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# By-catch from the central Queensland prawn fisheries: part I. The prawn fisheries, species composition and site associations from the by-catch.

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**A report to the Great Barrier Reef Marine Park Authority**

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CONTENTS

## SUMMARY

A study of trawl fisheries between 18°S and 19°S has shown that three fisheries for penaeid prawns, separable on the basis of species composition and geographic distribution, can be described. More than 300 trawlers operate in these fisheries, which have generated landings in excess of 2000 tonnes of prawns per year in the past two years.

The fisheries also take a considerable quantity of by-catch, little of which is of commercial value. In a two year study of by-catch fauna, 477 taxa were identified. The trawl by-catch was dominated by Crustacea and Osteichthyes (bony fish) in terms of numbers and weight taken. The Osteichthyes were the most diverse group, with more than 50% of species coming from this Class.

The by-catch was dynamic in nature, with relatively few species being present throughout the year, and dominant species changing over time. There were, however, characteristic faunal assemblages which appeared to be associated with coastal, near-reef and inshore waters. The coastal fauna was markedly different to the near-reef and inshore faunas, and the transition between the two occurred over a distance of less than 5 km. There was no such clear boundary between the near-reef and inshore faunas, the fauna of some sites grouping with near-reef fauna on some sampling occasions and with inshore fauna on others.

Preliminary comparisons of the faunas from trawl grounds and the reef environment showed marked differences between them. Few species were common to the reef environment and to trawl grounds, and families which were dominant on trawl grounds were relatively less abundant in near-reef environments.

## INTRODUCTION

Valuable trawl fisheries for penaeid prawns, bay lobsters (Scyllaridae) and scallops (Amusidae) exist on Queensland's continental shelf between 18°S and 21°S (Robertson and Dredge 1986). These fisheries take place in waters of the Great Barrier Reef Lagoon and their geographic distribution overlaps with areas under the control of the Great Barrier Reef Marine Park Authority (GBRMPA).

Implicit in GBRMPA's current zonation system for resource users in the Marine Park is a concern that trawling may have some effect on the Reef ecosystem. Some 23% of the 80 000 km$^2$ Central Section of the Great Barrier Reef Marine Park was zoned to preclude trawling in a draft plan. A recent study by Poiner and Harris (1986) offers some evidence that trawl fisheries alter the faunal communities in their immediate vicinity. But there is no published data on the effects that trawling may have upon nearby coral reefs and their associated fauna. Cannon *et al* (1987) pointed out that the inter-reef fauna in the vicinity of the Great Barrier Reef is virtually undescribed. No comparative discussion on the faunas from these two environments can be justified until this deficiency is corrected.

A two-year study of the prawn fisheries between 18°S and 21°S was initially designed to describe the fishery and biology of one of the major target species, *Penaeus longistylus* Kubo (Red spot king prawn). The study was extended to include a detailed description and analysis of by-catch taken in trawl fisheries which exist in this area. By-catch has been examined to give a checklist of species and records of their relative abundance over space and time. Descriptions of faunal associations have been made from these data. These, in turn, have been related to substrate composition, hydrographic conditions, distance from shore, depth and fishing effort.

The study was designed to supply both an historic record of the trawlable inter-reef fauna and a database which could be used as a basis for discussion on the extent of interaction between the inter-reef fauna affected by trawl fisheries and reef-associated fauna. In Part 1 of the study, trawl fisheries between 18°S and 21°S are described, by-catch species are documented, and faunal associations which occur between the coast and inter-reef areas are described. Part 2 of the study, which is reported separately, deals with year-to-year variation in faunal associations and with faunal associations found in a near-reef to off-reef transect. The study was not designed to describe the effects of trawling upon the reef ecosystem.

Jones and Derbyshire (in press) have described the by-catch composition in terms of species composition and abundance. Watson and Goeden (in press) analysed by-catch from the first twelve months of data collection in terms of site associations. Parts of this report are based upon their findings.[1]

## METHODS

### The Fishery

Catch rates, species composition and effort distribution in the trawl fisheries between 18°S and 21°S were monitored through a logbook programme. Some 50 fishermen, most of whom were based at Townsville, kept shot-by-shot records of catches taken in 6 by 6 nautical mile grids. Penaeid prawns were monitored as species complexes. Fishermen do not distinguish between the bi-specific tiger *(Penaeus esculentus, P. semisulcatus)*, king *(P. longistylus, P. latisulcatus)* and endeavour *(Metapenaeus ensis, M. endeavouri)* prawns when sorting. Depth, trawl duration and marketable by-catch were recorded. The logbook programme was voluntary and may not provide complete records of each vessel's fishing activities.

Logbook records were collected by a local contractor and forwarded to the Burnett Heads Fisheries Laboratory. Data from each day's fishing were summarised to give a single line, and loaded onto a random access file in a microcomputer. Summaries of the data, including average catch rate for each species complex, effort distribution and allocation, and individual boat summaries were obtained using a set of custom written BASIC programmes.

Total catch in the fisheries was estimated using two independent sources of information. Processors' buy-in records were collected at six- to12-month intervals and used as one estimate of total catch. Estimates of total effort expended in the fisheries were made by counting the number of trawlers visible on radar during sampling nights (see below) and by obtaining word of mouth estimates of boat nights fished from both fishermen and processors. These estimates of total effort were corrected, averaged, and multiplied by estimates of average monthly catch rates (kg prawn $day^{-1}$) obtained from logbook data to give estimates of total monthly catch. Neither estimate of total catch was error free. The buy-in figures supplied by processors were incomplete as many boats in the area have dry freezing facilities, and some fishermen export product directly from their vessels. Likewise, estimates of total fishing effort in the fishery suffer from a range of error sources. Estimates of total landings, whilst the best available, should be taken as order of magnitude estimates.

### By-catch Composition

In the period between January 1985 and December 1986, a monthly sampling and monitoring programme was carried out from the F.R.V. 'Gwendoline May', at 24 sites between 18°S and 19°30'S. Twenty sites were sampled in 1985 and 12 in 1986. Eight of the sites were common to both years of sampling (Figure 1). Sample sites were selected on the basis of being on main fishing grounds, on transects between the coast and the Great Barrier Reef and on a near-reef to off-reef transect. This report deals largely with by-catch taken from sites sampled in 1985. These were sited on the main fishing grounds and on the transects between the coast and the Great Barrier Reef.

Samples taken at each site were obtained by towing two 12 m head rope Florida Flyer trawls for a duration of 30 min at a speed of approximately 1.85 m $sec^{-1}$. During each trawl shot, each net swept an area of approximately 27 000 $m^2$. One net, made of 50 mm mesh was typical of trawl gear used in the fishery. The other, made of 40 mm mesh, was designed to take small prawns. By-catch samples were normally taken from the 50 mm mesh net whenever possible, but on 12 occasions were taken from the 40 mm mesh net after the 50 mm net failed to fish. Sampling took place over a two- to four-night period at or around the time of new moon unless weather conditions caused delays in sampling. Bottom salinity and water temperature were measured at each site, each month. Substrates of all sites were sampled with a Smith-MacIntyre grab in November 1985 and July 1986. Substrate samples were washed, sieved and weighed to give sediment fractions following Morgans (1956).

1 Material contained in this report should not be quoted without the prior approval of the author.

Total by-catch from the larger mesh net was weighed after large sponges, rays and sharks were noted and removed, and a 10 kg subsample was taken. The remainder of the by-catch was then examined for previously unrecorded species. The by-catch subsample was frozen and returned to the laboratory for examination. All specimens were identified to specific or generic level, counted and weighed. Records of species' identity and abundance were entered onto a computerized data base and subsequently examined for presence/absence, abundance and species associations.

Preliminary analyses which involved the calculation of all species' frequency of occurrence and overall abundance were carried out using the SPSS package. Species which occurred in fewer than 5% of samples or whose identification was doubtful were omitted from further analysis. Species associations over space and time were examined using the package "CLUSTAN". Raw data on species abundances were log transformed (log n+1) to suppress dominance of the data set by the relatively few species which made up more than 50% of by-catch. Site and time assemblages were then derived using a classification analysis which took into account the conjoint occurrence and abundance, or conjoint absence of species. Site or time assemblages were characterised both by associated species which were conspicuously absent while abundant elsewhere, and by species and species associations which were abundant while rare or absent in other assemblages. Technical details of analytical techniques used to develop site associations are given in Watson and Goeden (in press).

## RESULTS

### The Fishery

The continental shelf between 18°S and 21°S supports three clearly identifiable trawl fisheries. These are:

1. A near-reef fishery for two species of king prawn, red spot kings *(P. longistylus)* and blue legged kings *(P. latisulcatus)*. These species are taken in near reef waters in what is a predominantly winter and spring fishery. Endeavour prawns *(M. endeavouri)* make up a small component of total catch in this fishery.

2. A coastal night-time fishery for tiger *(P. esculentus* and *P. semisulcatus)* and endeavour *(Metapenaeus endeavouri, M. ensis)* prawns. Catch rates in the fishery peak in March-April. In recent years the very high prices paid for tiger prawns have resulted in the fishery persisting through the winter months.

3. A coastal daytime fishery for banana prawns, *Penaeus merguiensis*. Banana prawns are typically taken in the period between March and June, although later catches have been recorded. Landings from this fishery are characterised by their irregularity, and a strong correlation between magnitude of landings and rainfall could be expected (Staples 1985).

Bay lobsters *(Thenus* spp*)* and scallops *(Amusium* spp*)* are taken as by-catch in all these fisheries, and occasionally targeted.

Proportions of the major species groups in the total annual prawn landings, taken from processors' data are given in Table 1. The king prawn fishery has been the most valuable component between 1984 and 1987. Total king prawn landings can be estimated from two data sources. In the period between 1977 and 1984, virtually all landings were received by three processors and their records provide the best estimate of annual catch. Since then, the number of processors has increased, and the increased usage of on-board dry freezing of product has lead to greater leakage of product from local markets. The available processors' records therefore under-estimate total landings. A second estimate of total landings can be made by multiplying estimated total effort by average catch rate. These estimates of annual king prawn catch have been combined in Table 2.

In waters between about 18°S and 19°S the two fisheries for king prawns and tiger-endeavour prawns were almost completely segregated spatially. Further south, the extent of overlap between the two fisheries was greater (Figure 2 a,b,c). Tiger prawn grounds tended to be discrete, with most effort concentrated in areas near Lucinda and the Palm Islands, off Magnetic Island, seawards of Cape Bowling Green and Cape Upstart, and off Bowen. King prawns were taken over much greater areas off the western face of the Great Barrier Reef and in the inter-reef areas. There has been some year-to-year variation in the spatial distribution of effort aimed at king prawns in the period 1985-87. This variation may be attributable to variation in spatial recruitment patterns.

Relative effort directed at king and tiger-endeavour stocks over time is shown in Fig. 3 a,b. The pulsed nature of the winter king prawn fishery and less concentrated distribution of effort in the tiger/endeavour fishery are shown. The March-May catch of king prawns may have been *P. latisulcatus*, taken in coastal areas as they emigrated from estuarine nursery areas. There are no restrictions on the transfer of fishing effort from one stock to another. Many boats which trawl for tiger prawns in the early part of the year fish on the near-reef king prawn grounds in winter. The major source of effort directed at the king prawn stocks comes from vessels which fish in the area only during winter, moving to other grounds for the remainder of the year. At the peak of the king prawn season, more than 300 trawlers may work in the fishery.

Daily catch rates for 1985-87, which are shown as a function of time of year in Figure 4 a to f, show a marked peak at the beginning of each fishing season, and then a decline as the stock is exploited more rapidly than recruits become available. The effect of the lunar cycle on catch rates can also be seen in these figures.

### Characteristics of sites sampled in 1985

Depth and substrate composition of the 20 sites sampled in 1985 are given in Table 3. The shallower inshore sites (1, 2 and 15) had high clay and silt fractions, presumably of terrigenous origins. The mid Great Barrier Reef and near Reef sites were located in areas with predominantly calcareous sand substrates, possibly of biogenic origins.

## BY-CATCH

### Species taken

A total of 477 taxa of animals was identified from the 378 samples taken throughout the entire 1985-6 sampling programme. A full list of these taxa is given in Appendix 1. The 200 species which were selected for further analysis and their rank in order of numerical abundance in the 1985 sampling programme are also shown in Appendix 1. Trawl catches were dominated by the Crustacea (42% of all individuals identified) and bony fish (37% of all individuals). Fish dominated the by-catch in terms of species diversity (Table 4). Fewer than 3% of species were of commercial value. The distribution of species abundance is skewed (Figure 5), with the most abundant five species comprising 50.4 % of the total number of animals recorded.

### By-catch weight

During the first 12 months of sampling at the 20 sites, 217 of a projected 240 samples were collected. By-catch from these samples weighed 6.2 tonnes. A summary of by-catch weight as a function of month and site is given in Table 5. A two-way analysis of variance tested whether by-catch was significantly affected by site or time. The analysis of both times and sites against by-catch weight gave significant results ($F_{10}$ =12.85, P<.01 and $F_{19}$ =10.41, P<.01 respectively). The null hypotheses that by-catch weights were not significantly affected by site or time were rejected. Data summaries (Table 5) show a decrease in by-catch weight through winter and spring and an increase to a late autumn maximum. Changes in by-catch weight as a function of site were more subtle. Variation in by-catch weight could not be associated with clines in proximity to the coast, depth or any of the other physical parameters which were recorded.

### Relationship between trawled and reefal fish

Eighty-two families were represented in the 272 species of Pisces collected in 1985-6. The 10 richest families, in terms of numbers of species identified, are shown in Table 6. Species which were common to this study and Russell's (1983) checklist of fish from the Capricorn-Bunker Group are also given in this table. Russell's checklist is heavily biased towards species occurring in the reefal environment and generally identifies those species which were taken in trawl samples from non-reef areas (Russell, pers com). Fewer than 5% of species were common to the inter-reef - near-reef - coastal trawl grounds between 18°S and 21°S and the reefal environment of the Capricorn-Bunker Group between 22°30'S and 24°S. Of the 10 most species-diverse families from the reefal environment of the Capricorn-Bunker Group, only two (Apongonidae and Serranidae) appear in the most species-diverse families from the trawl samples. Their ranks, in terms of species abundance from trawl samples was 1 and 9 respectively, and 5 and 6 from Russell's (1983) survey of reef fishes. Several of the most diverse families recorded by Russell (1983) were rare or absent in the trawl by-catch.

### Relationship between trawled and reefal echinoderms

Mather and Bennett (1978) have given a comprehensive checklist of the Echinodermata recorded from Heron Island, a coral atoll situated at 23°20'S, 151°55'E. Numbers of species from the atoll's lagoon and reef, from the present trawl study, and the number of common species are given in Table 7. Fewer than 10 % of species occurred in both the trawl samples from 18°S-21°S and the reefal area of Heron Island. Many of the common species were reported as coming from inter-reef collections made at Heron Island (Mather and Bennett, 1978).

### Community assemblages from trawl samples

Eleven of the 12 monthly sample sets generated very similar aggregations of sites when analysed, March 1985 being the exception (Figure 6). In this month only six of the projected 20 sites were sampled and the data had little meaning. In each of the remaining 11 months, the faunal associations attributed to sites displayed a similar dichotomy of form, with the coastal sites 1, 2 and 15 having faunal characteristics much different to those of the deeper, wider sites. This coastal assemblage has been designated 'A'. A second split in the assemblage appeared at a lower level of dissimilarity, giving assemblages 'B' and 'C' (Figure 6). The two assemblages, 'B' and 'C', were consistently more similar to each other than to assemblage 'A'. Within the two assemblages 'B' and 'C', 13 sites could be said to belong to either 'B' or 'C' if a 70% frequency of occurrence in either assemblage was used as an arbitrary level of occurrence. The remaining four sites (sites 4, 7, 16 and 17) grouped with assemblage 'B' in 45% to 70% of monthly samples and occurred in 'C' on all other occasions (Table 8). The location of site assemblages is shown in Figure 7, with the three clearly segregated site-species assemblages shown as hatched circles. The transition sites are depicted by open circles. Sites which clustered in assemblage 'B' were located in open water in the Great Barrier Reef Lagoon, while those sites in assemblage 'C' occurred in near-reef and inter-reef areas. The transitional sites with weakest site-species assemblage links (sites 4 and 7) are geographically close to coral reefs, unlike the slightly less transitional sites 16 and 17. Sites 18 and 19, which are located as close to coral reefs as sites 4 and 7, clustered in assemblage 'B' in 10 out of the 11 monthly sample sets.

The general distribution of site assemblages roughly parallels both the coastline and depth contours. Sites 1, 2 and 15 (assemblage 'A') make up a coastal grouping, sites 3, 12, 13, 14, 18, and 20 (assemblage 'B') make up an inshore group and sites 5, 6, 8, 9, 10 and 11 (assemblage 'C') make up a near-reef and inter-reef group.

Site assemblages can be characterised by species which were confined to the site group (Table 9) or absent from the site group (Table 10). The frequency with which they appeared in monthly samples may reflect seasonal abundance characteristics for the species.

When sites were associated by substrate characteristics (using cluster analysis), three major groups separated out (Figure 8). There was a 75% coincidence between site groups separated on the basis of sediment characteristics and species presence/abundance (Table 8).

## Faunal assemblages and fishing effort

The area between 18°S and 21°S immediately to the west of the Great Barrier Reef has been subject to trawl fisheries since the early 1970s. Coastal areas in these latitudes have been trawled since the late 1950s. Detailed records of areas subjected to trawling and intensity of trawl fishing prior to 1984 do not exist. Logbook data indicate that the areas which included assemblage 'B' (the inshore sites) received more than twice the trawl effort per unit area than the areas which included assemblage 'A' (the coastal sites) and more than eight times that given to the area which included assemblage 'C' (near-reef sites). The transitional sites were subjected to about 80% of the effort given to assemblage 'B' (Table 11). As assemblages 'B' and 'C' are more closely related to each other in terms of faunal composition than each is to assemblage 'A', the difference between 'B' and 'A', and 'B' and 'C' cannot be attributed to the effects of additional trawling effort alone.

# DISCUSSION

The area between 18°S and 21°S supports trawl fisheries which can be distinguished by target species, geographic location, depth and diurnality. The major fisheries are for penaeid prawns. Inshore fisheries for tiger and banana prawns are largely segregated from an offshore and near-reef fishery for king prawns which is of greater magnitude and effort than the inshore fishery.

The existence of recognisable faunal associations in areas subject to trawling has been discussed by Pauly (1979), Rainer and Munro (1982) and Rainer (1984). Faunal associations in the south-eastern Gulf of Carpentaria were shown to be linked to depth, distance offshore and substrate composition by Rainer and Munro (1982). The same authors recognised three major faunal associations whose distributions were correlated with distance offshore and depth. Rainer (1984) was able to show seasonal effects upon the faunal associations of the same area. Recently Somers (1987) demonstrated the influence of substrate composition and depth upon the distribution of two commercially valuable penaeid species *(P. semisulcatus, P. esculentus)* which are prominent target and indicator species in the Gulf of Carpentaria. Poiner and Harris (1986) gave evidence that trawling may cause some disturbance to the faunal composition within faunal assemblages. Their analysis again showed the existence of faunal assemblages which appear to be linked to depth-distance from shore.

The present study gives clear evidence for the existence of a coastal, demersal fauna between 18°S and 21°S. This fauna is very dissimilar to those of inshore and near-reef - inter-reef assemblages, which could be differentiated (although at a lower level of dissimilarity) from the coastal assemblage. Some sites had faunal compositions which were transitory between the inshore and near-reef assemblages. They could not be distinguished by proximity to reefs or substrate composition. Faunal site-assemblages could be associated with depth, distance from shore and substrate composition (Watson and Goeden in press).

The assemblages between 18°S and 21°S were dynamic in nature. Most of the species were found in more than one assemblage, although in varying numbers and proportions with total catch. Many species were recorded during only part of the entire year. The seasonal nature of the trawl fisheries is a clear example of the seasonal flux in species availability. Despite the changes that were evident in the species composition, the dominant three assemblages were present throughout the year, and their geographic boundaries did not change greatly, in terms of the sampling programme's month to month resolution. Further data and discussion on the year-to-year constancy of assemblages and on the relationship between proximity to reefs and faunal assemblages will be presented in Part 2 of the report.

The coastal and near-reef trawl fisheries which target on different penaeid species are unlikely to be responsible for the differentiation of faunal assemblages. Identifiable faunas were associated with clines in depth and distance from shore in trawl grounds prior to trawling (Rainer and Munro 1982) and the change in substrate composition between inshore and near-reef waters could also be responsible for the different faunas. Maximum divergence in community structure was not associated with maximal or minimal fishing effort.

Cannon *et al* (1987) have demonstrated the broad scale existence of inshore-offshore demersal communities between 12°S and 24°S along the Queensland continental shelf in both trawled and undisturbed areas. There are no data on the faunal composition of the Great Barrier Reef Lagoon between 18°S and 21°S prior to the development of trawl fisheries. Poiner and Harris (1986) suggested that some change in faunal structure resulted from trawling in the south east Gulf of Carpentaria. Their data were obtained from adventitious sources rather than from purpose-designed research programmes and include error sources such as sampling gear variation and day-night catchability variation. These error sources mask their results, although their conclusions may well be valid.

There were gross dissimilarities between the trawlable fish faunas caught in the region 18°S to 21°S and the reef fauna of 23°S to 24°S documented by Russell (1983), which is the only comprehensive check list available for comparative examination. Fewer than 5% of species were common to the reefal environment of the Capricorn-Bunker Group addressed in Russell's (1983) study and to the trawl grounds in the central Barrier Reef region. The dominant families of the reef fish community were poorly represented in trawl catches, and the most species-rich families taken from the trawl fauna were, for the most part, poorly represented on the reef environment. Likewise, more than 90 % of the Echinodermata which were sampled by trawl between 18°S and 20°S have not been recorded during extensive surveys of a coral reef and lagoon at 23°20'S (Mather and Bennett 1978). Latitudinal variation and differences in collecting techniques are unlikely to be responsible for these differences. There are no comprehensive data on the faunal assemblages of the reefs between 18°S and 21°S, but studies conducted on the more noticeable groups (for example, Williams 1986) suggest that the dominant groups of the reef assemblages are isolated from the near-reef, open water and coastal assemblages described in this report. The fauna of the inter-reef areas and of the Great Barrier Reef Lagoon appear to be characteristic of fine sand and mud substrates, and are markedly different to those of the reef proper.

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**TABLE 1.** Proportion (%) of total prawns by species complex received by buyers between Lucinda and Bowen.

| Species | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|
| **Kings** | | | | |
| *P. latisulcatus* | | | | |
| *P. longistylus* | 65.7 | 72.3 | 54.3 | 54.2 |
| **Tigers** | | | | |
| *P. esculentus* | | | | |
| *P. semisulcatus* | 20.2 | 16.4 | 26.1 | 35.4 |
| **Endeavours** | | | | |
| *M. endeavouri* | | | | |
| *M. ensis* | 5.9 | 4.9 | 5.3 | 5.2 |
| **Banana** | | | | |
| *P. merguiensis* | 7.5 | 5.3 | 13.6 | 5.1 |
| **Corals** | | | | |
| *Metapenaeopsis,* | 0.8 | 0.1 | 0.2 | 0.7 |
| *Trachypenaeus* | | | | |

**TABLE 2.** Average catch rates and estimates of total landings from the central Queensland king prawn fishery.

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|
| Catch rate (kg/hour) | - | - | - | - | 9.82 | 11.07 | 10.61 |
| Catch (tonnes) | 200 | 750 | 250 | 650 | 650 | 1800 | 2000 |

**Table 3.** Characteristics of sites sampled in 1985.

| Site | Location | Depth(m) | Gravel(%) | Sand(%) | Silt(%) | Clay(%) | Median(O) |
|---|---|---|---|---|---|---|---|
| 1 | 18 27.5S 146 22.5E | 17 | 0.0 | 6.8 | 59.3 | 33.9 | 7.5 |
| 2 | 18 27S 146 25.5E | 23 | 7.8 | 61.1 | 20.0 | 11.2 | 1.4 |
| 3 | 18 23S 146 32.5E | 34 | 4.1 | 88.6 | 3.1 | 4.2 | 0.6 |
| 4 | 18 20.5S 146 38E | 42 | 8.1 | 84.7 | 4.6 | 2.7 | 0.5 |
| 5 | 18 17.5S 146 42E | 53 | 3.6 | 75.2 | 15.8 | 5.3 | 2.6 |
| 6 | 18 25.5S 146 48E | 53 | 3.6 | 82.3 | 14.1 | 0.0 | 3.1 |
| 7 | 18 33.5S 146 58.5E | 49 | 4.5 | 84.3 | 8.1 | 3.0 | 2.3 |
| 8 | 18 35.5S 147 07.5E | 56 | 3.6 | 77.7 | 16.7 | 2.0 | 3.1 |
| 9 | 18 36S 147 16E | 53 | 3.8 | 78.6 | 14.7 | 2.9 | 2.6 |
| 10 | 18 30S 147 18E | 62 | 6.1 | 85.1 | 7.9 | 0.8 | 2.2 |
| 11 | 18 41.5S 147 25.5E | 54 | 1.9 | 78.9 | 15.4 | 1.9 | 2.7 |
| 12 | 18 54.5S 147 29.5E | 49 | 3.2 | 85.3 | 7.5 | 4.0 | 1.1 |
| 13 | 19 02.5S 147 27.5E | 39 | 6.7 | 85.4 | 4.7 | 3.1 | 2.1 |
| 14 | 19 08.5S 147 22.5E | 30 | 2.6 | 87.7 | 5.4 | 1.4 | 1.2 |
| 15 | 19 15S 147 18.0E | 15 | 0.0 | 14.9 | 46.2 | 38.9 | 8.2 |
| 16 | 19 02S 147 38E | 51 | 5.8 | 87.6 | 5.0 | 1.6 | 1.0 |
| 17 | 18 52.5S 147 24.5E | 46 | 5.3 | 87.4 | 4.5 | 2.7 | 2.1 |
| 18 | 18 46.0S 147 11.5E | 42 | 3.9 | 88.0 | 5.7 | 2.4 | 2.2 |
| 19 | 18 43S 147 03E | 42 | 5.0 | 90.0 | 2.6 | 2.5 | 1.5 |
| 20 | 18 40.5S 146 52.5E | 41 | 2.9 | 84.9 | 9.3 | 2.9 | 1.6 |

Table 4. Abundance and biomass of major taxonomic groups.

| Phylum | Class | Number of species | | Abundance of individuals | Estimated biomass |
|---|---|---|---|---|---|
| | | Number | % | % | % |
| Chordata | Ascidiacea | 2 | .4 | | |
| | Chondricythes | 5 | 1.0) | | 75 |
| | Osteichthyes | 267 | 56.0) | .......38 | |
| | Reptilia | 5 | 1.0) | | |
| Crustacea | Malacostraca | 91 | 19.1 | 42 | 20 |
| Echinodermata | Crinoidea | 3 | 0.6) | | |
| | Asteroidea | 21 | 4.4) | | |
| | Ophiuroidea | 6 | 1.3) | .......16 | 2 |
| | Echinoidea | 8 | 1.8) | | |
| | Holothuroidea | 12 | 2.5) | | |
| Mollusca | Gastropoda | 31 | 6.5) | | |
| | Bivalvia | 8 | 1.8) | ........4 | 1 |
| | Cephalopoda | 10 | 2.1) | | |
| Porifera | | 1* | | | |
| Cnidaria | | 3* | | | |
| Sipuncula | | 1* | | | |
| Annelida | | 2* | | | |
| Bryozoa | | 1* | | | |
| Total | | 477 | 98.5 | 100 | 98 |

* Species not separated or identified

**Table 5.** By-catch weight (kg) related to site (station number) and time from 1985 monthly samples.

| Site | Time: J | F | M | A | M | J | J | A | S | O | N | D | Weight (kg): Mean | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | 12.8 | .83 |
| 2 | | | | | | | | | | | | | 15.6 | .50 |
| 3 | | | | | | | | | | | | | 54.1 | 1.52 |
| 4 | | | | | | | | | | | | | 31.6 | 1.12 |
| 5 | | | | | | | | | | | | | 24.9 | .94 |
| 6 | | | | | | | | | | | | | 19.4 | .92 |
| 7 | | | | | | | | | | | | | 38.1 | 1.31 |
| 8 | | | | | | | | | | | | | 25.4 | 1.23 |
| 9 | | | | | | | | | | | | | 30.7 | 1.11 |
| 10 | | | | | | | | | | | | | 17.9 | .71 |
| 11 | | | | | | | | | | | | | 28.6 | 1.17 |
| 12 | | | | | | | | | | | | | 29.4 | .99 |
| 13 | | | | | | | | | | | | | 31.8 | 1.20 |
| 14 | | | | | | | | | | | | | 47.2 | 1.25 |
| 15 | | | | | | | | | | | | | 18.8 | .82 |
| 16 | | | | | | | | | | | | | 23.0 | .87 |
| 17 | | | | | | | | | | | | | 37.3 | 1.20 |
| 18 | | | | | | | | | | | | | 28.1 | 1.24 |
| 19 | | | | | | | | | | | | | 24.7 | 1.26 |
| 20 | | | | | | | | | | | | | 44.9 | 1.13 |
| Mean (kg) | 31.1 | 30.9 | 28.2 | 37.6 | 49.6 | 27.9 | 32.4 | 27.1 | 23.4 | 19.1 | 18.7 | 24.8 | | |
| S.E. | .72 | .84 | 1.94 | .92 | 1.15 | .95 | .80 | .84 | .84 | .59 | .70 | .83 | | |

**Table 6.** Number of species in 10 most species-rich families from trawl grounds between 18°S-21°S compared with numbers of species from these families occurring in Russell's (1983) Capricorn-Bunker checklist.

| Family | Number of species 18°-21° (trawl) | Number of species (Russell, 1983) | Number of common species | Common species taken by trawl (Russell,1983) |
|---|---|---|---|---|
| Apogonidae | 17 | 33 | 2 | 0 |
| Scorpaenidae | 16 | 21 | 2 | 1 |
| Carangidae | 16 | 21 | 4 | 1 |
| Platycephalidae | 14 | 4 | 1 | 0 |
| Tetraodontidae | 12 | 11 | 2 | 0 |
| Nemipteridae | 11 | 9 | 3 | 2 |
| Monacanthidae | 8 | 13 | 3 | 3 |
| Leiognathidae | 8 | 0 | 0 | 0 |
| Serranidae | 8 | 32 | 3 | 0 |
| Synodontidae | 8 | 8 | 1 | 0 |
| Total | 118 | 152 | 21 | 7 |

**Table 7.** Numbers of species of Echinodermata from Heron Island reef (Mather and Bennett, 1978) from trawl grounds between 18°S and 19°30'S, and common species.

| Class | Number of species recorded at Heron Is. (Mather and Bennett, 1978) | Number of species taken by trawl | Common species |
|---|---|---|---|
| Crinoidea | 26 | 3 | 1 * |
| Asteroidea | 31 | 21 | 6 ** |
| Ophiuroidea | 17 | 6 | 1 * |
| Echinoidea | 16 | 8 | 1 |
| Holothuroidea | 29 | 13 | 1 |

* - Not all species identified from trawl samples
** - Three species from Heron Island noted as having inter-reef distribution

**Table 8.** Classification of sample sites into site-assemblages. Monthly, total and overall classification are shown. Transitional sites are shown as B/C. Site assemblage classification based on substrate analysis are also shown (from Watson and Goeden, in press).

| Site | Month<br>JFMAMJJASOND | Total samples classified as<br>"A" | <br>"B" | <br>"C" | Overall classification group | Sediment |
|---|---|---|---|---|---|---|
| 1 | AAAAAAAAAAAA | 12 | 0 | 0 | A | |
| 2 | AAAAAAAAAAAA | 12 | 0 | 0 | A | B |
| 3 | BBBBBBBBBBBB | 0 | 12 | 0 | B | B |
| 4 | BBBCBBCBCCBC | 0 | 7 | 5 | B/C | B |
| 5 | C-CCCCCCCCCC | 0 | 0 | 11 | C | C |
| 6 | CCCCCCCBCCCC | 0 | 1 | 11 | C | C |
| 7 | CB-BBBCCCCCB | 0 | 5 | 6 | B/C | C |
| 8 | CC-CCCCCCCCC | 0 | 0 | 11 | C | C |
| 9 | BB-CCCCCCCCB | 0 | 3 | 8 | C | C |
| 10 | BC-CCCCCCCCC | 0 | 1 | 11 | C | C |
| 11 | C--BCCCCCCCC | 0 | 1 | 9 | C | C |
| 12 | BB-BBBBBBBBB | 0 | 11 | 0 | B | B |
| 13 | BB-BBBBBBBBB | 0 | 11 | 0 | B | C |
| 14 | BB-BBBBBBBBB | 0 | 11 | 0 | B | B |
| 15 | BC-AAAAAAAA- | 8 | 1 | 1 | A | A |
| 16 | C--BCBCBBBBB | 0 | 7 | 3 | B/C | B |
| 17 | C--BBBCBBBCB | 0 | 7 | 3 | B/C | C |
| 18 | C--BBBBBBBB | 0 | 8 | 1 | B | C |
| 19 | C--BBBBBBBB | 0 | 8 | 1 | B | C |
| 20 | C--BBBBBBBB | 0 | 8 | 1 | B | B |

**Table 9.** Species found only in single site assemblages during monthly sampling. The number in brackets refers to the number of months in which the species appeared (Watson and Goeden, in press).

| Assemblage | | |
|---|---|---|
| "A" | "B" | "C" |
| *Amusium pleuronectes*(9) | *Portunus rubromarginatus*(11) | *Portunus argentatus*(9) |
| Charybdis truncata(9 | Hypodyte carinatus(9) | Nemipterus celebicus(9) |
| *Apogon peocilopterus*(7) | *Parapercis nebulosa*(9) | *Saurida undosquamis*(7) |
| *Repomuscenus belcheri*(7) | *Engyprosopon grandisquama*(8) | *Trachinocephalus myops*(7) |
| *Portunus pelagicus*(6) | *Paramonacanthus japonicus*(6) | *Upenaeus* sp 1(5) |
| *Metapenaeopsis palmensis*(5) | *Sepia* spp(6) | |
| *Nemipterus hexadon*(5) | *Dactyloptena papilio*(5) | |

**Table 10.** Species absent from site assemblages. Numbers in brackets show number of months in which the species was absent from the site assemblage (Watson and Goeden, in press).

| Assemblage | | |
|---|---|---|
| "A" | "B" | "C" |
| Upeneus sp 1 (12) | Amusium pleuronectes(9) | Dactylopus dactylopus(7) |
| Penaeus longistylus(11) | Charybdis truncata(7) | Amusium pleuronectes(5) |
| Trachinocephalus myops(11) | Priacanthus tayenus(6) | Apogon peocilopterus(5) |
| Synodus similis(10) | Arnoglossus waitei(5) | Charybdis jaubertensis(5) |
| Maretia planulata(9) | Nemipterus hexodon(5) | Lethrinus nematacanthus(5) |
| Sorsogonia tuberculata(9) | Penaeus semisulcatus(5) | Metapenaeopsis lamellata(5) |

**Table 11.** Fishing effort (trawl hours monitored) in 6 by 6 nautical mile grids which included sample sites, by site assemblage.

| | | Fishing Effort (Trawl hours) | | | | |
|---|---|---|---|---|---|---|
| Site Assemblage | Number of sites | 1985 | 1986 | 1987 | Total | Average effort/ grid |
| Coastal(A) | 3 | 45 | 56 | 423 | 524 | 58.2 |
| Inshore(B) | 7 | 869 | 150 | 1583 | 2602 | 123.9 |
| Inter-reef(C) | 6 | 152 | 50 | 47 | 249 | 14.8 |
| Transitional | 4 | 303 | 169 | 714 | 1186 | 98.8 |

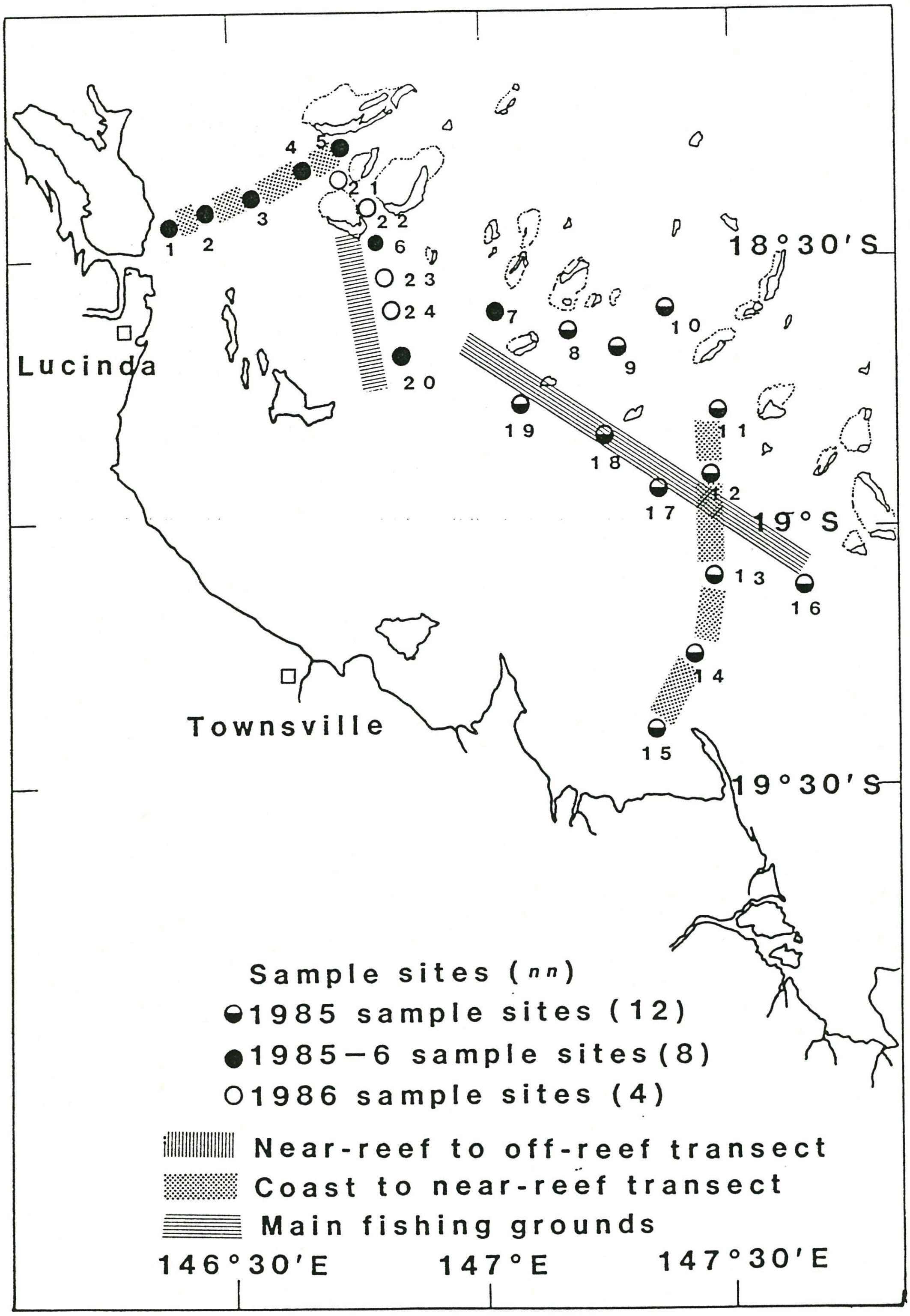


Figure 1. Sample sites

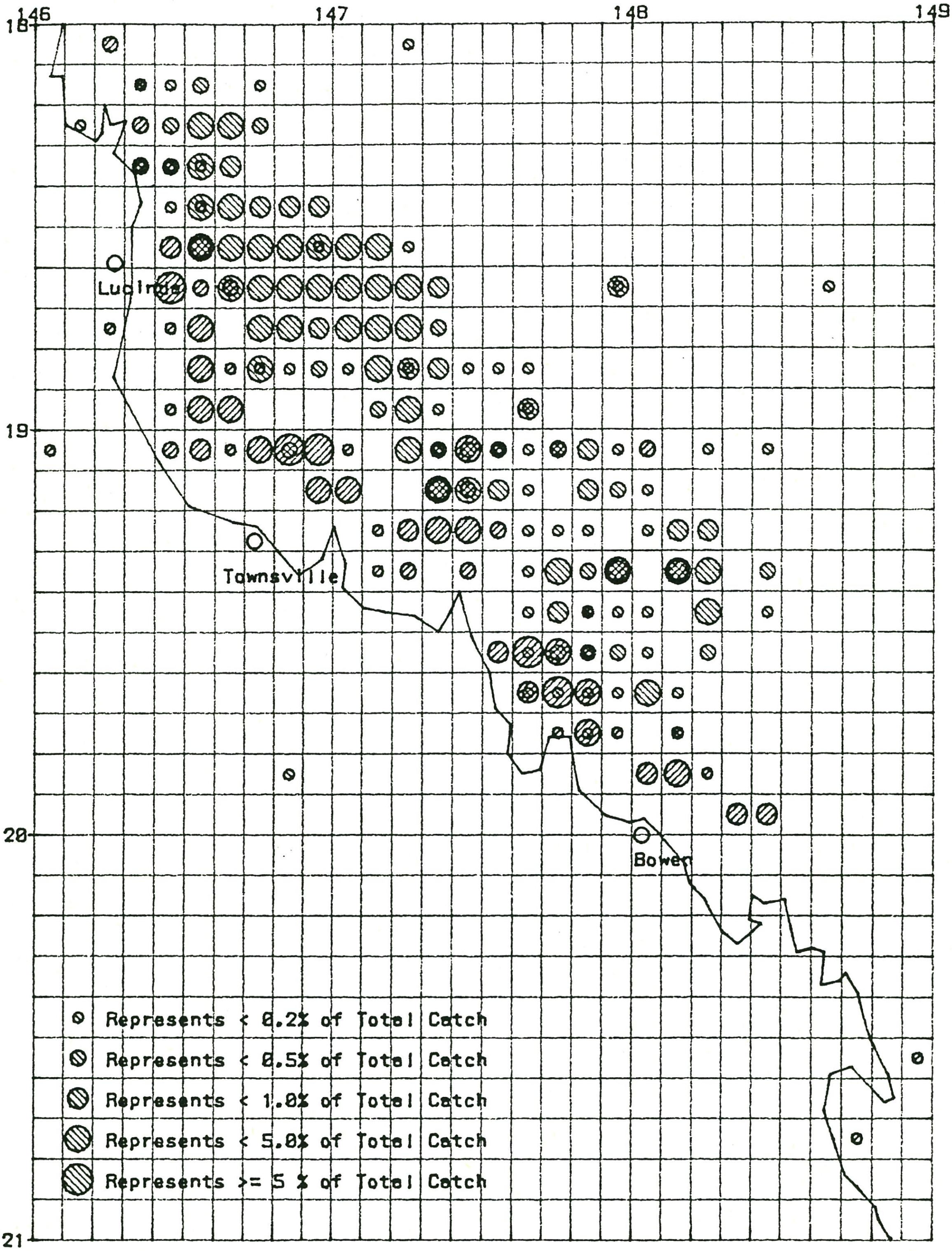


Figure 2 a. Geographic catch distribution of the central Queensland king ( ) and tiger-endeavour ( ) prawn fisheries-1985

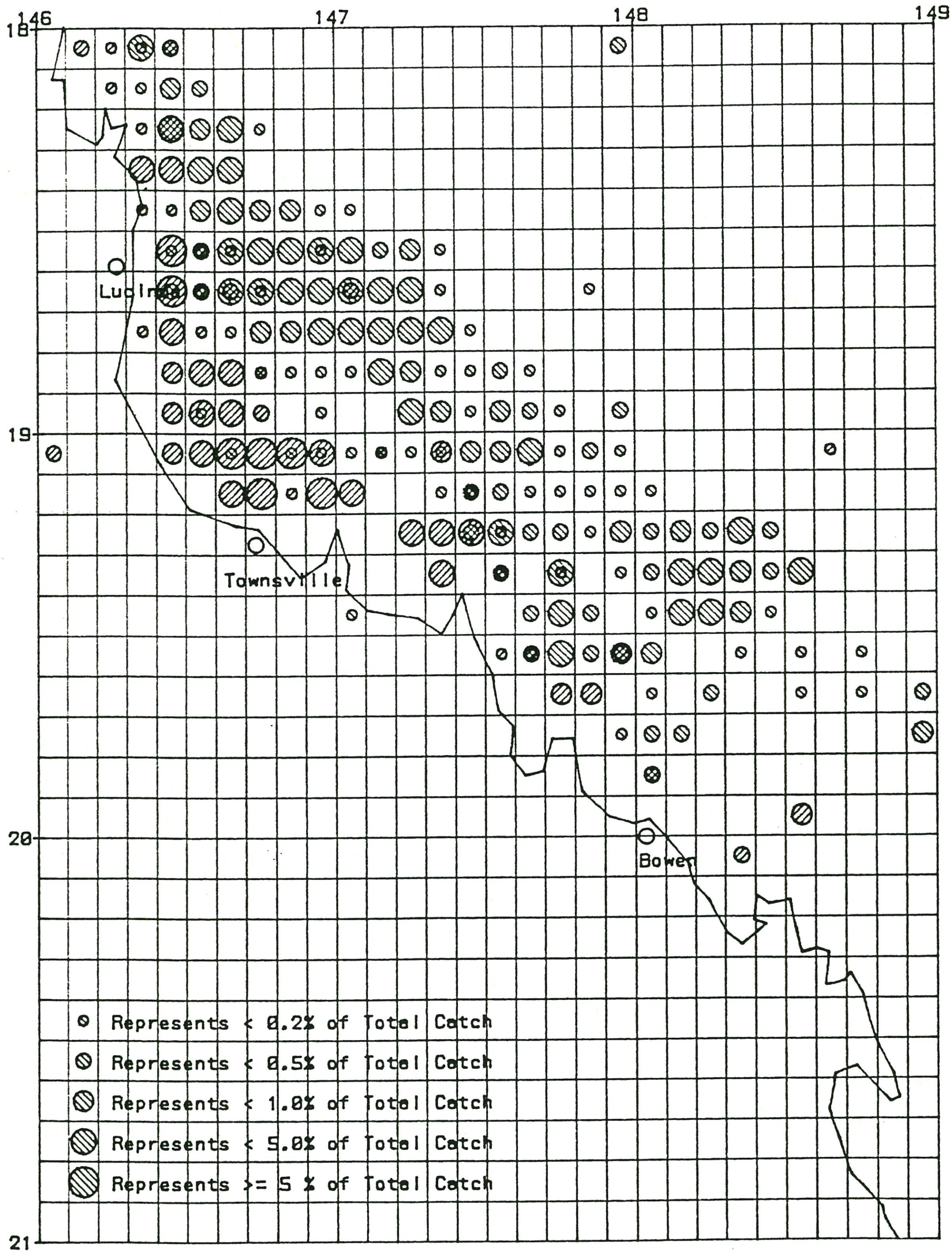


Figure 2 b. Geographic catch distribution of the central Queensland king ( ) and tiger-endeavour ( ) prawn fisheries-1986

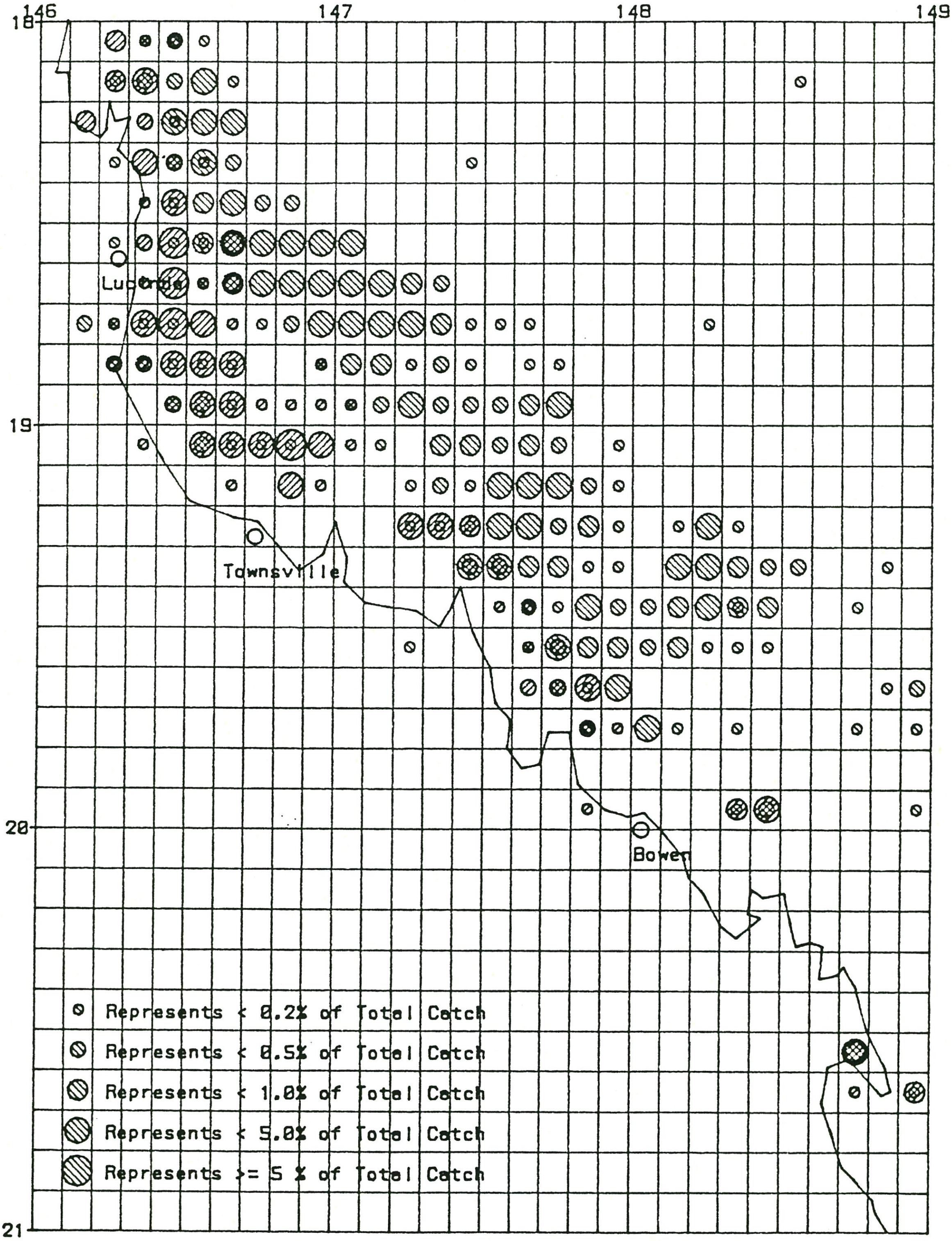


Figure 2 c. Geographic catch distribution of the central Queensland king ( ) and tiger-endeavour ( )prawn fisheries-1987

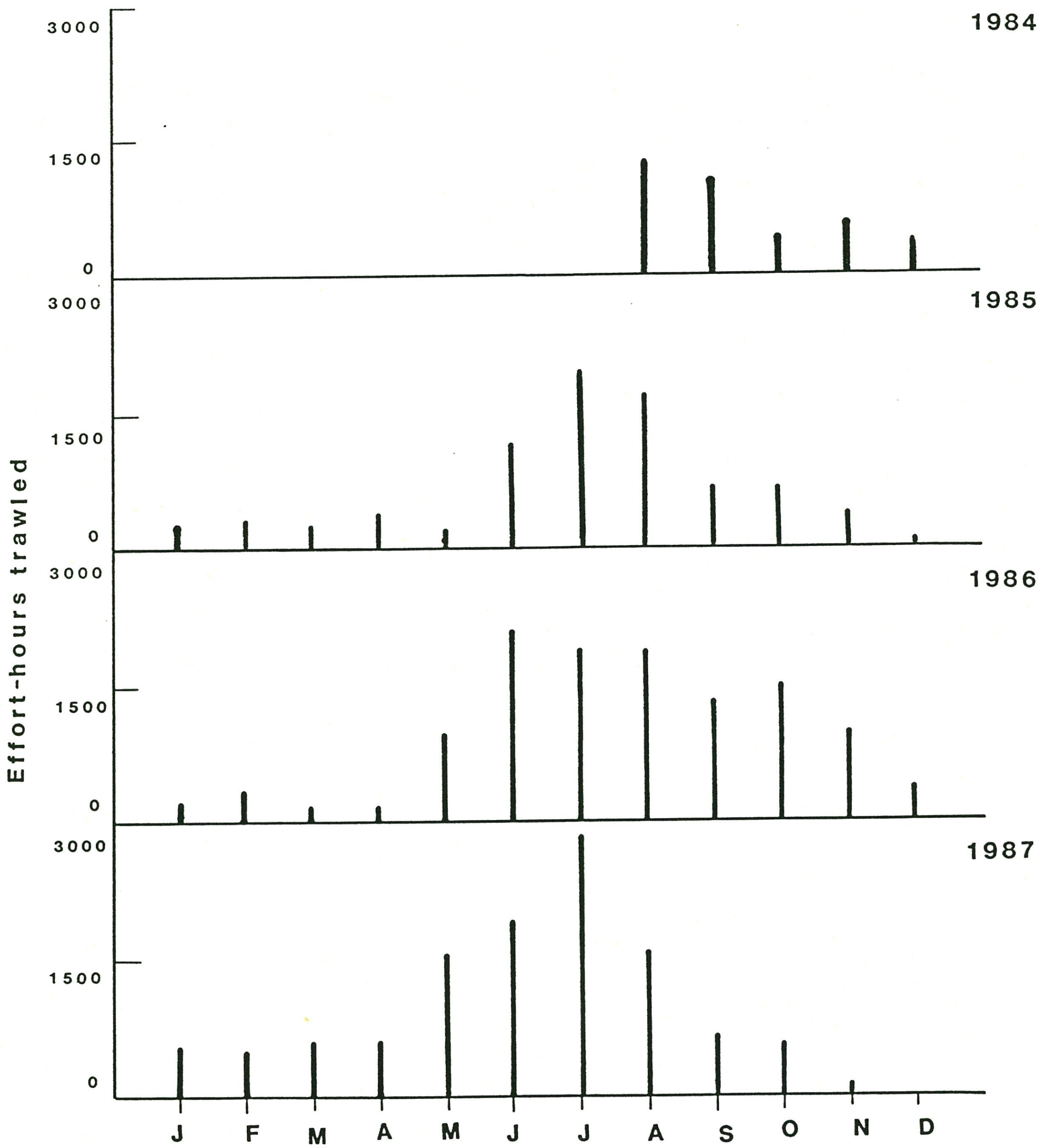


Figure 3 a. Monitored effort directed at king prawn stocks between 1984 and 1987

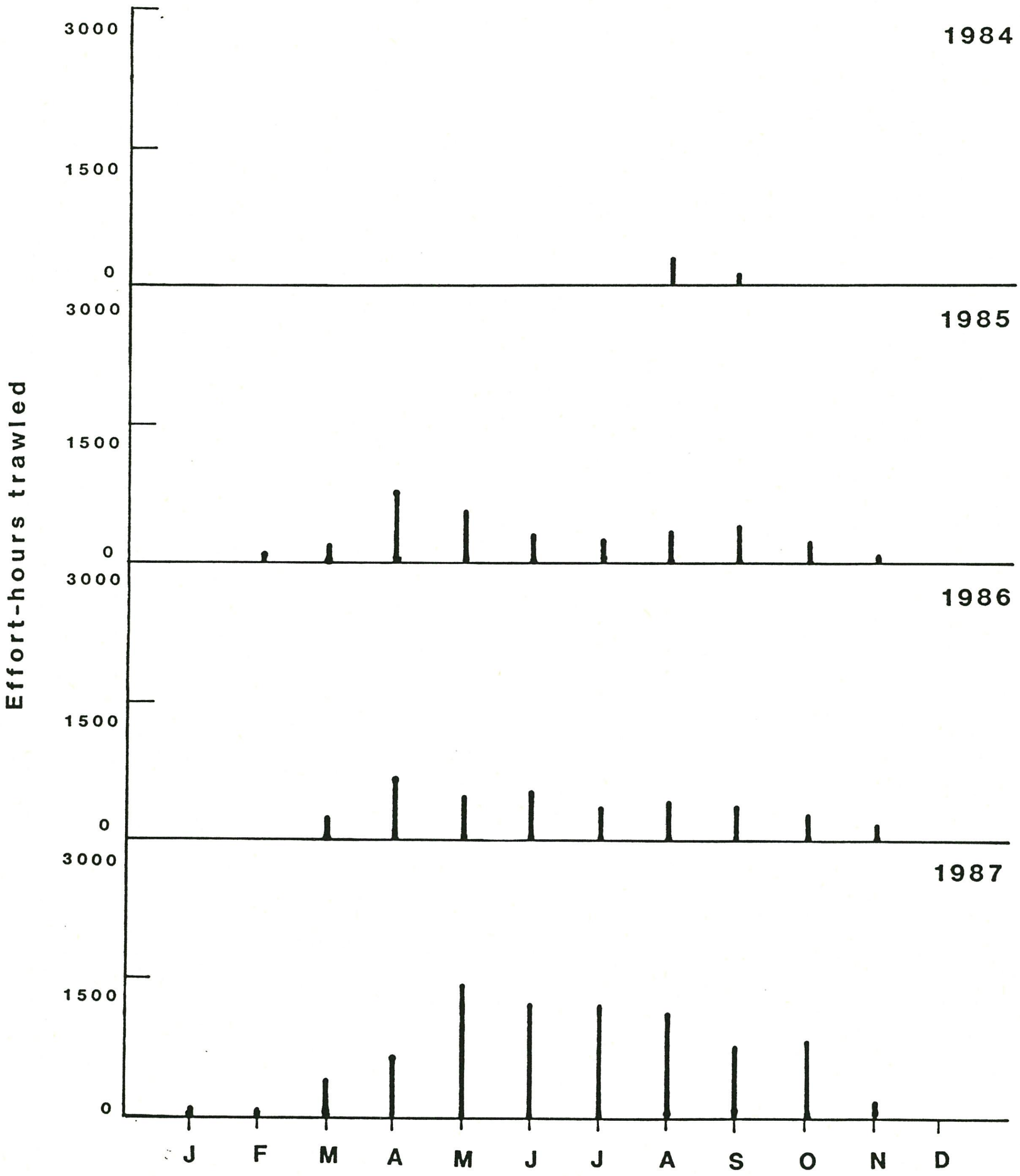

Figure 3 b. Monitored effort directed at tiger-endeavour prawn stocks between 1984 and 1987

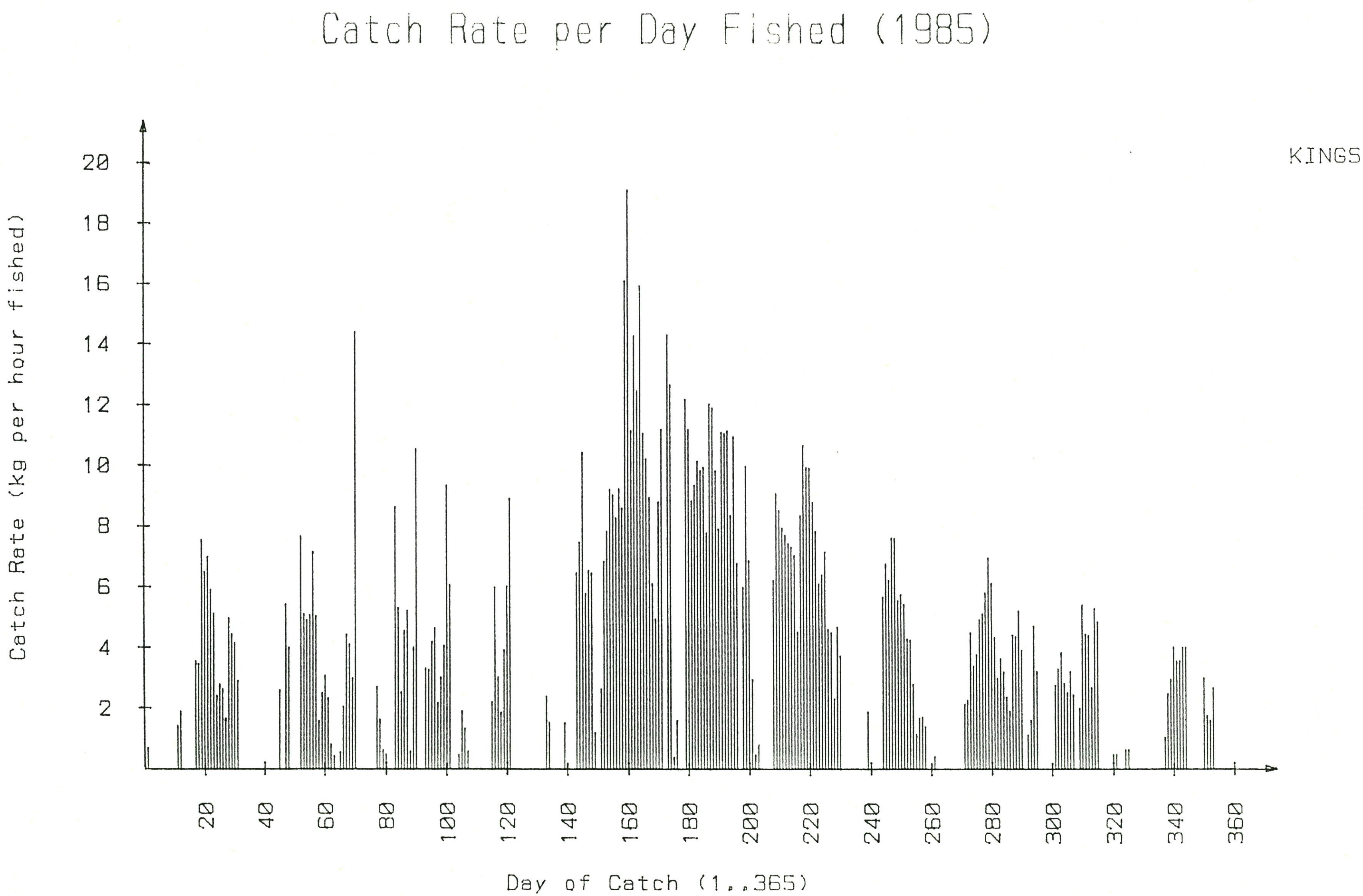


**Figure 4 a. Daily catch rates in the king prawn fishery-1985**

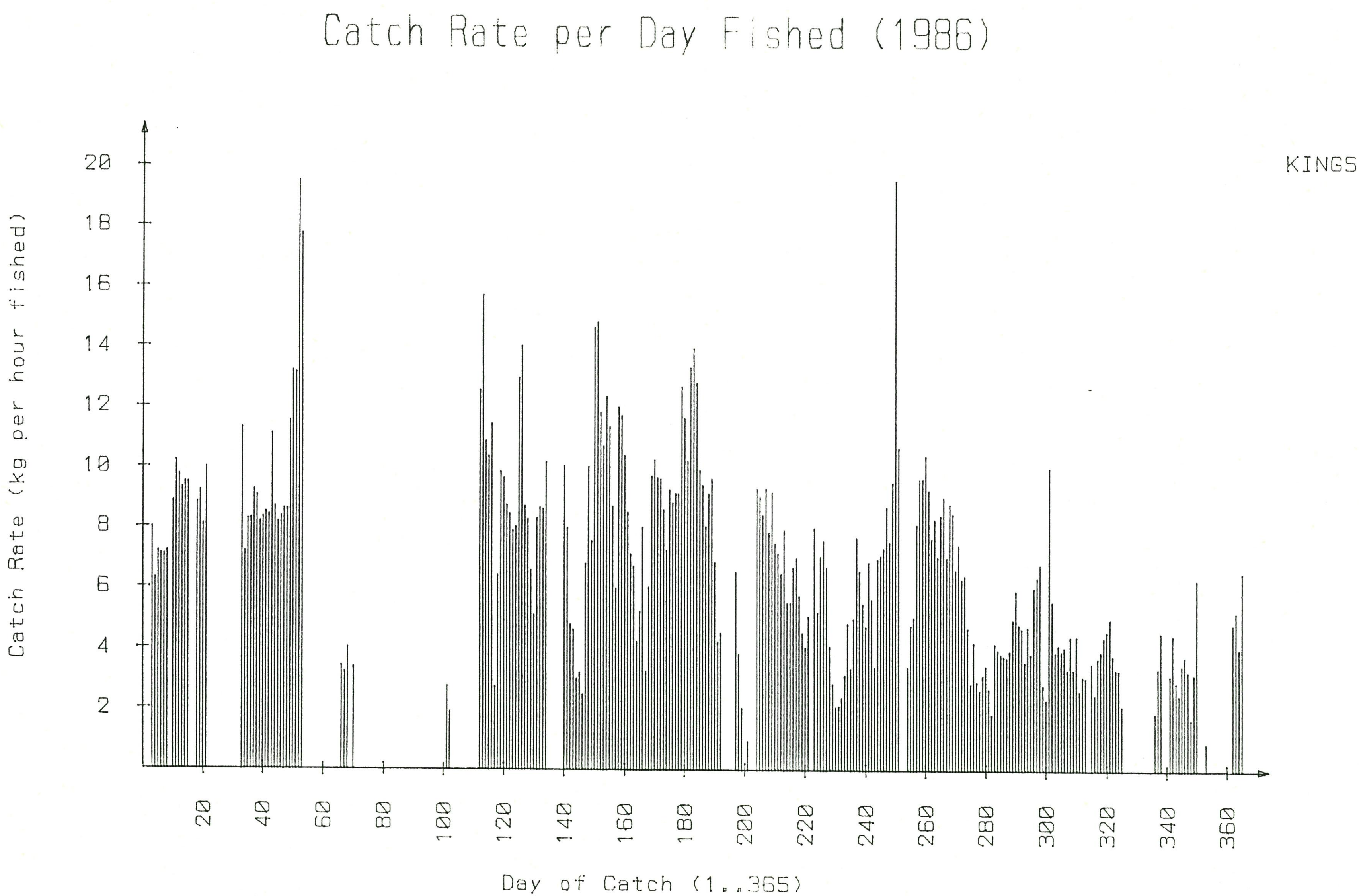


Figure 4 b. Daily catch rates in the king prawn fishery-1986

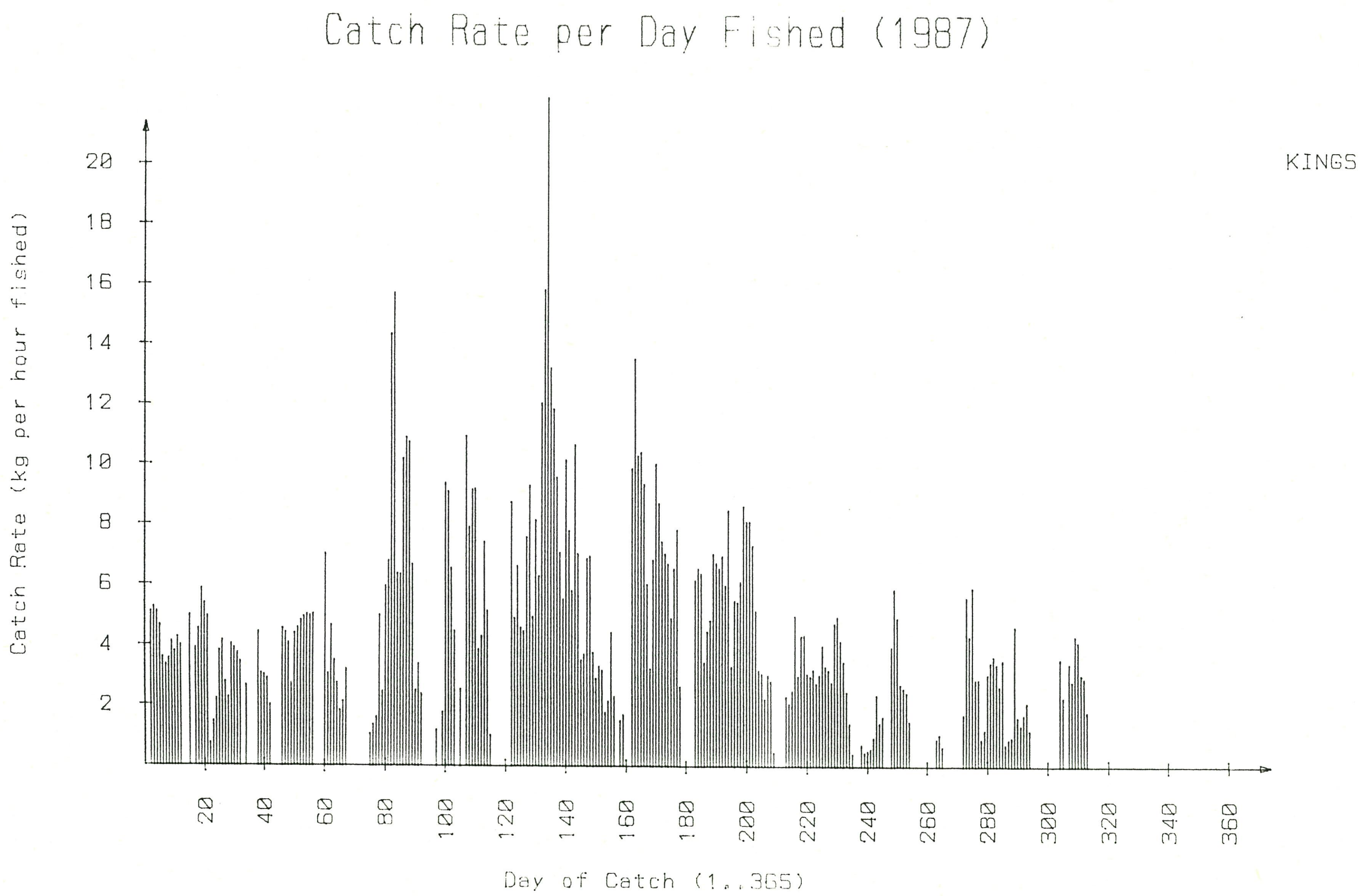


Figure 4 c. Daily catch rates in the king prawn fishery-1987

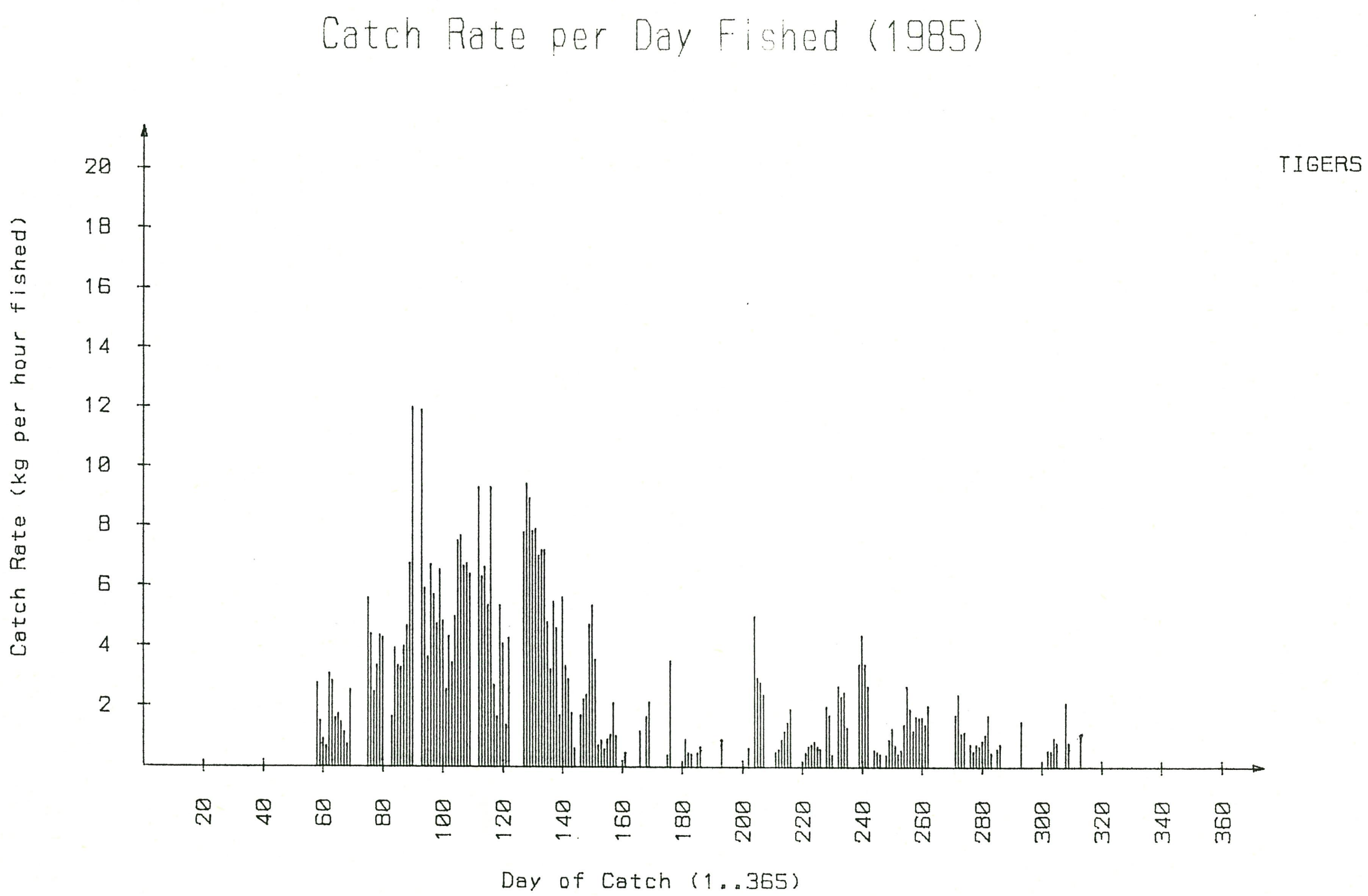


Figure 4 d. Daily catch rates in the tiger prawn fishery-1985

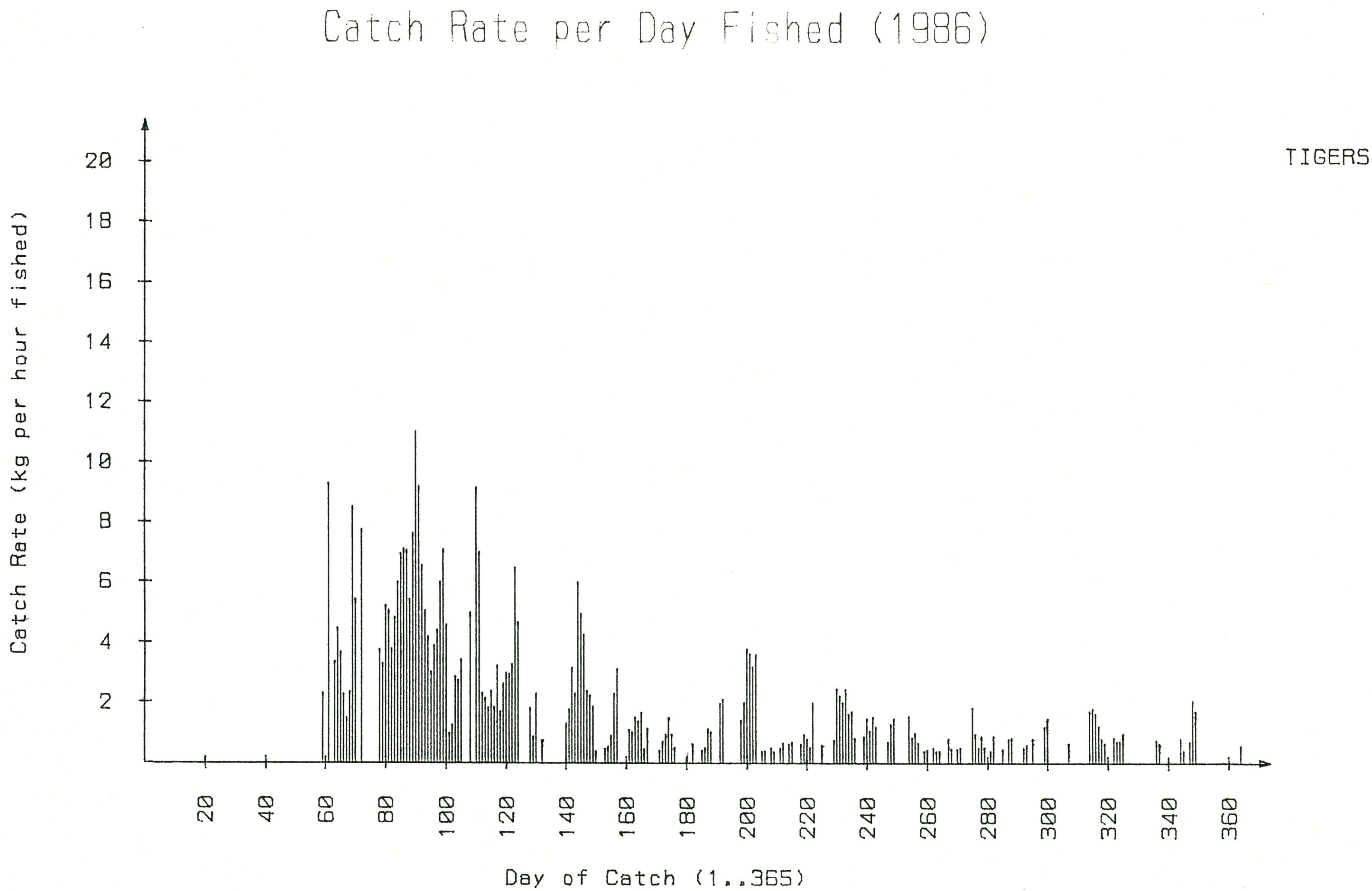


**Figure 4 e. Daily catch rates in the tiger prawn fishery-1986**

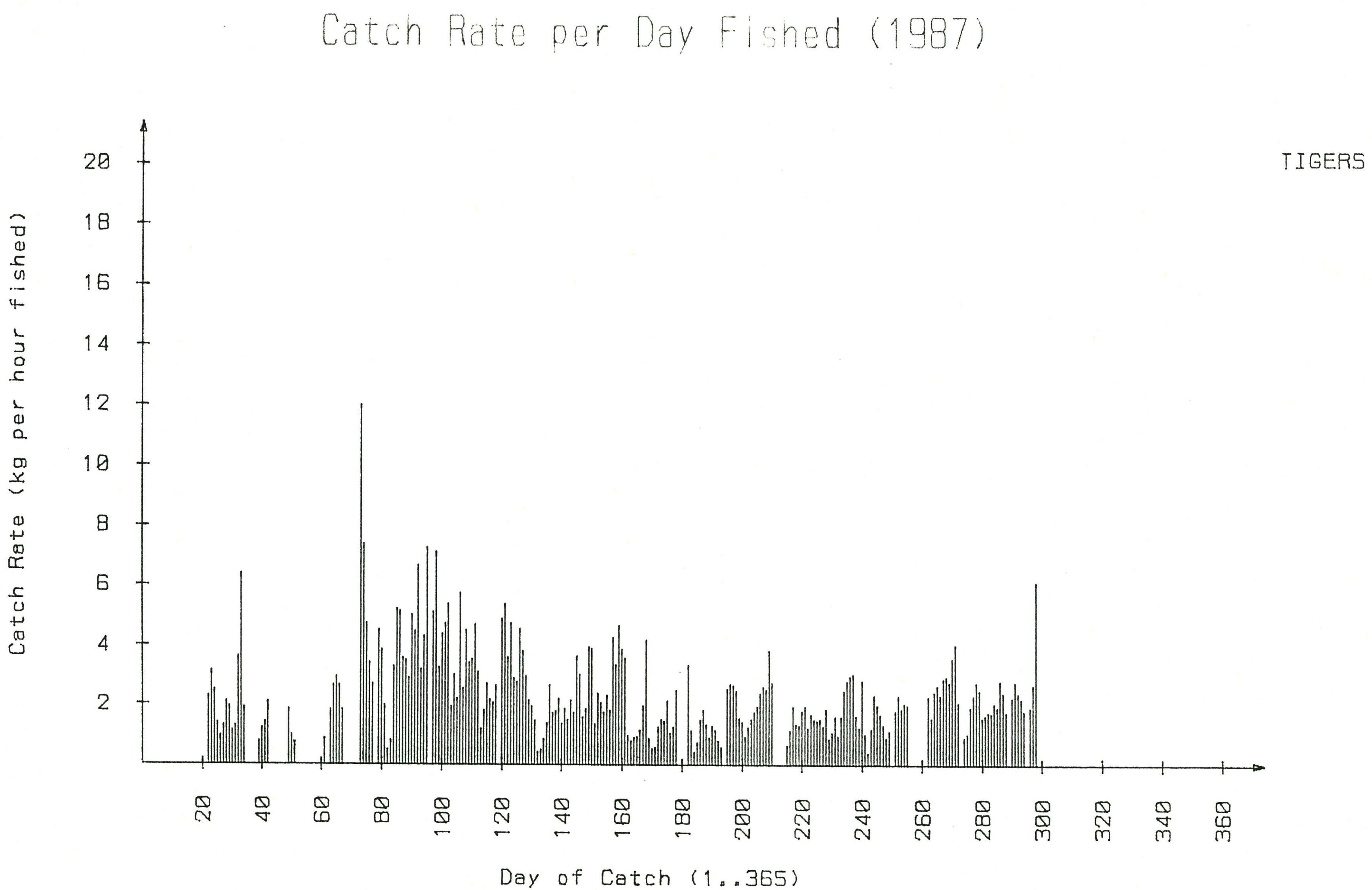


Figure 4 f. Daily catch rates in the tiger prawn fishery-1987

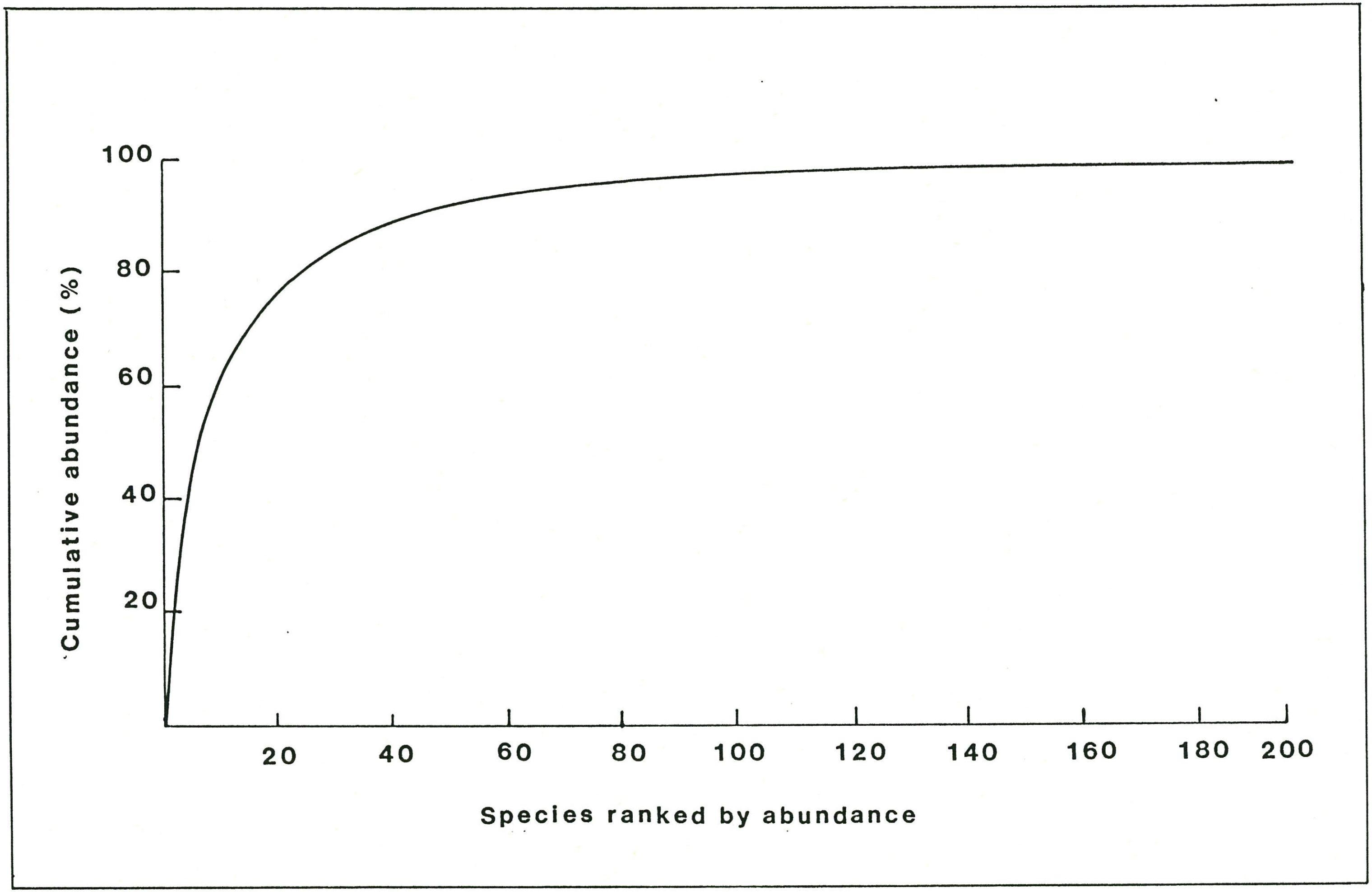


Figure 5. Cumulative abundance of species selected for analysis, expressed as percentages.

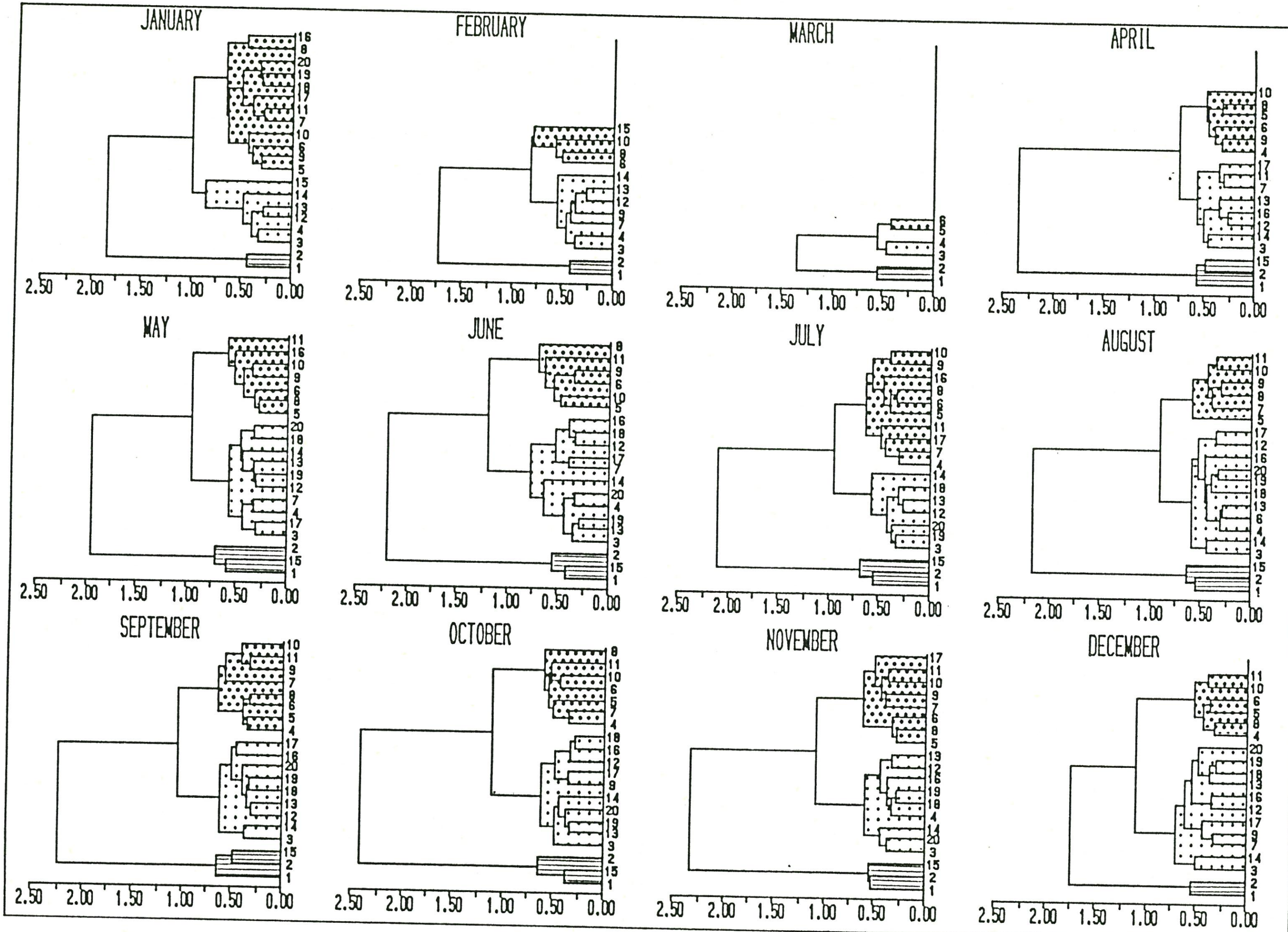


Figure 6. Monthly dendrograms from cluster analysis of sites vs. species. Dissimilarity indices are shown on the abscissa and sites on the ordinate. Site assemblages: 'A'- coastal (stripes), 'B'- inshore (small dots), 'C'- inter-reef (large dots). (From Watson and Goeden, m/s)

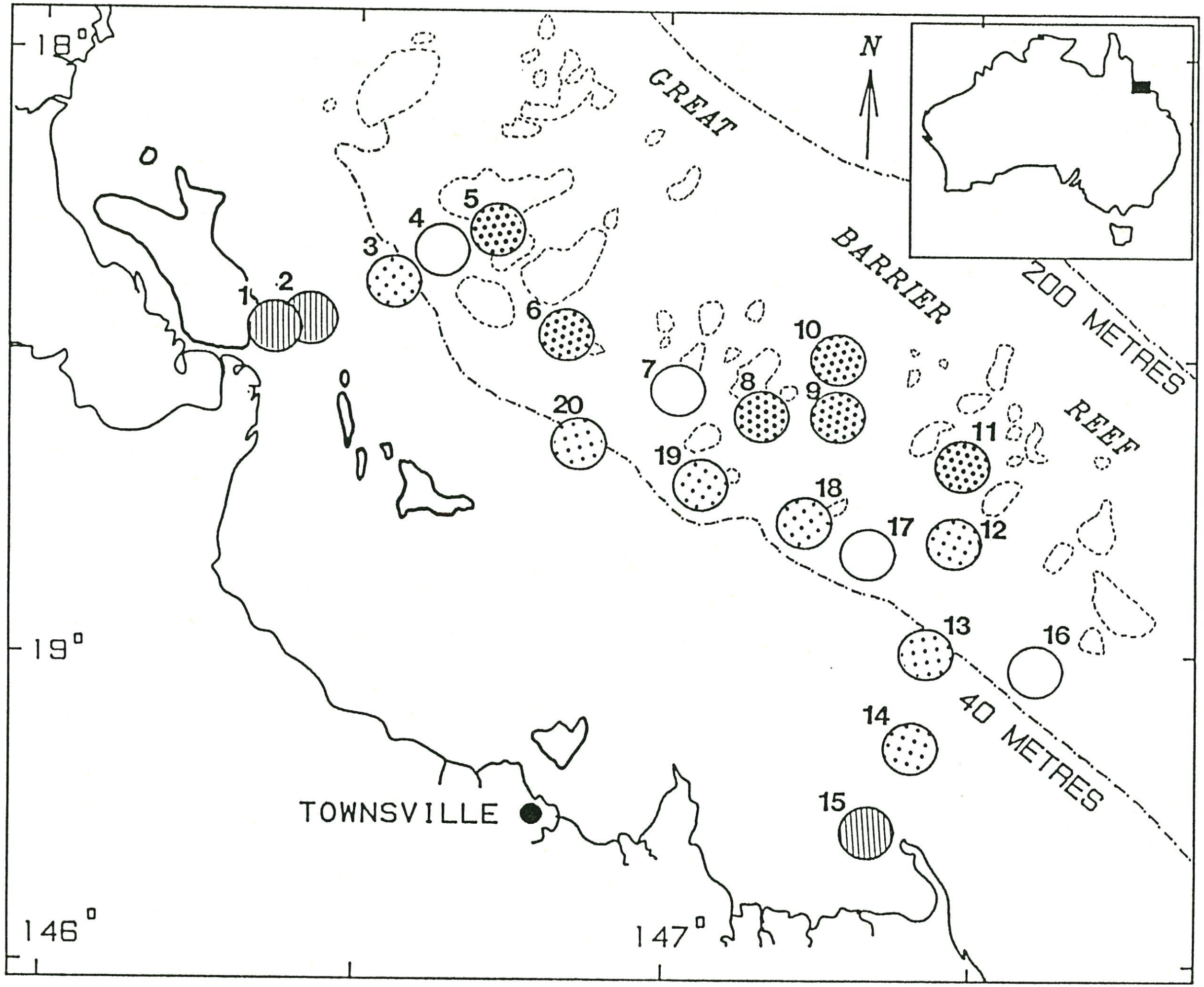


Figure 7. Location of site assemblages. Coastal (A)- stripes, Inshore (B)- small dots, Inter-reef (C)- large dots. (From Watson and Goeden, m/s)

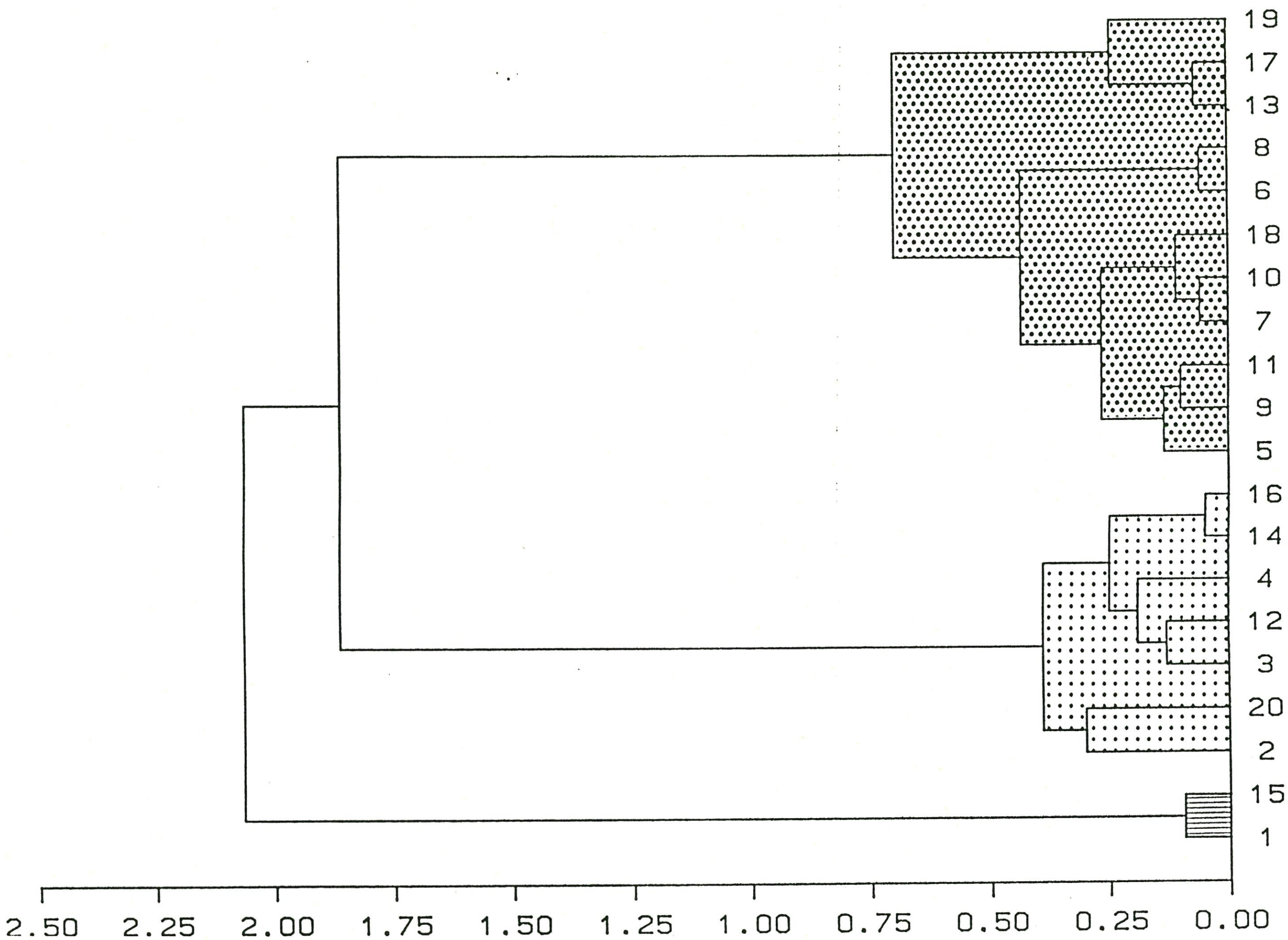


Figure 8 . Dissimilarity indices for sediment composition vs. sites. Absciss represents dissimilarity index, ordinate gives sites. (From Watson and Goeden,m/s)

**APPENDIX 1.** Checklist of the 477 species taken by trawl in 1985-86 and rank of numerical abundance for the 200 taxa used in community structure and assemblage analysis.

P. MOLLUSCA
- C. GASTROPODA
  - SC.PROSOBRANCHIA
    - O. ARCHEOGASTROPODA
      - F. FISSURELLIDAE
        - *Scutus unguis*
    - O. MESOGASTROPODA
      - F. XENOPHORIDAE
        - *Xenophora* sp.1 — 109
      - F. STROMBIDAE
        - *Strombus dilatatus*
        - *Strombus vittatus*
        - *Terebellum terebellum*
      - F. CYMATIIDAE
        - *Distorsio reticulata*
      - F. BURSIDAE
        - *Bursa* sp.1
      - F. CASSIDAE
        - *Phalium bisulcatum*
        - *Phalium glabratum angasi*
      - F. TONNIDAE
        - *Tonna cerevisina*
        - *Tonna tetracotula*
        - *Tonna* sp.1
      - F. CYPRAEIDAE
        - *Cypraea* sp.1
      - F. OVULIDAE
        - *Volva volva*
      - F. NATACIDAE
        - *Polinices* sp.1
    - O. NEOGASTROPODA
      - F. MURICIDAE
        - *Bedeva c.f. paivae*
        - *Chicoreus banksii*
        - *Chicoreus* sp.1
        - *Murex nigrospinosus*
        - Rapana rapiformis
      - F. FASCIOLARIIDAE
        - *Pleuroploca* sp.1
      - F. HARPIDAE
        - *Harpa articularis*
      - F. VOLUTIDAE
        - *Melo* sp.1
        - *Volutoconus grossi mcmichaeli*
      - F. VASIDAE
        - *Tudicula armigera*
  - SC. OPISTOBRANCHIA
    - O. ANASPIDIA
      - F. APLYSIIDAE
        - *Aplysia* sp.1
        - *Dolabella auriculana*
    - O.NOTASPIDIA
      - F. PLEUROBRANCHIDAE
        - *Pleurobranchidae* sp.1
    - O. NUDIBRANCHIA
      - F. DORIDIDAE
        - *Dorididae* sp.1

F. CHROMODORIDIDAE

Ceratosoma cornigerum

F. ARMINIDAE

Armina sp.1

C. BIVALVIA

SC. LAMELLIBRANCHIA

O. TOXODONTA

F. ARCIDAE

*Opularca tenella*

O. ANISOMYARIA

F. PECTINIDAE

*Chlamys leopardus* 103

*Chlamys* sp.1

F. AMUSIIDAE

*Amusium balloti.* 8

*Amusium pleuronectes* 45

F. SPONDYLIDAE

*Spondylus wrightianus*

O. HETERODONTA

F. CARDIIDAE

*Fragum hemicardium*

F. TELLINIDAE

*Tellinidae* sp.1

C. CEPHALOPODA

SC. COLEOIDEA

O. SEPIOIDEA

F. SEPIIDAE

*Metasepia pfefferi*

*Sepia elliptica* | 25

*Sepia plangon* |

*Sepiadarium kochi*

F. SEPIOLIDAE

*Euprymna* sp.1

*Sepioloidea lineolata*

O. TEUTHOIDEA

F. LOLIGINIDAE

*Loligo chinensis* *118*

*Loligo* sp.1

*Loliolus* sp.1

O. OCTOPODA

F. OCTOPODIDAE

Octopus spp.

P. CRUSTACEA

C. MALACOSTRACA

SC. HOPLOCARIDA

O. STOMATOPODA

F. GONODACTYLIDAE

*Gonodactylus graphurus* 192

F. HARPIOSQUILLIDAE

*Harpiosquilla harpax*

*Harpiosquilla melanoura*

F. SQUILLIDAE

*Squilla anomala* 134

*Squilla costata*

*Squilla multicarinata* 125

*Squilla nepa*

*Squilla quinquedentata*

*Squilla woodmasoni* 148

*Squilla* sp.1

| | |
|---|---|
| *Squilla* sp.2 | |
| SC. PERACARDIA | |
| O. ISOPODA | |
| *Calcipila cornuta* | |
| *Creniola saurida* | |
| SC. EUCARIDA | |
| O. DECAPODA | |
| F. SOLENOCERIDAE | |
| *Solenocera australiana* | |
| *Solenocera* sp.1 | 101 |
| *Solenocera* sp.2 | |
| F. PENAEIDAE | |
| *Atypopenaeus stenodactylus* | |
| *Metapenaeopsis* spp | 1 |
| *Metapenaeopsis lamellata* | 49 |
| *Metapenaeopsis mogiensis* | |
| *Metapenaeopsis palmensis* | 61 |
| *Metapenaeopsis rosea* | |
| *Metapenaeus endeavouri* | 42 |
| *Metapenaeus ensis* | 28 |
| *Parapenaeopsis cornuta* | |
| *Penaeus canaliculatus* | |
| *Penaeus esculentus* | 69 |
| *Penaeus latisulcatus* | 33 |
| *Penaeus longistylus* | 13 |
| *Penaeus merguiensis* | |
| *Penaeus monodon* | |
| *Penaeus semisulcatus* | 57 |
| *Trachypenaeus anchoralis* \| | |
| *Trachypenaeus curvirostris* \| | 4 |
| *Trachypenaeus granulosus* \| | |
| *Trachypenaeus fulvus* \| | |
| F. SICYONIDAE | |
| *Sicyonia cristata* | 66 |
| F. ALPHIIDAE | |
| *Alpheus* sp.1 | |
| F. PALINURIDAE | |
| *Panulirus ornatus* | |
| F. SCYLLARIDAE | |
| *Scyllarus demani* | 81 |
| *Scyllarus rugosus* | 95 |
| *Scyllarus martensii* | |
| *Thenus orientalis* | 35 |
| *Thenus* sp.1 | |
| F. PAGURIDAE | |
| *Paguridae* spp. | |
| F. GALATHEIDAE | |
| *Galatheidae* sp.1 | |
| F. DROMIIDAE | |
| *Dromidia* sp.1 | |
| *Dromidiopsis australiensis* | |
| *Dromidiopsis edwardsi* | |
| F. DORIPPIDAE | |
| *Dorippe frascone* | |
| F. LEUCOSIIDAE | |
| *Arcania elongata* | |
| *Ixa inermis* | |
| F. MAJIDAE | |
| *Austrolobinia capricornesis* | |
| *Hyastenus campbelli* \| | 181 |

*Hyastenus diacanthus*|
*Naxoides taurus*
*Phalangipus australiensis* 191

F. PARTHENOPIDAE

*Cryptopoida* sp.1
*Parthenope contrarius*
*Parthenope longimanus*
*Zebrida adamsi*

F. CORYSTIDAE

*Jonas luteanus*
*Notopus dorsipes*

F. PORTUNIDAE

*Charybdis anisodon*
*Charybdis calianassa*
*Charybdis cruciata*
*Charybdis jaubertensis* 63
*Charybdis natator* 159
*Charybdis truncata* 26
*Lupocyclus philippinesis*
*Lupocyclus rotundatus* 97
*Podophthalmus vigil*
*Portunus argentatus* 11
*Portunus gracilimanus* 83
*Portunus orbitosinus* 121
*Portunus pelagicus* 89
*Portunus rubromarginatus* 9
*Portunus sanguinolentus*
*Portunus tenuipes* 5
*Portunus tuberculosis*
*Thalamita parvidens*
*Thalamita sima*
*Thalamita* sp.1

F. XANTHIDAE

*Actumnus pugilator*
*Demania macnielli*
*Demania c.f. splendida*
*Eucrate dorsalis*
Liagore rubromaculata
Neoxanthias michelae
Pilumnus ?longicornis
Pilumnus nigrispinifer
Thacanophrys longispinus
Trichia dromiaeformis

P. ECHINODERMATA

C. CRINOIDEA

SC. ARTICULATA

O. COMATULIDA

F. COMASTERIDAE

*Comanthina schlegeli*

F. ASTEROMETRIDAE

*Pterometra venusta*
*Comatulid* spp 71

C. ASTEROIDEA

O. PHANEROZONIA

F. LUIDIIDAE

*Luiidia maculata* 154

F. ASTROPECTINIDAE

*Astropecten zebra* 180

F. GONIASTRIDAE

*Anthenea* sp.1

| | |
|---|---|
| *Goniasteridae* sp.1 | |
| *Goniodiscaster australiae* | |
| *Iconaster longimanus* | 175 |
| *Iconaster* sp.1 | |
| *Stellaster equestris* | 38 |
| F. ORIASTERIDAE | |
| *Asterodiscus elegans* | |
| *Culcita novaeguinea* | |
| *Pentaceraster gracilis* | 155 |
| *Pentaceraster regulus* | |
| *Pentaceraster* sp.1 | |
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| F. OPHIDIASTERIDAE | |
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| *Tamaria fusca* | |
| *Tamaria megaloplax* | |
| F. METRODIRIDAE | |
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| O. SPINULOSIDA | |
| F. ACANTHASTERIDAE | |
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| F. PTERASTERIDAE | |
| *Euretaster insignis* | |
| C. OPHIUROIDEA | |
| O. PHRYNOPHIURIDA | |
| F. EURYALIDAE | |
| *Euryale aspera* | 160 |
| O. GNATHOPHIURIDA | |
| F. OPHIOTRICHIDAE | |
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| O. CHILOPHIURIDA | |
| F. OPHIODERMATIDAE | |
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| *Ophiuroid* spp | 140 |
| C. ECHINOIDEA | |
| O. CIDAROIDA | |
| F. CIDARIDAE | |
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| O. CENTRECHINOIDA | |
| F. DIADEMATIDAE | |
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| F. TEMNOPLEURIDAE | |
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| O. EXOCYCLOIDA | |
| F. LAGANIDAE | |
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| *Peronella orbicularis* | 92 |
| F. SPATANGIDAE | |
| *Maretia planulata* | 2 |
| C. HOLOTHUROIDEA | |
| O. DENDROCHIROTIDA | |
| F. CUCUMARIIDAE | |
| *Pentacta anceps* | |

*Pentacta crassa*
*Pentacta quadrangularis*
*Psuedoclolochirus axiologus*
F. PHYLLOPHORIDAE
*Actinocucumis typicus*
*Phyllophorus (Urodemella) holothuroides*
O. ASPIDOCHIROTIDA
F. HOLOTHURIIDAE
*Holothurian* spp 52
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*Bohadschia* sp.1 |
*Holothuria (Mertensiothuria)* sp.1 |
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*Zooanthus* sp.1 43
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C. CHONDRICHTHYES
SC. ELASMOBRANCHI
O. SELACHII
F. ORECTOLOBIDAE
*Orectolobus* sp.1
F. HEMISCYLIDAE
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O. BATOIDEA
F. RHYNCHOBATIDAE
*Rhynchobatus* sp.1
F. DASYATIDAE
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C. OSTEICHTHYES
SC. ACTINOPTERYGEI
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F. CLUPEIDAE
*Amblygaster sirm*
*Sardinella fimbriata ? /S. albella*
F. ENGRAULIDAE
*Thryssa hamiltonii*
*Thryssa setirostris*
*Stolephorus devisi = Encrasicholina devisi*
O. ANGUILLIFORMES
F. MURAENIDAE
*Gymnothorax reticularis*
*Gymnothorax undulatus*
F. MURAENOSCIDAE
*Muraenesox bagio*
*Muraenosox cinereus*
F. NETTASTOMATIDAE
*Nettastomatidae* sp.1
O. SILURIFORMES
F. PLOTOSIDAE
*Euristhmus lepturus*
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- O. MYCTOPHIFORMES
  - F. SYNODONTIDAE
    - Saurida micropectoralis
    - Saurida tumbil 76
    - Saurida undosquamis 18
    - Saurida sp.1 (juvenile)
    - Synodus sageneus 55
    - Synodus similis 22
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    - Trachinocephalus myops 16
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    - *Antennarius nummifer*
    - *Antennarius striatus* 143
    - *Antennarius* sp 149
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  - F. CARAPIDAE
    - *Carapus c.f. homei*
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- O. GADIFORMES
  - F. BREGMACEROTIDAE
    - *Bregmaceros c.f. nectabanus*
- O. BELONIFORMES
  - F. BELONIDAE
    - *?Ablennes hians* (juv)
  - F. EXOCOETIDAE
    - *Cypselurus* sp.1
  - F. HEMIRAMPHIDAE
    - *Euleptorhamphus viridis*
- O. BERYCIFORMES
  - F. HOLOCENTRIDAE
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- O. SYNGNATHIFORMES
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      or *F. petimba*. See Russell (1983) p. 32
  - F. CENTRISCIDAE
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  - F. SCORPAENIDAE
    - *Cottapistus cottoides*
    - *Dendrochirus brachypterus*
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- *Hypodytes carinatus* 14
- *Inimicus caledonicus* 60
- *Liocranium praepositum*
- *Minous trachycephalus* 80
- *Minous versicolor* 107
- *Paracentropogan longispinus*
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- *Kanekonia c.f. queenslandica*
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- *Onigocia spinosus*
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- *Papilloculiceps (Cymbacephalus) nematophthalmus*
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F. DACTYLOPTERIDAE

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F. PEGASIDAE

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- *Cephalopholis boenack*
- *Cromileptes altivelis*
- *Epinephelus areolatus*
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F. PLESIOPIDAE

- *Fraudella carasiops*

F. TERAPONIDAE

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| *Apogon brevicaudatus* | |
| *Apogon ellioti* | 36 |
| *Apogon c.f. fasciata* | 130 |
| *Apogon nigripinnis* | 111 |
| *Apogon poecilopterus* | 50 |
| *Apogon quadrifasciatus* | 64 |
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| *Apogon* sp.3 | |
| *Apogonichthys* sp.1 | |
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| *Pristiapogon exostigma* | |
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| *Carangoides humerosus* | 147 |
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| *Caranx bucculentus* | |
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| *Gnathanodon speciosus* | |
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F. EPHIPPIDAE
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| F. CEPOLIDAE | |
| *Acanthocepola abbreviata* | |
| *Acanthocepola krusensterni* | |
| F. SPHYRAENIDAE | |
| *Sphyraena flavicauda* | |
| F. POLYNEMIDAE | |
| *Polydactylus heptadactylus* | |
| F. LABRIDAE | |
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| F. OPISTOGNATHIDAE | |
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| *Parapercis diplospilus* | |
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| F. URANOSCOPIDAE | |
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| F. GOBIIDAE | |
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| F. BOTHIDAE | |
| *Pseudorhombus argus* | 124 |
| *Pseudorhombus arsius* | 120 |
| *Pseudorhombus diplospilus* | 79 |
| *Pseudorhombus dupliciocellatus* | 39 |
| *Pseudorhombus elevatus* | 74 |
| *Pseudorhombus spinosus* | 30 |
| *Pseudorhombus* sp.1 | |
| *Arnoglossus intermedius* | 40 |
| *Arnoglossus waitei* | 65 |
| *Bothus* sp.1 | |
| *Engyprosopon grandisquama* | 3 |
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| *Grammatobothus pennatus* | 75 |
| *Grammatobothus polyophthalmus* | 85 |

- F. PLEURONECTIDAE
  - *Samaris cristatus* 102
- F. SOLEIDAE
  - *Aesopia cornuta* 169
  - *Dexillichthys muelleri*
  - *Pardachirus pavoninus* 189
  - *Soleichthys* sp.1
  - *Strabozebrias cancellatus* 153
  - *Zebrias craticula* 158
- F. CYNOGLOSSIDAE
  - *Cynoglossus* sp.1 67
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- F. TETRAODONTIDAE
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  - *Anchisomus multistriatus* 156
  - *Arothron immaculatus*
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  - *Canthigaster rivulata*
  - *Chelonodon patoca*
  - *Lagocephalus scleratus* 41
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  - *Torquigener brevipinnis*
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- F. MONACANTHIDAE
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  - *Anacanthus barbatus*
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- F. DIODONTIDAE
  - *Tragulichthys jaculiferus* 117
- F. OSTRACIIDAE
  - *Lactoria cornuta* 132
  - *Rhyncostracion nasus* 82
  - *Tetrosomus gibbosus* 123

C. REPTILIA

SC. LEPIDOSAURIA

O. SQUAMATA

- F. HYDROPHIIDAE
  - *Acalyptophis peronii*
  - *Aipysurus duboisii*
  - *Aipysurus laevis*
  - *Hydrophis ornatus*
  - *Hydrophiidae* spp.

P. PORIFERA

- several spp.

P. CNIDARIA

- *Dendronephthia* sp.1
- *Dendronephthia* sp.2

| | |
|---|---|
| | *Cnidaria* spp. |
| P. SIPUNCULA | several spp. |
| P. ANNELIDA | *Chloea* sp.<br>Annelid spp. |
| B. BRYOZOA | several spp. |