey, we conducted depth sounder grids across a number of shoals that we felt might offer the environment most similar to that of the Yongala. We were particularly searching for reefs which showed profiles rising steeply from around 30m to level out at about 16m. Two deepwater shoals, which appeared to fit these criteria, were ultimately selected for survey in this study. Tink Shoal and "Small" Shoal (arbitrarily named for this study as it is unnamed on charts) were located approximately 28 km south-east and 32 km north-east of the Yongala Shipwreck, respectively (Figure 1). Tink Shoal and "Small" Shoal encompassed an area of about 30 hectares and 10 hectares respectively. Dive survey locations were both located at the southern edge of Tink Shoal and "Small" Shoal at 19^{o} 22.087' South and 147^{o} 51.870' East and 19^{o} 01.710' South and 147 ^{o} 33.559' East respectively.

At each location, one 25-minute dive (maximum bottom time allowable) covering approximately 200m of straight-line distance was made and log5 abundance counts of all species recorded. As we could not hope to survey the entire reef (due to it's size) counts were made of fishes occurring in an estimated 10m wide band along the swimming direction. This differs from the Yongala counts in which all fish in sight on the shipwreck were recorded. Dives on the Shoals began at 30m depth and finished up the reef slope at depths around 15m.

General environmental notes were also recorded.

The slightly different survey methods used between the shoals and Yongala made it inappropriate to compare abundance of fish directly. It is appropriate however, to compare the species present and their relative abundance at the different sites. The presence or absence of individual species during any survey was compared using a cluster analysis to highlight the differences in the fish community between the Yongala and neighbouring shoals.

2.3 Data Organisation

During the first three visits to the Yongala, three experienced observers simultaneously recorded numbers of all fish species (Table 2). For the subsequent two visits only two of these observers were present. For each species the maximum abundance category recorded among the observers was used in subsequent analyses. It was felt that data was comparable between visits 1 to 3 and 4 to 5, as by completion of the third survey using all observers, it was clear from data comparison that there was little difference in log5 estimates of abundance between those observers. Any differences in estimated abundance between observers were generally due to one observer missing individuals of species that were naturally low in abundance. For the deepwater shoal surveys only two observers were available (Table 3).

3. RESULTS AND DISCUSSION

3.1 Survey Details

Visits to the Yongala site were generally characterised by moderate to strong currents and the presence of other divers (Table 2). Water clarity was highly variable.

Table 2: Details of Yongala surveys:

Date	Counts by:	Conditions	Tide	Current	Visibility	Other vessels
14 Jun 1996	AT, AC, HM	rough,	0754 2.6m 1424 0.7m	moderate	15m	no
19 Sep 1996	AT, AC, HM	moderate	0745 1.3m 1440 2.4m	strong	12m	Watersport, Reef Magic
27 Nov 1996	AT, AC, HM	calm	1030 3.1m 1721 1.49m	strong near surface	5 - 8m	Running Free, Watersport, Spoilsport
8 May 1997	AC, HM	moderate	0919 2.9m 1535 0.7m	moderate	12m	Watersport
3 Sep 1997	AT, HM	calm	0905 2.5 1458 1.2	light	20m	Watersport, Spoilsport

AT = Angus Thompson, AC = Alistair Cheal, HM = Hamish Malcolm

A comparison between the Yongala and the two deepwater shoals at a similar time and under similar weather conditions suggested that water clarity is significantly greater at these shoals (Table 3). General notes on the physical and benthic lifeform characteristics of the Yongala and both shoal sites are presented in appendix 1. However, compared to the shoals habitat, which more closely resemble off-shore coral reefs, the Yongala provides a more topographically complex habitat with very low percentage hard coral cover and supports a generally different benthic community.

Table 3. Details of Tink Shoal and "Small Shoal" surveys conducted on 8 May 1997 and 9 May 1997 respectively

Location	Counts by:	Conditions	Tide	Current	Visibility	Other vessels
Tink Shoal	AC, HM	calm, clear	0919 2.9m 1535 0.7m	light	20m	no
"Small Shoal"	AC, HM	calm, clear	O954 2.6m 1607 0.9m	light	30m	two trawlers

3.2 Differences Between the Fish Communities of the Yongala and Deepwater Shoals

The distinctive fish community of the Yongala is highlighted in the cluster analysis (Figure 2), which clearly shows the separation of the Yongala community from that of the neighbouring deepwater shoals. Details of the differing species composition between shoal and Yongala habitats are presented in Figure 3. Note that due to differing methods and swim times the abundance data are not directly comparable between either of the shoals and the Yongala. However, relative abundance estimates give an indication of the most prevalent species at each location. To avoid repetition of information the major differences in fish community structure between the Yongala and the shoals will be highlighted in appropriate sections of the following Yongala fish community discussion.

3.3 Fish Community of the Yongala

Fish species present

A total of 122 fish species from 27 families were recorded from the five visits to the Yongala. A list of all fish species recorded on or around the Yongala wreck is presented in appendix 2 and includes their common names. As common names do vary, when first used in this report, they will be accompanied by their correct scientific names. The most speciose families were the wrasse (Labridae: 21 species), damselfish (Pomacentridae: 17 species), sea-perch (Lutjanidae: 15 species) and the cods and coral trout (Serranidae: 10 species). Together these four families comprised 52% of the total species pool.

Species of commercial and recreational importance

One of the most striking features of the fish community at the Yongala wreck, compared to the deepwater shoals (Figure 3) and other reef locations in this region, is the great abundance and variety of large demersal (Lutjanidae and Serranidae) and pelagic (Carangidae) predators (Figure 4). The majority of these fishes are targets for both recreational and commercial anglers within the Great Barrier Reef.

These demersal predators are dominated numerically by sea-perch (*Lutjanus* spp.) which aggregate immediately adjacent to and within the wreck. As was noted by Williams (1981) the sheer abundance, variety (Figure 4) and generally large body size (Table 4) of the sea-perch species found at the Yongala is greater than at any other location we have seen on the Great Barrier Reef. The uniqueness of the Yongala sea-perch community is further reinforced by the absence of many large species (*Lutjanus argentimaculatus*, *L.erythropterus*, *L.johnii*, *L.lemniscatus* and *L.malabaricus*) at the nearby deepwater shoals when surveyed during this

study, compared to their abundance at the wreck (Figure 3). However, at least two of these species are known to frequent nearby shoals with low numbers of small mouthed and large mouthed nannygai (*L.erythropterus* and *L.malabaricus* respectively) having been filmed at the nearby Morinda shoal (Figure 1.) by AIMS researchers in September 1997 (M.Cappo pers. comm). Whether these fish were transient or resident is unknown

Table 4. Count and length estimates for selected species from pilot study undertaken on 17 December 1998.

Family	species	common name	Actual counts (min. estimate)	Estimated size range
Labridae	*Cheilinus undulatus*	humphead maori wrasse		60cm - 1m
Lutjanidae	*Lutjanus argentimaculatus*	mangrove jack	30 fish	40 - 50cm
	Lutjanus carponotatus	stripey	2 fish	35 - 40cm
	Lutjanus erythropterus	small mouth nannygai	80 fish	45 - 65 cm
	Lutjanus johnii	fingermark	58 fish	60 - 80cm
	Lutjanus lemniscatus	dark tailed seaperch	10 fish	40 - 60cm
	Lutjanus lutjanus	big eye seaperch	>625 fish	
	Lutjanus malabaricus	large mouth nannygai	23 fish	55 - 70cm
	Lutjanus sebae	red emperor	1 fish	65 cm
Serranidae	*Epinephelus coioides*	estuary cod	8 fish	50 - 95cm
	Epinephelus lanceolatus	Queensland grouper	4 fish	1.5 - 2m
	Plectropomus leopardus	coral trout		35 - 80cm
	Plectropomus maculatus	bar cheeked coral trout		50 - 80cm

An unusual feature of the Yongala is the prevalence of the small mouthed and large mouthed nannygai. These species are not often observed by SCUBA divers, particularly at such high densities and large sizes (Figure 4, Table 4). The large number of adult nannygai at what is essentially an inshore location is significant as both species are thought to migrate successively further offshore (as far as outer shelf reefs) with increasing age and body size (Williams and Russ 1994, Newman and Williams 1996). Due to their aggregating behaviour, populations of nannygai can be fished hard and are highly prized by fishermen. Aggregating fishes can be susceptible to overfishing. Whether the Yongala's large adult sea perch population provides a significant breeding stock within the region is unknown. However sea-perch are highly fecund and a large female may produce up to 5 to 7 million eggs per season (Williams & Russ 1994).

The presence of a healthy population of adult fingermark or spotted scale sea-perch (*Lutjanus johnii*) (Figure 4) on the Yongala is also unusual given that this species generally resides on coastal and near-shore reefs. The Yongala population is thought to represent the farthest offshore record for fingermark on the central Great Barrier Reef (Mike Cappo pers. comm).

A large amount of the fish biomass is also incorporated in the abundant cod and trevally species. It is noteworthy that the economically important coral trout are represented by good numbers of large sized common coral trout (*Plectropomus leopardus*) and bar-cheeked coral trout (*P.maculatus*).

Trophic and family group patterns

Unlike the visually obvious abundance of large predatory fish, the low numbers of roving herbivores (such as surgeonfishes (Acanthuridae), parrotfishes (Scaridae) and rabbitfishes (Siganidae)) is not immediately obvious (Figure 4). These taxa were more abundant and diverse on the nearby deepwater shoals (Figure 3) which displayed a herbivorous fish community closely resembling that of nearby mid-shelf shallow coral reefs (Russ 1984; Sweatman et. al. 1997)

If herbivores are relatively absent on the Yongala then planktivores are the opposite, with huge schools of mixed species often blanketing the wreck. Very high numbers of fusiliers (Caesionidae) represent larger planktivores. The damselfish assemblage is numerically dominated by three small, planktivorous, densely schooling species (*Neopomacentrus bankieri*, *N.cyanomos* and *Chromis nitida*) with other damselfish present in relatively low numbers (Figure 4). The damselfish assemblage at the deepwater shoals was more speciose and balanced, being dominated by both planktivores (*Chromis weberi*) and omnivores (*Pomacentrus moluccensis* and *P. brachialis*).

Butterfly fishes (Chaetodontidae) and angelfishes (Pomacanthidae) were far more speciose on both deepwater shoal sites. These taxa are generally associated with coral dominated reefs, with at least two of the butterfly fishes (*Chaetodon melannotus* and *C. plebeius*) almost exclusively feeding on coral (Sano et al 1984, Randall et al. 1990). It is unclear, however, to what extent the relative lack of hard coral species on the Yongala (appendix 1) may be contributing to the absence of butterfly fish and angelfish species.

Differences in wrasse (Labridae) communities between deepwater shoals and the Yongala did not appear as marked when compared to some other families (Figure 3) possibly due to the ability of many wrasse species to feed on a wide variety of prey organisms (Sano et al. 1984). The wrasse community at the Yongala tends to be consistently dominated by three very different species (Figure 4); moon wrasse (*Thalasoma lunare*), cleaner wrasse (*Labroides dimidiatus*) and the humpheaded maori wrasse (*Cheilinus undulatus*). The former two species were also noted as being particularly common wrasse on the Yongala over 15 years ago (Williams 1981), suggesting some degree of long term stability in the wrasse community. As

many large fish are present at the Yongala, it is not surprising that a fish species such as the cleaner wrasse, which preferentially feeds on ectoparasites and mucus of other fish, is abundant. Maori wrasse can be susceptible to spearing and line-fishing. The presence of a number of large maori wrasse on the Yongala is an encouraging indication of the value of Marine Park protective zoning at this site.

The batfish (*Platax teira*) is ever present in the mid to upper waters surrounding the wreck, but was not represented at all on the deepwater shoals (Figure 3). Batfish often aggregate at regularly visited dive sites. These aggregations are almost certainly due to their predilection for discarded food scraps and human faecal waste.

3.4 Temporal Changes in Abundance

Results from the five surveys of the Yongala reveal the stability of the community through time. The majority of species show very similar abundance estimates for each visit (Figure 4). This suggests that the relative abundance estimates are accurate, and that the fish present show a high fidelity to the wreck site, at least for 8 months of the year between the months of early April (a preliminary visit not analysed in this study) to late November. The fidelity to the site is not unexpected for the smaller more reef-associated fishes such as the damselfish, wrasse and parrotfish, for which the wreck provides an island of habitat in a largely featureless plain of sand. It is however interesting that many of the species (including some of the larger sea-perch and a few species of trevally) which must either be foraging off the wreck or are predominantly pelagic seem to be using the wreck as a "home base". The location of the Yongala may be influencing this behaviour, allowing easy access for predatory fish to prey items such as sand dwelling invertebrates (a major dietary component for some sea-perch species) and the rich seasonal supplies of baitfish (sardines and pilchards) off Bowling Green Bay. Also, the large schools of small fish species inhabiting the wreck were observed being preyed upon by larger predators, particularly trevally.

It is worth noting that commercial fishermen believe larger individuals of large mouth nannygai are seasonal in appearance on inshore deepwater shoals, appearing mainly in the winter months (May to October) and moving to deeper water (>60m) in the summer (Williams and Russ 1994). There was a tendency towards a decrease in numbers of large mouth nannygai in September and November samples although numbers were still within the 26 - 125 fish category. However, numbers of the small mouth nannygai showed a greater decline in numbers at the beginning of the summer period (from the 126-625 fish category in the preceding June, to the 5-25 fish category in November 1996). As our primary community

surveys spanned April to late November, the possibility exists that these fish may move from the wreck at times outside of this period. Alternatively low counts of small mouth nannygai in November could have been an artifact of a combination of high turbidity (Figure 2) and the fish having moved just off the wreck. The latter alternative appears to be the case given that 80 small mouth nannygai were counted in a pilot survey on 17 December 1998 (Table 4).

The total absence of big eye sea-perch (*Lutjanus lutjanus*) during the last Yongala community survey (Figure 4) is hard to explain, as they were extremely abundant during each prior survey. Visibility was excellent during the last survey and any fish on the wreck would not have been overlooked. Possible explanations are that these fish were sheltering deep within the wreck, were foraging well off the site or had emigrated. However during the pilot survey on 17 December 1998, this species was once again present in large numbers (Table 4).

A suite of pelagic species are seemingly transient on the wreck, specifically a number of trevally species, the barracuda *(Sphyraena putnamiae*) and the mackerel and tunas (Scombridae). Anecdotal records also suggest that large schools of queenfish frequent the vicinity of the shipwreck. There are also a number of small, rarely observed (at the Yongala) species which are sporadically included in the counts (Figure 5). These are likely missed on some counts due to sampling error. Groups of eagle rays have also been observed on the wreck (D. Wachenfeld pers. comm).

The only other detailed description of the Yongala fish community that we are aware of was conducted on a single day 17 years ago (Williams 1981). It is significant that the fish community he described is extremely similar to that which we consistently observed over our 15 month study period. This information suggests that the Yongala community has remained relatively stable over both seasonal and decadal time scales.

3.5 Human Use

In addition to ecological value, the fishes on Yongala have economic value in attracting recreational divers. A dive on the Yongala is the guarantee of an extremely memorable dive for even the mildest fish enthusiast. In 1994 there were 3113 visitor days on the Yongala using commercial operators (Cuthill 1996). There were approximately 4570 visitor days on the Yongala between 1 July 1995 and 30 June 1996 using commercial operators based on Environmental Management Charge returns to the Great Barrier Reef Marine Park Authority.

One of the major reasons this shipwreck is so popular is the abundance of marine life. A CRC study found that "marine wildlife plays a much more important role in providing enjoyable diver experiences than does the wreck" (Cuthill 1996). However spearfishing and illegal line fishing has been recorded on the Yongala (from QDEH patrol data). During the last 4 monitoring dives on the Yongala, a number of sea-perch species were observed with hook and line damage to the mouths. Coral trout with recent spear damage were also observed during those surveys, and a 2m Queensland groper was also observed in June 1998 with distinct spear damage (D. Bolger pers. com.). These fish may have been targeted while moving outside of the Yongala protection zone although this is unlikely given the distance of the Yongala from other reefs. Precautionary principles suggest that managers should be concerned about any indications of illegal fishing. In 1996 a commercial fishing vessel was charged with anchoring on the Yongala. Because the Yongala acts as a Fish Attraction Device and concentrates fish within a relatively small area, a concerted fishing effort over a short period of time could deplete certain target species and have a major impact on the Yongala fish community.

3.6 Management Issues

Although the Yongala Historic Shipwreck is protected under Marine National Park B zoning, the level of enforcement presence is restricted due to the wreck's exposed position, and the distance from the nearest port. Tourism vessels using the shipwreck probably discourage illegal fishing activity by their presence and also keep a look out for illegal activities (an anchoring prosecution in 1997 resulted from a tourism vessel reporting the presence of an anchored fishing vessel).

The extent of illegal fishing and quantity of fish being removed is unknown and is difficult to stop without a more targetted enforcement strategy and hard hitting penalties. The extent of the fish halo associated with the Yongala is not known, but may extend beyond 500m. A management issue that may need to be considered is whether 500m adequately protects this fish community.

Until recently, with the advent of accessible GPS technology, the remote location of the wreck and its lack of surface identification may have helped minimise the level of illegal activity. If surface moorings are ever established, vessels will be able to rapidly locate the wreck. Impacts on the fish community due to the increased potential for illegal fishing activity must be considered and ways to mitigate those impacts be addressed.

The effect of large, and possibly increasing, numbers of divers on fish behaviour is unknown. Increasing numbers of divers have the potential to disturb the fauna associated with the Yongala. Any negative effect on the fish community by the large numbers of people that dive on the Yongala has not been apparent during these few surveys. However this does not preclude impacts from having occurred, nor suggest future impacts will not occur due to increasing numbers of divers. Effects of diving activity should be monitored as usage levels increase, to ensure the Yongala's unique values are not degraded due to overuse.

More information on the biological processes influencing the structure of marine communities of the Yongala would assist with management of the site. The answers to questions such as 1) "What are the recruitment dynamics of the different fish species on the Yongala? " 2) "How long do individual fish spend on the wreck?", would improve understanding of community processes on the Yongala (and indeed within the region), and aid in the formulation of management strategies. Longer-term research projects are required to address these questions.

4. CONCLUSIONS

The wreck of the Yongala clearly supports a uniquely structured fish community differing from that observed on nearby shoals in terms of its trophic structure. The Yongala is located in a high current, highly productive near-shore zone that typically has a flat, soft substrate. Other areas of hard substrate in the vicinity are generally further off-shore or associated with continental islands or headlands. This physical setting in conjunction with the complex structure of the Yongala, likely contributes to the unique fish community structure.

On the Yongala there are few omnivores, specialist benthic invertebrate feeders, or herbivores, which are typically abundant on coral reefs. Conversely there are very high numbers of planktivores and large predators. This structure implies a greater dependence on a rich plankton supply compared to benthic food sources. It also indicates a simple energy pathway in which energy is moving from the plankton through to the higher order predators (via the predation of planktivorous fish or directly) with limited passage through benthic organisms.

Currently the Yongala is one of the few inter-reefal areas of hard substrate within the GBR lagoon that is protected from fishing. This protection is almost certainly aiding the marked stability of the community over annual (and possibly decadal) time scales and is likely

contributing to the maintenance of the current trophic structure. As human usage at the wreck is increasing, pro-active management and ongoing monitoring of the Yongala site is necessary in order to maintain the stability of such a unique and enthralling fish community.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

Cuthill, M. (1996) Managing the Yongala Historic Shipwreck. *Msc. Thesis*, James Cook University, North Queensland.

Gleeson,M. and Elliott, M. (1987) *S.S. Yongala, dive to the past*. Turton & Armstrong publishers, Australia

Newman, S. J. and Williams, D. McB. (1996) Variation in reef associated assemblages of the Lutjanidae and Lethrinidae at different distances offshore in the central Great Barrier Reef. *Env. Biol of Fishes* 46;123-138

Randall, J. E., Allen, G.R., Steene, R.C. (1990) *The complete divers and fishermen's guide to Fishes of the Great Barrier Reef and Coral Sea.* Crawford House Press, Australia.

Russ, G.R. (1984) Distribution and abundance of herbivorous grazing fishes in the Central Great Barrier Reef. i. Levels of variability across the entire continental shelf. *Mar. Ecol. Prog. Ser*. 20:23-34

Sano, M., Shimizu, M., Nose, Y. (1984) Food habits of teleostan reef fishes in Okinawa Island, Southern Japan. The University Museum, University of Tokyo, *Bulletin No. 25*

Sweatman, H., Thompson, A., Cheal, A., and Ryan, D (1997) Fishes. In Sweatman (ed) Long Term Monitoring of the Great Barrier Reef. *Status Report Number 2.* Australian Institute of Marine Science, pp 63 – 97

Williams,D.McB. and Russ,G.R. (1994) Review of data on fishes of commercial and recreational fishing interest in the Great Barrier Reef. Volume 1. *Great Barrier Reef Marine Park Authority Research Publication No. 33.*

Williams, D.McB. (1981) The fish community of the Yongala Wreck. *Unpublished report to Australian Institute of Marine Science*

Williams, D.McB. (1982) Patterns in the distribution of fish communities across the central Great Barrier Reef. *Coral Reefs* 1:35-43

FIGURES

Figure 1: Location of the Yongala shipwreck and deepwater shoal study locations.

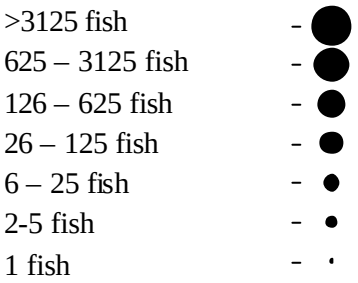
Figure 2. Dendrogram of cluster analysis highlighting the disparity between Yongala and neighbouring deepwater shoal fish communities.

Figure 3. Comparison of relative abundance and species richness of fish communities between the Yongala wreck and two deepwater shoals, Tink Shoal and "Small Shoal".

Figure 4. Temporal changes in abundance of fish species from speciose families or from individually abundant species at the Yongala wreck.

Figure 5. Temporal changes in abundance of less abundant taxa at the Yongala wreck.

Note: For Figures 3 to 5 the following symbols are used to represent the relevant log 5 abundance categories.



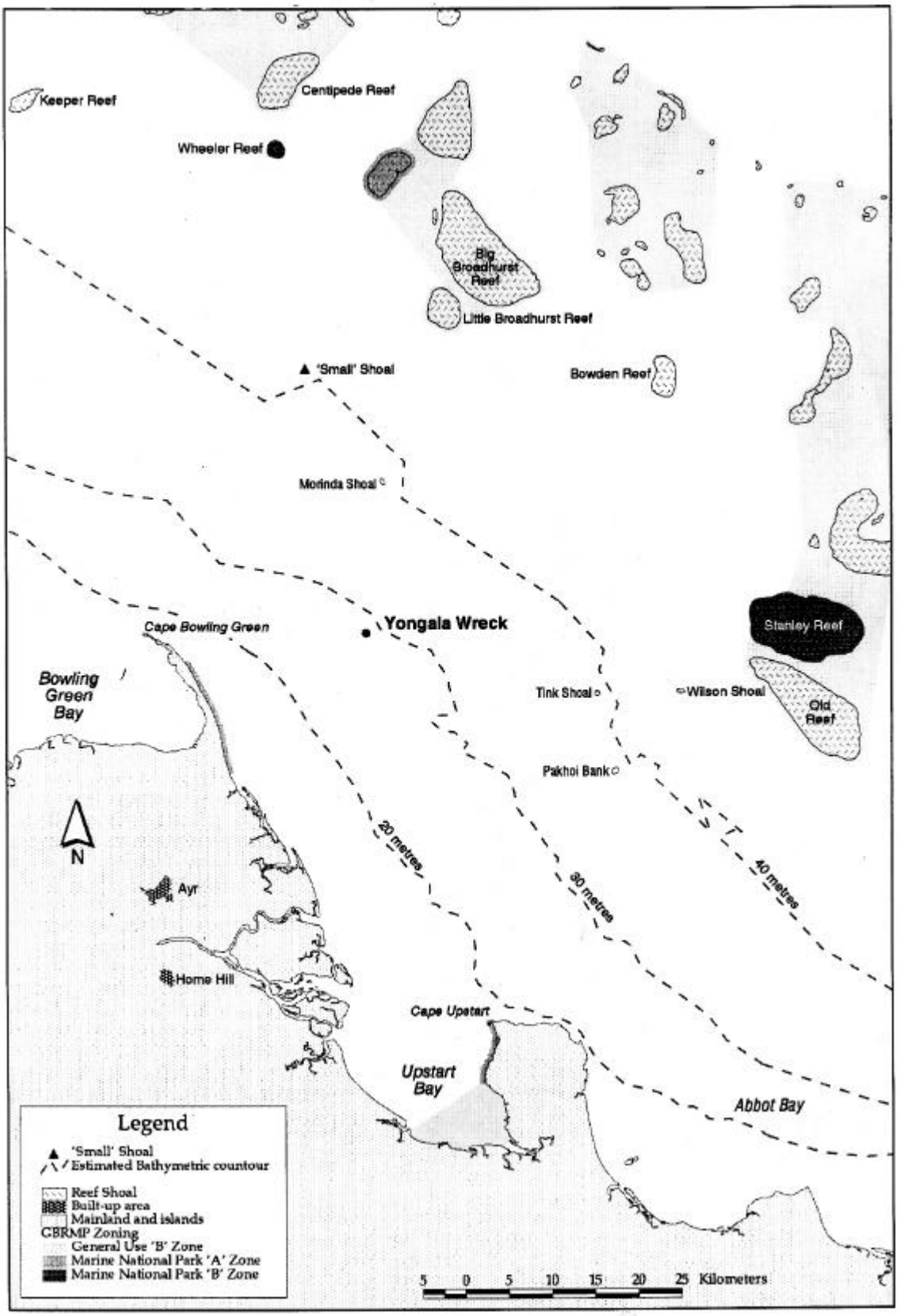


Figure 1: Location of the Yongala shipwreck and adjacent shoals.

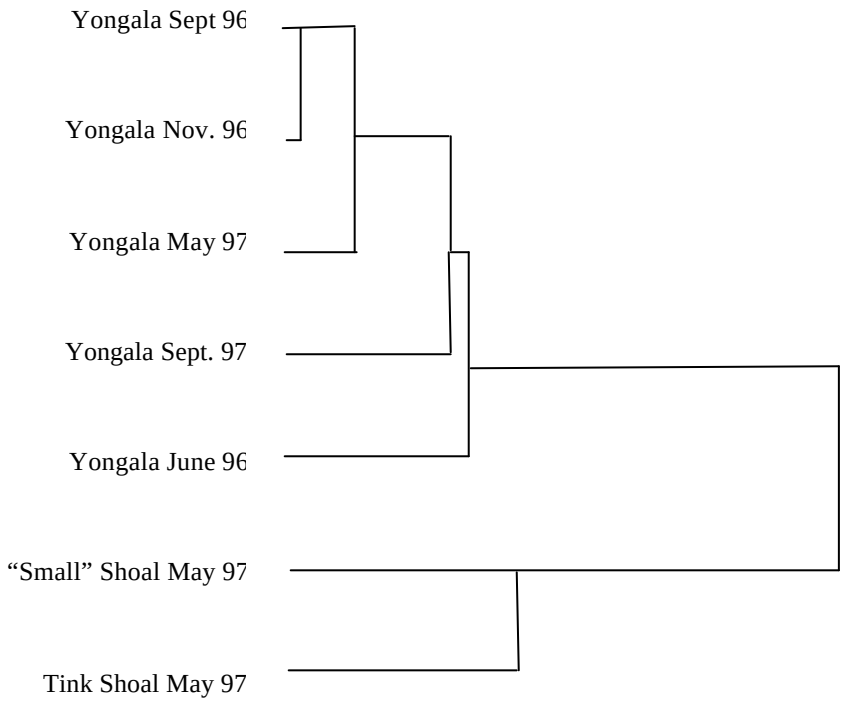


Figure 2. Dendrogram of cluster analysis highlighting the disparity between Yongala and neighbouring deepwater shoal fish communities. Longer lines in the horizontal between links between surveys reflect greater differences in the community structure,

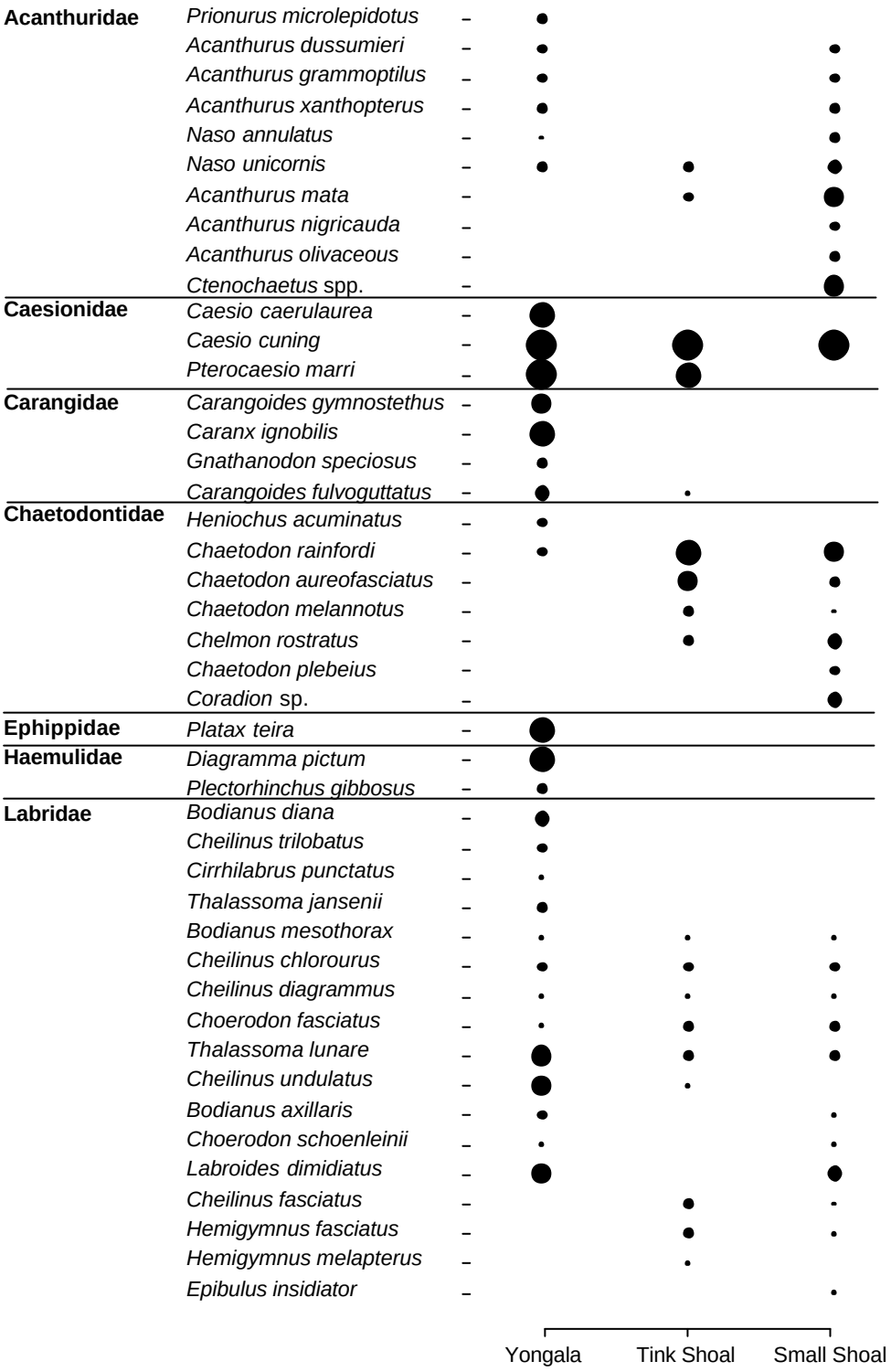


Figure 3. Comparison of relative abundances and species richness of fish communities between the Yongala wreck and two deepwater shoals, Tink Shoal and "Small Shoal". Survey dates were between 8 and 9 May 1997. The radius of each circle is proportional to the log 5 abundance category (see page 17) of the given species in a particular census. If a species was not recorded the appropriate space is left blank. (Cont'd over)

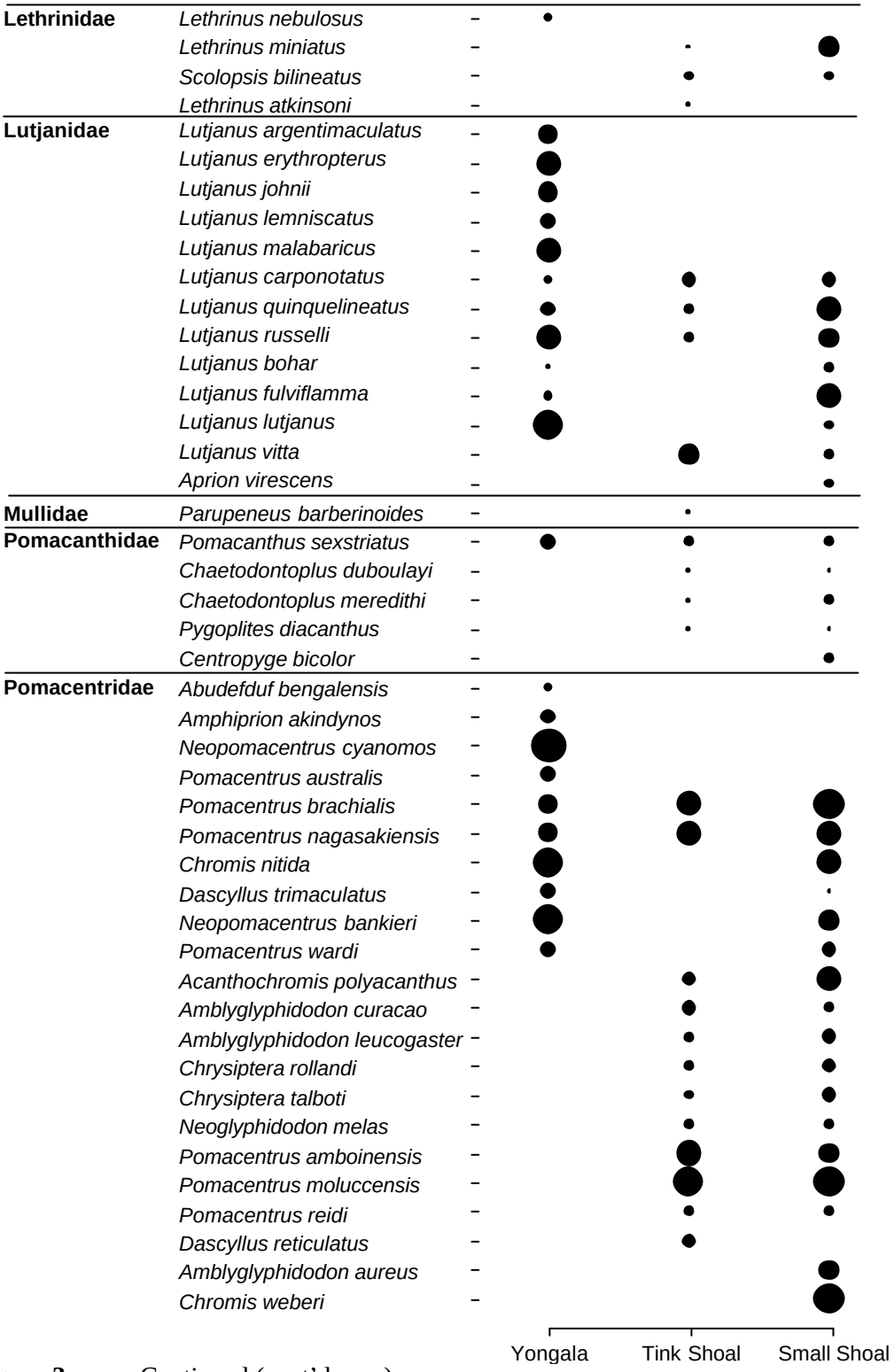


Figure 3. Continued (cont'd over).

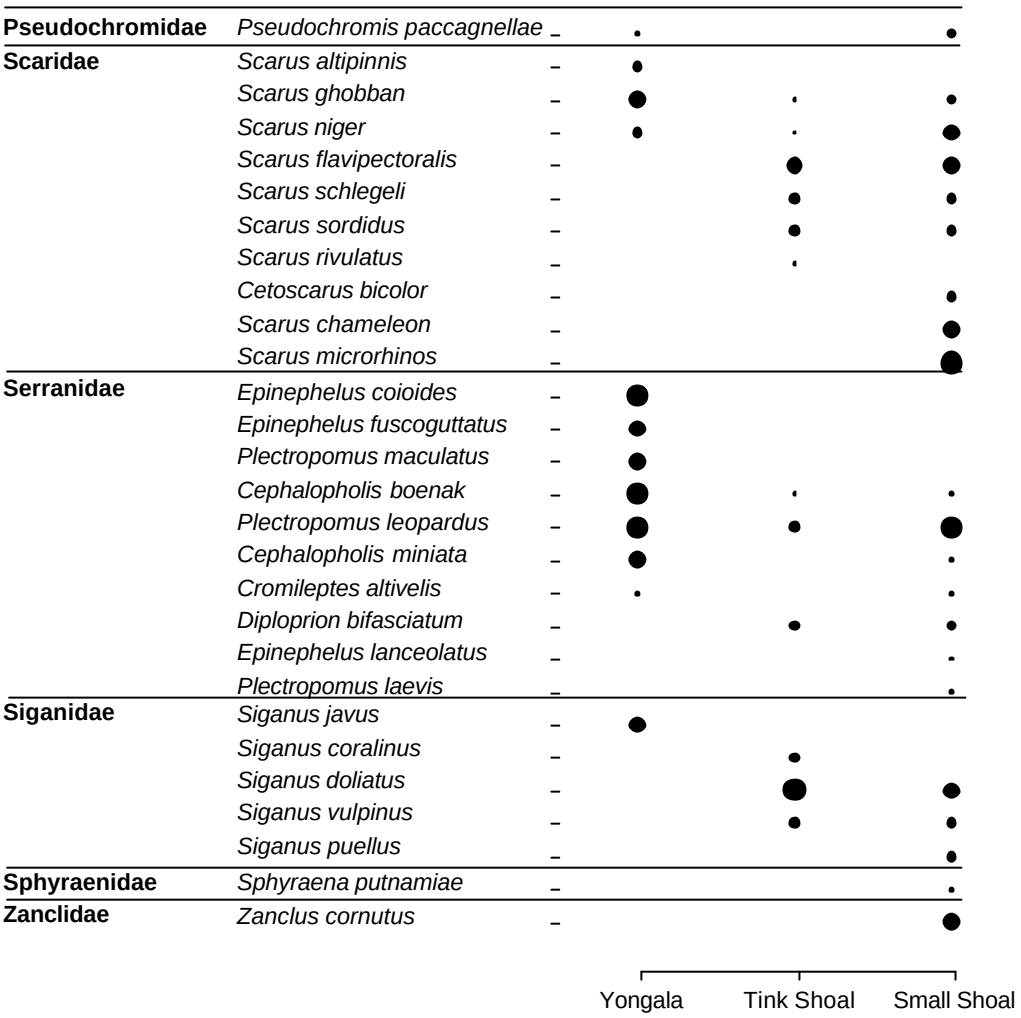


Figure 3. Continued

Figure 4. Temporal changes in abundance of fish species from speciose families or from individually abundant species at the Yongala wreck. Interpretation of this Figure as for Figure 1. (Cont'd over)

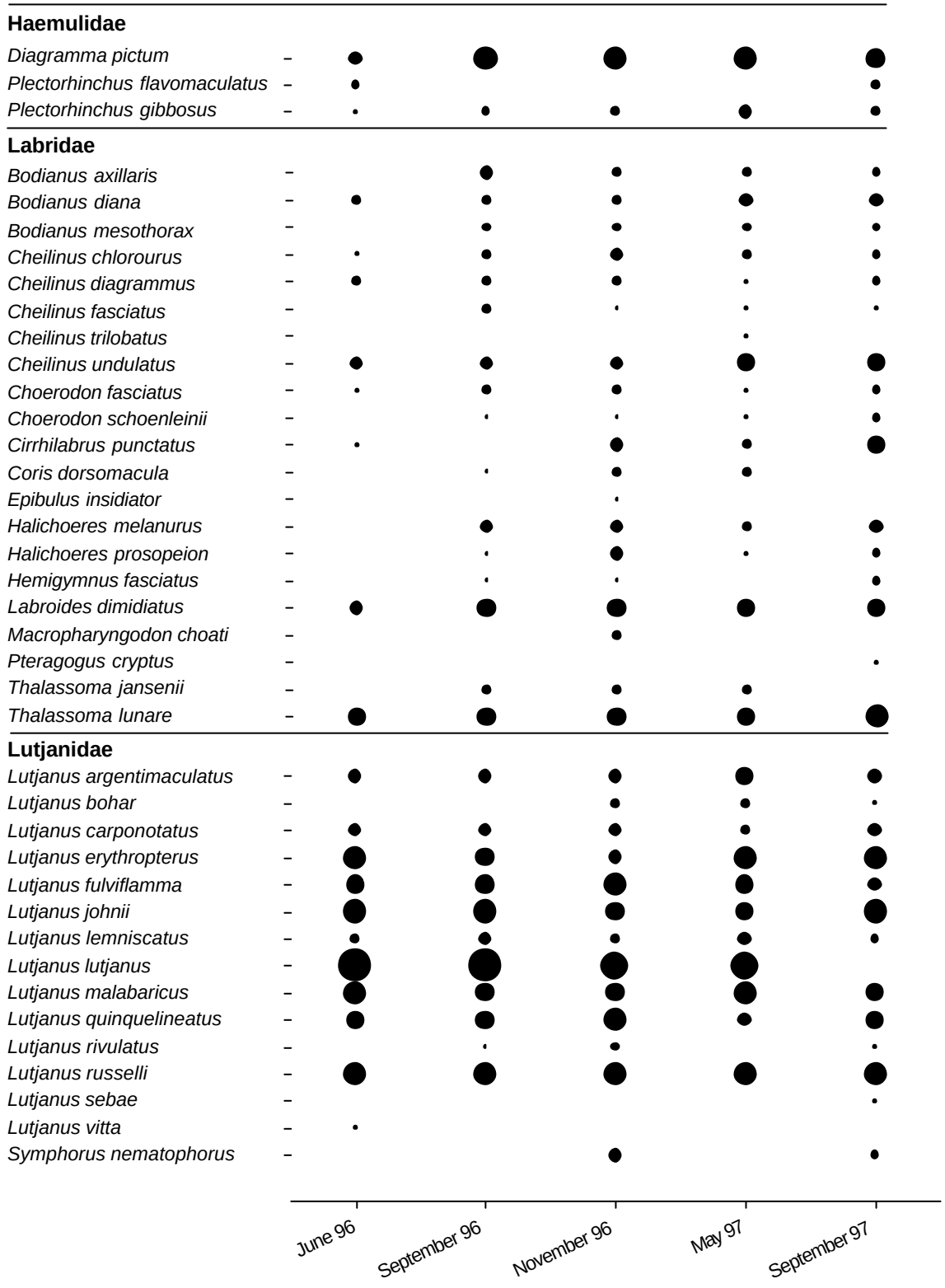


Figure 4. Continued. (Cont'd over)

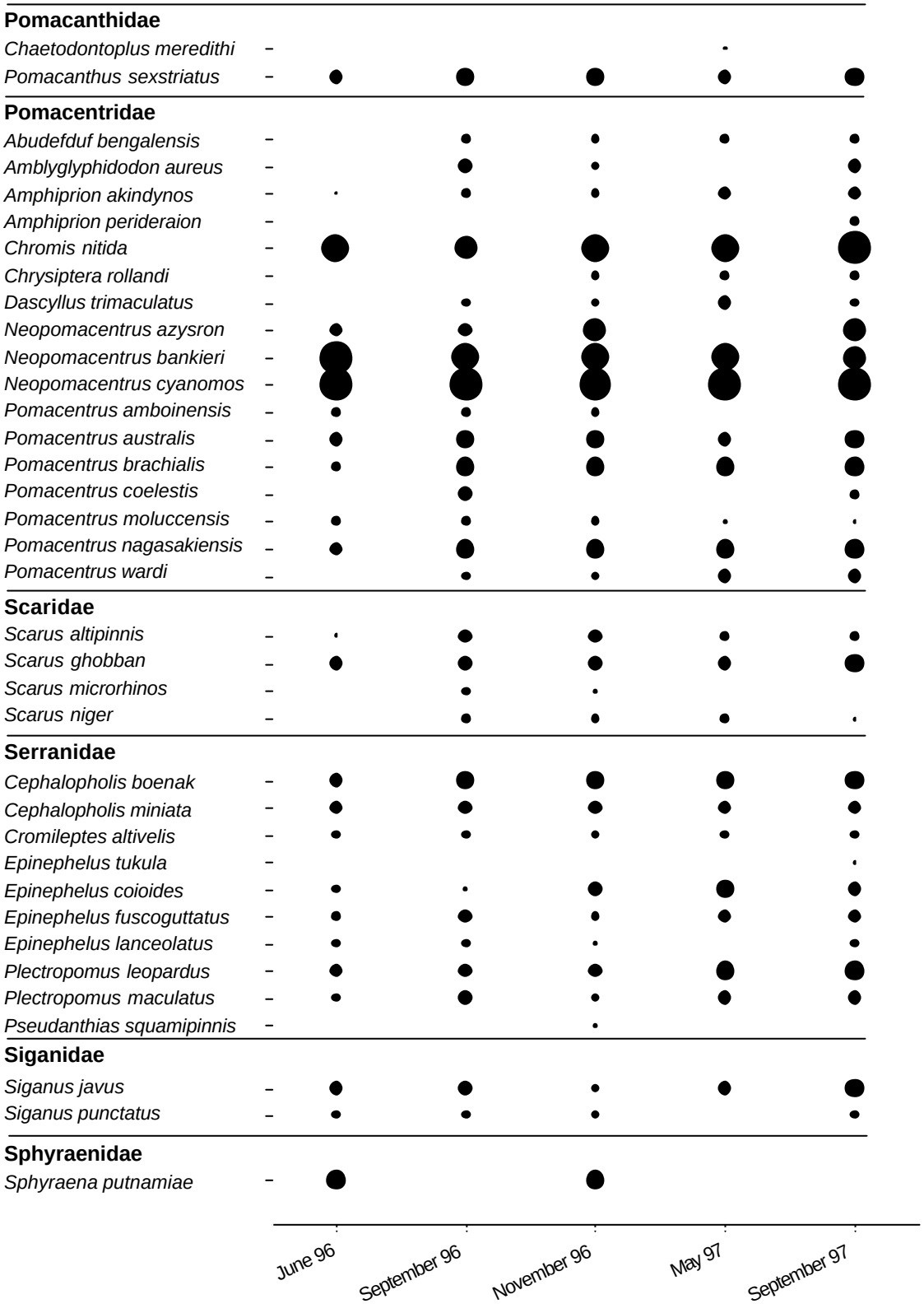


Figure 4. Continued.

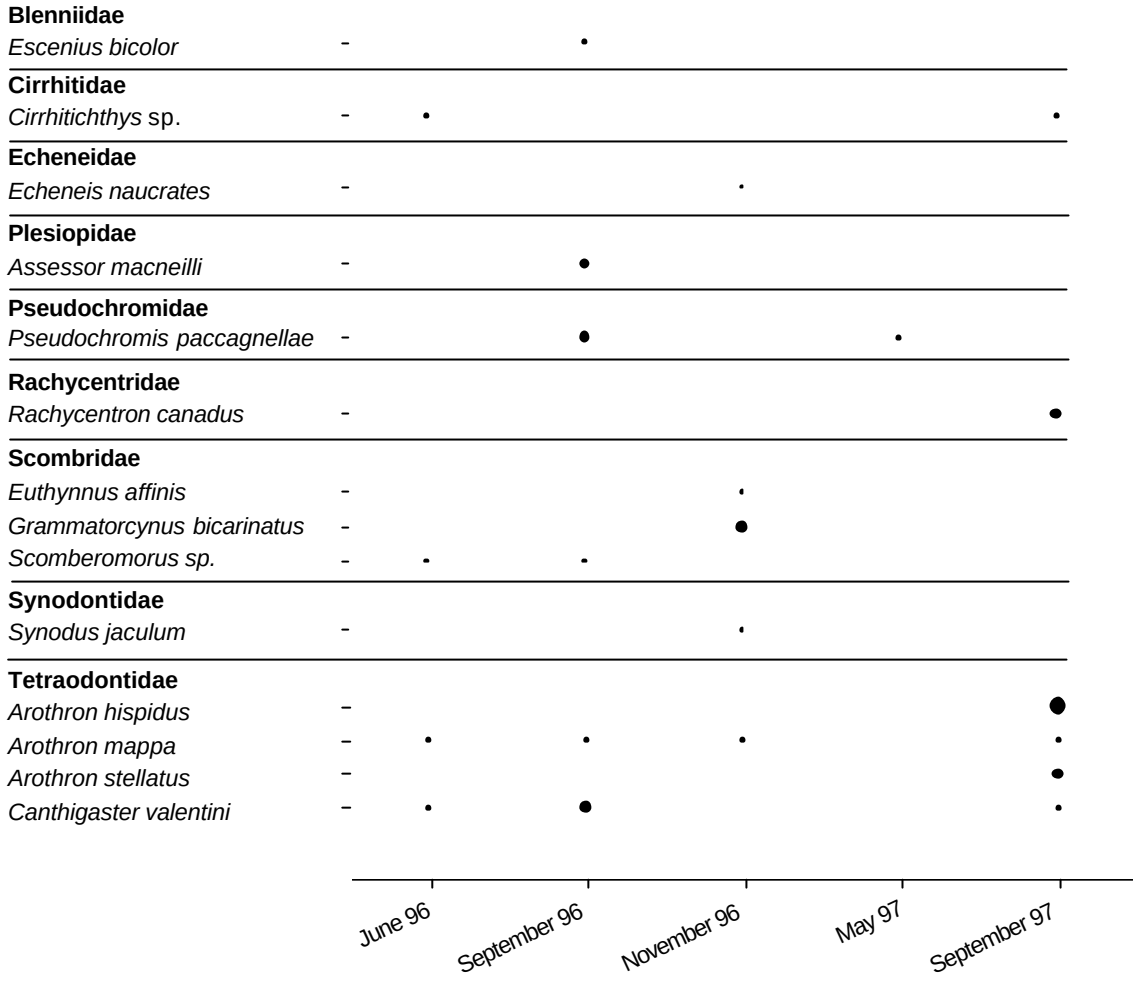


Figure 5. Temporal changes in abundance of less abundant taxa at the Yongala wreck. Explanation of the graph layout as for Figure 1.

Appendix 1.

Habitat Descriptions

Yongala:

The Yongala provides a solid substrate from which grows a variety of sessile benthic lifeforms. Sponges, gorgonians, soft corals, bivalves and ascidians dominate the benthic community. Benthic life decreases quickly on the sand away from the wreck. Noticeably low in percentage cover are hard coral species which tend to dominate the nearby mid-shelf reefs. Topographically the wreck provides a complex physical environment of caves (essentially entrances into the wreck via port holes, holds etc) of variable size on the deck, bow and stern while the hull provides a flatter sloping substrate.

Deepwater shoals:

***Tink Shoal*:** From the deepest point the reef sloped upwards at approximately 40-50 degrees until the 18m mark at which point it flattened out to an undulating substrate ranging from 15 - 18m depth. The reef was composed of a hard calcareous base with little topographic relief. In general coralline algae and algal turf dominated the benthos. A low percentage cover of a mixture of hard corals, soft corals, sponges and gorgonians dominated the rest of the benthic community. Sandy gullies lay in hollows between reef areas. There was little height in the benthic community apart from the occasional bommie dominated by massive hard corals. The habitat is not complex compared to that afforded by the Yongala.

"Small Shoal": From the deepest point the reef sloped up steeply, from 60 degrees to near vertical, until the 20m mark at which depth the incline reduced to 30-40 degrees until around 13m where it began to undulate. The deep steep wall did hold some large and small caves (although not nearly as cavernous as some on the Yongala) but was mainly rock based with a coating of algal turf and some small hard corals and sponges. Above 20m a lot more hard coral (estimated 20% cover in areas) was noted than at Tink shoal. The dominant hard coral life form was tabulate *Acropora*. Algal turf, coralline algae, soft corals and sponges also dominated the benthic community. Structurally this site is more complex than that at Tink Shoal due in part to the greater percentage cover of hard coral.

Appendix 2.

List of all species recorded at the Yongala wreck (cont'd over)

Family	Species	Common name
Acanthuridae	*Acanthurus blochii*	ringtail surgeon
Acanthuridae	*Acanthurus dussumieri*	white spine surgeon
Acanthuridae	*Acanthurus grammoptilus*	finelined surgeon
Acanthuridae	*Acanthurus mata*	elongate surgeon
Acanthuridae	*Acanthurus xanthopterus*	yellowfin surgeon
Acanthuridae	*Naso annulatus*	white margin unicorn
Acanthuridae	*Naso unicornus*	blue spine unicorn
Acanthuridae	*Prionurus microlepidotus*	sixplate sawtail
Apogonidae	*Apogon aureus*	ringtail cardinalfish
Apogonidae	*Apogon fraenatus*	spur cheeked cardinalfish
Apogonidae	*Apogon* sp. *?*	cardinal fish
Blenniidae	*Escenius bicolor*	bicolour blenny
Caesionidae	*Caesio caerulaurea*	goldband fusilier
Caesionidae	*Caesio cuning*	red belied fusilier
Caesionidae	*Pterocaesio marri*	marrs fusilier
Carangidae	*Alectes ciliaris*	pennantfish
Carangidae	*Carangoides fulvoguttatus*	gold spot trevally
Carangidae	*Carangoides gymnostethus*	bludger trevally
Carangidae	*Caranx ignobilis*	giant trevally
Carangidae	*Caranx papuensis*	brassy trevally
Carangidae	*Elagatis bippinulata*	rainbow runner
Carangidae	*Gnathanodon speciosus*	golden trevally
Carangidae	*Trachinotus blochii*	snub-nosed dart
Chaetodontidae	*Chaetodon aureofasciatus*	gold striped butterflyfish
Chaetodontidae	*Chaetodon auriga*	threadfin butterflyfish
Chaetodontidae	*Chaetodon lineolatus*	lined butterflyfish
Chaetodontidae	*Chaetodon rainfordi*	rainfords butterflyfish
Chaetodontidae	*Heniochus acuminatus*	longfin bannerfish
Chaetodontidae	*Coradion sp.*	coralfish
Cirrhitidae	*Cirrhitichthys sp.*	hawkfish
Echeneidae	*Echeneis naucrates*	remora
Ephippidae	*Platax teira*	tiered batfish
Haemulidae	*Diagramma pictum*	slaty bream/ painted sweetlips
Haemulidae	*Plectorhinchus flavomaculatus*	netted sweetlips
Haemulidae	*Plectorhinchus gibbosus*	brown sweetlips
Labridae	*Bodianus axillaris*	axilspot hogfish
Labridae	*Bodianus diana*	dianas hogfish
Labridae	*Bodianus mesothorax*	splitlevel hogfish
Labridae	*Cheilinus chlorourus*	floral maori wrasse
Labridae	*Cheilinus diagrammus*	cheeklined maori wrasse
Labridae	*Cheilinus fasciatus*	redbreasted maori wrasse
Labridae	*Cheilinus trilobatus*	tripletail maori wrasse
Labridae	*Cheilinus undulatus*	humphead maori wrasse
Labridae	*Choerodon fasciatus*	harlequin tuskfish
Labridae	*Choerodon schoenleinii*	blackspot tuskfish
Labridae	*Cirrhilabrus punctatus*	dotted wrasse
Labridae	*Coris dorsomacula*	pale barred
Labridae	*Epibulus insidiator*	slingjaw wrasse

Species list (cont'd)

Labridae	*Halichoeres melanurus*	tailspot wrasse
Labridae	*Halichoeres prosopeion*	two tone wrasse
Labridae	*Hemigymnus fasciatus*	barred thicklip
Labridae	*Labroides dimidiatus*	cleaner wrasse
Labridae	*Macropharyngodon choati*	choats wrasse
Labridae	*Pteragogus cryptus*	cryptic wrasse
Labridae	*Thalassoma jansenii*	jansens wrasse
Labridae	*Thalassoma lunare*	moon wrasse
Lethrinidae	*Lethrinus nebulosus*	spangled emperor
Lutjanidae	*Lutjanus argentimaculatus*	mangrove jack
Lutjanidae	*Lutjanus bohar*	red bass
Lutjanidae	*Lutjanus carponotatus*	stripey or spanish flag
Lutjanidae	*Lutjanus erythropterus*	small mouth nannygai
Lutjanidae	*Lutjanus fulviflamma*	blackspot snapper
Lutjanidae	*Lutjanus johnii*	Fingermark/spotted scale seaperch
Lutjanidae	*Lutjanus lemniscatus*	dark tailed seaperch
Lutjanidae	*Lutjanus lutjanus*	big eye seaperch
Lutjanidae	*Lutjanus malabaricus*	Large mouth nannygai
Lutjanidae	*Lutjanus quinquelineatus*	five lined seaperch
Lutjanidae	*Lutjanus rivulatus*	maori seaperch
Lutjanidae	*Lutjanus russelli*	moses perch
Lutjanidae	*Lutjanus sebae*	red emperor
Lutjanidae	*Lutjanus vitta*	brown stripe seaperch
Lutjanidae	*Symphorus nematophorus*	chinaman fish
Muraenidae	*Gymnothorax javanicus*	moray eel
Plesiopidae	*Assessor macneilli*	blue devilfish
Pomacanthidae	*Chaetodontoplus duboulayi*	scribbled angelfish
Pomacanthidae	*Chaetodontoplus meredithi*	Qld angelfish
Pomacanthidae	*Pomacanthus sexstriatus*	six-banded angelfish
Pomacentridae	*Abudefduf bengalensis*	bengal sergeant
Pomacentridae	*Amblyglyphidodon aureus*	golden damsel
Pomacentridae	*Amphiprion akindynos*	barrier reef anemone fish
Pomacentridae	*Amphiprion perideraion*	pink anemonefish
Pomacentridae	*Chromis nitida*	barrier reef chromis
Pomacentridae	*Chrysiptera rollandi*	Rolland's demoiselle
Pomacentridae	*Dascyllus trimaculatus*	three spot dascyllus
Pomacentridae	*Neopomacentrus azysron*	yellow tail demoiselle
Pomacentridae	*Neopomacentrus bankieri*	chinese demoiselle
Pomacentridae	*Neopomacentrus cyanomos*	royal demoiselle
Pomacentridae	*Pomacentrus amboinensis*	ambon damsel
Pomacentridae	*Pomacentrus australis*	australian damsel
Pomacentridae	*Pomacentrus brachialis*	charcoal damsel
Pomacentridae	*Pomacentrus coelestis*	neon damsel
Pomacentridae	*Pomacentrus moluccensis*	lemon damsel
Pomacentridae	*Pomacentrus nagasakiensis*	sandy damsel
Pomacentridae	*Pomacentrus wardi*	wards damsel
Pseudochromidae	*Pseudochromis paccagnellae*	royal dottyback
Rachycentridae	*Rachycentron canadus*	cobia
Scaridae	*Scarus altipinnis*	minifin parrotfish
Scaridae	*Scarus ghobban*	bluebarred parrotfish
Scaridae	*Scarus microrhinos*	steephead parrotfish
Scaridae	*Scarus niger*	greendot parrotfish

Species list (cont'd)

Sciaenidae	*Protonibea diacanthus*	black jewfish
Scombridae	*Scomberomorus* sp.	mackerel
Scombridae	*Euthynnus affinis*	mackerel tuna
Scombridae	*Grammatorcynus bicarinatus*	shark mackerel
Serranidae	*Cephalopholis boenak*	brown barred rock-cod
Serranidae	*Cephalopholis miniata*	coral cod
Serranidae	*Cromileptes altivelis*	barramundi cod
Serranidae	*Epinephelus coioides*	gold spot estuary cod
Serranidae	*Epinephelus fuscoguttatus*	flowery cod
Serranidae	*Epinephelus lanceolatus*	Queensland grouper
Serranidae	*Epinepelus tukula*	potato cod
Serranidae	*Plectropomus leopardus*	coral trout
Serranidae	*Plectropomus maculatus*	bar cheeked coral trout
Serranidae	*Pseudanthias squamipinnis*	scalefin anthia
Siganidae	*Siganus javus*	java rabbitfish
Siganidae	*Siganus punctatus*	goldspotted rabbitfish
Sphyraenidae	*Sphyraena putnamiae*	chevron barracuda
Synodontidae	*Synodus jaculum*	javelin fish
Tetraodontidae	*Arothron hispidus*	star & stripes puffer
Tetraodontidae	*Arothron mappa*	map puffer
Tetraodontidae	*Arothron stellatus*	star puffer
Tetraodontidae	*Canthigaster valentini*	black saddled toby