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1282.

THE CONSEQUENCES OF FISHING ACTIVITIES ON OUTBREAKS OF THE CROWN-OF-THORNS STARFISH (*Acanthaster planci*).

A report prepared for the Great Barrier Reef Marine Park Authority by:

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ABBREVIATIONS USED IN THE TEXT.

A.F.S.	AUSTRALIAN FISHERIES SERVICE.
COMMONWEALTH D.P.I.	COMMONWEALTH DEPARTMENT OF PRIMARY INDUSTRIES. (See also Q.D.P.I.)
C.P.U.E.	CATCH PER UNIT EFFORT.
COT	CROWN-OF-THORNS STARFISH.
C.S.I.R.O.	COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION.
F.I.R.T.A.	FISHING INDUSTRY RESEARCH TRUST ACCOUNT.
G.B.R.M.P.	GREAT BARRIER REEF MARINE PARK.
G.B.R.M.P.A.	GREAT BARRIER REEF MARINE PARK AUTHORITY.
N.F.B.	NORTHERN FISH BOARD.
Q.C.F.O.	QUEENSLAND COMMERCIAL FISHERMEN'S ORGANISATION.
Q.D.P.I.	QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRY.
Q.F.B.	QUEENSLAND FISH BOARD
Q.F.M.A.	QUEENSLAND FISH MANAGEMENT AUTHORITY.

PART 1: INTRODUCTION

CHAPTER 1: RATIONALE AND CONCEPTUAL FRAMEWORK

1.1 AIMS

This study seeks to fulfill two purposes.
(1). Specifically it investigates the consequences of commercial fishing on possible predators of the Crown of Thorns starfish, A.planci.
(2). More broadly it seeks to establish the framework for a database of fisheries related information on the Great Barrier Reef.
The rationale and conceptual framework needed to impliment these two aims are outlined in the following sections.

1.2 RATIONALE AND FRAMEWORK FOR THE STUDY OF THE CONSEQUENCES OF FISHING PRESSURE ON POSSIBLE OUTBREAKS OF ACANTHASTER.

1.2(i) RATIONALE

Over the last 25 years a number of hypotheses have been formulated to account for the occurrence of 'outbreaks' of large feeding aggregations of the coral feeding asteroid Acanthaster planci. which causes extensive damage to coral reefs (Endean & Stablum, 1973; Birkeland, 1982; Moran, 1986).

Of all the hypotheses that focus on man-induced causes of A.planci, the predator removal hypothesis produced by Endean (1969) has recieved the most attention in the scientific literature (Moran, 1986).
This hypothesis emphasizes that outbreaks are unique events which arise because man has removed the predators of the starfish.
Initially the major predator controlling starfish numbers on the reef was thought to be the giant triton Charonia tritonis (Endean, 1969).
In more recent years Endean (1977, 1982) has extended the hypothesis to include the effects of fish predators such as the Groper Pomicrops lanceolatus. This extended version of the hypothesis stressed that Charonia tritonis was a major predator of large juvenile and small adult starfish whereas Pomicrops lanceolatus preyed on juvenile A.planci (Moran 1986).

Endean (1982) further claimed that the collection of triton shells and overfishing on some reefs may have been responsible for recent outbreaks on the Great Barrier Reef. The Maori Wrasse, Cheilinus undulatus has also been implicated as a potential predator of juvenile starfish (Endean, 1982).

A number of other species which have been observed to feed on A.planci in the Red Sea (e.g. Balistoides viridescens, Pseudobalistes flavimarginatus, and Arothron hispidus), (Ormond & Campbell, 1974) were not included in the hypothesis as it was doubted whether they were important predators on the Great Barrier Reef.

More recently indirect evidence from a preliminary gut analysis study found fragments of A.planci with an estimated

diameter of 400mm in the guts of the commercially important Spangled Emperor, Lethrinus nebulosus (Birdsey unpub report to GBRMPA). However it is not clear whether the starfish were alive or dead when eaten. Indeed Glynn (1984b) found that a variety of different animals including polychaetes, crustaceans, and fish fed on starfish which were either mutilated or dead. Alternatively it could be evidence of sublethal mortality (Zann et al., in press) with the removal or mutilation of an arm. Regardless, the species warrants investigation as do a number ~~of a number~~ of other commercially important sedentary reef species.

Based on the above rationale this study was undertaken to examine any possible relationship between fishing pressure on reefs of the Great Barrier Reef and recorded outbreaks of A.planci. The commercial catch records for 5 species of commonly caught reef fish are considered for the last 24 years and any relationship to outbreaks of Crown-of-Thorns examined. This includes yearly and regional differences in official landings of both individual species and a combined total estimate. Available spearfishing and Charter boat records have also been examined for any significant differences in catch rates both regionally and temporally. Recreational fishing is considered only superficially in examining a total annual production of fish for all methods per region in Chapter 12.

1.3 CRITERIA FOR DATABASE ESTABLISHMENT

1.3(i) MANAGEMENT REQUIREMENTS

A comprehensive database is essential for successful fisheries management (Crutchfield, 1986). This should incorporate accurate and up to date records indicating catch by species, areas caught and landed, and some measure of fishing effort. Also records of licensed fishing vessels and their general fishing characteristics is imperative.

Furthermore managements ability to assess the database will affect the quality and timeliness of research commissioned and the success of resultant policy (Beurteaux, 1987).

1.3(ii) ESTABLISHING A DATABASE

In compiling such a database as would be of use to management decisions in Queensland one has to first identify the sources of information and secondly assess there accuracy.

In the case of Queensland this is notoriously difficult and an understanding of the history of Queensland fisheries is essential. This is outlined in section 2.4.
The lack of comprehensive records from any one data source has resulted in the compilation of a number of information sources which differ widely in their accuracy and comprehensiveness and so in turn must be interpreted differently and with caution.

1.4 CONCEPTUAL AND DATABASE FRAMEWORK.

(i) ORIGINAL CONCEPTUAL FRAMEWORK

Due to the lack of any consistent and accurate catch records for Queenland this study was originally envisaged as drawing on a number of sources of information, and then attempting to collate them into a cohesive, and meaningful database.

Two differing perspectives were envisaged to best evaluate any relationship between Crown of Thorns outbreaks and fishing activities on the G.B.R.

Firstly a long term regional perpective provides the major focus on regional and temporal differences of Queensland fish production. It identifies general trends and examines how they may relate to outbreaks of Crown of Thorns. This perspective is more fully outlined in the following section.

Secondly a detailed biological perspective focuses on the relationship between A.planci and demersal reef fish at a reefal level. A detailed study of two specific localities, Boult reef in the Capricorn Bunker group and Cairns area reefs is made.

However due to the unavailability of data at the completion of this study the original conceptual framework had to be abandoned. As it stands the original conceptual framework is still sound. In the event these other data sources become available it is recommended this framework be utilised. These projects, their estimated time of completion and relevance to management are detailed in Chapter 13.

(ii) A LONG TERM REGIONAL PERSPECTIVE

Catch records and production figures for the commercial fishery will be used to assess the following as they might pertain to A.planci outbreaks.

(a). Queensland total production
(b). The relative importance of individual species in Queensland.
(c). Regional contrasts of fisheries production, catch composition, fishing techniques, and industry differences.

Commercial annual production figures for individual species by landing region are taken from Queensland Fish Board (Q.F.B.) annual reports from 1957 to 1981. No records are available after this date though a number of sources were investigated (Q.F.M.A, and fish processors).

CHAPTER 2. AN OVERVIEW OF QUEENSLAND FISHERIES.

2.1 INTRODUCTION

Contrary to popular belief Queensland coastal waters are not as rich in quantity of fish as generally believed although the diversity of fish species cannot be disputed. The Queensland fishery is characterised by a variety of fishing methods and products which are influenced by the length of coastline and the largely tropical element (Williams, 1980).

The commercial fishing industry in Queensland is one of the largest in Australia coming second in value only to Western Australia.The extent of the the fish caught by amateur fishermen in Austalia has not been determined but in 1976-77 an estimated 27% of fresh & frozen food was caught by leisure fishermen.

However unofficial sources within the industry suggest the total value of production may be as much as 2-3 times the official figure. It is estimated that greater than 50% of the catch is traded on the black market.

There are a large number of amateur fishermen who because of the quantities involved sell all or at least part of their catch.This group could be described as professional amateurs and their activities can impinge heavily on operations of the commercial fishermen.

Management policies are needed to overcome resource depletion, to conserve the income of commercial fishermen and to resolve conflicts between recreational and commercial fishing.

The most important edible fish caught around Queensland are mullet mackerel, bream, whiting and giant perch (barramundi).

In general it appears that the traditional fisheries are nearly fully exploited.

Seefried (1983) noted the following characteristics about the Queensland fishery.Over the 5 year period 1976 to 1981.

1/Fin fish production has remained reasonably static and in some cases has declined (Emperor, Snapper, Threadfin salmon, Whiting, and Flathead).

2/Barramundi production peaked in 77-78 78-79 but has since declined by about 50%

3/Tuna fishing is at present almost nonexistent.

4/Overall fish production has declined since a peak in 74-75.

2.2 METHODS OF REEF FISHING

Reef fish are taken by fishermen engaged in a number of fisheries(e.g. prawn, and mackerel) and in most cases reef fish provide only a supplement to other fishing methods.

Most vessels are capable of being used for reef fishing and the majority of these carry line fishing licenses. Approximately 138 master fishermen claimed reef fishing was their primary income whilst some 300 licenses are held in Queensland (Williams, 1980).

Optimum locations sought by commercial fishermen are areas clear of and generally about one half mile from the reef rim drop-offs in depths of between 4 and 14 fathoms adjacent to submerged reef, bommies and reef outcrops.

The fish are taken by handlines which are rigged and baited

according to the conditions and fishermens preferences. The quantity caught is largely determined by an individual fishermen's experience and skill.

The bulk of commercial reef catch is held on ice and unloaded as fresh fish.

2.3 REGIONAL DIFFERENCES IN LINE FISHING OPERATIONS.

Reef fishing by handline is carried out along the entire east coast though few fishermen work north of Cape Flattery. Little data exists regarding number of people in the industry. Williams (1980) found 156 professional fishermen were registered as primary reef fishermen in 1979 (or 5.9 % of total number of professional fishermen in Queensland) and 112 in 1980 (4.9 %).

The majority of fishermen were found to work in one 'fishing area' only although 25% operated in two. Many were reported as considering reef fishing secondary or tertiaryform of fishing. The percentage of parttime fishermen was estimated at 12 %.

2.4 HISTORY AND STRUCTURE OF FISH MARKETING IN QUEENSLAND.

This section provides a general outline of the background along which the Queensland fishing industry has developed over the last 30 years and gives an understanding of the problems associated with consistent data records.

(i). Queensland Fish Board.

Until 1982 marketing of fish was controlled by the fish supply management Act 1972 which established the Queensland Fish Board (Q.F.B.) as the statutory marketing authority for the fishing industry.

The Queensland Fish Board (Q.F.B.) established in 1973 was responsible for the marketing of fishermens catch in certain sections of Queensland which had been declared fish supply districts. Previously from 1966 to 1973 the north Queensland Fish Board had been responsible for the marketing of fish north of Rockhampton.

On 25th March 1982, the Queensland Fishing Industry Organisation and Marketing Bill was passed mainly as a response to the poor financial situation of the Q.F.B., and the demands from the fishing industry to reorganise the marketing of fish. The act included provision for the institution of a new authority termed the Queensland Fish Mangement Authority (Q.F.M.A.). The act made the Q.F.M.A responsible for the co-ordination and control of marketing, production, licensing, product quality standards, and fish promotion (Queensland Statutes, 1982). It also made provision for the compilation of monthly returns from seafood wholesalers and processors in order to provide an accurate catch data base.The Q.F.B.'s regulatory functions were ceded to the Q.F.M.A.,however the board was retained to operate in the role of a trader on an equal footing with the private industry.By giving fishermen the choice of selling their product

through the Fish Board, or other licensed processors or wholesalers it was hoped that black market sales would be reduced (Seefried, 1983).

Today the Q.F.M.A. is intimately associated with the Queensland Department of Primary Industries (Q.D.P.I. who appoints it's members and with the Queensland Commercial Fishermens Organisation (Q.C.F.O.).
The fishing Industry in Queensland may also lobby the State minister for Primary industry, who has the final say reguarding state fisheries policy, through the National Fishing Industry Council (N.F.I.C.). The N.F.I.C. came into being during 1986 when fishermen expressed dissatisfaction with the former national body, the Australian Fishing Council (A.F.I.C.).
The current structure of the Queensland fishing industry is shown in figure 2.1 taken from Gray and Spencer (1986, Ed. Hundloe).

(ii) Black Market.

In major ports such as Southport, Scarborough, Townsville, and Cairns it has been estimsted that more than 50 % of the catch is traded on the black market.
The fish supply management act 1972 required all fish and seafood caught within the fish supply district and destined for sale in Queensland to be delivered to the fish board.
However due to dissatisfaction with the boards marketing performance fishermen have been supplying the black market.
The 1982 Queensland Fishing Industry Marketing and Organisation act has incorporated some of the recommendations of the commitee so that fishermen now have the choice of selling their product thru the fish board, fishermen's cooperatives or licensed private processors and wholesalers.

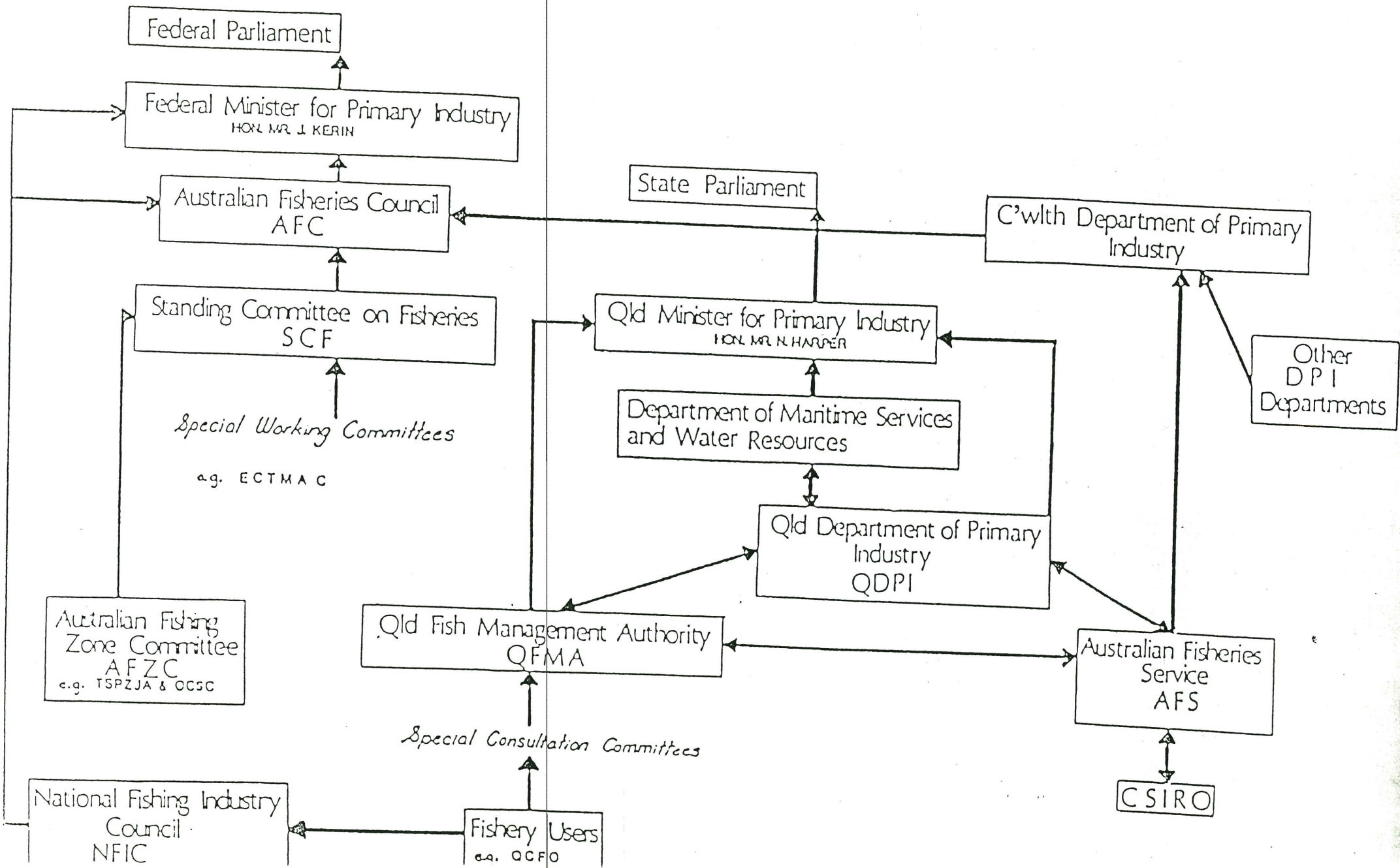
2.5 OTHER STUDIES

Williams (1979, 1980) undertook an analysis of of commercial fishing operations in Queensland examining number of fishermen, areas fished, mobility, period spent fishing, location of home port, and subsidiary fishing activities.

Reports describing the general nature of the Commercial fisheries in the Capricornia section have been compiled by in a joint effort by Q.D.P.I. and Q.C.F.O (1977) and by GBRMPA (1979. Fishing related activities in the Cairns Section are desribed in publications by Haysom and Mcpherson (1978), Q.D.P.I. (1980) and zoning recommendations by GBRMPA (1981).

Information on the economic characteristics of the recreational and commercial fisheries in the Great Barrier Reef region are detailed in Hundloe et al, 1980; Hundloe, 1981; Hundloe et al, 1981; Driml, 1980; Driml et al, 1982, Bandaranaike, 1981; and Jensen, 1979. These studies provide regional and total estimates of capital and recurrent expenditure, incomes, values of catches, and consumption of seafood.

Fig 2.1: Structure of Queensland Fish Marketing.



PART 2: METHODOLOGY

CHAPTER 3: METHODOLOGY FOR COMMERCIAL FISHERY ANALYSIS.

3.1 INTRODUCTION

The analysis and subsequent outcome of a study is affected by the quality and consistency of the available data sources. The objectives of looking at the commercial fishing industry on the Great Barrier reef with respect to Crown-of-thorns starfish outbreaks was to gain a long term regional perspective. The secondary objective was to establish a conceptual framework for the establishment of a relevant fisheries database that would be of use to the GBRMPA. Intrinsic to both these objectives is the identification of all available data sources of relevance. Accordingly other data sources and future developments pertaining to commercial fishing are outlined in chapter 13.

3.2 SOURCES OF INFORMATION

Annual Queensland Fish Board records of landings by Port were the only data available for analysis. These records list the total quantities of fish and shellfish recieved at various Q.F.B. markets and agencies throughout Queensland. Data was collated back until 1957 and up to 1981 when the major responsibilities of the Queensland Fish Board became largely defunct.

Records of all species landed at Fish Board Landing Ports are stored in a database at the GBRMPA from 1974 till 1981 in fulfillment of the secondary objective of a relevant database.

As far as the primary objective concerning the investigation of the consequences of fishing with repect to Acanthaster outbreaks, annual landings of five commercially important demersal reef species were selected for analysis. The justication for species selection is outlined below.

3.3 JUSTIFICATION OF SPECIES SELECTION FOR ANALYSIS

Apart from the Spangled Emperor Lethrinus nebulosus, which has been identified as a possible predator or at least an active opportunistic scavenger of the Crown of thorns (Birdsey 1977, unpub GBRMPA), no other commercially sought or caught species have been identified as likely predators.
The justification for the inclusion of the other 4 species is as follows.

1. All are large resident demersal fish on coral reefs.
2. All are benthic omnivorous feeders.
3. All are commercially caught fish on coral reefs.

From this it can be inferred that all species would suffer an equivalent degree of fishing pressure. Any severe depletion of large demersal fish stocks, which are the most likely piscivorous predators of Crown-of-Thorns, can best be inferred from analysis of catch rates of these species on reefs. Ideally information is then needed on the relative composition of each species at reefs in various localities. However no data was available at the time

of writing, though a study by Q.N.P.W.S. at Boult reef is presently being undertaken.

On the basis of the above criteria, landings of the following species were analysed. Annual and regional patterns were examined to see if they bore any significant relationship to the dynamics of Crown of Thorns outbreaks.

The species are Sweetlip, Lethrinus chrysostomus; Emperor, Lethrinus nebulosus; Coral Trout, Plectropomus sp.; Morwong, Plectorhynchus pictus; Nanygai, Lutjanus malabaricus were all selected for analysis.

The biology and information available on each species is summarized below. The species code and common species names given are those provided by the Queensland Department of Primary industries publication "Recommended Marketing Names for Fish" (1995).

1/ EMPEROR

ScientScientific Name: Lethrinus nebulosus DPI CODE: 4066
Other names: SPANGLED EMPEROR; YELLOW SWEETLIP
Biology

Reaching a length of up to 860mm it is common fish in offshore waters from Gladstone north. Although it is a good marketable species it does not find as ready sale as it should, principally because the percentage recovery of fillets is relatively low (Grant, 1982).

2/ SWEETLIP

Scientific Name: Lethrinus chrysostomus DPI CODE: 4064
Other names: LIPPER; RED THROAT; TRICKY SNAPPER
Biology

The most common Emperor on the Great Barrier reef, it is taken by line fishing from Gladstone north. This fish may reach a length of 900mm and a weight of 9 kg.

3/ NANYGAI

Scientific Name: Lutjanus malababaricus and L.sebae DPI CODE:4053
Other Names: SCARLET SEA PERCH; RED EMPEROR; RED JEW; RED SNAPPER
Biology

The similarity of L.malabaricus to the true red Emperor L.sebae has resulted in both species being marketed under the same name.

More common on the northerly reefs it forms mixed schools with the saddle tailed sea perch Lutjanus sanguineus.

4/ CORAL TROUT

Scientific Name: Plectropomus spp. DPI CODE: 544

Biology

Plectropomus leopardus is the most commonly caught species of trout with P.maculatus more common on inshore areas. Growing to at least 480mm, Coral trout is a commonly sought species owing to it's premium market price.

5/ MORWONG

Scientific Name: Plectorhynchus pictus DPI CODE: 502
Other names: Painted sweetlip

Biology

Probably the commonest Morwong, P.pictus is abundant on reefs and in estuaries along the entire Queensland coastline. However a number of more edible species are marketed under this name including P.goldmanni, P.chaetodonoides, and P.flavomaculatus.

3.4 REGIONAL SECTIONS

Some 31 processing plants were under the control of the Q.F.B. Seventeen of these are within the bounds of the Great Barrier Reef Marine Park.

To best reflect any regional differences in species composition and catch rates the G.B.R has been partitioned into four 'Regional Fisheries Sections' (Table 3.1). These can be regarded as the primary catch area for fish processed at adjacent shore based processing plants within these Fisheries Sections.

The broad spatial scale adopted is a result of the resolution of the available data. As no actual catch per unit area data is available the best that can be inferred is that there was greater likelihood of the fish being caught within the Fisheries Section adjacent to the port of landing than any other Section.

The Northern, Central, and Capricornia fisheries sections are based on the the GBMRPA zoning sections of the G.B.R. The Northern Fisheries Section incorporates both the GBRMPA Far Northern and the Cairns-Cormorant pass Sections. The Central and Capricornia Fisheries Section are identical to those GBRMPA zoning sections of the same name.

The Southern Fisheries Section lies outside the bounds of the Great Barrier Reef, but the processing plants in this section still process fish caught from the reef and shipped down.

3.5 DATA STORAGE

Data was compiled into a cohesive database using a modified relational database known as 'Paradox'. This software package was chosen for the ease of manipulation. Data of all Q.F.B. records by species by port from 1974 till 1981 are compiled whilst prior to this only those species of relevance to this study are collated. This data along with the Crown-of-thorns database(see section 10.2) is stored at the G.B.R.M.P.A. on the UNIX based mainframe.

TABLE 3.1. REGIONAL SECTIONS AND QUEENSLAND FISH BOARD DEPOTS.

REGIONAL FISHERIES SECTION	FISH BOARD DEPOT
1. NORTHERN SECTION Cape York - Tully	Cairns Port Douglas Innisfail
2. CENTRAL SECTION Tully - Mackay	Ingham Paluma Townsville Ayr Homehill Bowen Proserpine Mackay
3. CAPRICORNIA SECTION Mackay - Maryborough	Yeppoon Rosslyn Bay Rockhampton Gladstone Bundaberg Pialba Maryborough Tin Can Bay
4. SOUTHERN SECTION Maryborough - Brisbane	Brisbane Caloundra Cleveland Doboy Creek Mooloolaba Sandgate Scarborough Southport Tewantin Wynnum

3.6 METHODS OF ANALYSIS

The Q.F.B. data has been analysed to examine both the spatial and temporal trends in annual production of the above species. The regional Fisheries Sections defined in 3.5 are used to best examine differences which exist in terms of combined annual landings, species composition, and processing plant differences. These results of each Fisheries Section are examined in the following 4 chapters.

Table 4.1 shows the combined total landings of fish by region, whilst Table 4.2 demonstrates the total landings of individual species by region. Appendix A provides regional tables of annual landings of fish species by processing plant.

The figures used are the combined total of fish fillet and whole fish production over a period of 24 years from 1957 until 1981 when the Q.F.B. became defunct. Figures had to be modified to convert fish fillets to whole fish, and to convert figures prior to 1974 from pounds to kilograms.

No attempt is made at any Catch per Unit effort (CPUE) analysis due to a paucity of information regarding actual fishing effort concurrent with the Q.F.B landing data. In addition other inconsistencies in the landing data makes any detailed analysis impossible. These problems are outlined in section 3.7.

Rather the analysis is more concerned with spatial and temporal patterns of production and the way in which they relate to 'outbreaks' of Crown-of-thorns starfish.

3.7 INTERPRETATION OF FISH BOARD DATA

Inconsistencies in the Q.F.B. data had to be overcome to build a cohesive database for analysis. These are outlined below as an aid to interpretation of the results and to forewarn the reader of the inaccuracies inherent in the data. The absolute figures given should not be taken on their face value but rather should be taken as an indication of long term trends in the dynamics of the fishing industry over the last 24 years. Estimates of the black market and other private processing plants need to be investigated(see Chapter 14).

1. From the Year 1970 on landings of fish were separated into fillets of fish and finned fish. Previously only finned fish had been recorded. This change can be viewed both as a change in policy and changes in technology both in the processing and the catching of fish. A conversion factor of two has been used to convert fish fillets to whole fish.

2. Records changed from pounds(lbs) to kilograms(kg) in 1974. A conversion factor of 2.2 is used.

3. In the years 1966 till 1973 the Northern Fish Board (N.F.B.) was in operation controlling markets north of Rockhampton. Landings were recorded separately for the two Fish Boards over these years. Any change in catch composition should be viewed in light of these changes in administration.

4. On 31st January 1973 the landing ports governed by the Northern Fish Board were ceded back under the aegis of the Queensland Fish Board. Consequently data provided by the Northern Fish Board in 1973 is for the 7 months ended 31st January 1973 whilst data from the Queensland Fish Board is recorded as the Year ending 30th June 1973.

5. In 1976, the end of the financial year was changed from the 30th June back to the 30th April. Therefore data in 1976 from the fish Board is for the ten months ending 30th June 1976.

6. Over the years the Fish Board depots recorded in the Annual Q.F.B. reports have varied considerably due to some plants becoming operational and others obsolete.

7. The Queensland Fish Board stoppped official recording of fish landings after 1981 once its powers were revoked under the Queensland Fishing Industry Organisation and Marketing Bill (1982). Consequently analysis occurs only up till 1981 as data was unavailable after this time.

8. Landings of Coral trout were not recorded until after 1963. This should be considered when looking at total landings for a Fisheries Section.

CHAPTER 4: METHODOLOGY FOR CROWN-OF-THORNS STARFISH ANALYSIS.

4.1 INTRODUCTION

Outbreaks of the Crown-of-thorns starfish were first recorded on the G.B.R. in 1962 at Green Island. Since that time extensive and often emotional debate has been generated concerning the causes of the Acanthaster phenonemon, including a number of committees of inquiry. Considerable information now exists on the distribution and intensity of Crown-of-thorns outbreaks over the last 25 years. This is the result of observations made both by scientists and the general public.

Moran (1997) noted a number of characteristics of outbreaks on the G.B.R. which provide a useful background for the ensuing analysis.

(1) Outbreaks which have occurred in the region are probably the most extensive in the world having been reported in an area from the Swain reefs to those near Princess Charlotte Bay, a distance of about 1200 km.

(2) Two series of extensive outbreaks have occurred on the G.B.R. Outbreaks were first recorded at Green Island in 1962, and continued on various parts of the G.B.R. until 1977. No reports of outbreaks were then recieved until the end of 1979 when outbreaks were again reported at Green Island. This second series of outbreaks is still occurring at present.

A number of problems exist in gauging the extent of outbreaks and how they can be related to fisheries-information. For instance it is not known whether outbreaks occurred in the period 1977 to 1979 of whether this reflects the fact that no scientific surveys were undertaken during this period (Moran, 1987). These problems and associated caveats are outlined in section 4.3.

4.2 PROBLEMS IN THE ANALYSIS OF COTS AND THE DYNAMICS OF THE FISHING INDUSTRY.

An investigation of this nature is necessarily limited in it's conclusions due to inconsistancies in the data. These problems arise largely from differences in the resolution of scale at which these processes have been measured. This makes any conclusive analysis of a relationship between fishing pressure and the dynamics of Acanthaster outbreaks impossible due to the following confounding factors.

1. Data is available only for landing ports. No data is available on catch areas even at a regional level let alone at a specific reefal scale. Consequently catch areas have had to be inferred as being those reefs being proximate to the various landing ports.

2. No long term data exists giving the number of fishermen in the 'industry'. Many primary Mackerel and trawler fishermen, reef fish secondarily . This makes it very difficult to gauge any CPUE figures. Any estimation is further confounded by changes ~~in the~~ in the technology of both fishing methods and of processing.

3. No absolute counts of Crown-of-thorns starfish exist. The database consists only of sightings at reefs which happened to be visited at a particular period of time.These observations were largely based on information that Starfish were on the reef.

Consequently the best that can be inferred is to examine trends in the annual landings for a particular region with respect to whether or not an outbreak occurred. Even such a basic analysis as this is again confounded by the vagaries of scale. For instance if an area such as the Capricorn/Bunker group is deemed to be a scale appropriate at which to look at outbreaks no evidense for outbreaks would be found. If however the area under consideration was widened to incorporate the Swains complexes a relationship could be inferred.

4. A catch 22 situation exists with any interpretation of a relationship between Crown-of-thorns Starfish and fishing. Namely did fishing pressure exacerbate the outbreaks or did outbreaks bring about a change in the dynamics of the fishing industry.

4.3 SOURCES OF INFORMATION

The AIMS modified GBRMPA database of Crown-of-thorns observations was made available for analysis. This database records the following data; date, reefname, reef-ID, sample ID, number of Crown-of-thorns, method of observation, and habitat.

4.4 METHODOLOGY

Due to problems outlined above, comparative analysis has been kept simple. The Crown-of Thorns database from AIMS has been used in the analysis. Data has been stratified in the following manner.

1. Data was broken into 5 geographic 'COT' areas based on the GBRMPA zoning sections. These are subdivisions of the three reef based fishery sections defined previously in section 2.1. This is to facilitate comparison. Observations of Crown-of -thorns for each area are compared against annual landings of the appropriate fisheries section (i.e. Northern section landings are used for both the Crown-of-thorns Far Northern and the Cairns section). These are shown in table 4.1 and in figure 4.1.

TABLE 4.1 : GEOGRAPHIC EXTENT OF FISHING AND COT SECTIONS.

FISHING SECTION	CROWN-OF-THORNS SECTION
1.Northern Section Cape York to Tully	1. Far Northern Section 2. Cairns Section
2. Central Section. Tully to Mackay	1. Central Section. Tully to Mackay.
3. Capricornia Section. Mackay to Bundaberg.	1. Capricornia Section 2. Capricorn/Bunker Section

2. The Crown-of-thorns data was further broken down into observations by method. This removed any inconsistencies and shortcomings of the various methods allowing a more resolute comparison. From the six methods used in the AIMS/GBRMPA database, the were futher lumped into the following categories.
A. Observations by Scientists.
B. Observations by Non-Scientists.
C. Observations by Manta-towing.

Using the above data a relative index of Crown-of-thorns activity/observations has been calculated for each area over each calendar year (COT Index).
This index is based on the number of reefs in an area observed to have Crown-of-thorns starfish on them over the total number of reefs surveyed in that area for that year.

$$\frac{\text{Number of Reefs with Crown-of Thorns}}{\text{Total Number of Reefs surveyed.}}$$

This index has several flaws and caution is required in the interpretation of the results. The figures to follow contain boxes underneath which provide the figures on which the indices are based and should be used to interpret the figures.
Indices have been calculated only for greater than three observations for an area in a year. However the problem arises, where if for example 3 reefs were surveyed in an area and all 3 were recorded as having outbreaks of Crown-of-Thorns an index of 1.0 would be calculated. However if in another year 46 reefs were surveyed and Crown-of-thorns were observed on 20 of these reefs a lower index value would be calculated, even though a greater number of reefs were surveyed.

3. The proximity of reefs to landing ports has also been used to further examine evidence for a relationship between the two phenomena. This is based on the assumption that those reefs closer to landing ports are likely to recieve greater fishing pressure due to their proximity and ease of access. Reefs have been subdivided into four distance categories based on their distance from major poulation centres. These categories are: <30 km, 30-60 km, 60-90 km, >90 km.

4. The 'intensity' of outbreaks is also examined by breaking the data down into a 5 class abundance scale. As a number of observations were for a reef were often made for one year, the maximum number of Crown-of-thorns seen irrespective of method is used. The abundance scale used is as follows.

A: 1 Starfish
B: 2-9 Starfish
C: 10-49 Starfish
D: 50-99 Starfish
E: > 100 Starfish

Reefs which have had observations of greater than 100 individual Starfish at any one time are also considered. Regardless of the method of observation used, populations of this size are to be considered outbroken. The basis for this rationalisation is shown in table 4.2 taken from Moran (1987) showing various definitions of an outbreaking and normal reef. Names of the reefs are given along with their distance from port and the amount of fishing activity they recieve. Reefs which have had recurring outbreaks are also shown.

TABLE 4.2: DEFINITIONS OF AN OUTBREAKING AND NORMAL REEF (from Moran 1987).

Definition	Reference
OUTBREAKING	
14 starfish per 1000 m	Endean & Stablum, 1975b
40 starfish per 20 min. swim	Pearson & Endean, 1969
100 starfish per 20 min. swim or manta tow	Chesher, 1969a
10 starfish per 1 min. spotcheck	Pearson & Garrett, 1976
NORMAL	
1 starfish per 100m of reef	Dana et al., 1972
6 starfish per km of reef	Endean, 1974
4-5 starfish per km of reef	Chesher, 1969a
5-20 starfish per km of reef	Ormond et al., 1973
Less than 14 starfish per 1000 m	Endean & Stablum, 1975b
Less than 10 starfish per 20 min. swim	Pearson & Endean, 1969
Less than 20 starfish per 20 min. swim	Chesher, 1969a

5. Exploratory Time series analysis was undertaken, to examine any causal relationship between Crown-of-Thorns and Fishing pressure, but then abandoned due to the following reasons.

1. Landing data is used not catch area data, so the best that can be inferred is a general region. No absolute area can be defined.
2. The Crown-of-thorns data represents biased observations at one point in time which do not give the absolute number of crown of thorns or even the number of reefs in a year which have played host to the starfish.
3. Different temporal scales have been used in the analysis of the data. The fisheries data is based on the fisheries year ending 30.04 of each year whilst Starfish observations are based on calender years.
4. Observations were made at times when the Acanthaster 'phenonenom' was topical. This is most obvious in the Cairns section with observations being concentrated in 1966 through to 1971 when the phenonema first became a public concern, and then no observations made for the next 9 years after interest had ~~died~~ waned. A spate of observations were then made when concern arose again.

PART 3: ANALYSIS OF COMMERCIAL FISHERY AND CROWN-OF-THORNS STARFISH.

CHAPTER 5. THE NORTHERN FISHERIES SECTION.

5.1 INTRODUCTION

The Northern Fisheries Section has 2 major processing plants at Cairns and Innisfail which process the majority of the fish landed from this region. A third processing plant at Port Douglas was initiated in 1978. This section incorporates the Far Northern and the Cairns to Cormorant Pass Section (Fig 5.1).
It extends from Two mile opening in the North to the passage South of Beaver and Taylor Reefs in the South. It covers an area of some 36,000 square kilometres with a total of 211 reefs of a variety of types.

In the Northern Fisheries Section, Williams (1982) recorded 6 primary fishermen and 8 Mackerel fishermen. These fishemen were spread over a large geographic area with 2 ~~two~~ fishermen in the following home ports; Cairns, Port Douglas, Cooktown. It would be envisaged that these operations would have largely non-overlapping territories.
The combined total production of reef fish caught in the Northern Fisheries Section is shown in table 4.1 and fig.4.1, whilst table 4.2 provides a breakdown by species of fish landed for the Northern Section. Appendix A1 has a full listing of species landed by port.

5.2 ANNUAL PRODUCTION TRENDS

~~Fig 5.3 clearly demonstates how the combined landings have~~ varied over the 25 years examined with an eleven fold maximum range of
landings between years. Total Landings for 1967 jumped 4-fold from the previous year to 55 tonnes. This tonnage was sustained again in 1968, but landings fell steadily for the next 3 years. In 1972 landings increased significantly to 46 tonnnes but fell to 16 tonnes the following year (N.B. Fish landings for 7 months only). Landings again increased steadily over the next 3 years reaching a peak production of 50 tonnes in 1978. Landings fell again substantially after this time.

5.3 SPECIES COMPOSITION

Coral trout (fig. 5.4) has been the most heavily landed reef fish in this region subsequent to 1963. Landings have fluctuated considerably peaking in 1968 with 32 tonnes of fish processed and 1970 when 35 tonnes were landed. A minimum tonnage of 8 tonnes was reached in 1973 but landings again increased over the next 5 years to a maximum of 31 tonnes of fish processed in 1978.
These yearly patterns of landing are similar for the the two major processing plants (figures 5.4) and also reflect those patterns observed for the total landings of reef fish landed for the Northern Fisheries Section.

Landings of Sweetlip (Fig. 5.5) in the Northern section decline substantially from a peak of 18 tonnes in 1958 to only 7 tonnes of fish processed the following year. Landings continued to fall over the next four years to a low of 3 tonnes in 1963. Landings jump dramatically over the years 1966 through to 1968 when a total of 16 tonnes of fish were landed. Apart from 1972 a sharp decline in landings of Sweetlip was to be seen over the 5 years to 1973 (3.4 tonnes). Landings increased steadily after this till a maximum landing of 13.5 tonnes in 1976. Landings for all years fell after 1977 to under 10 tonnes of Sweetlip landed per annum.

Landings of Emperor in the Northern Section (fig. 5.6) remained under under 3.5 tonnes for the years 1957 through to 1966 but increased nearly 4-fold over the next two years to a peak of 11.5 tonnes in 1968. Landings fluctuated widely over the following years with the greatest tonnage of Emperor being landed in 1975 (13.4 tonnes). Landings dropped over the next 4 years to a plateau of approximately 4.7 tonnes of processed fish, which was sustained through until 1980, after which time landings of Emperor increased. Innisfail was the major port of landing for this species up until 1978 after which time Cairns And Port Douglas became the major ports of landing.

Landings of Morwong (fig. 5.7) have been minimal in this region, nearly all being under one tonne.

A peak of 1.7 tonnes of Nanygai (fig. 5.8) is recorded as being landed for the Northern section in 1967 after a 5 year period of no official landings. After 1967 landings levelled out at a plateau of around 0.4 tonnes for the next 5 years. Landings rose steadily after this, the most dramatic rise being from 1.3 tonnes in 1977 to 3.7 tonnes in 1978.

TABLE 5.1: COMBINED TOTAL LANDINGS (Kgs) OF REEF FISH BY REGION.

Northern Section: Cairns, Innisfail, Port Douglas
Central Section: Ingham, Townsville, Bowen, Homehill, Proserpine, Mackay
Capricornia Section: Rockhampton, Yeppoon, Gladstone, Bundaberg, Maryborough, Pialba, Rosslyn Bay, Tincan Bay
Southern Section: All Brisbane Fish markets.

YEAR	FISHERIES SECTIONS			
	NORTHERN	CENTRAL	CAPRICORNIA	SOUTHERN
1957	15302	27997	35270	4399
1958	19007	26518	53833	8870
1959	8361	13251	55426	7112
1960	7485	6604	64111	10342
1961	7630	8025	27391	4440
1962	8485	21269	38125	4702
1963	20292	40323	55512	3320
1964	19162	30701	72215	3446
1965	28004	27181	73028	6538
1966	18570	23921	70942	20955
1967	55441	51323	61980	6090
1968	56460	49440	35594	5490
1969	43694	52160	38864	5811
1970	49071	143740	94999	13053
1971	33928	162674	115061	13245
1972	46498	172952	93042	5582
1973	16382	205394	97864	13773
1974	39074	247869	92900	8896
1975	36883	237382	92344	6312
1976	41657	162506	88251	24449
1977	50138	178016	91216	31898
1978	48182	95602	59193	29976
1979	35550	204543	72769	31609
1980	29851	246046	94161	479842
1981	34810	235715	64601	61688

Kg

TABLE 5.2: TOTAL LANDINGS OF REEF FISH BY REGION. 9 Species

Northern Section: Cairns, Innisfail, Port Douglas
Central Section: Ingham, Paluma, Townsville, Bowen, Homehill, Proserpine, Mackay.
Capricornia Section: Rockhampton, Yeppoon, Gladstone, Bundaberg, Maryborough, Pialba, Rosslyn Bay, Tincan Bay
Southern Section: All Brisbane Fish Markets.

YEAR	SPECIES	FISHERIES SECTIONS			
		NORTHERN	CENTRAL	CAPRICORNIA	SOUTHERN
57	Morwong	481	333	3443	300
57	Nanygai	0	0	78	2275
57	Sweetlip	14821	27475	27634	1529
57	Emperor	0	189	4115	295
58	Morwong	538	163	3882	424
59	Nanygai	0	3	124	5440
58	Sweetlip	15013	25578	45166	2524
59	Emperor	456	774	4660	482
59	Morwong	117	143	714	995
59	Nanygai	845	0	286	2473
59	Sweetlip	7355	12257	47948	3278
59	Emperor	45	851	6478	366
60	Morwong	90	119	1678	290
60	Nanygai	0	0	336	3947
60	Sweetlip	5945	6032	53994	2755
60	Emperor	1450	453	3103	3351
61	Morwong	41	33	255	194
61	Nanygai	101	20	72	2543
61	Sweetlip	5200	7487	22462	1281
61	Emperor	2289	485	5101	423
62	Morwong	21	151	1363	133
62	Nanygai	1	20	77	2629
62	Sweetlip	4913	19407	45290	1568
62	Emperor	3550	1691	13394	372
63	Morwong	11	65	1963	52
63	Coral trout	14735	19570	11357	683
63	Nanygai	0	0	104	584
63	Sweetlip	3046	19062	35719	1919
63	Emperor	2490	1625	6370	82
64	Morwong	3	108	408	87
64	Coral trout	13555	14166	11820	73
64	Nanygai	4	0	437	1939
64	Sweetlip	3647	15310	51032	1119
64	Emperor	1954	1117	8517	229

TABLE 5.2: CONTINUED

YEAR	SPECIES	NORTHERN	CENTRAL	CAPRICORNIA	SOUTHERN
65	Morwong	0	132	438	78
65	Coral trout	17555	10153	22150	538
65	Nanygai	0	0	397	3192
65	Sweetlip	7932	14890	41869	2406
65	Emperor	2517	2006	8175	324
66	Morwong	51	53	387	359
66	Coral trout	12416	11357	22601	8002
66	Nanygai	0	0	548	4577
66	Sweetlip	4042	11204	39529	7589
66	Emperor	2060	1307	7876	428
67	Morwong	2	205	70	125
67	Coral trout	32891	23369	15961	428
67	Nanygai	1745	26	429	3596
67	Sweetlip	12990	23589	39112	1728
67	Emperor	7923	4135	6407	213
68	Morwong	24	45	18	276
68	Coral trout	28652	20989	9498	46
68	Nanygai	288	15	90	3361
68	Sweetlip	15951	24739	21232	1100
68	Emperor	11545	3651	4756	707
69	Morwong	12	113	280	272
69	Coral trout	21793	23173	9861	71
69	Nanygai	269	0	115	4152
69	Sweetlip	11711	25835	22573	781
69	Emperor	9910	3038	6034	535
70	Morwong	0	67	48	3857
70	Coral trout	34837	86086	32904	1291
70	Nanygai	261	19	203	4514
70	Sweetlip	8300	35658	55150	2273
70	Emperor	5673	21911	6693	1117
71	Morwong	0	46	124	215
71	Coral trout	15430	83738	41766	961
71	Nanygai	381	199	506	8964
71	Sweetlip	7828	26178	63166	2013
71	Emperor	10288	52513	9499	1091
72	Morwong	5	16	117	769
72	Coral trout	27426	90320	45145	849
72	Sweetlip	10958	21478	42946	3625
72	Emperor	8109	61138	4833	339
73	Morwong	0	69	107	373
73	Coral trout	7812	96546	46730	1732
73	Nanygai	400	0	1171	8348
73	Sweetlip	3381	59249	43256	1895
73	Emperor	4789	49530	6600	1425

TABLE 5.2: CONTINUED

YEAR	SPECIES	NORTHERN	CENTRAL	CAPRICORNIA	SOUTHERN
74	Morwong	15	6	171	462
74	Coral trout	13643	104305	37163	2192
74	Nanygai	1018	0	0	8
74	Sweetlip	10310	24928	46303	3847
74	Emperor	14088	118630	9263	2387
75	Morwong	0	7	81	371
75	Coral trout	11706	84699	29303	547
75	Nanygai	1129	0	0	0
75	Sweetlip	10623	36480	51115	3336
75	Emperor	13425	116196	11845	2058
76	Morwong	3	0	258	342
76	Coral trout	18816	74095	38526	566
76	Nanygai	907	6	213	4657
76	Sweetlip	13532	69501	39292	17638
76	Emperor	8399	18904	9962	1246
77	Morwong	22	0	332	584
77	Coral trout	29467	59166	32392	758
77	Nanygai	1321	174	1198	24246
77	Sweetlip	12061	76380	44971	3197
77	Emperor	7267	42296	12323	3113
78	Morwong	69	23	257	724
78	Coral trout	30937	10388	22338	650
78	Nanygai	3681	284	999	20164
78	Sweetlip	8529	71735	26808	5509
78	Emperor	4967	13172	8791	2929
79	Morwong	0	0	134	589
79	Coral trout	22611	93862	21462	1717
79	Nanygai	1632	808	1405	21433
79	Sweetlip	6564	90598	37832	4415
79	Emperor	4743	19275	11936	3455
80	Morwong	14	86	128	448004
80	Coral trout	19337	123917	33453	1859
80	Nanygai	1213	256	1397	22567
80	Sweetlip	4505	96312	46332	4287
80	Emperor	4782	25475	12851	3125
81	Morwong	166	4	249	850
81	Coral trout	20483	130813	22362	3215
81	Nanygai	470	13	1747	48939
81	Sweetlip	6605	90270	25742	4964
81	Emperor	7086	14615	14461	3720

Fig 5.2: Total landings of reef fish for the Northern Fisheries Section.

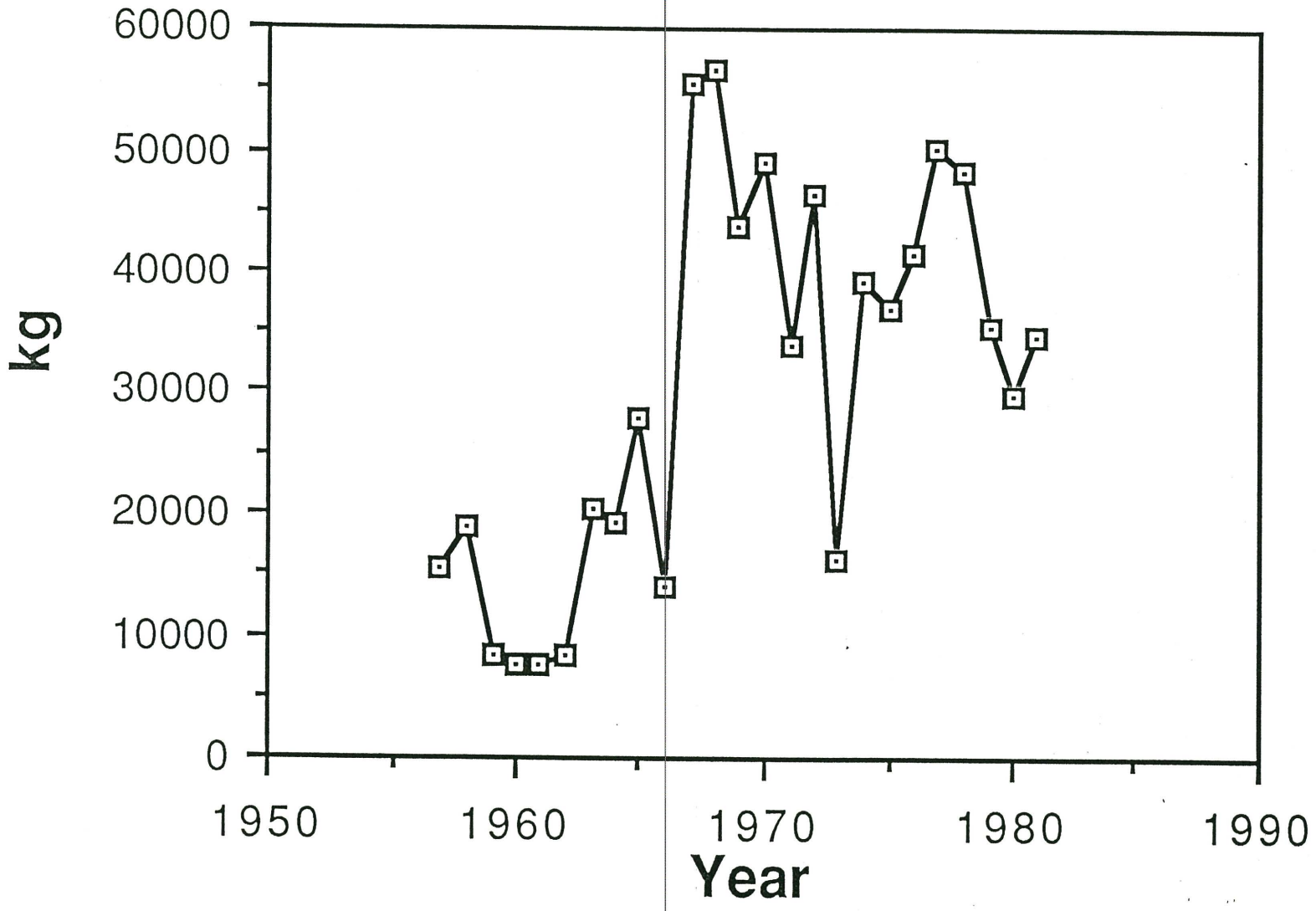


Fig 5.3: Landings of Coral trout in the Northern Fisheries Section.

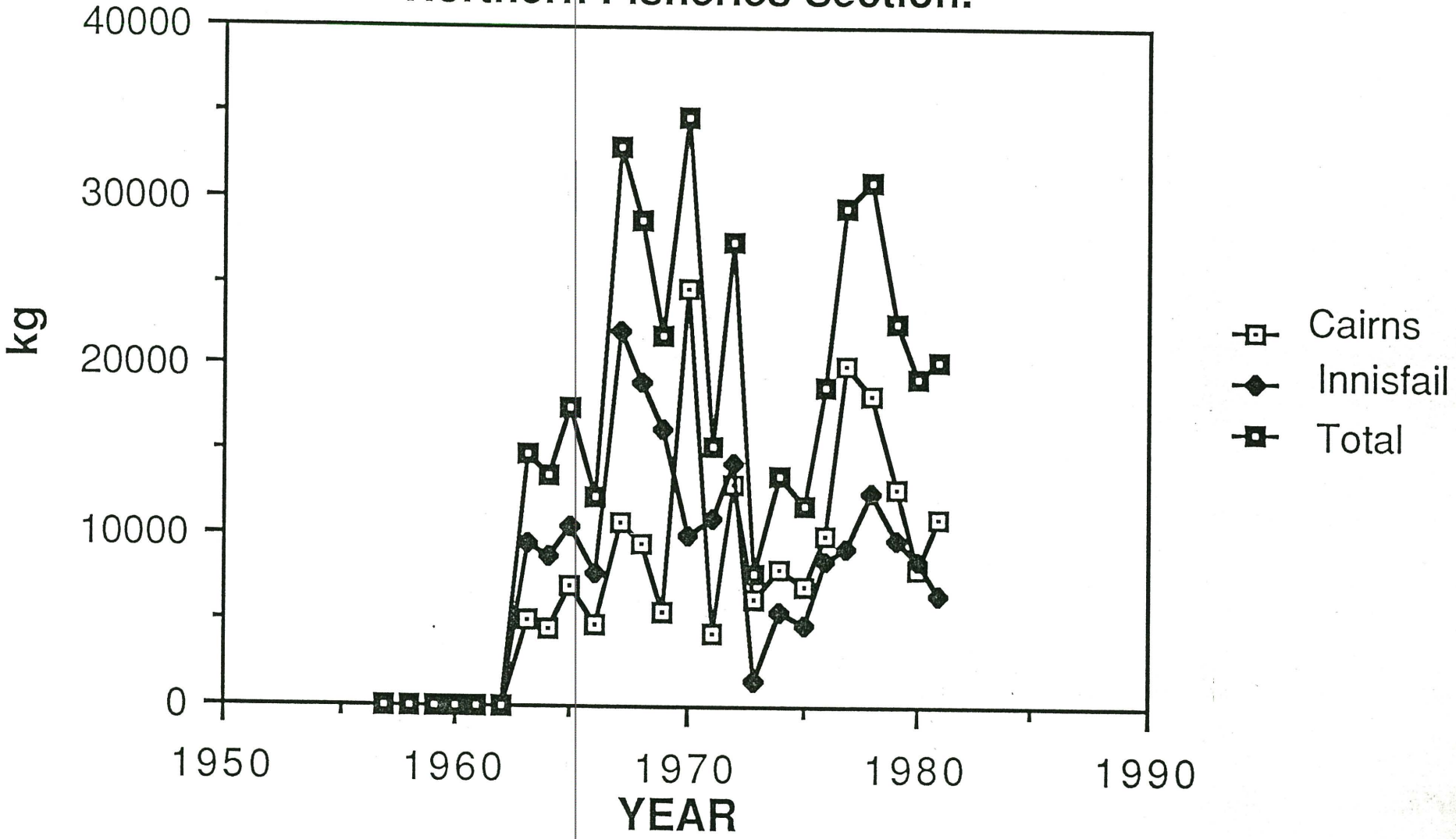


Fig 5.4: Landings of Sweetlip in the Northern Fisheries Section.

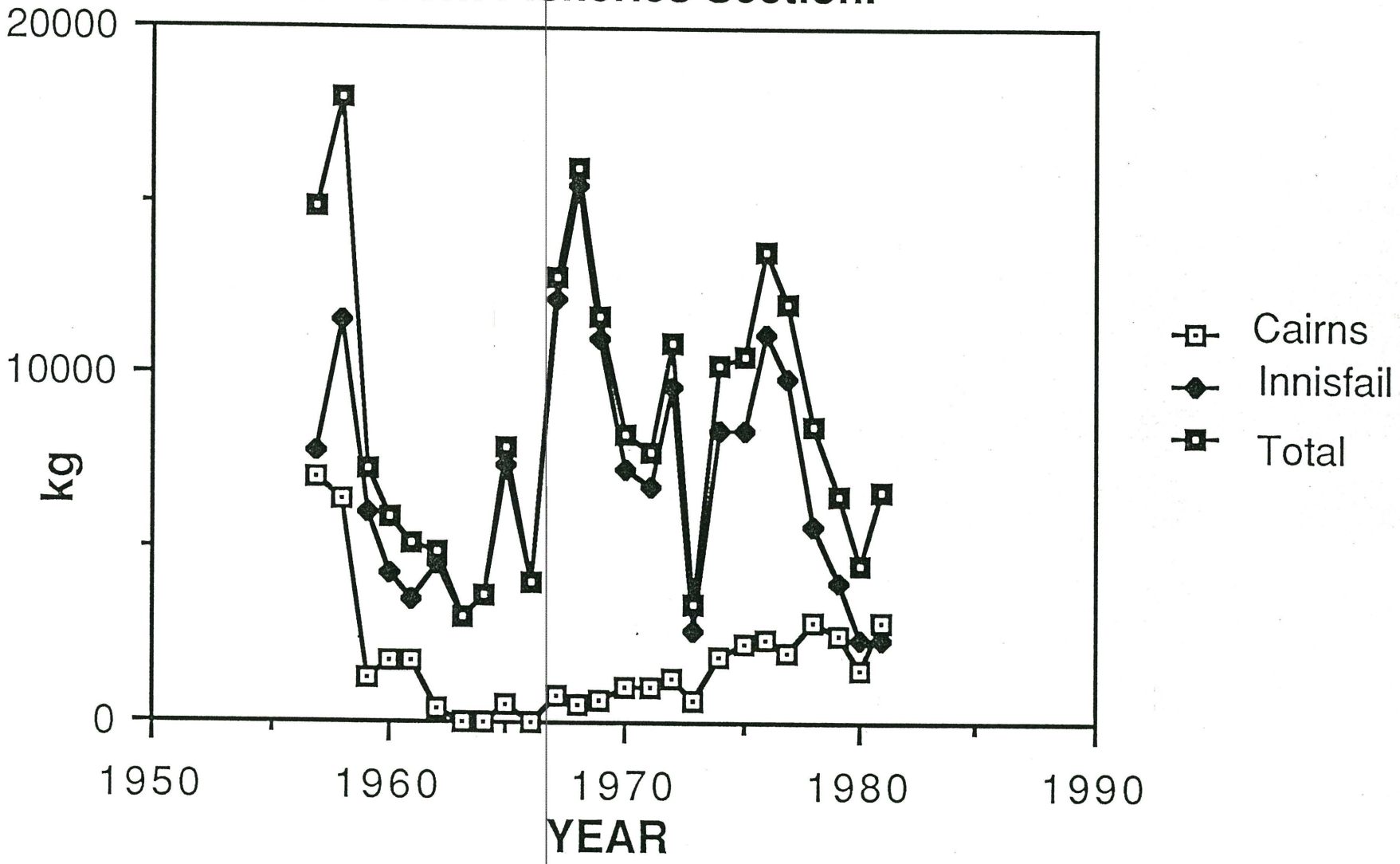


Fig 5.5: Landings of Emperor in the Northern Section.

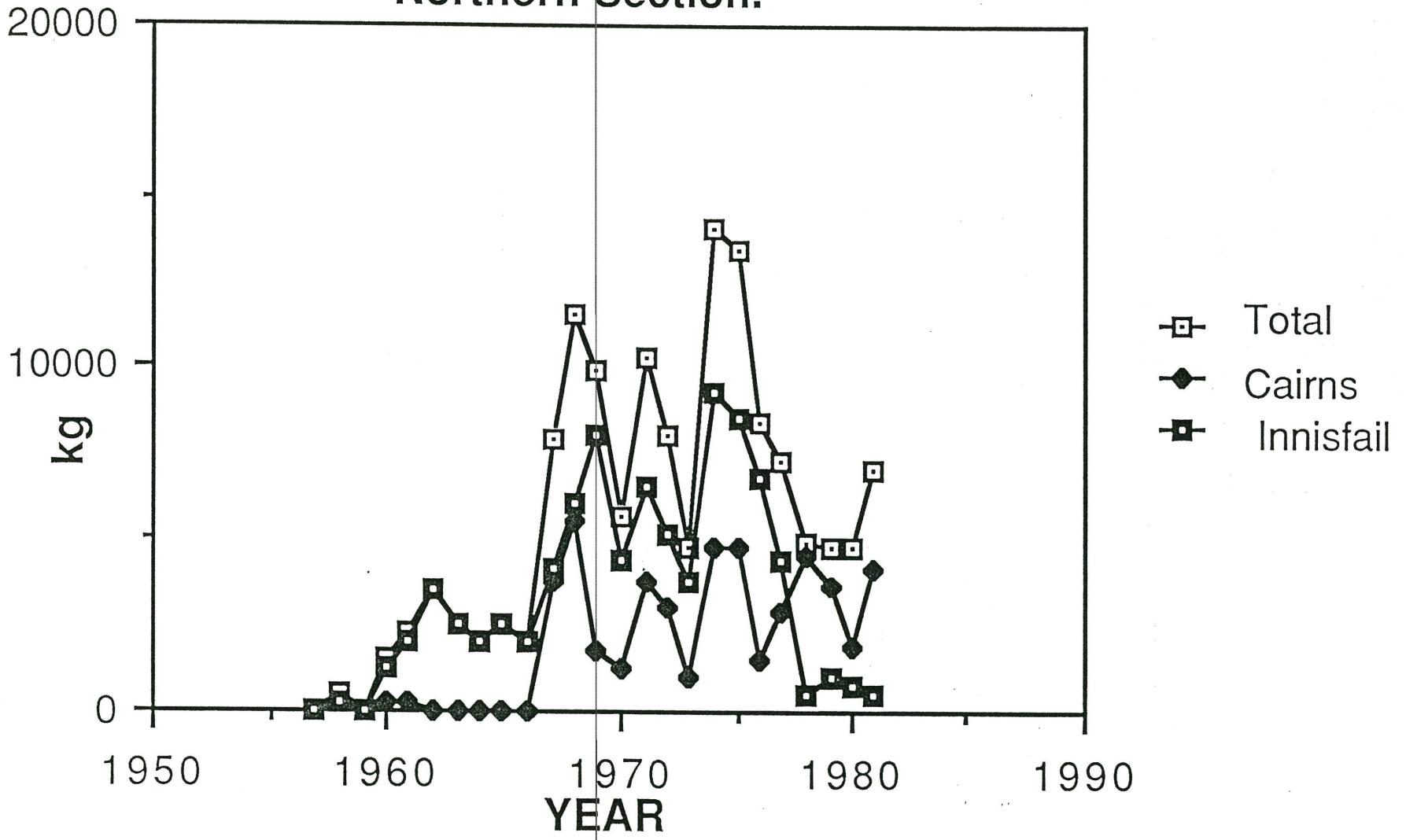


Fig 5.6: Landings of Morwong in the Northern Fisheries Section.

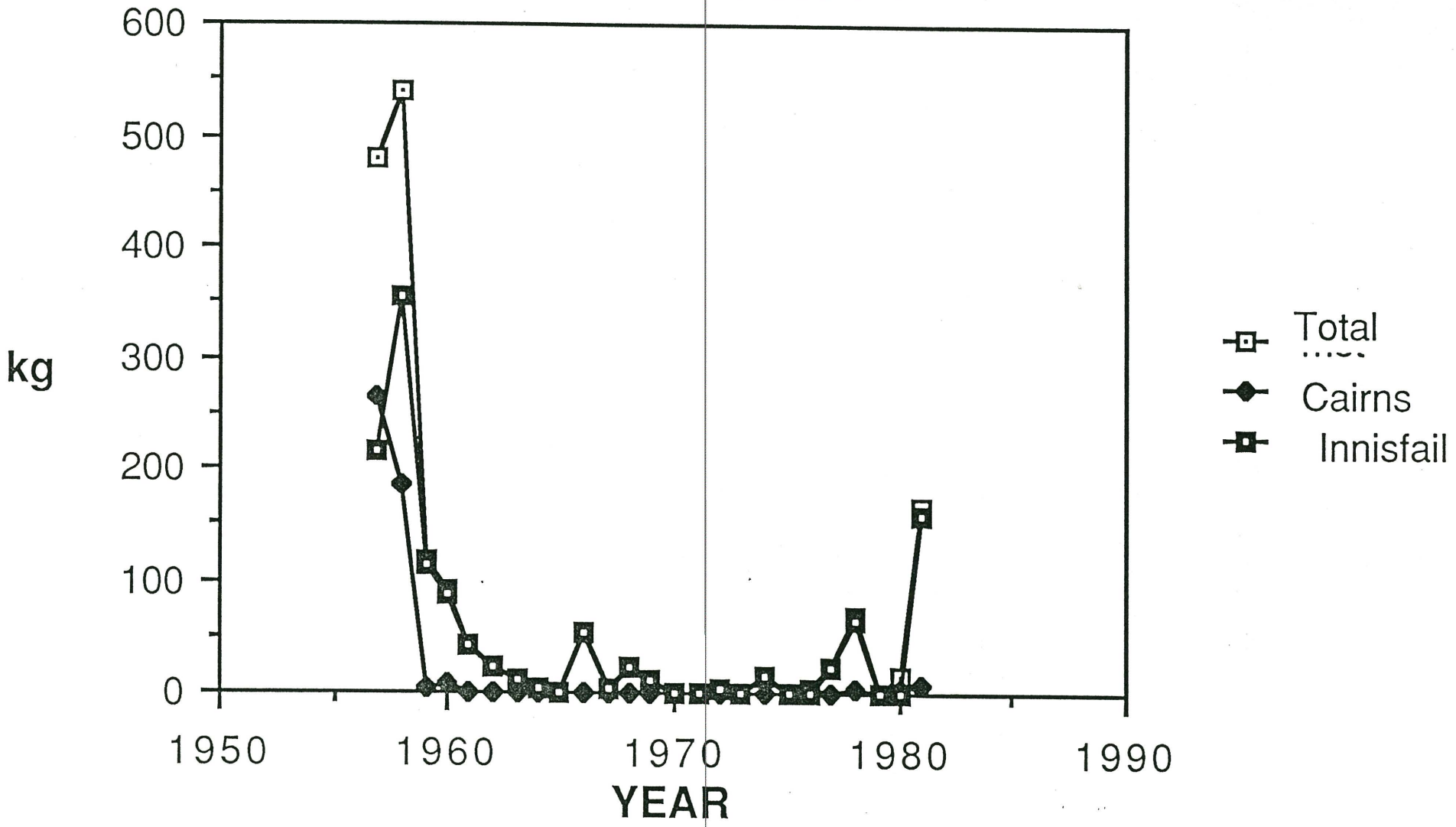


Fig 5.6: Landings of Morwong in the Northern Fisheries Section.

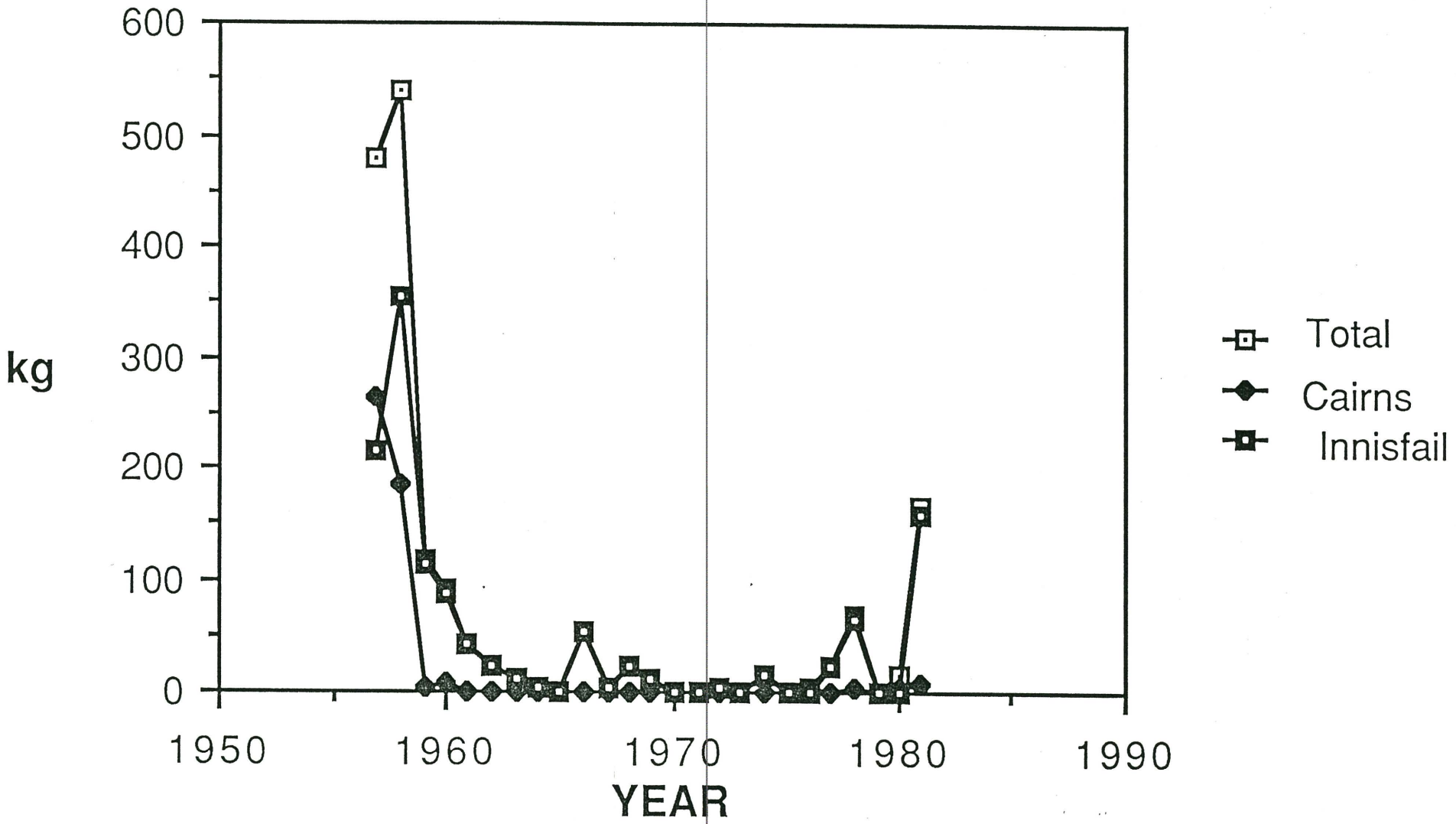
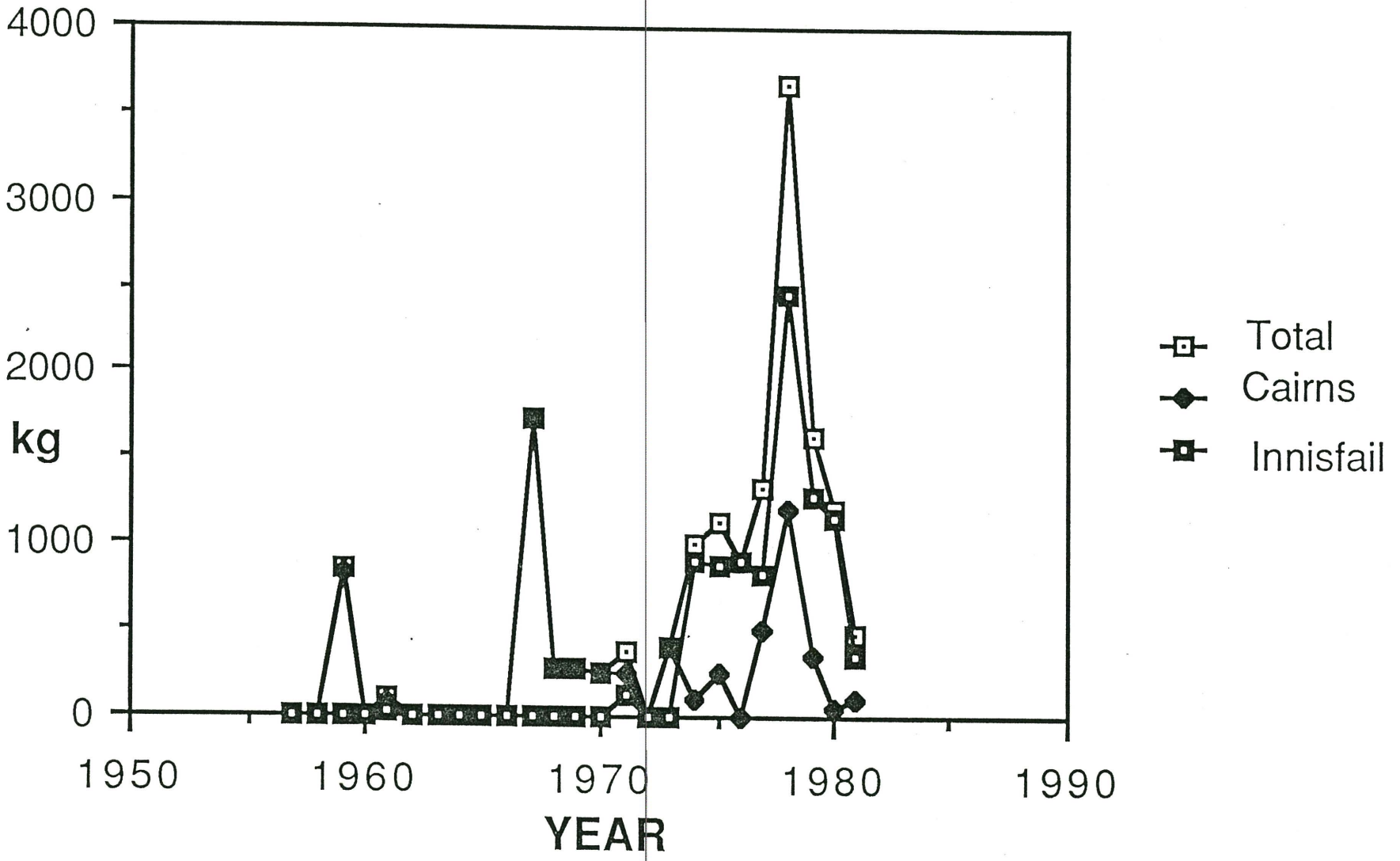


Fig 5.7: Landings of Nanygai in the Northern Fisheries Section.



5.4 CROWN-OF-THORNS STARFISH IN THE NORTHERN SECTION

i. Observations by Method

Observations of Crown-of Thorns starfish have been few in this section and restricted to the years 1980-1984. Non-scientist observations were the most common method (Fig 11.4). Crown-of-thorns starfish were recorded on all 3 of the reefs surveyed in 1982 and likewise with the 5 surveyed in 1983. In 1984, of 3 observations, all made by non-scientists, only one reef is recorded as having any Crown of thorns.
The observed 'outbreaks' have never been severe. All observations by non-scientists were of populations numbering under 50 individuals (Table 11.1, Appendix D1ii).

A restricted number of Manta-towing observations in 1980 and Scientist observations in 1982 similarly identified small aggregations on a limited number of reefs (Figures 11.3-4).

ii. Outbreaks and Fishing

It is impossible to relate the observations made to the amount of fish landed for this area.
This section is largely uninhabited and a considerable distance from any major processing plants. Williams (1980) records no primary reef fishermen with home ports in this area, and 6.7 % of all primary reef fishermen fishing this area in 1979. However the influence of traditional fishing methods is unknown (c.f. Andrew Smith Unpub report).

5.5 CROWN-OF-THORNS STARFISH IN THE CAIRNS SECTION.

i. Introduction

This section has been the most controversial area being the first area to have large populations identified in 1962 at Green Island as well as having recurring outbreaks. It has been suggested this area is the origin of primary outbreaks with outbreaks spreading south from this origin (Moran, 1987).
As such this area has recieved a greater amount of attention and number of observations than any other region.

ii Observations by Method

Observations by Scientists in this area represent the most comprehensive dataset available to date, spanning the years 1966 through till 1971 and then 1980 through to 1984 (Fig 11.5).
Of 53 reefs surveyed in 1966, 50 reefs contained outbreaks. Of these 50 reefs 12 had over 100 Acanthaster individuals and as such could definitely be inferred as having outbreaks. Of the others, 15 reefs had less than 10 individuals, 18 reefs had less than 50 but greater than 10, and 5 reefs had between 50 and 100 individuals (Appendix D2i).
Observations of Crown of thorns on reefs surveyed from 1967 through to 1971 was similarly high (greater than 60%) but the modal frequency had changed with most observations being of less than 50 individuals. Certainly there were very few observations of what could be considered the plague proportions seen in 1966. (i.e >100). However whether observers were better trained in

these subsequent years and were not prone to over estimation is difficult to say.

Observations of the start of another 'outbreak' were initially made by non-scientists in 1977. The following years through until 1984 are comprehensively covered by all three methods (Figures 5.9-11).

The intensity of outbreaks identified by all methods is confined to populations of under 50 individuals and the majority of these observations identify populations of under 10 individuals (Table 5.3). Four reefs identified by Scientists in 1980 had populations of greater than 100 individuals and only one reef in 1981 and 1982 had populations of this proportion. Likewise Manta-towing and Non-Scientist observations identify 2 reefs with over 100 individuals in 1981 and 1982 and in the years 1979, 1983, and 1985 only 1 reef in the Cairns sector as having greater than 100 individuals. These reefs are listed in Table 11.2.

iii. Distance of Reefs from Population Centres.

Table 5.3 shows the number of reefs by distance from major population centres which have had Crown-of-thorns starfish sightings. It is readily apparent that those mid shelf placed reefs (30- 90 km) have had the majority of outbreaks.

Twenty three reefs have had observations of over 100 individuals on them with two of these, Arlington and Feather having recurrent outbreaks (Table 5.4). Of these 23 reefs 16 lie within 60km of Cairns or Innisfail, whilst the majority of the remaining 7 lie greater than 90 km from any port.

TABLE 5.3: DISTANCE OF REEFS IN THR NORTHERN FISHERIES SECTION WHICH HAVE HAD OUTBREAKS FROM POPULATIONS CENTRES AND INTENSITY OF OUTBREAK.

CATEGORIES OF OUTBREAK.

A= 1 Starfish
B= 1-9 Starfish
C= 10-49 Starfish
D= 50-99 Starfish
E= >100 Starfish

NORTHERN SECTION

	<30KM					30-60 KM					60-90 KM					>90 KM				
YEAR	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
1966																1				
1970																	1			
1977																1				
1979																1				
1980																4				
1981																1	2			
1982																1	1			
1983																3	1			
1984																11	3			
1985																				

CAIRNS SECTION.

	< 30 KM					30-60 KM					60-90 KM					>90 KM				
YEAR	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
1962		1																		
1966			1	1		3	3	7	2	8		1	5		1		7	4	1	1
1967		1			2		1			1			1		1	1	4	2	1	
1968	2	1				1														
1969	1					4	2	4	1	1										
1970	2					17	2	2				2	2			1	4	2		
1971						10		1												
1972																				
1973																				
1974																				
1975																				
1976																				
1977												1					2			
1978	1																			
1979	1									1							4			1
1980	1					1	1			1		3	1			2	5	5	1	3
1981	1					1	12			1							3	5		2
1982							3	2		2	1		3		1		5	4		
1983							3	5				2	1				7	4		
1984						2	4	1								1		2		
1985						1	1			1										

TABLE 5.4 : REEFS WITH MORE THAN 100 INDIVIDUALS AT ONE TIME
CAIRNS SECTION

YEAR	REEF	DISTANCE
1966	ADELAIDE	2
	ARLINGTON	2
	ARTHURS PATCHES	2
	FEATHER	2
	FLORA	2
	GIBSON	2
	HOWIE	2
	SCOTT	2
	SUDBURY	2
	RUDDER	3
	MACKAY	4
1967	FITZROY	1
	UPOLU CAY	1
	ARLINGTON REEF	2
1969	NATHAN	2
1978	ARLINGTON	2
	ENDEAVOUR	4
1980	PIXIE	2
	FORRESTER	4
	HELSDON	4
	TWO ISLES	4
1981	FEATHER	2
	UN-NAMED	4
1982	FEATHER	2
	PEART	2
	MACGILLIVRAYS	4
1983	HILDER	4
1985	THETFORD	2

5.6 DISCUSSION OF CROWN-OF-THORNS STARFISH AND COMMERCIAL LANDINGS.

From the above it is evident that the periods 1966-71 and 1979-82 are the periods of major Crown-of-thorns starfish activity in the Northern Section. The majority of reefs with definite outbreaks are located in a midshelf position 30-90 km from either Cairns or Innisfail.

If we examine the total commercial landings of reef fish for the Northern Fisheries Section in light of the above discussion it is apparent that landings of fish increased most substantially at a time when the number of observations of Crown-of-thorns starfish suggested a major 'outbreak' was occurring on reefs in the Northern Fisheries Section. Landings from 1966 to 1967 increased from 18.8 tonnes to 55.4 tonnes. This tonnage was further augmented in 1968 to 56.4 tonnes. The subsequent decline in landings of fish after 1968 was followed by a concurrent fall in observations of Crown-of-thorns after 1971. Landings oscillated over the next few years reaching a low of 16.4 tonnes in 1973. As mentioned the recorded landings for this month were only for the 7 months, ending the 30th of April 1974, so that the decline in landings is probably not as marked as it appears in figures 11.2-5. Landings rose steadily after 1973 to a peak of 50.2 tonnes of combined reef fish landed in 1977. Landings declined significantly again over the next three years, before increasing marginally in 1981.

Observed Crown-of-thorns starfish activity during this time was quiescent in this section, until 1979. By 1980 a maximum number of reefs with outbreaks occurring on them, were recorded.

Figures 12.2 shows the total landings of reef fish for the Northern Section in five yearly increments. This has the effect of smoothing the variance in annual production and is possibly a better time scale to examine fish production and Crown-of-thorns observations. The period 1967-71 had the maximum production of fish for the 25 years examined in 1968, and a consistently high average production of 47.7 tonnes with a variance of 17.4%
The following 5 years from 1972-76 had an average tonnage of 36.1 tonnes of fish landed, with a variance of 10.3 tonnes or 28.7 %.
The period 1977-81 had an average of 39.7 $\pm$ 7.9 tonnes or 20.1%.
It had a peak production of 50.1 tonnes in 1977.
Fig 12.3 shows the range of production yields for both total combined landings and individual fish species, for the Northern Fisheries Section. This is related to the intensity of Crown-of-thorns starfish observations for the section. In terms of total landings, during the 1960's, 1968 had the greatest production. In the 1970's 1977 was the year of maximum reef fish production with 1978 being similarly high. This peak in production occurs two years prior to the onset of Crown-of-thorns sightings.
Coral trout landings were greatest in 1970, and Sweetlip in 1958, but 1968 was also notably high. These two species make up the bulk of the reef fish catch.

The overall picture gained of the combined total landings of fish for the Northern Fisheries Section is of a steady increase in production over a number of years followed by a 'crash, and a then a subsequent rise again. Whether the pattern of a rise in landings over a number of years and then the subsequent 'crash' can be solely attributed to overfishing through stock depletion or to stochastic natural events such as prior bad year class survival is open to question.
The first major outbreaks in the late 1960's would appear to occur simultaneously with dramatic increases in demersal reef fish production. The second outbreak of Crown-of-Thorns in the late 1970's would certainly suggest some causal relationship with a lag phase of some two years. Time series analysis failed to establish any relationship (see 10.5). Data for landings of fish in the Section subsequent to those provided are however crucial to any further examination of the relationship.

Craik (1979) cites the following reefs as being most commonly fished in the Cairns region by amateur fishermen. Tongue, Norman, Saxon, Scott, Hastings, Milln, Flynn, Moore, Michelmas, and Ruby reefs and Stagg patches. However none of these reefs are noted as having major Acanthaster populations on them (Table 11.2). Reefs in the Innisfail area, (Arthurs Patches, Feather, Howie, Gibson, Nathan, and Wardle) which are fished regularly by amateur fishermen have all, excepting Wardle reef, had severe outbreaks.

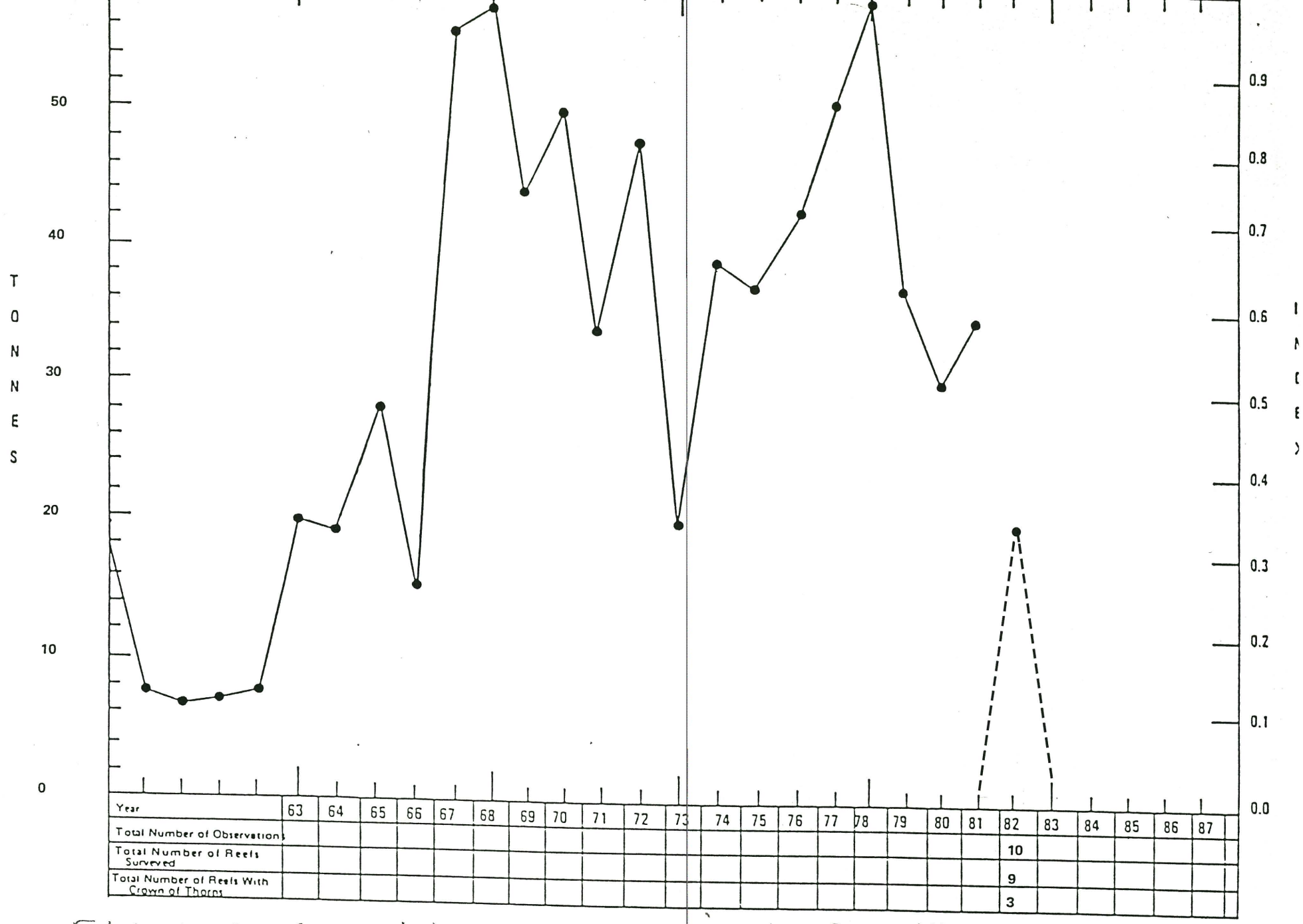
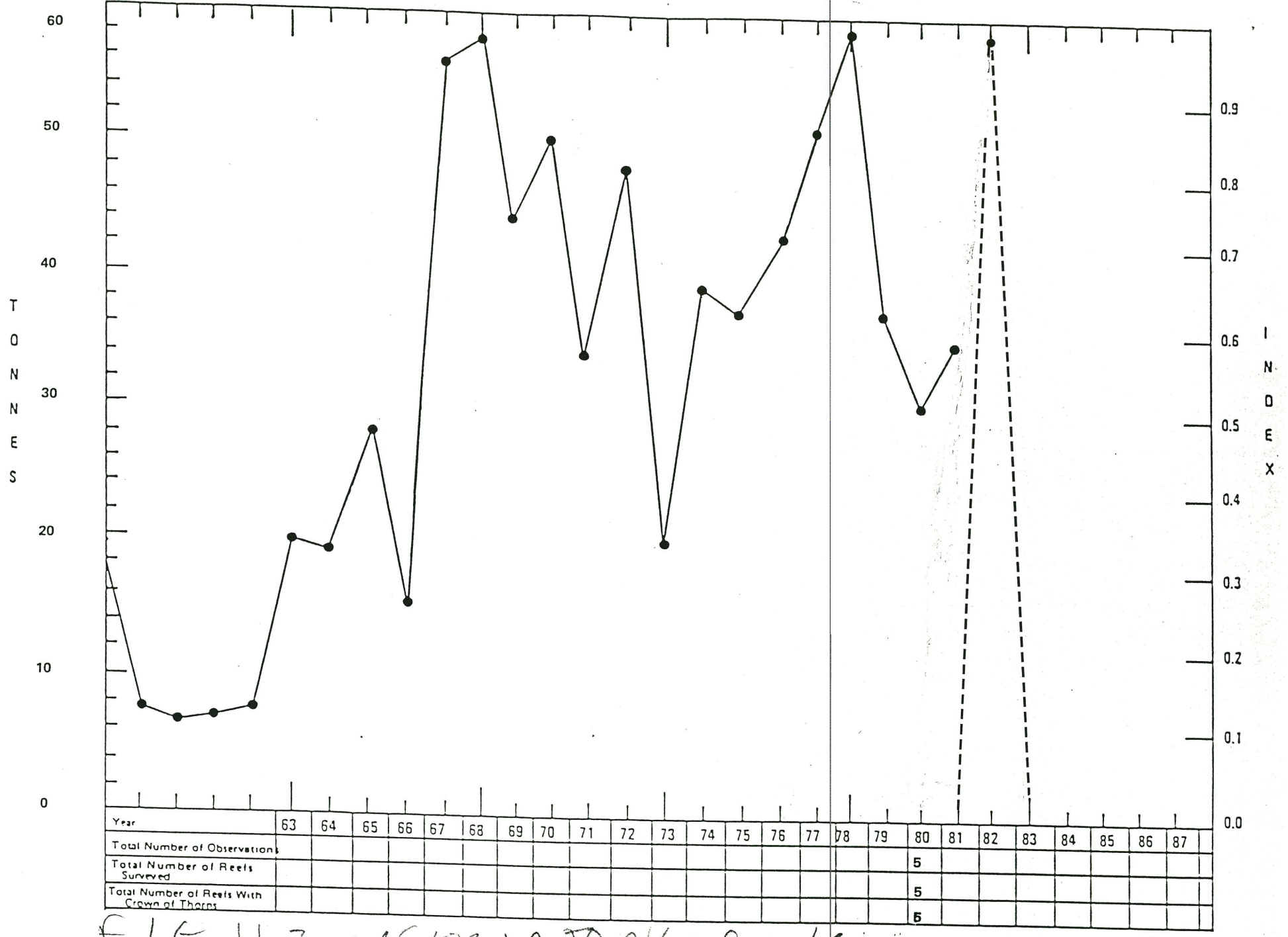
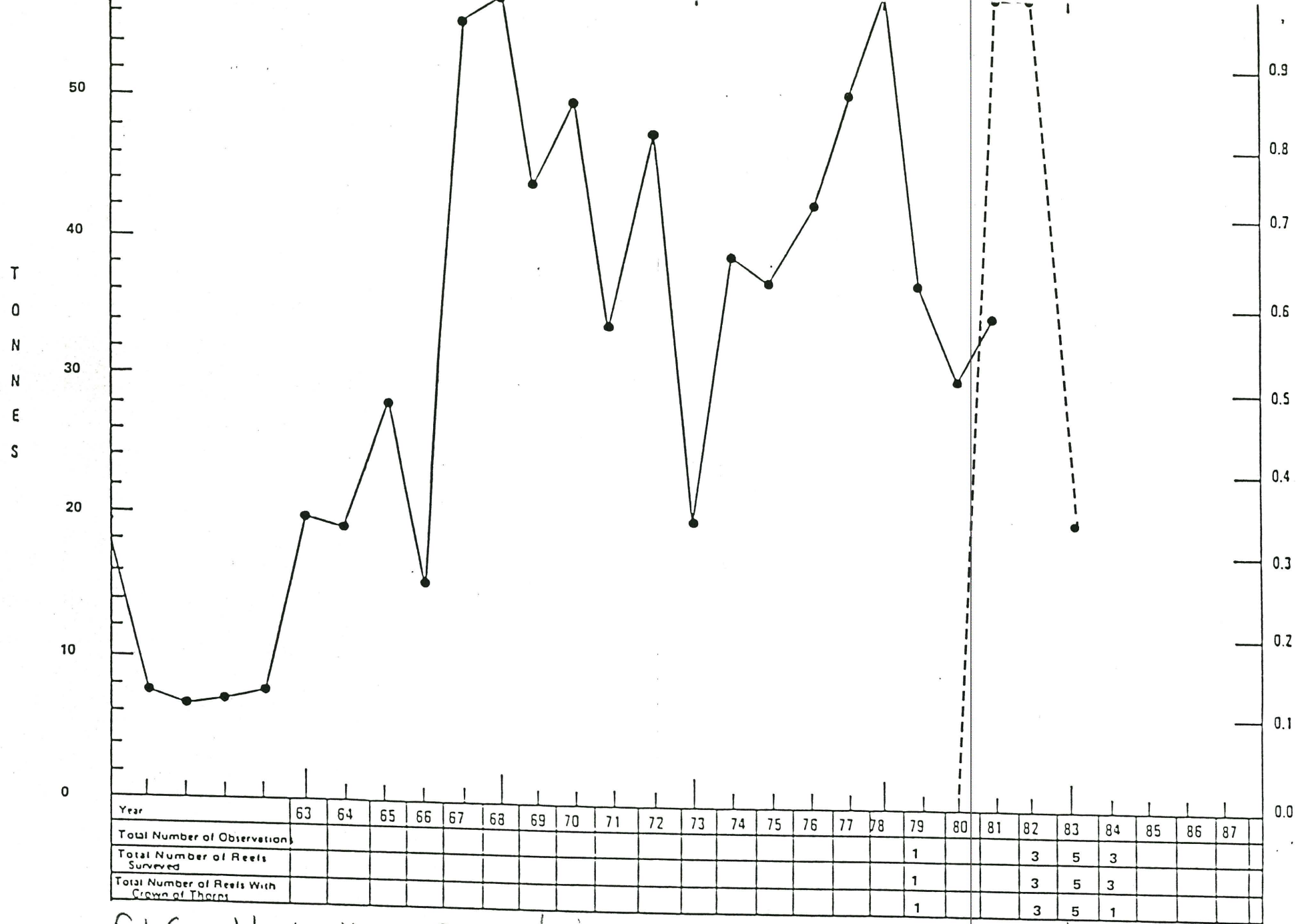


FIG 11.2 Scientist OBSERVATIONS for NORTHERN SECTOR



Year	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87
Total Number of Observations																		5							
Total Number of Reefs Surveyed																		5							
Total Number of Reefs With Crown of Thorns																		5							

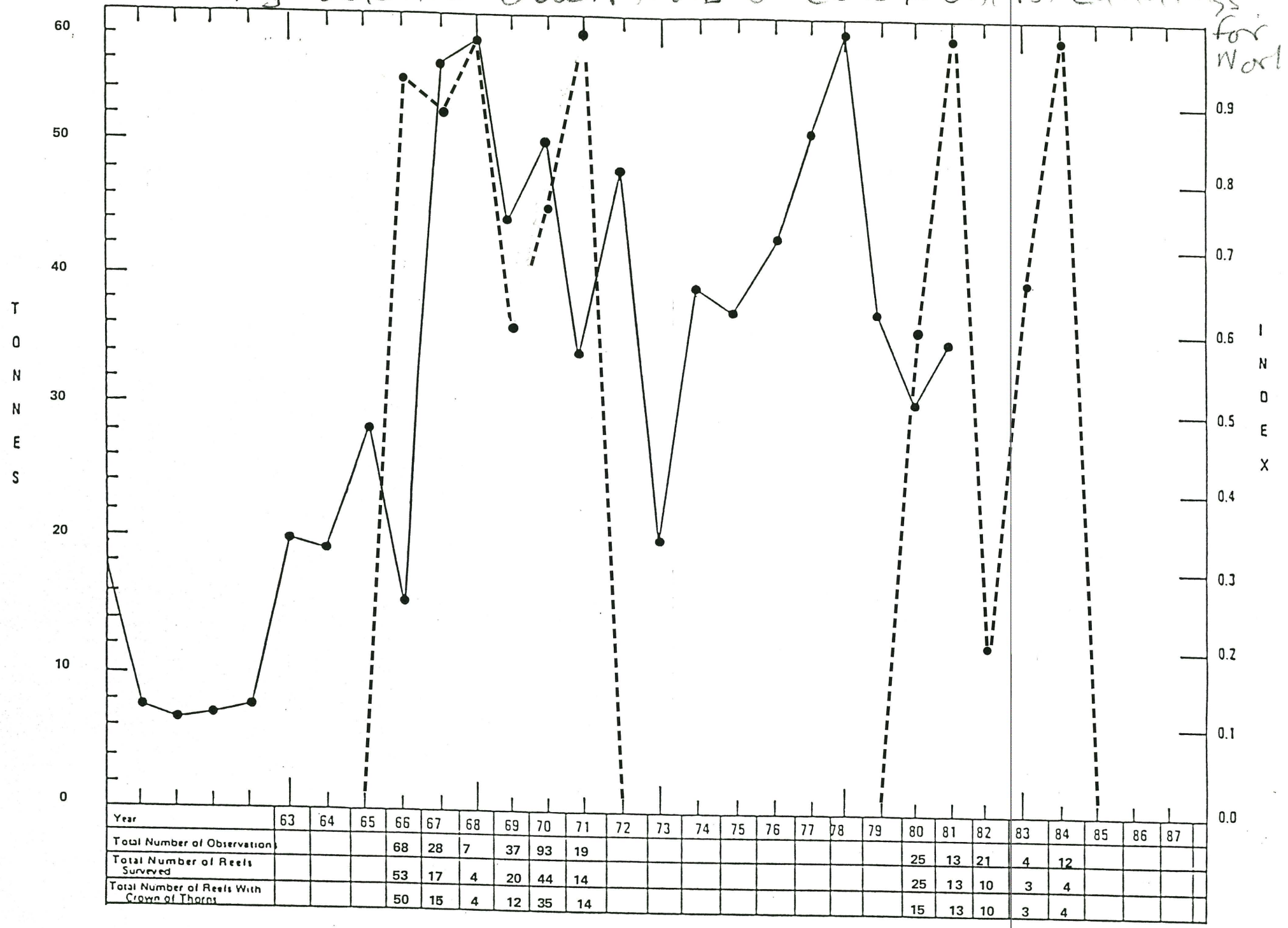
FIG 11.3 OBSERVATIONS ~~of~~ for the Northern
MANTA TOW



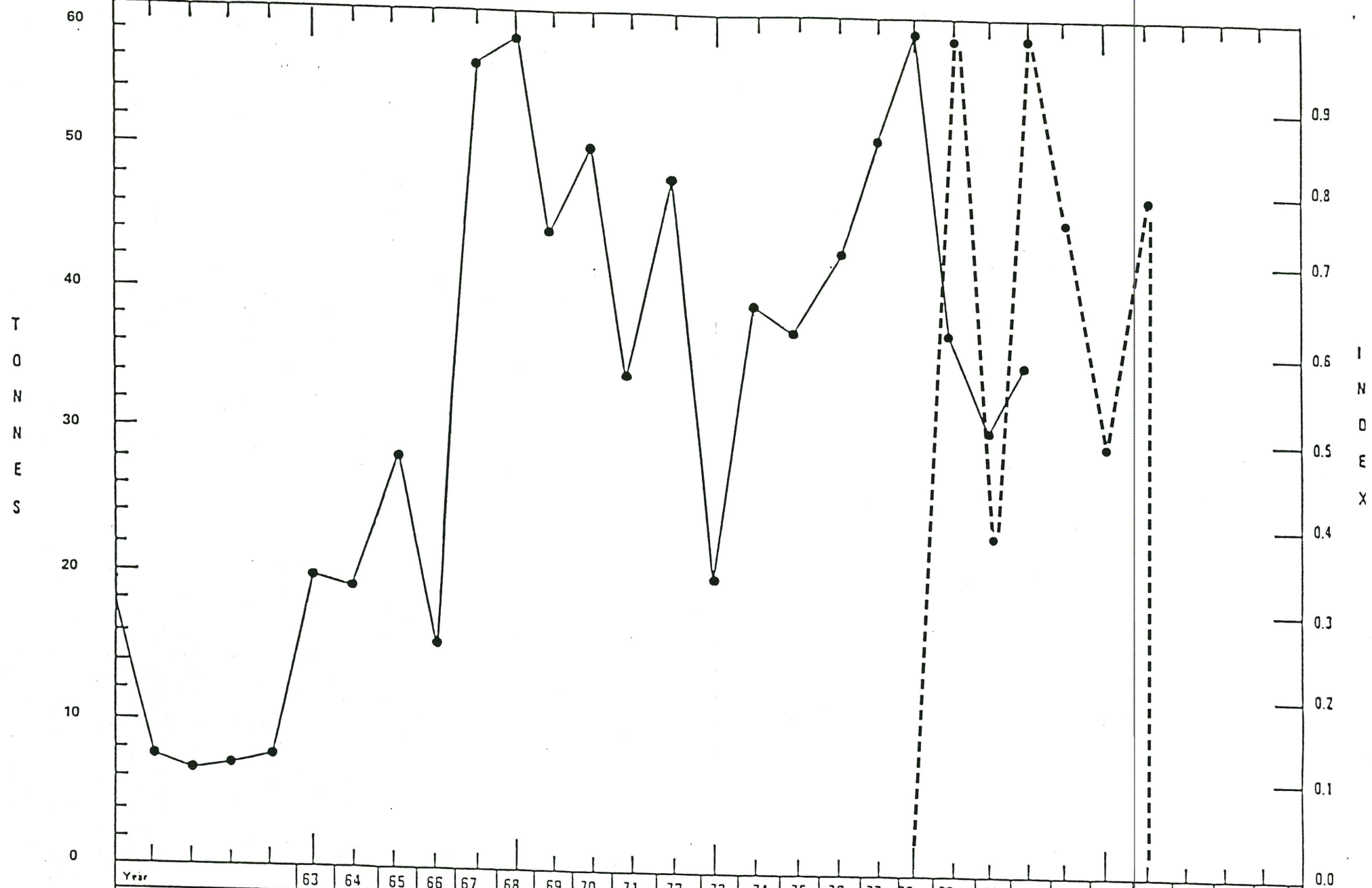
Year	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87
Total Number of Observations																	1			3	5	3			
Total Number of Reefs Surveyed																	1			3	5	3			
Total Number of Reefs With Crown of Thorns																	1			3	5	1			

FIG 11.4 NON Scientist OBSERVATIONS for EL.
NORTHERN SECTION

FIG 11.3 Scientist Observations of COTS AGAINST Landings for Worl

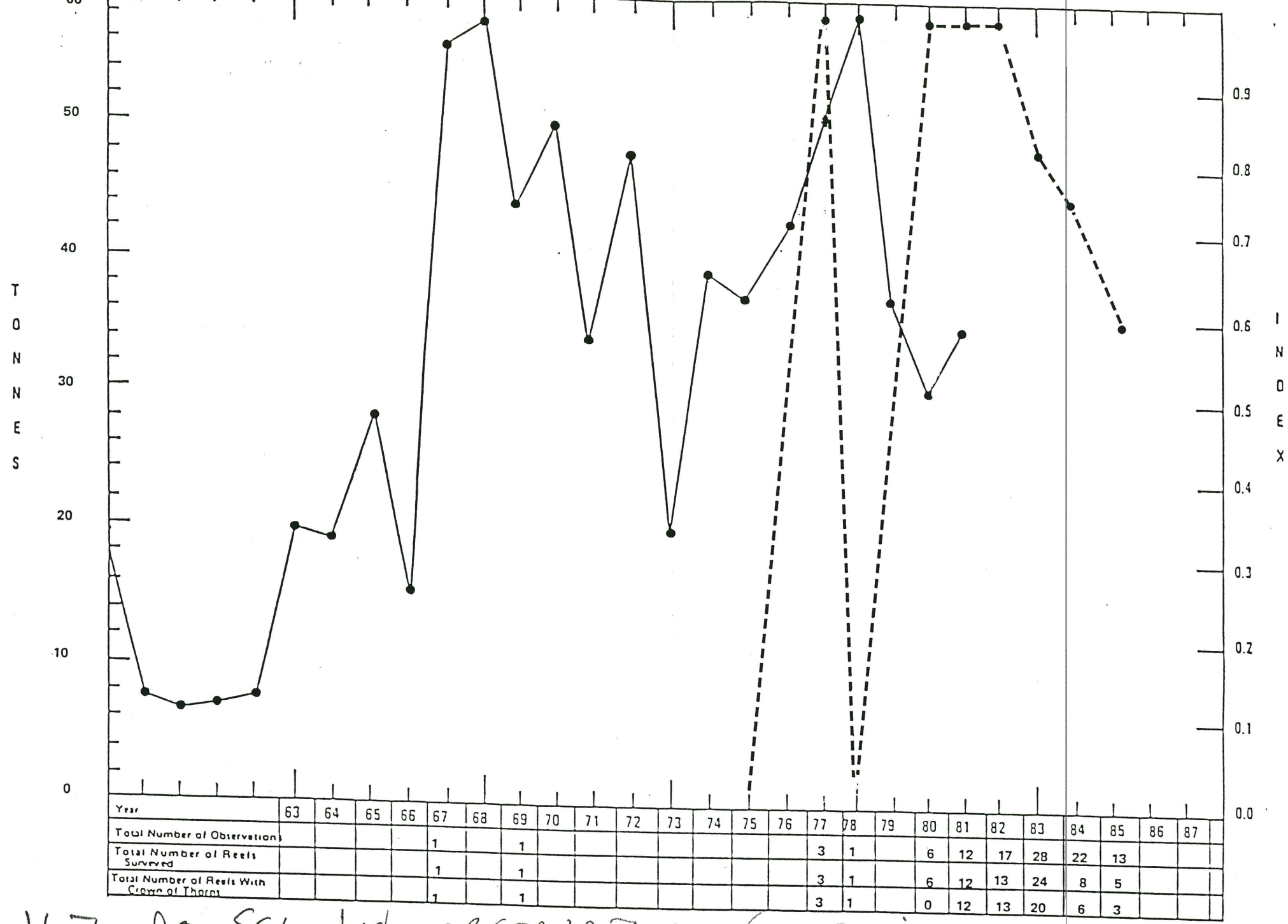


Year	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87
Total Number of Observations				68	28	7	37	93	19									25	13	21	4	12			
Total Number of Reefs Surveyed				53	17	4	20	44	14									25	13	10	3	4			
Total Number of Reefs With Crown of Thorns				50	15	4	12	35	14									15	13	10	3	4			



Year	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87
Total Number of Observations																	6	8	3	4	5	6			
Total Number of Reefs Surveyed																	6	8	3	4	4	5			
Total Number of Reefs With Crown of Thorns																	6	3	3	3	2	4			

FIG 11.6 MANTA TOW FOR CAIRNS



Year	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87
Total Number of Observations					1		1								3	1		6	12	17	28	22	13		
Total Number of Reefs Surveyed					1		1								3	1		6	12	13	24	8	5		
Total Number of Reefs With Crown of Thorns					1		1								3	1		0	12	13	20	6	3		

FIG 11.7 Non Scientist OBSERVATIONS for CAIRNS

CHAPTER 6. THE CENTRAL SECTION.

6.1 INTRODUCTION

The Central Fisheries Section is the same as that designated as the Central Section in the G.B.R.M.P. (fig. 6.1). It extends from Dunk Island in the north to Hydrographers Passage east of the Whitsundays in the south and contains some 220 reefs and a large number of High Islands.

Major shore based Q.F.B. processing factories are present at Ingham, Townsville, Bowen, and Mackay, whilst other plants have operated at Paluma, Ayr, Homehill, and Proserpine at various times. The processing plant at Mackay processes the most fish of any factory on the G.B.R.

The combined total production of reef fish caught in the Central Fisheries Section is shown in table 5.1 and fig 6.1, whilst table 5.2 provides a breakdown by species of fish landed for the Central Section. Appendix A2 has a full listing of species landed by port.

6.2 ANNUAL PRODUCTION TRENDS

The Central Fisheries Section has had the most variable combined annual reef fish landings in comparison to the other Sections, fluctuating 40 fold between the maximum and minimum landings (Fig 6.2). Apart from a substantial decline in annual production of reef fish over the years 1976-78, landings have in general increased. The most significant increase is an almost 3-fold jump in landings of fish from 52.1 tonnes in 1969 to 142.5 tonnes in 1970. Combined landings increased over the following 3 years to 205.3 tonnes of reef fish landed in 1973. Annual landings remained above the 200 tonne level until 1975 with a peak production of 24.8 tonnes in 1974. Landings crashed dramatically in 1976 to 162.5 tonnes of fish landed and then fell further to 95.6 tonnes in 1978. Annual reef fish landings for the Cental Fisheries Section rose again sharply in 1979 to 200.4 tonnes, with a peak production level of 254.9 tonnes following in 1980.

6.3 SPECIES COMPOSITION

The most noticable feature about the Central Section is that landings of all the species examined have increased significantly over the years examined. The majority of reef fish landings have been processed through the Mackay Fish depot, with Townsville also handling significant quantities.

Coral trout is the most commonly commercially landed fish in the Central Section (Table 5.2). Landings increased nearly 4-fold from 1969 to 1970, jumping from 23.1 to 86.0 tonnes (fig. 6.2). Annual landings of Coral trout steadily increased over the next 4 years to a plateau of 104 tonnes of fish landed in 1974. Annual production of Coral trout declined by an order of magnitude during the next 4 years to a minimum of 10.3 tonnes of fish landed in 1978. Landings improved markedly over the next 3 years to a maximum annual production for the Central Fisheries Section of 130 tonnes of fish landed in 1981.

Annual landings of Sweetlip (fig. 6.3) apart from minor slumps in production has generally increased in a series of plateaus culminating in a peak production figure of 96.3 tonnes in 1980. Annual production increased most substantially in 1973 with a 3-fold increase to 59.2 tonnes of Sweetlip landed.
Landings rose steadily from 1975 to 1980 to a production peak of 96.3 tonnes of Sweetlip landed for the Central Section.
Emperor is a commercially important species in the Central Fisheries Section with the majority of fish being processed through the Mackay Fish depot. Annual production figures for Emperor (fig. 6.4) were minimal until 1970 (under 3 tonnes) but then increased 20-fold to 61.1 tonnes in 1972. After a marginal slump in 1973, landings of Emperor jumped to a peak production figure of 116 tonnes in 1974. A similar production yield was sustained in the next year, but landings fell to a low of 18.9 tonnes in 1976. Production remained relatively constant in the subsequent years.
Morwong landings have been inconsequential in the Central Fisheries Section most probably as it is not a particularly good eating species.
Annual production of Nanygai in this region is also extremely low (under 50kg) until 1979 when landings rose to 0.8 of tonnes. However production fell to previous landing figures over the next two years.

Fig 6.3: Landings of Coral trout in the Central Fisheries Section.

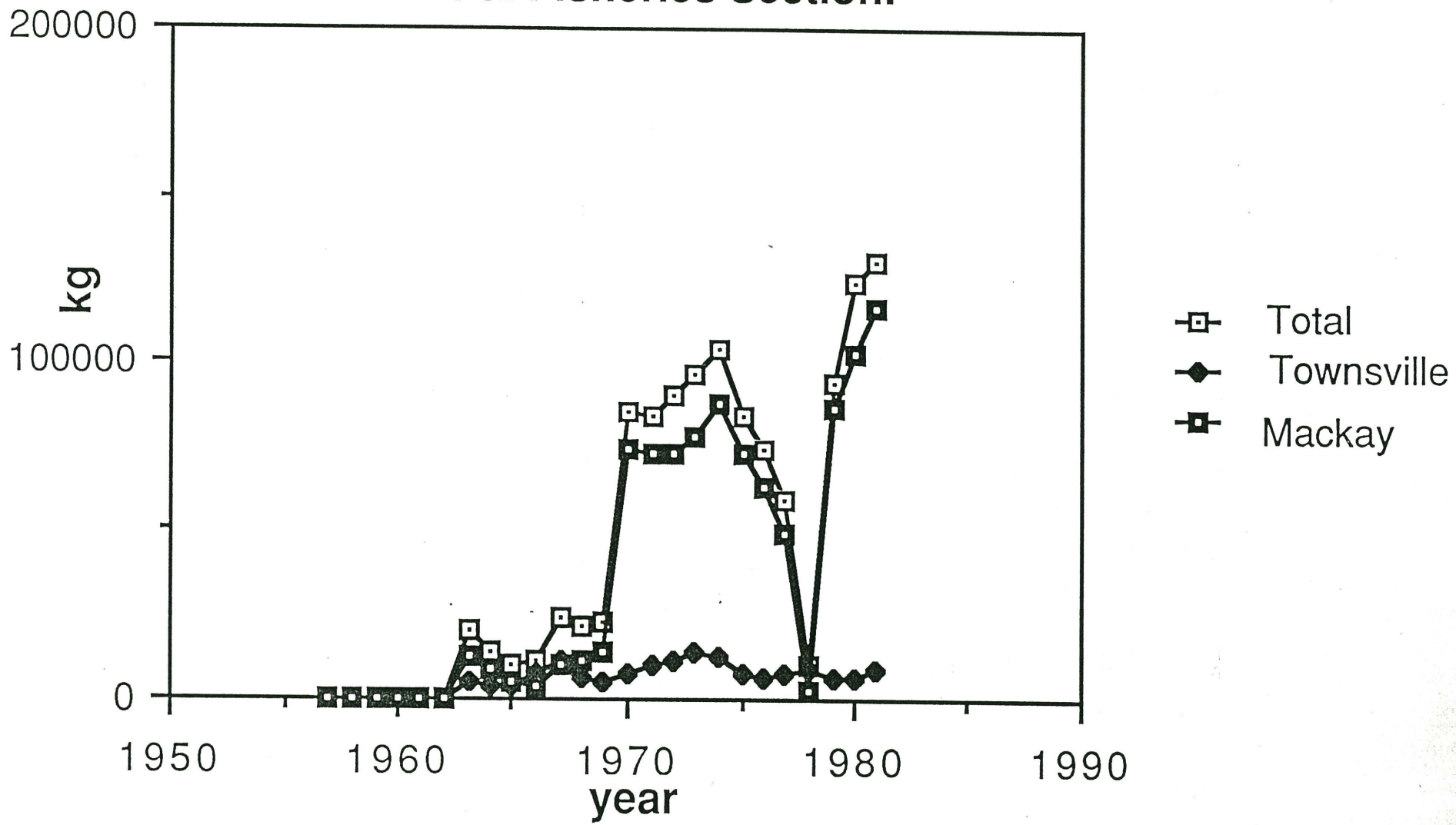


Fig 6.2: Combined landings of reef fish in the Central Fisheries Section.

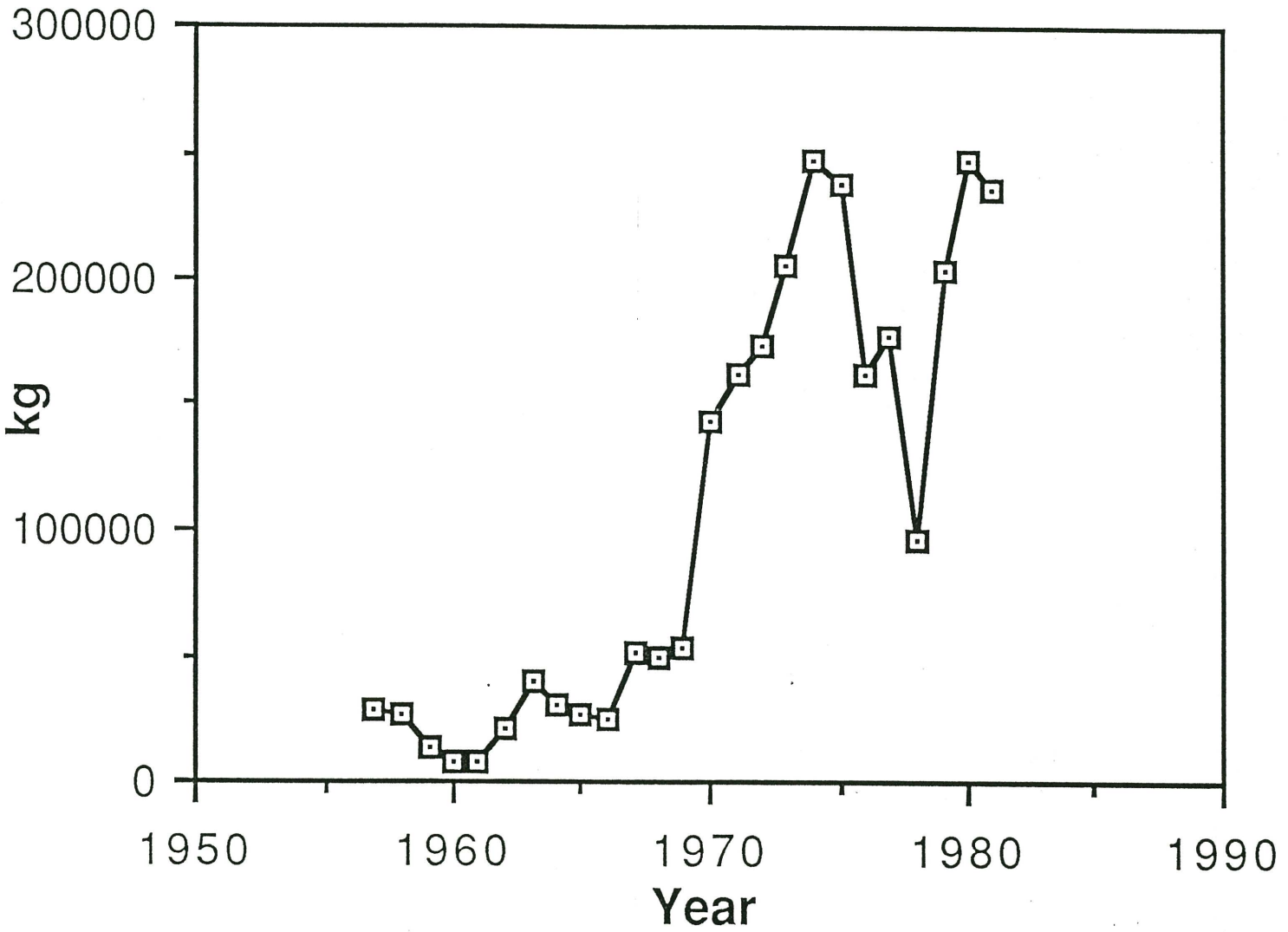


Fig 6.4: Landings of Sweetlip in the Central Fisheries Section.

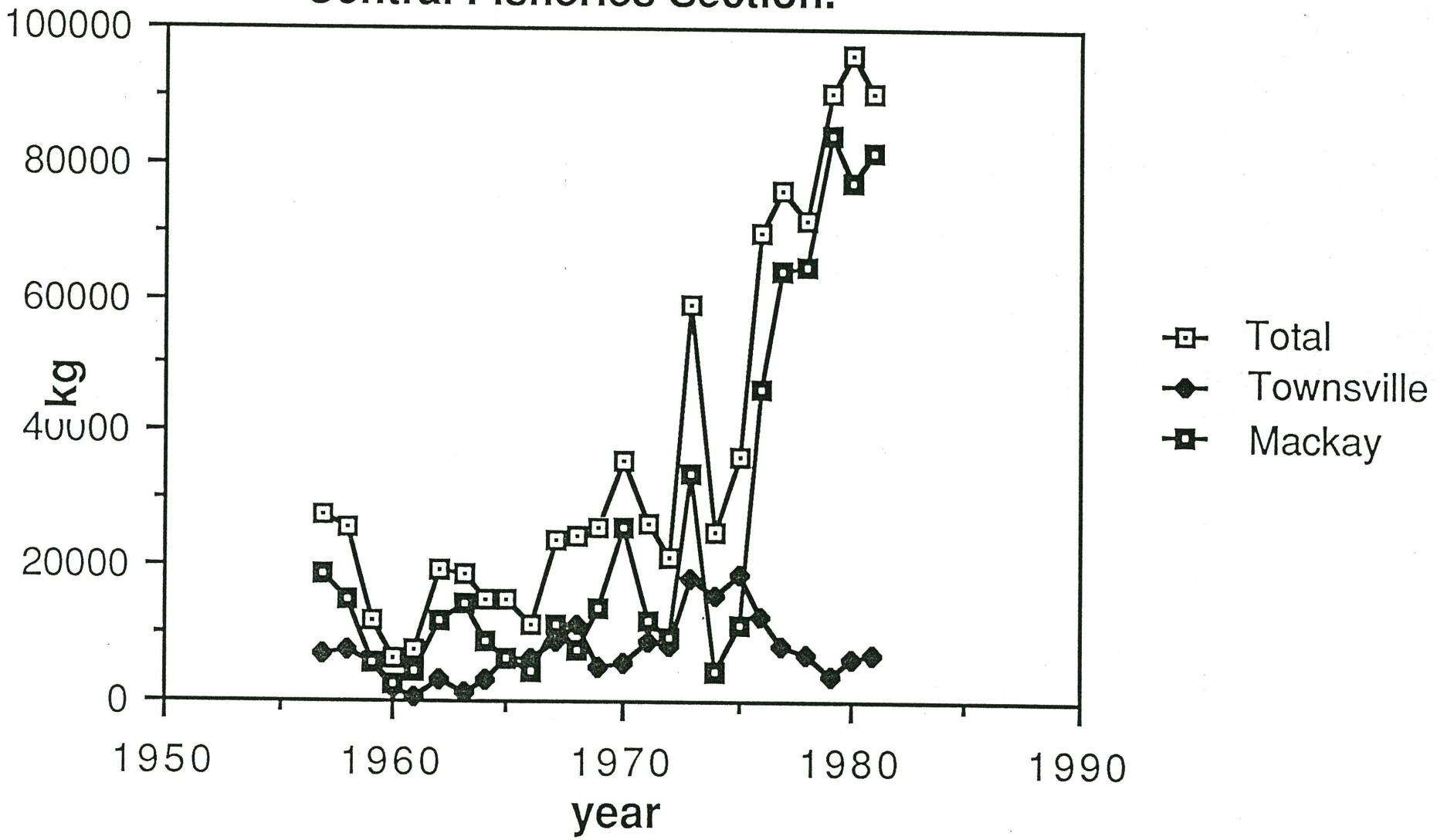


Fig 6.5: Landings of Emperor in the Central Fisheries Section.

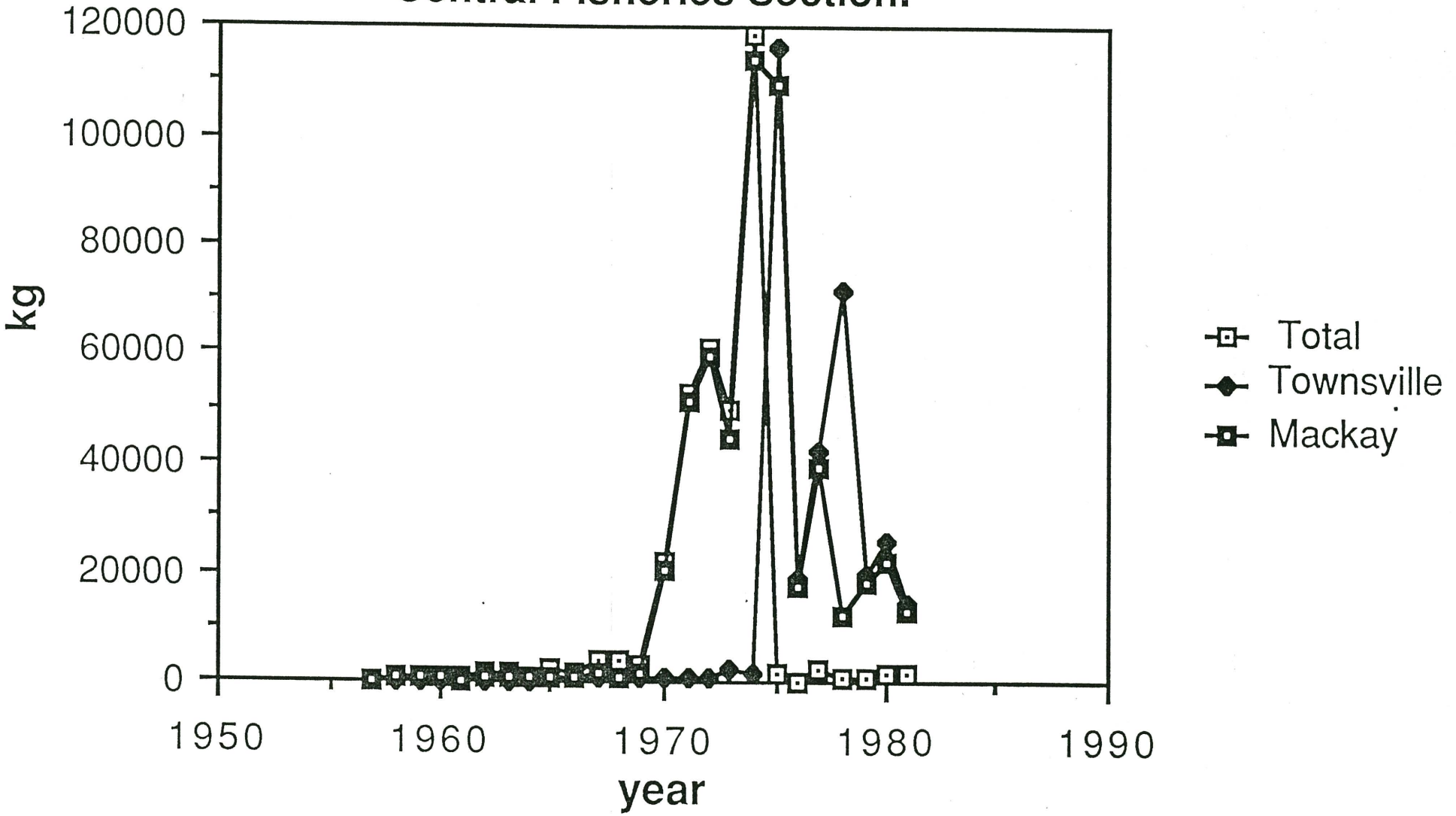


Fig 6.6: Landings of Morwong in the Central Fisheries Section.

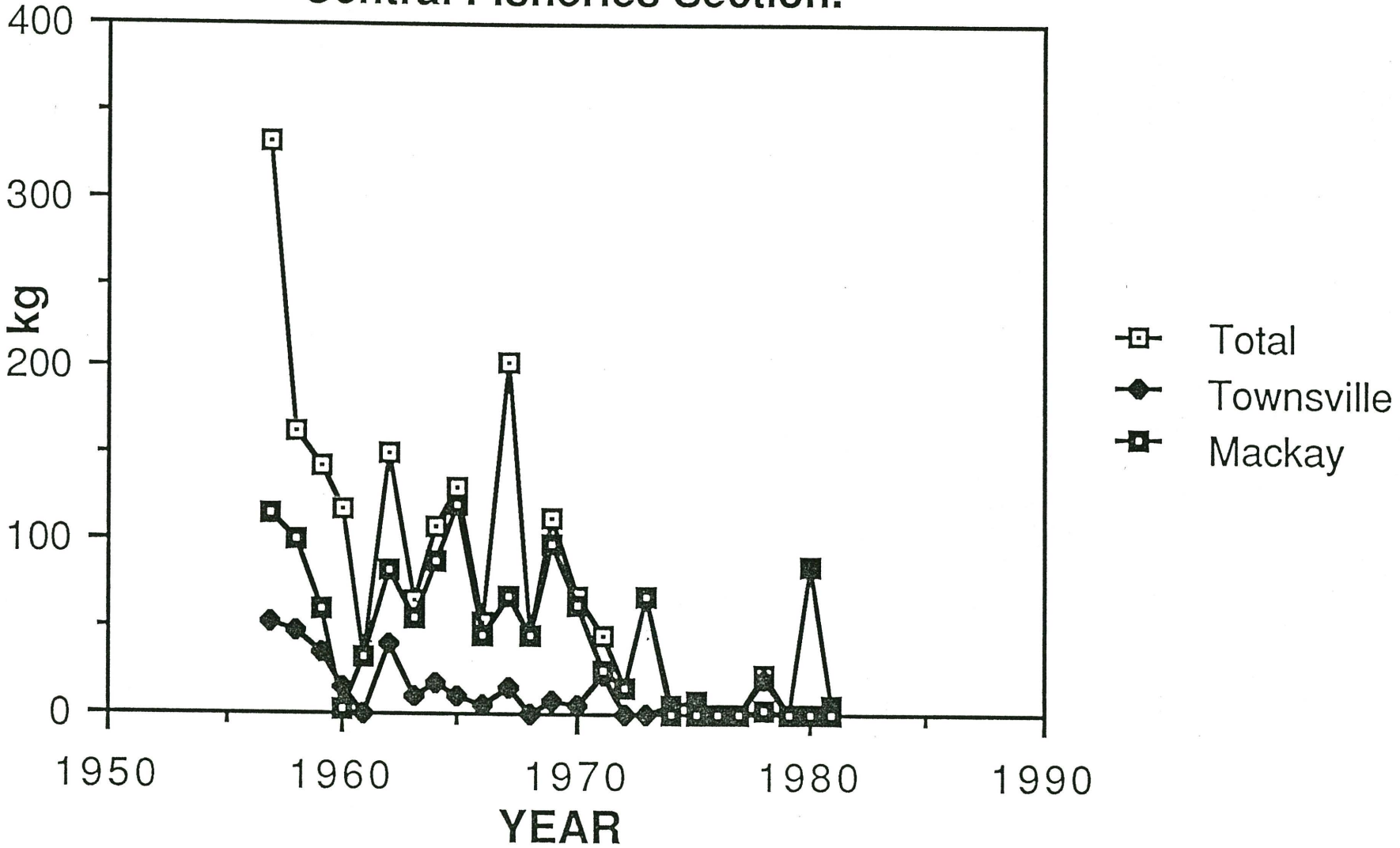
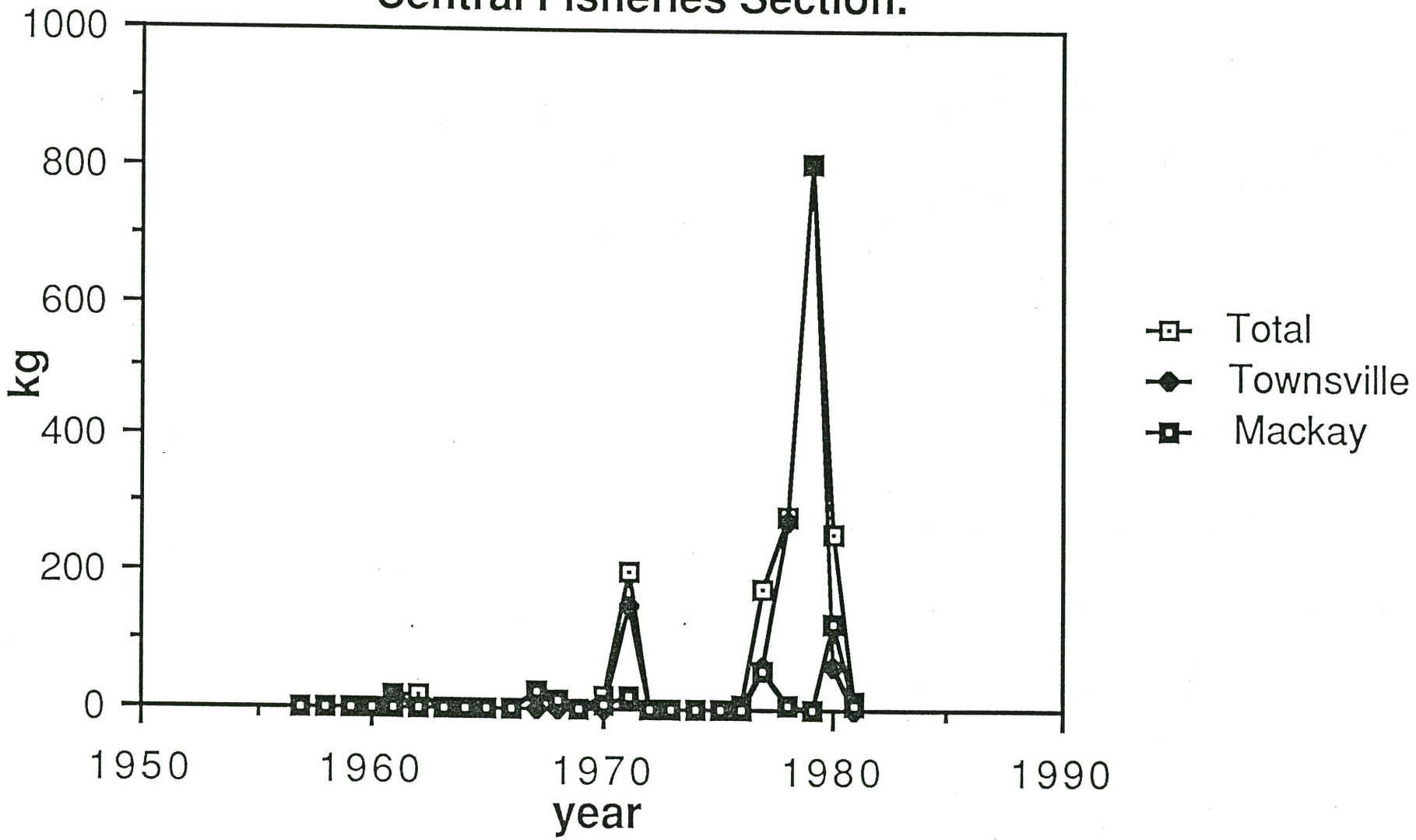


FIG 6.7: Landings of Nanygai in the Central Fisheries Section.



6.3 CROWN-OF-THORNS STARFISH IN THE CENTRAL SECTION.

i. INTRODUCTION

The Central fishing Section is the same as that defined as the Central Section in the G.B.R.M.P. Although the area is large being some .... square kilometres, it has not been subdivided like the other Fisheries Sections for the COT analysis. In is left unsubdivided due to the fact that outbreaks in this area have been wide ranging over a smaller periods of time compared to the other sections.

ii. Observations by Method

Observations of Crown-of-thorns in the Central Section of the GBRMP are largely confined to the periods 1969 through to 1973, and then again from 1980 through to 1985.

Scientist observations are the most common method, and sufficient in number, to identify a major period of Crown-of-thorns starfish activity from 1969 until 1973 (Fig 6.8). A further series of observations by Scientists identified the start of an 'outbreak' in 1981 peaking in 1984. Likewise Manta-towing (Fig.6.9) and observations made by non-scientists (Fig 6.10) identified outbreaks around these time periods, though they differ in the year of maximum number of reefs with starfish populations on them. ~~abundance.~~ This is however attributable to differences in number of observations made rather than any real pattern.

iii. Distance of Reefs from Population Centres.

All reefs in the Central section lie further offshore than those in the Northern Fisheries Section, the majority being concentrated at distances greater than 60 km offshore. In fact the majority of reefs with observations of Crown-of-thorns are placed greater than 90 km away. Of those 29 reefs with significant outbreaks (TABLE 6.??), 7 are placed 60-90 km offshore whilst the remainder are greater than 90 km from any population centre.

Nine reefs have had re-occurring outbreaks, 5 of these twice and 4 reefs (Bramble, Bowden, Slashers, and Dip) 3 occurences.

TABLE 6.1: DISTANCE OF REEFS IN THE CENTRAL FISHERIES SECTION FROM POPULULATION CENTRES AND INTENSITY OF OUTBREAK.

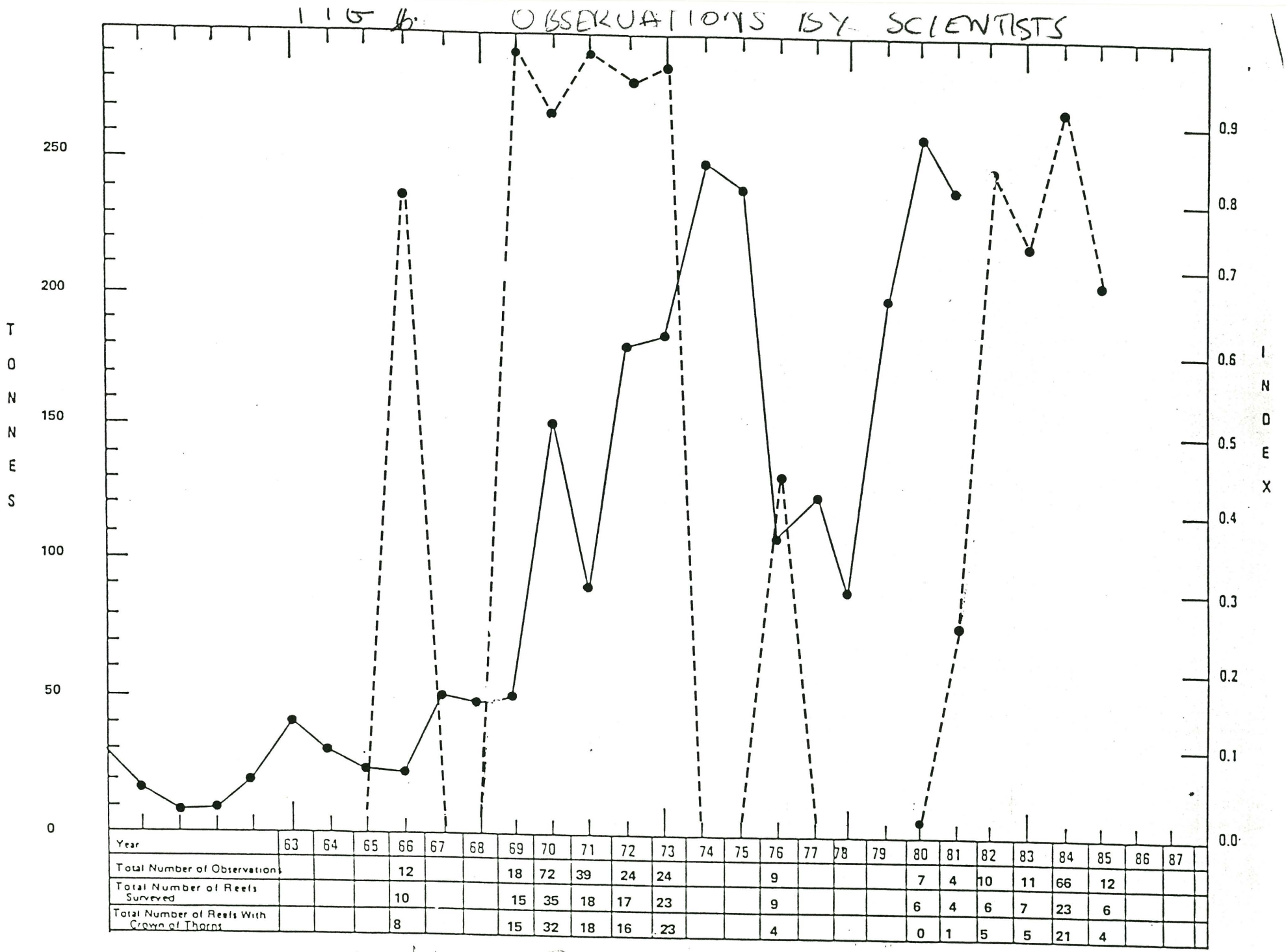
CATEGORIES OF OUTBREAK.
A= 1 Starfish
B= 1-9 Starfish
C= 10-47 Starfish
D= 50-99 Starfish
E= > 100 Starfish

CENTRAL SECTION

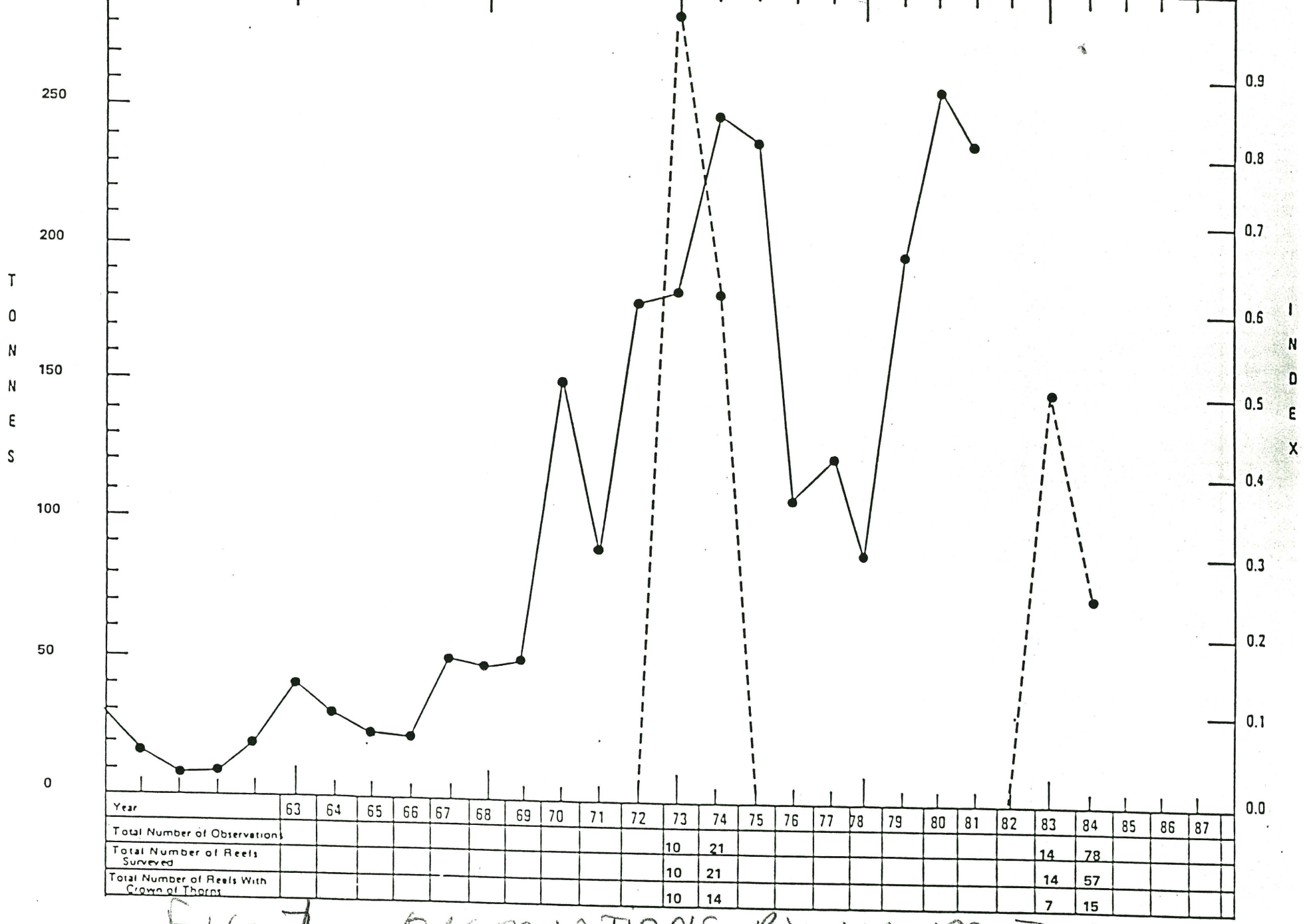
	< 30 KM					30-60 KM					60-90 KM					> 90 KM				
YEAR	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
1966	1										1	1	1				1	1		
1967																				
1968																				
1969											3	4			1	3	4	1		
1970	1										2	5	1		1	11	8	3	1	5
1971												1			2	1	3	1	1	7
1972											3	6				1	7	2		1
1973											4	3		1	1	9	2	2		3
1974													1	1			3	2	1	4
1975																				
1976			1										1			1	1			
1977								1												
1978																				
1979												1					1			
1980															1		1			
1981						1						2	1			1	5	1		
1982											1	3	3		1	2	3	1		
1983																2	5	4	2	2
1984								1			1	3	3	4	4	3	8	3	2	5
1985											1		3				1	2		1

Table 6.2:REEFS WITH MORE THAN 100 INDIVIDUALS AT ONE TIME
CENTRAL SECTION

YEAR	REEF	DISTANCE	FISHING ACTIVITY
1969	BRAMBLE	4	
1970	GRUB	3	
	ARAB	4	
	GLOW	4	
	KELSO	4	
	PITH	4	
	SLASHERS	4	
1971	GRUB	3	
	HELIX	3	
	BOWL	4	
	CHICKEN	4	
	COIL	4	
	DAVIES	4	
	FORK	4	
	GLOW	4	
	KNIFE	4	
	LYNCH'S	4	
	SLASHERS	4	
	SPOON	4	
1972	BOWDEN	4	
1973	HOPE	3	
	BOWDEN	4	
	PRAWN	4	
	SHRIMP	4	
1974	BOWDEN	4	
	PRAWN	4	
	UN-NAMED	4	
1980	BAIT	3	
1982	BRAMBLE	4	
1983	KEEPER	3	
	BRAMBLE	4	
	DIP	4	
	KELSO	4	
	TRUNK	4	
1984	BRITOMART	3	
	HELIX	3	
	JOHN BREWER	3	
	KEEPER	3	
	ARC	4	
	DIP	4	
	HOPKINSON	4	
	SLASHERS	4	
	YANKEE	4	
1985	DIP	4	

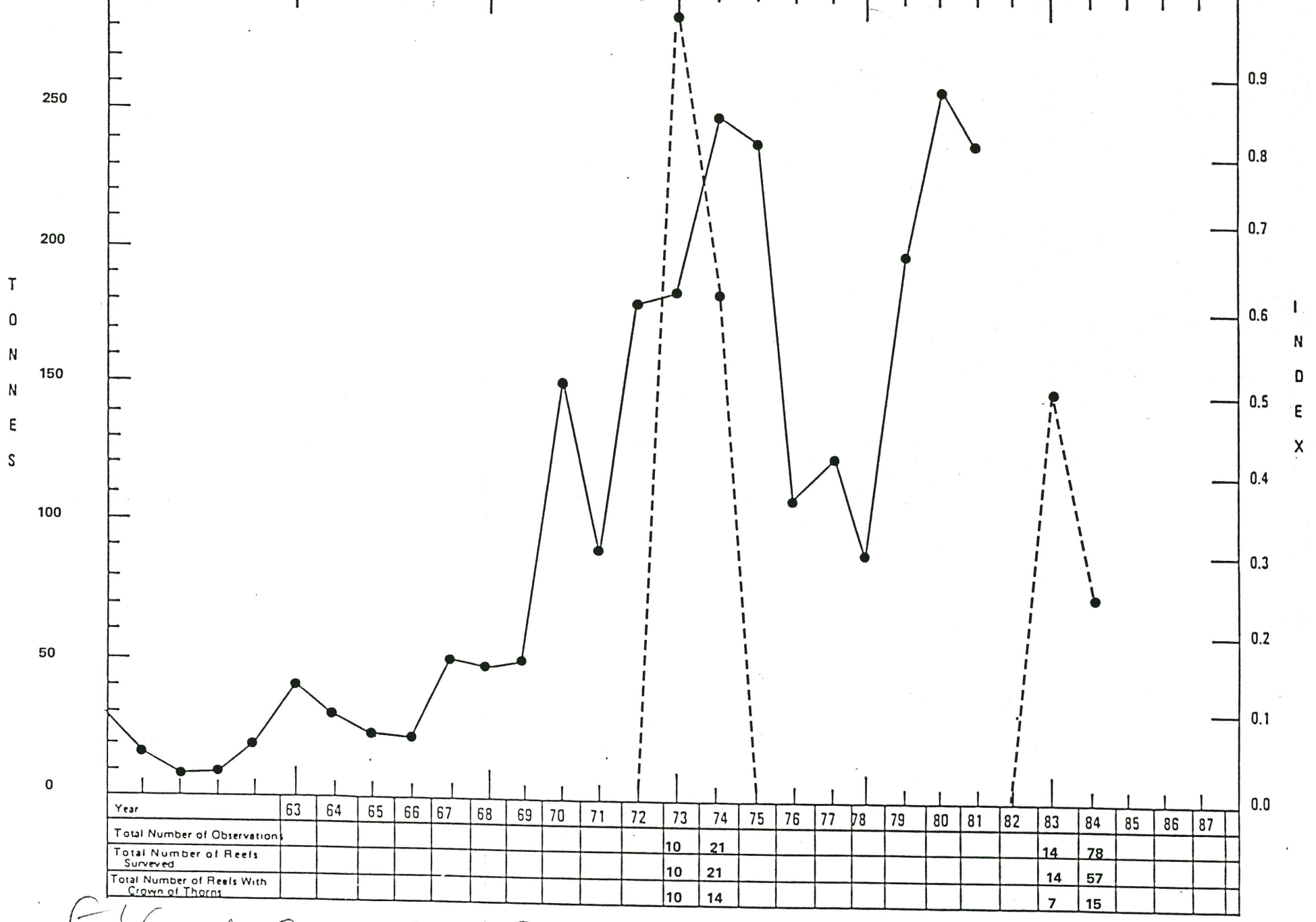


Year	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87
Total Number of Observations				12			18	72	39	24	24			9				7	4	10	11	66	12		
Total Number of Reefs Surveyed				10			15	35	18	17	23			9				6	4	6	7	23	6		
Total Number of Reefs With Crown of Thorns				8			15	32	18	16	23			4				0	1	5	5	21	4		



Year	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87
Total Number of Observations											10	21									14	78			
Total Number of Reefs Surveyed											10	21									14	57			
Total Number of Reefs With Crown of Thorns											10	14									7	15			

FIG 6. OBSERVATIONS BY MANTA TOWING
CENTRAL



Year	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87
Total Number of Observations											10	21									14	78			
Total Number of Reefs Surveyed											10	21									14	57			
Total Number of Reefs With Crown of Thorns											10	14									7	15			

FIG 6.9 CENTRAL NON-SCIENTIST

CHAPTER 7: CAPRICORNIA FISHERIES SECTION.

7.1 INTRODUCTION

The Capricornia Fishing Section encompasses both the Capricornia and Capricornia Sections of the Great Barrier Reef Marine Park. It is an area of some 12,000 square kilometres, and includes the Pompey, Swain, and Capicorn-Bunker reef complexes. In terms of fishing it represents one of the most economically important areas on the Great Barrier Reef. Studies by the Institute of Applied Social Research (1981) as well as studies by D.P.I. in association with CCFC on the commercial fishing Industry (1979), have detailed the economic characteristics of the fishing industry in this area.

Major shore based Q.F.B. processing factories are present at Rockhampton, Yeppoon, Gladstone, Bundaberg, whilst other minor depots have operated at Maryborough, Pialba, Rosslyn Bay and Tinaan Bay at various times.

The combined total production of reef fish caught in the Capricornia Fisheries Section is shown in table 5.1 and fig 7.1, whilst table 4.2 provides a breakdown by species of fish landed for the Capricornia Fisheries Section. Appendix A3 has a full listing of species landed by port.

7.2 ANNUAL PRODUCTION TRENDS

The Capricornia Fisheries Section consistently had the greatest annual landings of reef fish for all sections, up until 1970 (Table 7.1). Annual production dropped substantially in 1961 and again in 1968 and 1969 (Fig 7.2). Combined landings of reef fish species increased steadily from 53.8 tonnes in 1958 to a plateau of approximately 71 tonnes in the years 1964 through until 1966. Annual landings decreased 2-fold over the next two years to a low of 35.5 tonnes in 1968. A large jump in combined landings occurred in 1970 from 38.8 to 94.9 tonnes. Landings improved further in 1971 to 113 tonnes, then declined to 93 tonnes the following year. Annual production for the Capricornia Fisheries Section remained centred around the 93 tonne mark until 1977 after which time they dropped substantially to 59.1 tonnes in 1979. Reef fish landings increased significantly over the next two years to a peak of 127.1 tonnes in 1980. but fell two fold in 1981.

7.3 SPECIES COMPOSITION

Sweetlip is the most commonly caught reef fish in this section of the reef (Table 5.2) and as such largely reflect those trends seen for the entire combined landings (Fig 7.2). Most notable is the threefold jump in landings from 22.5 tonnes in 1969 to 63.1 tonnes in 1971 (fig. 7.4).

Coral trout (fig. 7.3) is the second most commercially important fish in the Capricornia Section. Landings of Coral trout increased assymtopically from 1969 when 9.8 tonnes were recorded as being landed until 1973 when a plateau of 46.7 tonnes

were recorded. Landings of Coral Trout declined subsequently apart from increase in 1976 and again in 1980.

Landings of Emperor (fig. 7.5) show similar patterns of annual production found for Coral trout. Notable is the 13.3 tonnes landed in 1962 from 5.1 tonnes landed the previous year. A decline in landings is evident over the next 6 years reaching a low production yield of 4.7 tonnes in 1968. Landings rose again over the next 3 years to 9.4 tonnes in 1971 but then crashed again to 4.8 tonnes in 1972. Landings improved substantially to 11.9 tonnes in 1975, but then fluctuated over the next 3 years before increasing steadily to a peak of 14.4 tonnes landed for 1981.

Morwong is a commonly caught fish in the Capricornia Section, more so than in the other sections of the Marine park. Landings have declined however from values of around the 2-3 tonne mark in the late fifties and early sixties to figures under one tonne subsequent to 1964 (fig 7.6).

Q.F.B records of Nanygai for the Capricornia Fisheries Section, show marginal landings, being less than one tonne until 1973 when 1.1 tonnes were landed (fig. 7.7).
No Landings of Nanygai were recorded for 1974 and 1975. Landings increased steadily after this time to a peak of 1.7 tonnes in 1981.

Fig 7.2: Combined landings of reef fish in the Capricornia Fisheries Section.

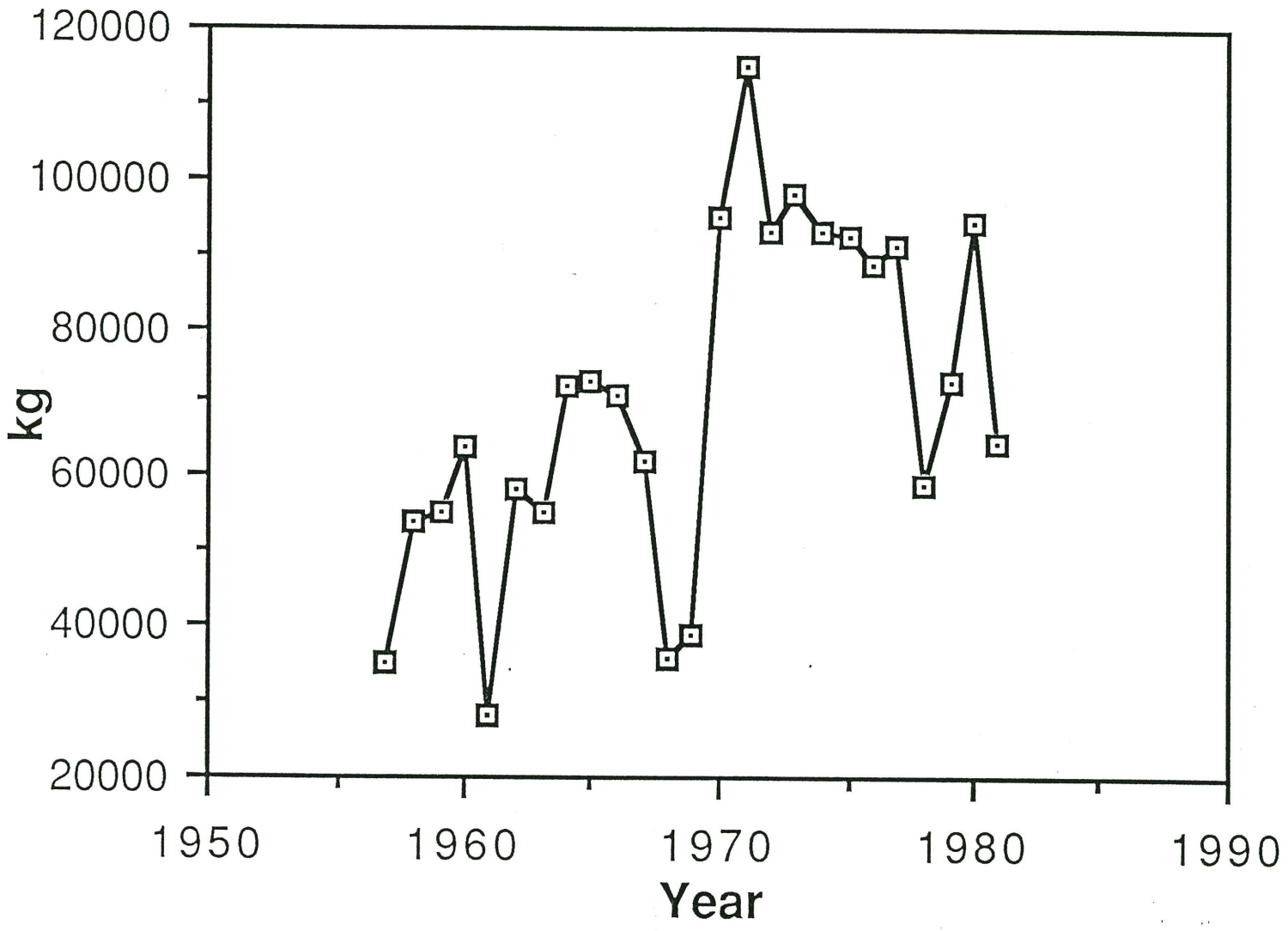


Fig 7.3: Landings of Coral trout in the Capricornia Fisheries Section.

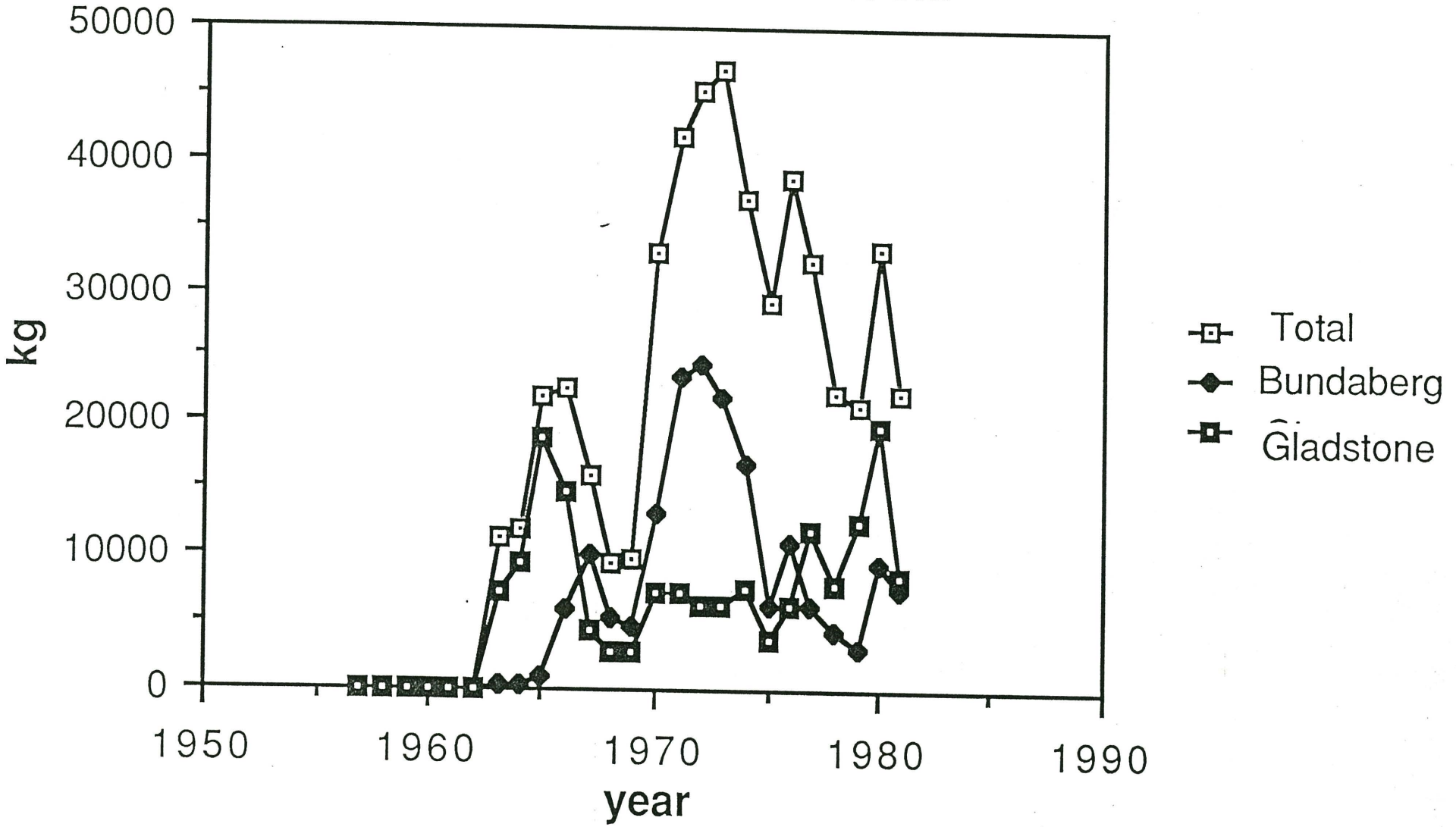


Fig 7.4: Landings of Sweetlip in the Capricornia Fisheries Section.

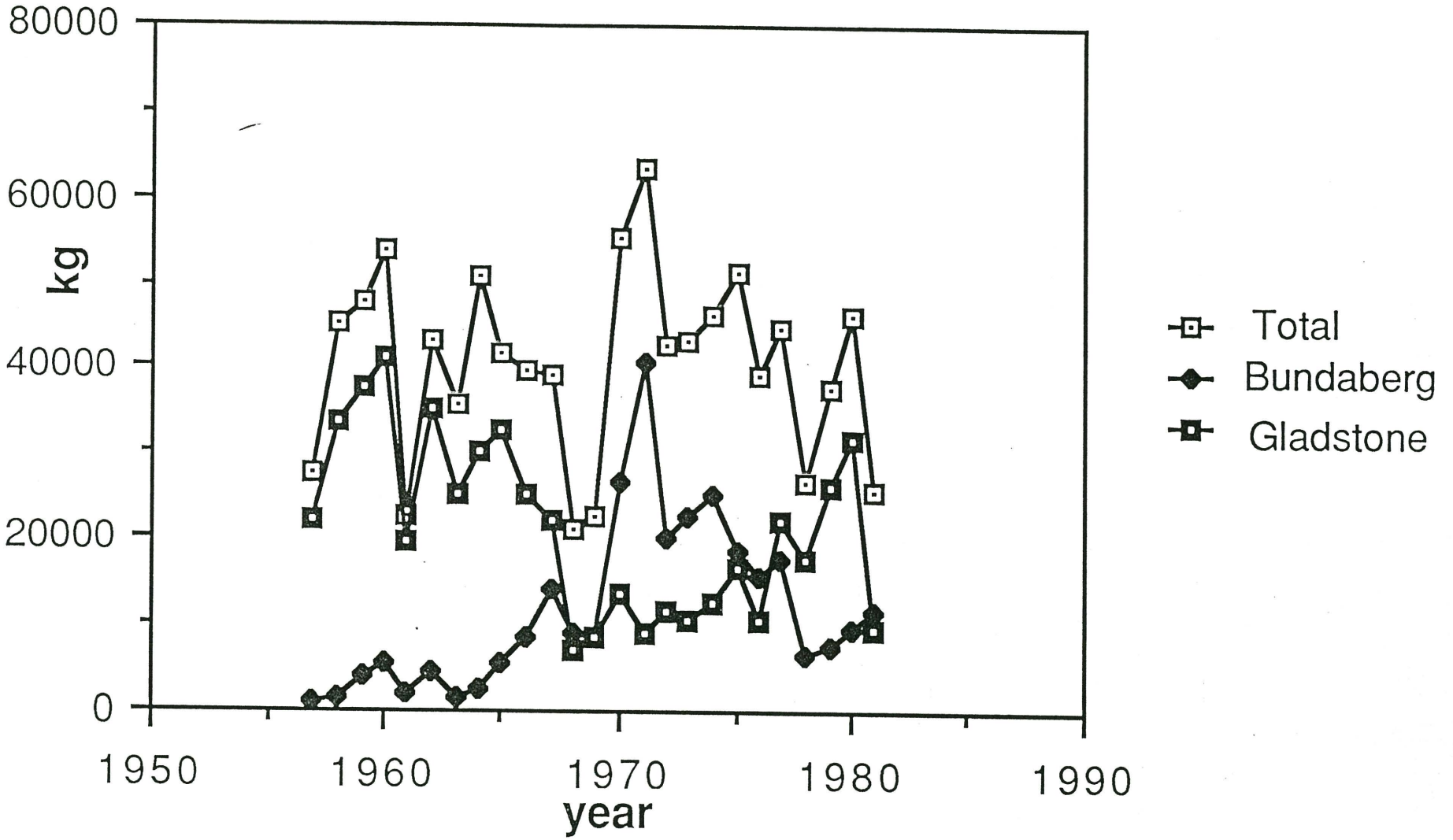


Fig 7.5: Landings of Emperor in the Capricornia Fisheries Section.

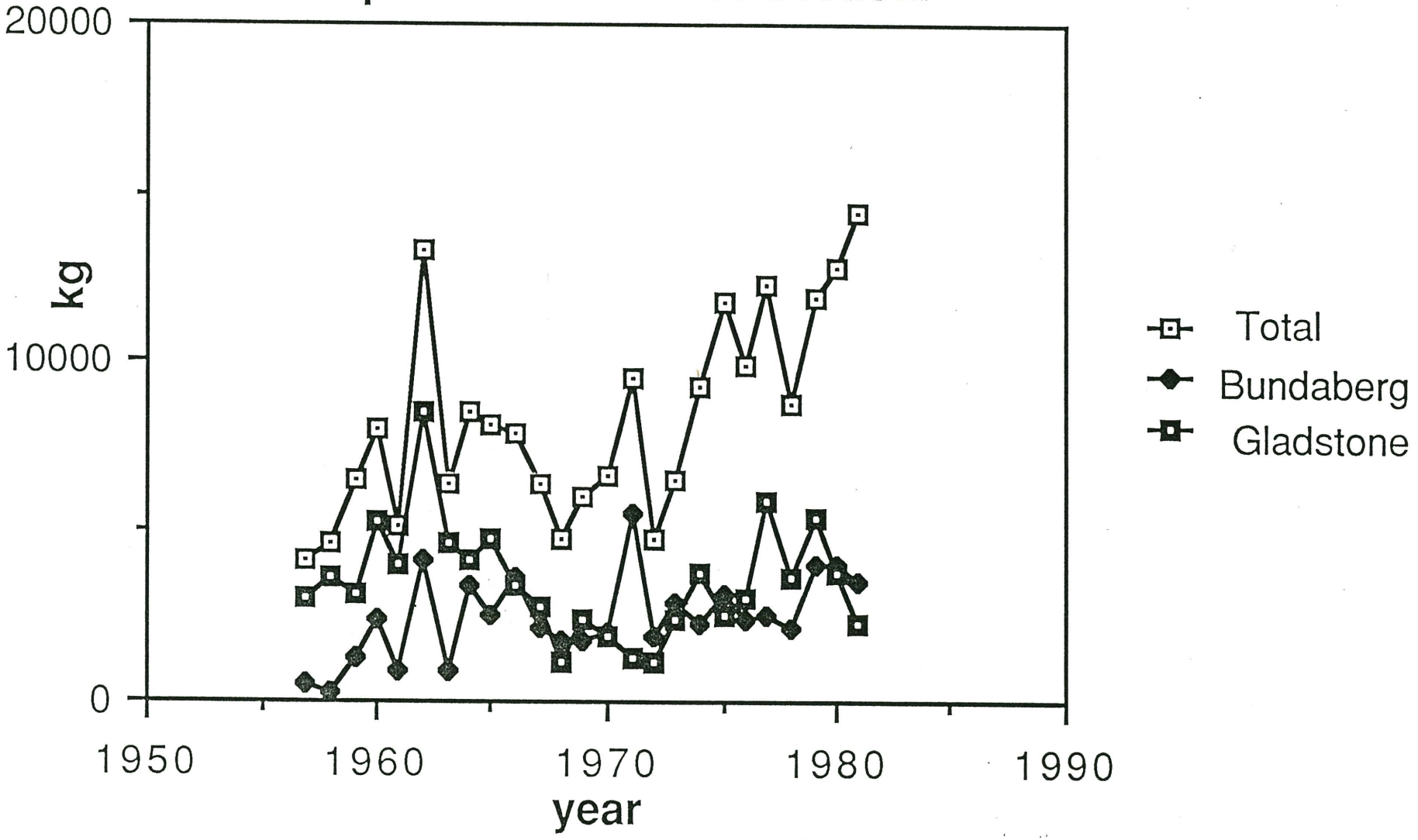


Fig 7.6: Landings of Morwong in the Capricornia Fisheries Section.

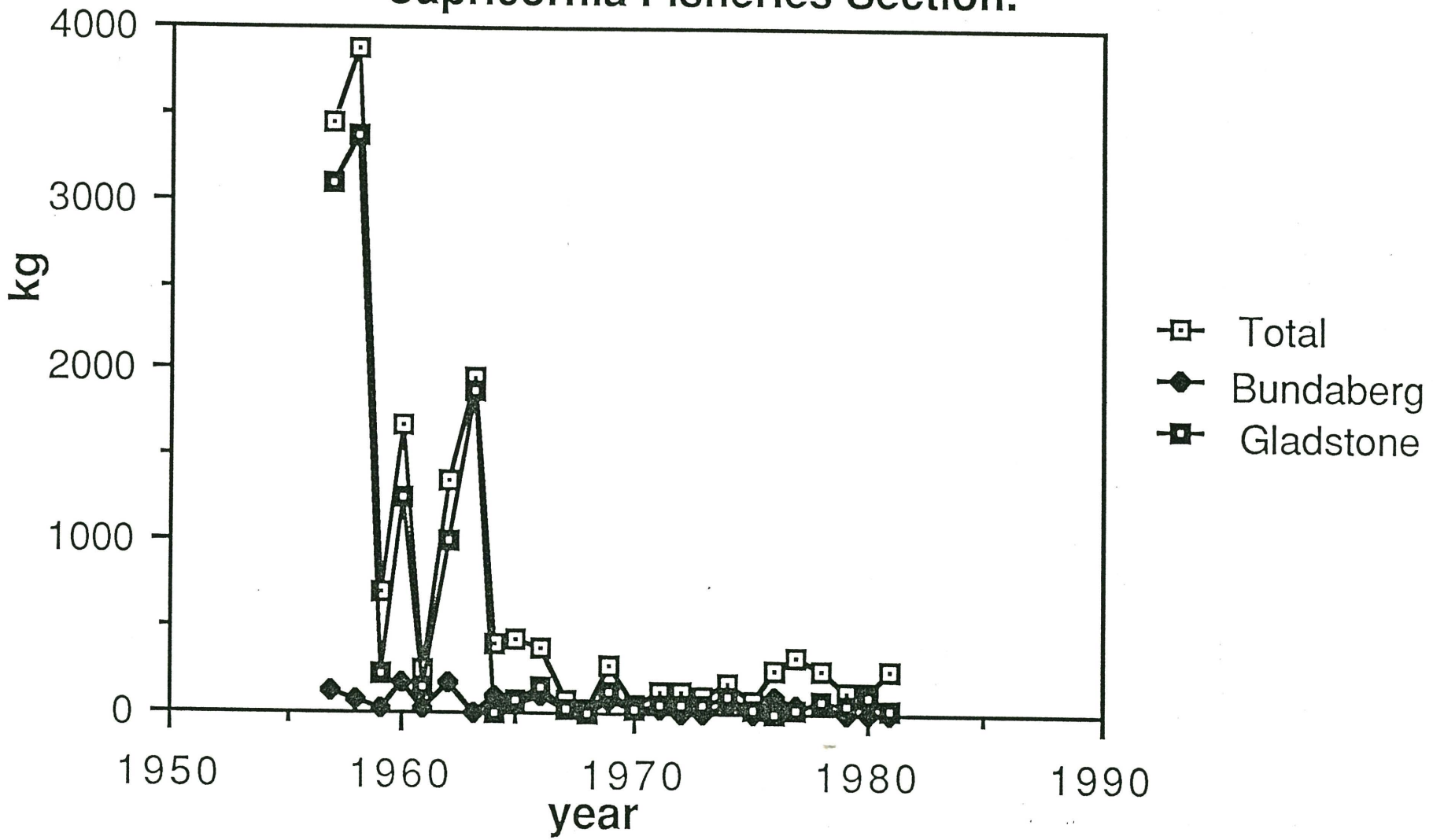
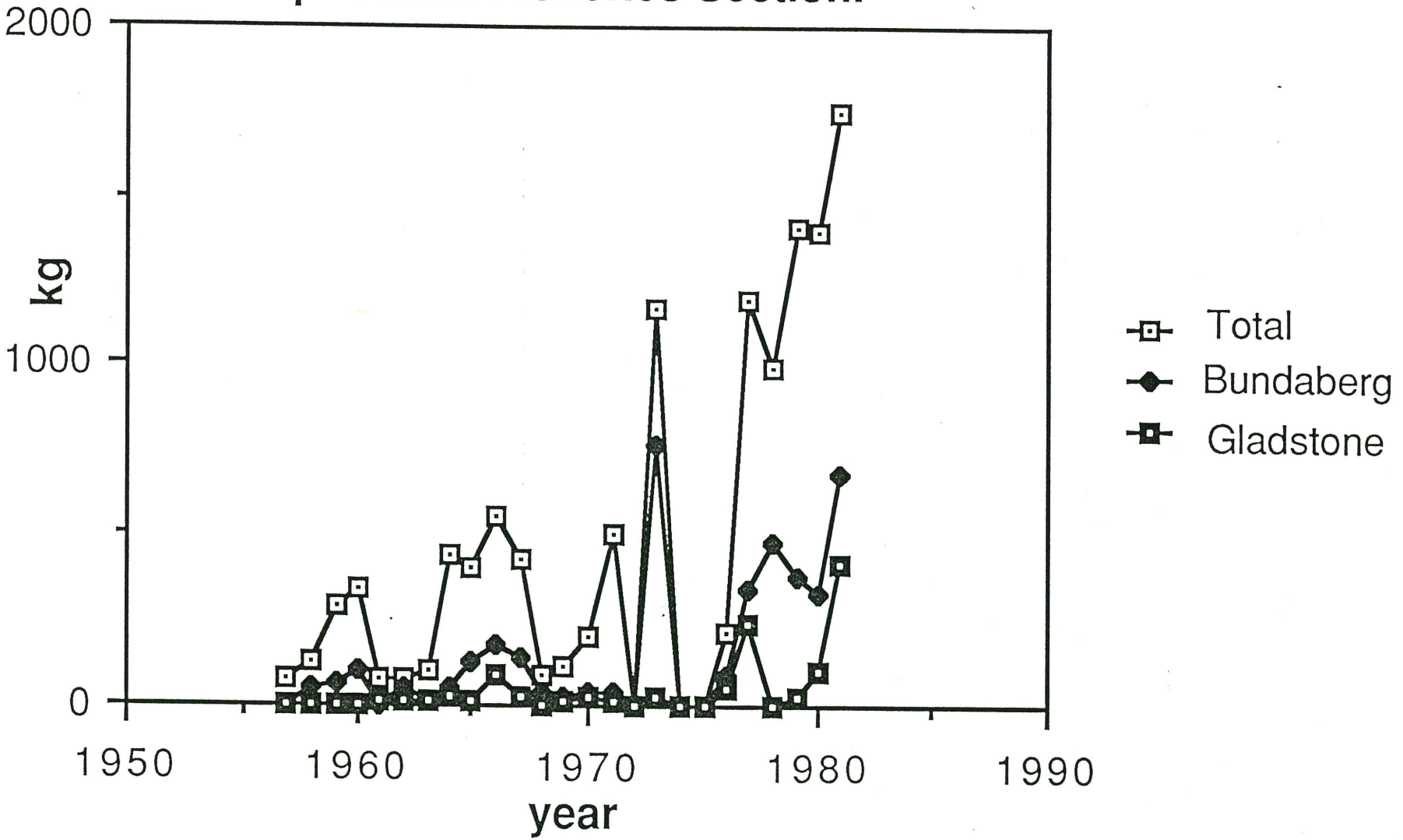


Fig 7.7: Landings of Nanygai in the Capricornia Fisheries Section.



7.4 CROWN-OF-THORNS STARFISH IN THE CAPRICORNIA SECTION.

i. Observations by Method.

Observations by Scientsts of Crown-of-thorns starfish in the Capricornia Fisheries Section were made in the years 1970-71, 1976-77, and 1983-84 (Fig 7.8). There were not however sufficient observations made in the period 1970-71 (KC), for any analysis or index to be calculated. It should be noted though, that the observations made in this time in the Swains reefs, were of medium sized population of between 50-100 individuals (Table 7.1). A comprehensive study in 1977, found Crown-of-thorns starfish on 46 of the 91 reefs surveyed. Of these, 2 reefs had populations of greater than 100 starfish, whilst the majority of the remaining reefs had isolated populations of under 10 individuals. In the previous year a survey of six reefs had failed to find any Crown-of-thorns starfish.

Non-Scientist observations in the period 1981-83 identified a recurrence of starfish on reefs in this region. Of 16 reefs surveyed in 1983, 7 had Crown-of-Thorns, though six of these had populations of under 10 individuals. Likewise observations by Scientists in this same year found starfish on 9 of the 21 reefs surveyed again - all small aggregations. Continuing small populations were sighted in 1984, by Scientsts and Non-scientists, but Manta-towing recorded no observations of starfish on the 9 reefs surveyed. Likewise 13 reefs 'manta-towed' in 1985 recorded no sightings of Crown-of-thorns.

ii. Distance of Reefs from Population Centres.

Reefs in the Capricorn-Bunker group and the Swains complex lie greater than 60km away, and are accessible from a number of ports. These facts make it difficult to discern any clear relationship between distance from port and occurrences of Crown-of-thorns starfish. Only one un-named reef in the Swains has had what could be termed an outbreak. No major populations are evident in the Capricorn-Bunker group.

7.5 DISCUSSION OF CROWN-OF-THORNS STARFISH AND COMMERCIAL LANDINGS.

At the time of the first sightings of Crown-of-Thorns starfish in this section of the reef in 1970-71, landings of reef fish species had tripled from 38.8 tonnes in 1969 to a peak annual production of 115 tonnes in 1971. This was due to major increases in landings of Coral trout and Sweetlip. The average combined reef fish landings for the period 1967 to 1971 was 69.3 tonnes with a variance of 45 %. The following 5 year period, 1972 to 1976 had a high sustained average reef fish production of 92.8 tonnes and a variance of only 3.2 percent.
Combined landings fluctuated considerably from 1977 to 1981 with an average production of 76.3 tonnes and a variance of 18%.
Minor Crown-of-thorns starfish populations were identified in the Swains reefs at this time. Two reefs were found to have populations of over 100 starfish in 1977, whilst 9 reefs had small populations in 1984.

Although fishing activites are considerable in this section of the GBRMP, Crown-of-thorns starfish activity has been minimal. Craik (1979) using amateur club records from 1957 to 1978 found that although this area is probably one of the most heavily fished on the G.B.R., there had been no decrease in catches or in average fish size in the last 20 years.

TABLE 7.1: DISTANCE OF REEFS IN THE CAPRICORNIA FISHERIES SECTION WHICH HAVE OUTBROKEN AND INTENSITY OF OUTBREAK.

OUTBREAK CATEGORIES.
A= 1 Starfish.
B= 2-9 Starfish
C=10-49 Starfish
D= 50-99 Starfish
E= > 100 Starfish

CAPRICORNIA SECTION

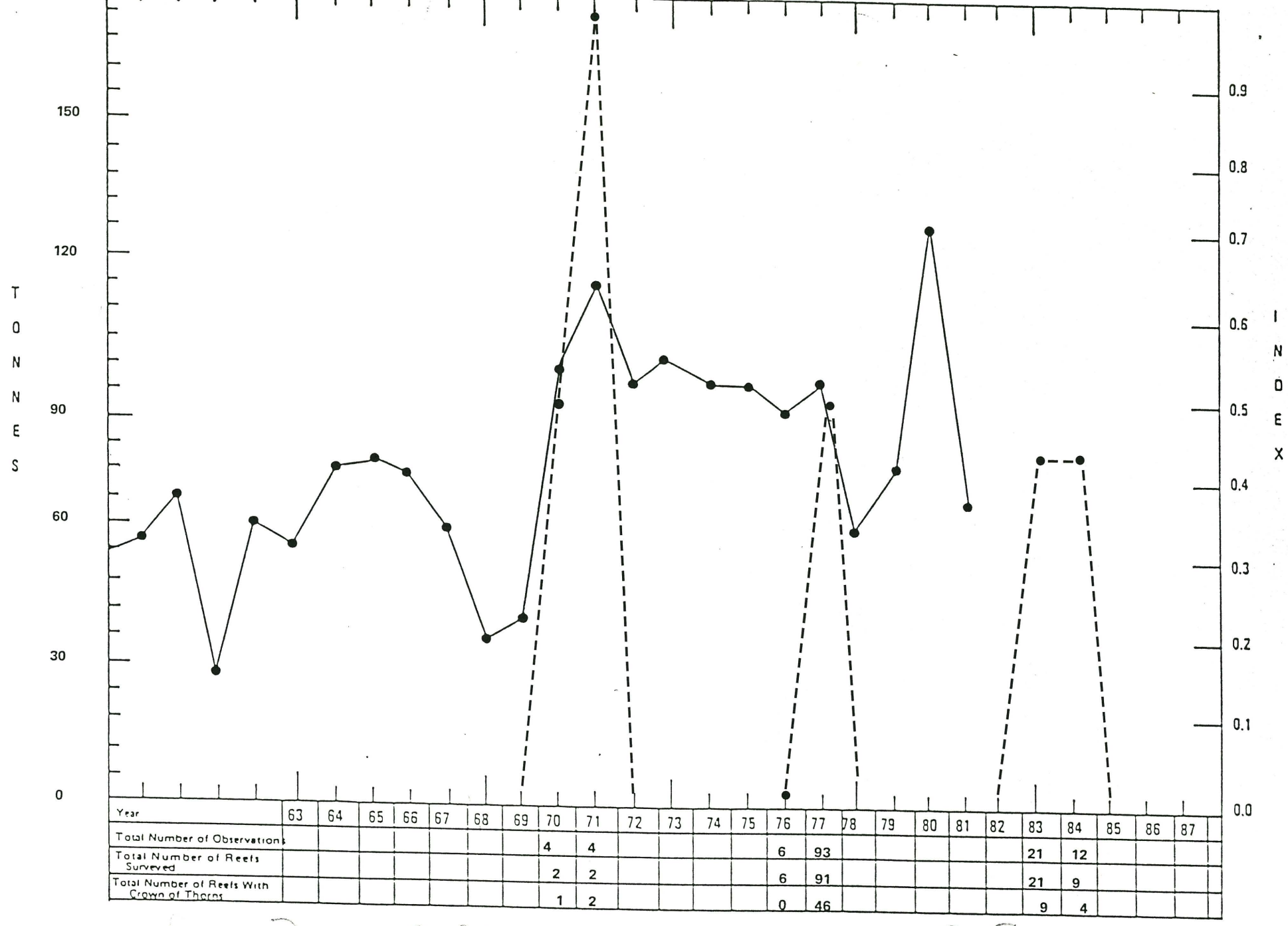
	< 30 KM					30-60 KM					60-90 KM					>90 KM				
YEAR	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
1969																	1			
1970																		1		
1971																	1		1	
1972																				
1973																				
1974																				
1975																				
1976																				
1977																3	11	7	2	2
1978																				
1979																		1		
1980																				
1981																	1			
1982																	1	1	1	
1983																3	1	2		
1984							1									1		4		
1985						1											1			

CAPRICORN/ BUNKER SECTION.

	<30 KM					30-60 KM					60-90 KM					>90 KM				
YEAR	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
1967																		1		
1968																				
1969																	2	4		
1970												1				1				
1971																				
1972																				
1973																				
1974																				
1975																				
1976																				
1977																				
1978																				
1979																	1	1	1	
1980																				
1981																	1			
1982												1				2	1	2		
1983												1				1	1			
1984												1					1	3		
1985																				

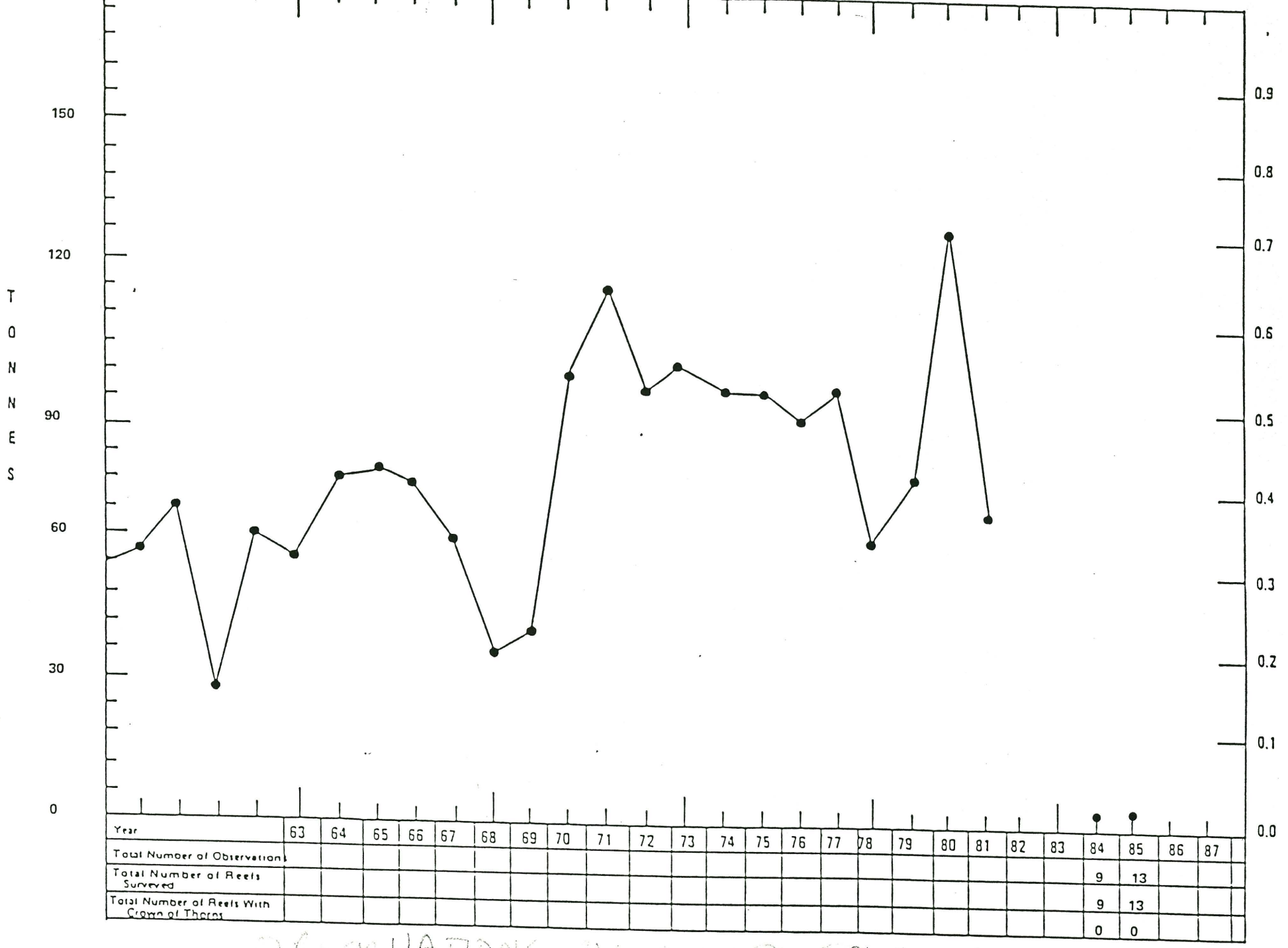
TABLE 7.2: REEFS WITH OBSERVATIONS OF GREATER THAN 100 INDIVIDUALS CAPRICORNIA FISHERIES SECTION.

YEAR	REEF	DISTANCE	FISHING ACTIVITY
1977	UN-NAMED	4	



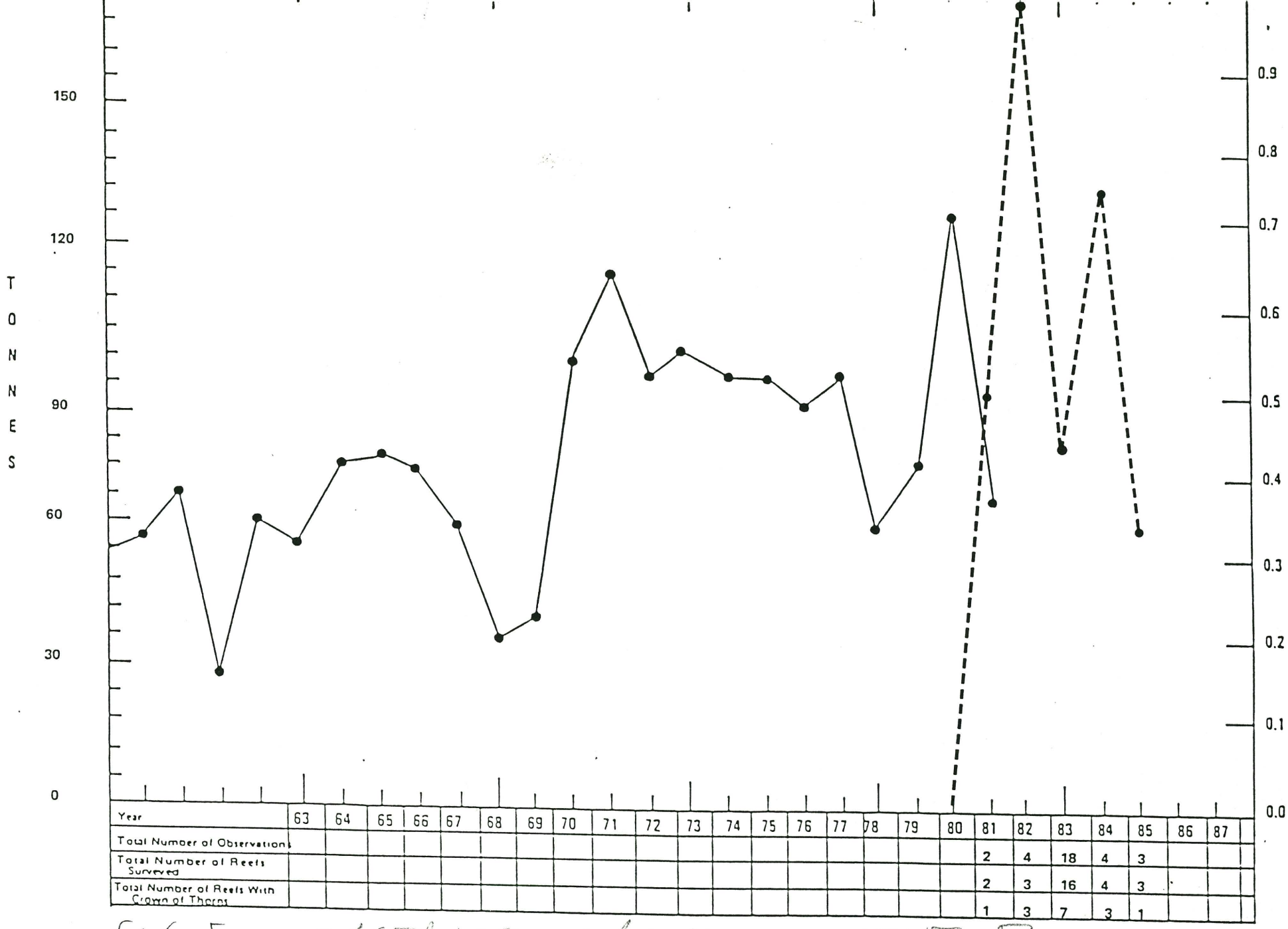
Year	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87
Total Number of Observations								4	4					6	93						21	12			
Total Number of Reefs Surveyed								2	2					6	91						21	9			
Total Number of Reefs With Crown of Thorns								1	2					0	46						9	4			

FIG 7 OBSERVATIONS BY SCIENTISTS IN CAPRICORNIA



Year	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87
Total Number of Observations																						9	13		
Total Number of Reefs Surveyed																						9	13		
Total Number of Reefs With Crown of Thorns																						0	0		

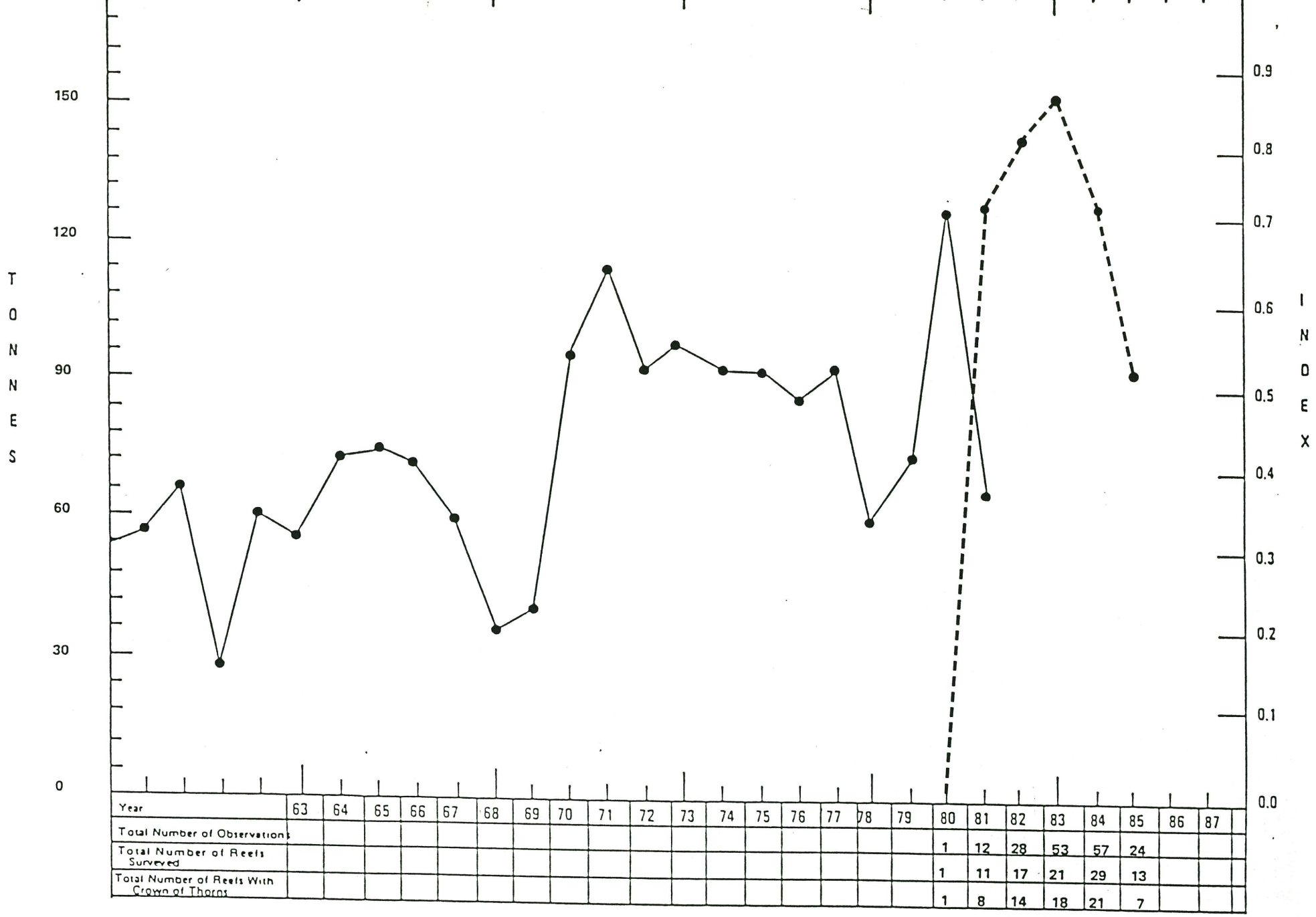
OBSERVATIONS BY MANTA TOWING IN CALIFORNIA



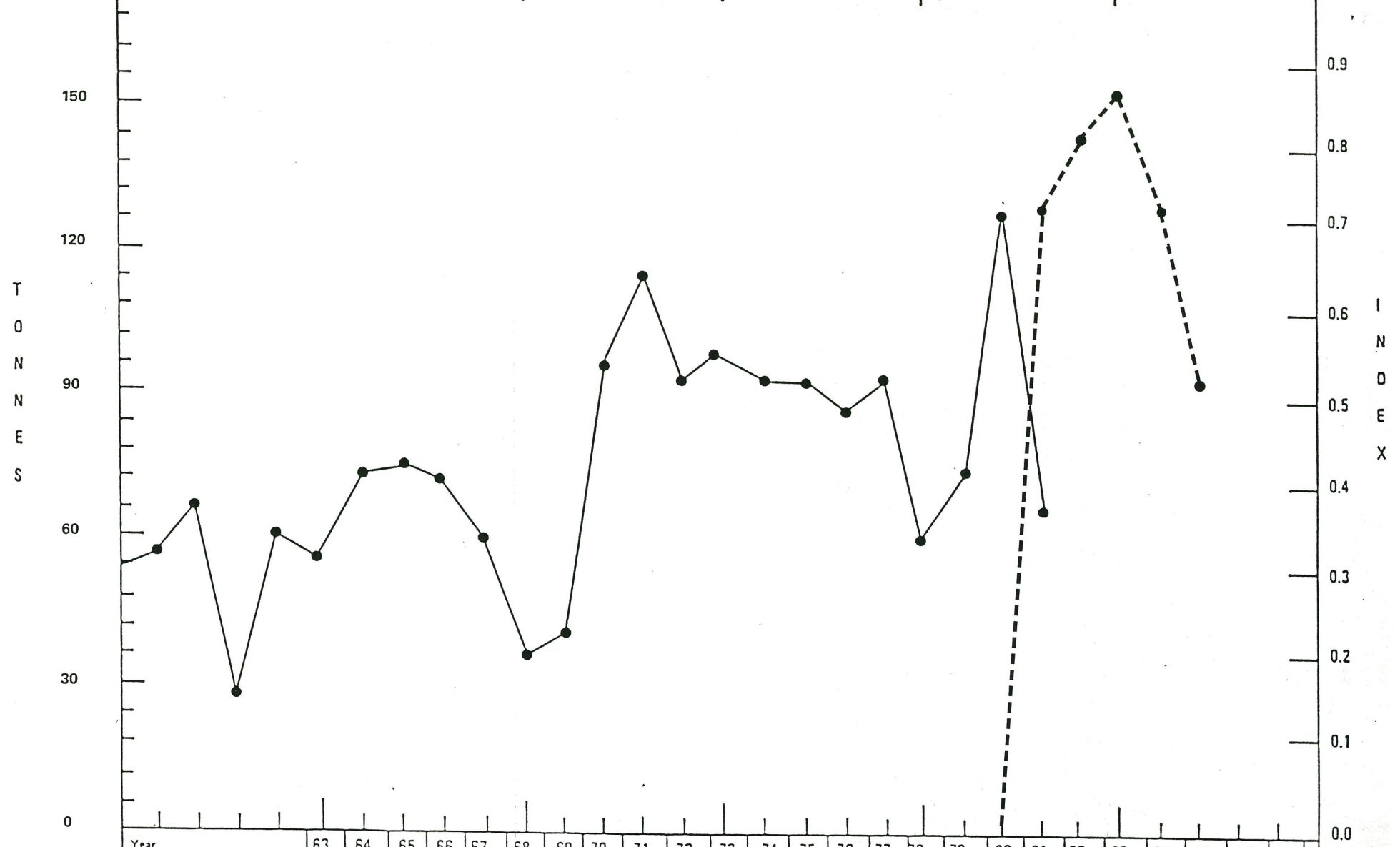
Year	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87
Total Number of Observations																			2	4	18	4	3		
Total Number of Reefs Surveyed																			2	3	16	4	3		
Total Number of Reefs With Crown of Thorns																			1	3	7	3	1		

FIG 5. OBSERVATIONS BY NON SCIENTISTS

CROP BANKS



Year	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87
Total Number of Observations																		1	12	28	53	57	24		
Total Number of Reefs Surveyed																		1	11	17	21	29	13		
Total Number of Reefs With Crown of Thorns																		1	8	14	18	21	7		



Year	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87
Total Number of Observations																		1	12	28	53	57	24		
Total Number of Reefs Surveyed																		1	11	17	21	29	13		
Total Number of Reefs With Crown of Thorns																		1	8	14	18	21	7		

FIG 6 OBSERVATIONS BY NON SCIENTISTS
WRONG landings Cap Sunk

PART 4: OTHER FISHERIES

CHAPTER 8: SPEARFISHING

8.1 INTRODUCTION

Spearfishing is a controversial and emotive issue, particularly in the Crown-of-thorn debate. Endean (19??) cited spearfishing as being the major cause of removal of the large specialised predators such as the Queensland groper Pomicrops lanceolatus.

There are few published reports on the catches of recreational spearfishing or of competitions. Saenger (1976) analysed some data and it is this data plus data provided by the Queensland Branch of the Australian Underwater federation (A.U.F.Q.) that is used in this analysis.

Spearfishing clubs today are very conservation minded with competitions aimed at collecting a diversity of species and not necessarily the largest, taking the fishing 'pressure off the traditional 'Target' species. Clubs are scattered along the G.B.R., the Bundaberg club being particularly active. (See Appendix E4).

8.2 SOURCES OF INFORMATION

The sources of data used are

(1) Competitive results from the Bundaberg Skindivers Club Spearfishing competitions, 1963-1974; Cairns clubs, Mackay clubs, 1961-75; Ayr clubs, 1968-72; Cairns clubs, 1969-1973.

(2) Non competitive spearfishing results from two trips by the Bundaberg Skindivers club to Lady Elliot Island, and Tryon Island in the Capricorn-Bunker group in 1974.

(3) The Queensland State Titles, 1955-1975.

No records were available on recreational activities carried out outside the auspices of the A.U.F.

The data is stored in a relational database as detailed in section 3.4.

8.3 METHODS

Data has been broken down according to the availability of data into the following four regions.

1. Cairns
2. Ayr
3. Mackay
4. Bundaberg

Catch per unit effort data has been calculated using catch rates both in terms of number and of weight of fish over expended man-hours(Appenndix E1). Fish and weight per man are also used as hours expended were not always recorded. This facilitates comparison between regions and also with ~~of~~ fishing activities such as Charter boats and amateur fishing.

The average weight per fish of the most commonly occurring species for each year is calculated to examine whether there have been any decrease in the mean size over the years and also to

illuminate any regional differences in the mean size.
The most commonly speared fish selcted for analysis are;
1. Coral trout Plectropomus sp.
2. Netted Sweetlip Plectorhynchus flavomaculatus
3. Brown Sweetlip Plectorhynchus gibbosus
4. Many lined Sweetlip Plectorhynchus chaetodontoides
5. Painted Sweetlip Diagramma pictum

8.4 RESULTS

i. Cairns

Spearfishing results in the Cairns area were available from 1969 to 1973 from competitions held in the area. Both the mean numbers and mean weight of fish per man increased in 1970 and stayed at a similar level the following year.(Figures 8.1, 8.2, 8.4). However both fell in 1972, but this is more likely a result of inadequate sample size than any real pattern. A mean of 5.6 ± 1.6 fish per man and a mean weight per man of 9.3 ± 1.86 was calculated over this 5 year period. The mean weight per fish has remained relatively constant over this time (2.25 ± 0.5 kg).

ii.Ayr

Spearfishing results from 1969 to 1972 show a slight but steady increase both in numbers of fish caught per man, and the mean weight per fish caught (Figures 8.5, 8.7, 8.8). The mean weight of fish per man has jumped 7 fold over the same period, most notably from 1970 to 1971.
Coral trout and Painted Sweetlip were the most commonly speared species of fish off Ayr reefs. Coral trout had a mean weight per fish over the years 1968 to 1972 of 3.4 ± 0.58 kg and displayed a decline in mean weight per fish over this period(Fig 8.9). Painted Sweetlip increased in mean weight per fish and had a mean weight over these years of 2.8 ± 0.4.

iii. Mackay

Records from spearfishing competitions off Mackay are for 1961, 1968, and then 1971 through until 1975. A mean of 4.1 ± 1.7 fish per man and a mean weight per man of 9.7 ± 4.8 was found over these years (Fig 8.13). Both values were reasonably constant over the period 1971 to 1975. The mean weight per fish increased over this same period (2.9 ± 1.2).

Only sparse records of commonly caught fish were available for Mackay (Fig 8.14). The mean weight per Coral trout and Painted Sweetlip both dropped 2 fold in 1975.

iv. Bundaberg

Data from the Bundaberg spearfishing club is the most comprehensive dataset available with both competitive and non-competitive records. Estimates of weight and number of fish per man per hour were calculated as accurate lengths of time spent in the water were recorded (Figures 8.15 and 8.16).

Both have fluctuated over the years. The apparent increases in 1972 should be dis-regarded due to the inadequate sample size.
A mean of 1.8 ± 1.1 fish per man and 3.7 ± 2.9 kilograms per man was calculated over this period. A mean weight of 2.25 ± 0.53 kilograms per fish over this time, with notable increases in 1971

FIG 8.1: Mean Fish per Man caught in Cairns spearfishing competitions.

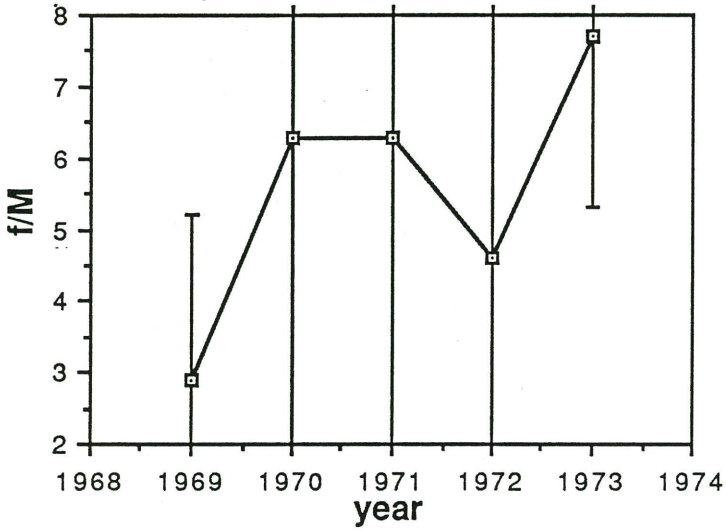


Fig 8.2: Mean weight (kg) of Fish per Man caught in Cairns spearfishing competitions.

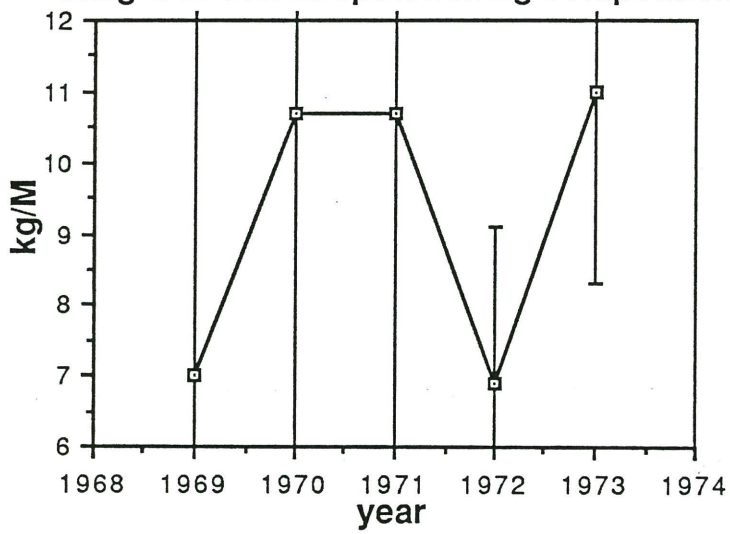


Fig 8.3: Mean weight per fish caught in Cairns spearfishing competitions.

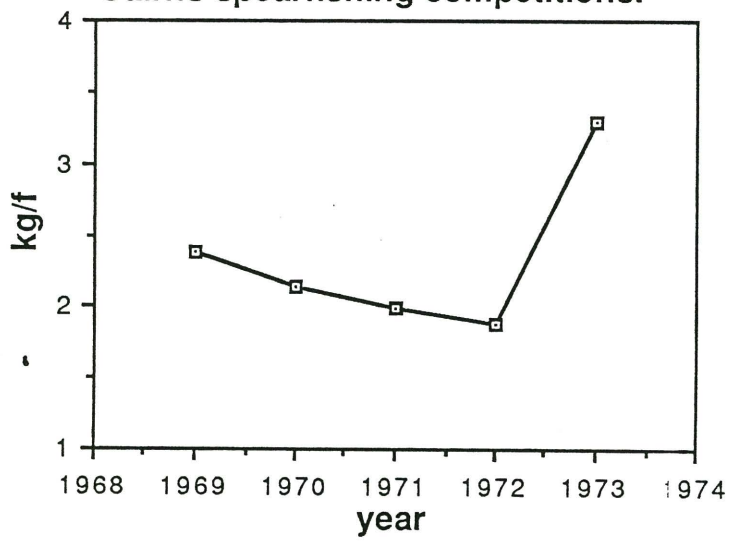


Fig 8.4: Combined catch effort data for Cairns spearfishing competitions.

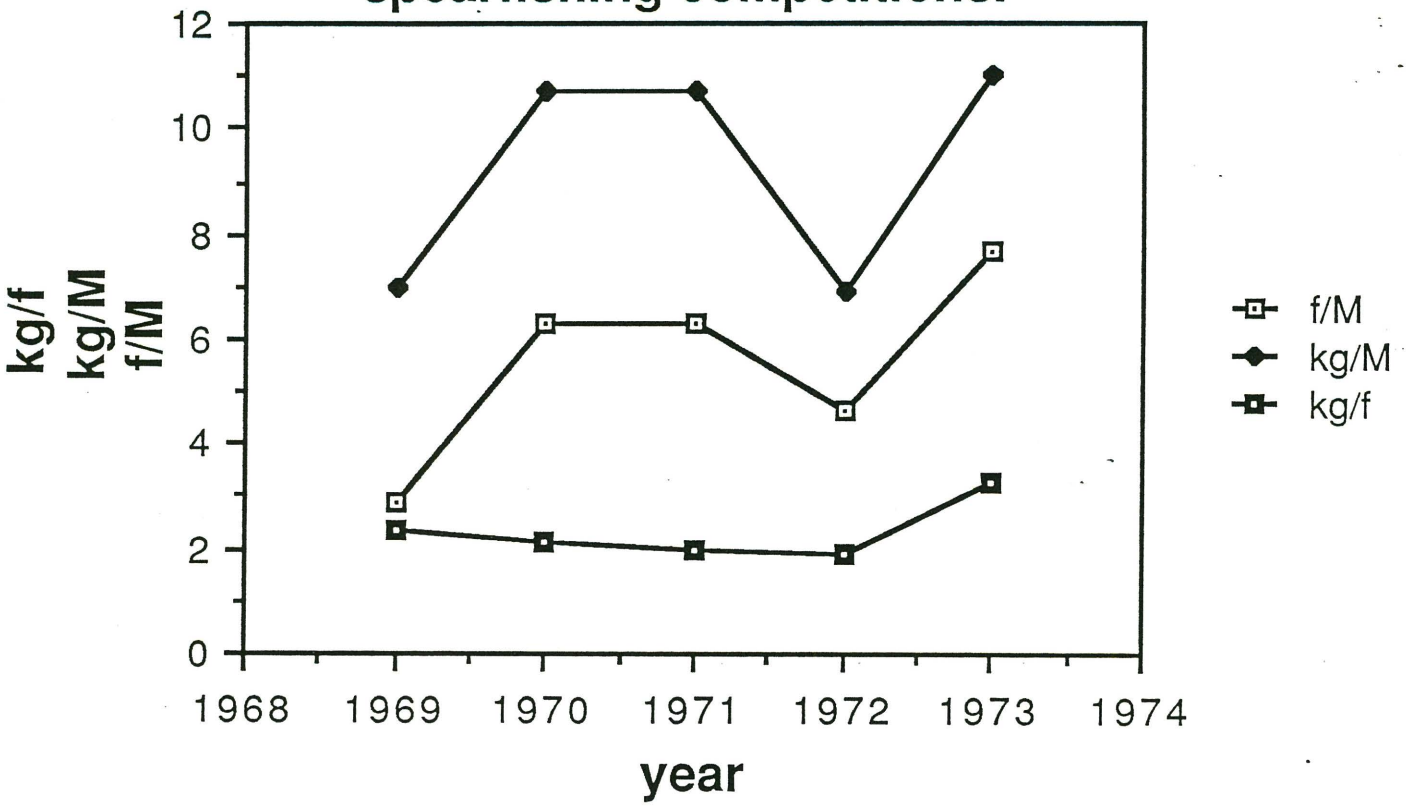


Fig 8.5: Mean Fish per Man caught in Ayr spearfishing competitions.

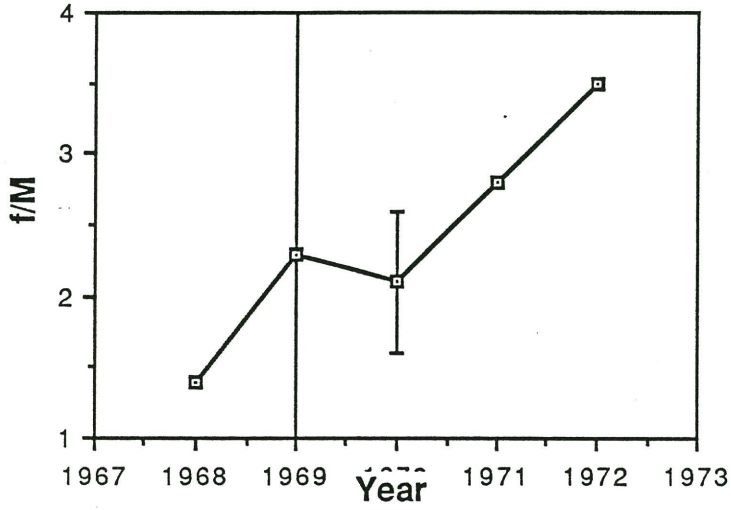


Fig 8.6: Mean weight (kg) per fish caught in Ayr spearfishing competitions.

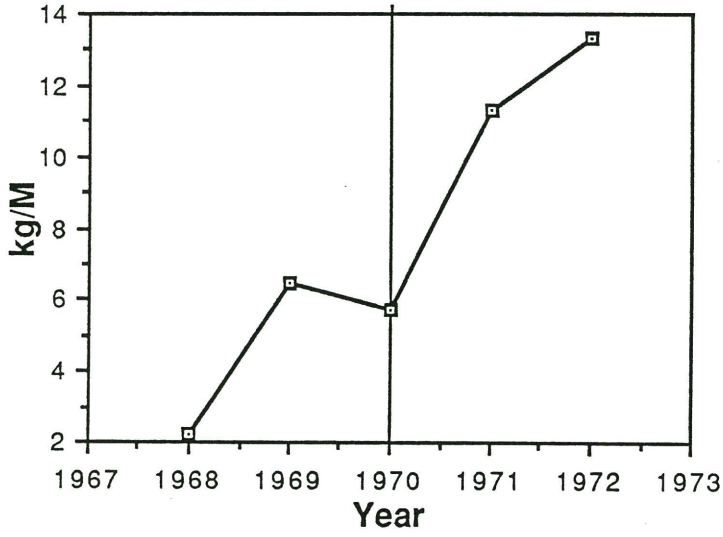


Fig 8.7: Mean weight (kg) per fish caught in Ayr spearfishing competitions.

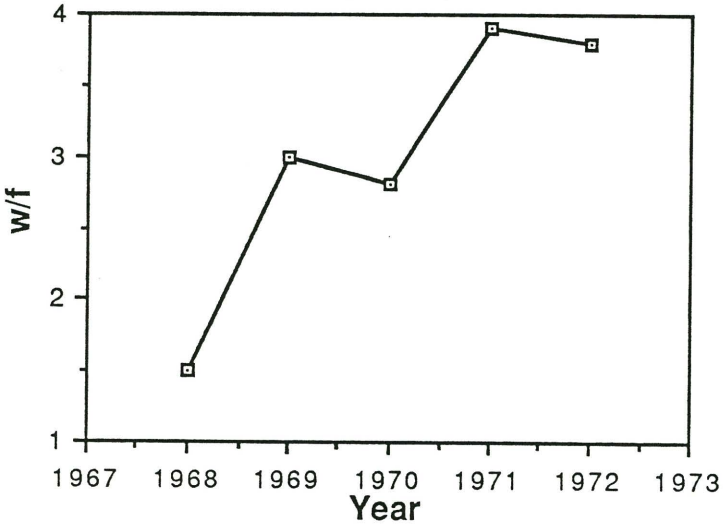


Fig 8.8: Combined catch effort data for Ayr spearfishing competitions.

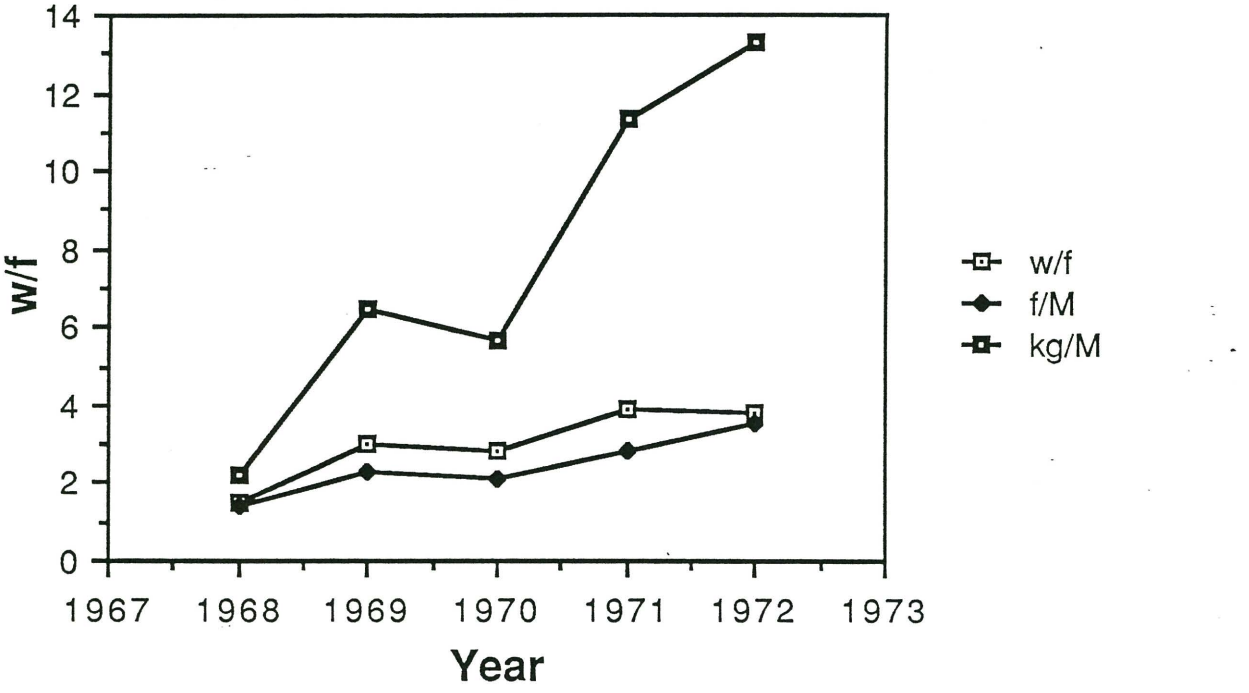


Fig 8.9: Mean weight (kg) per fish for common species in Ayr competitions.

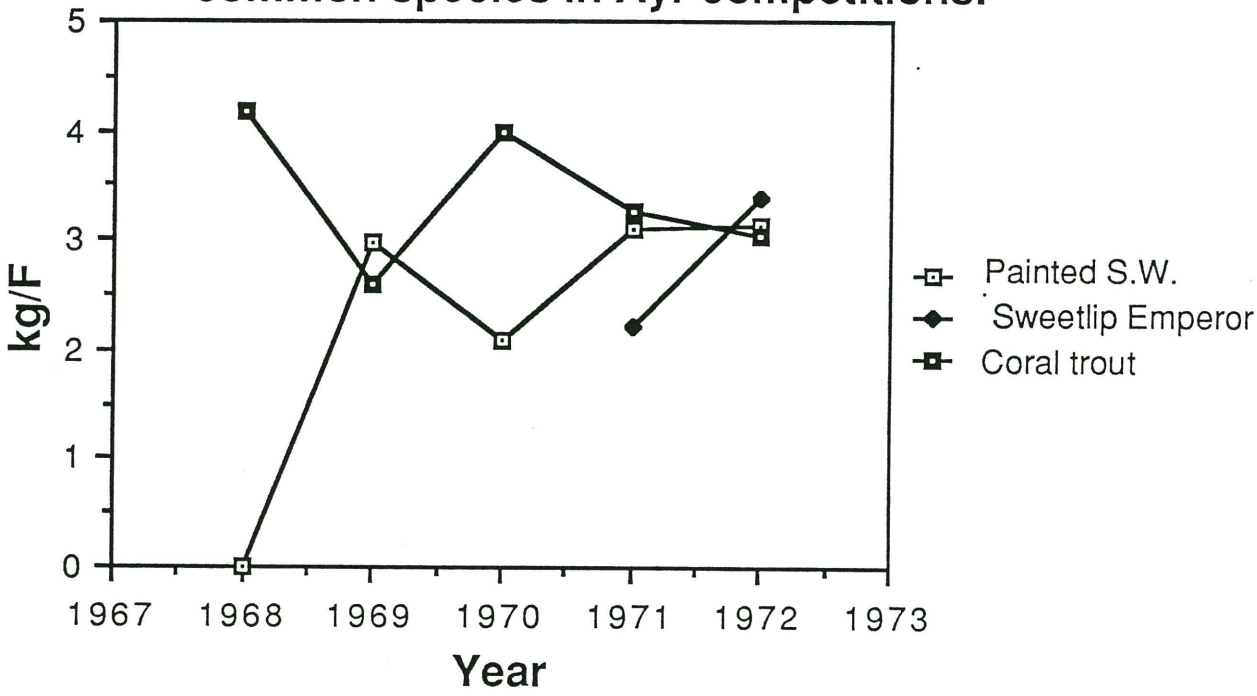


Fig 8.10: Mean number of fish per Man caught in Mackay spearfishing competitions.

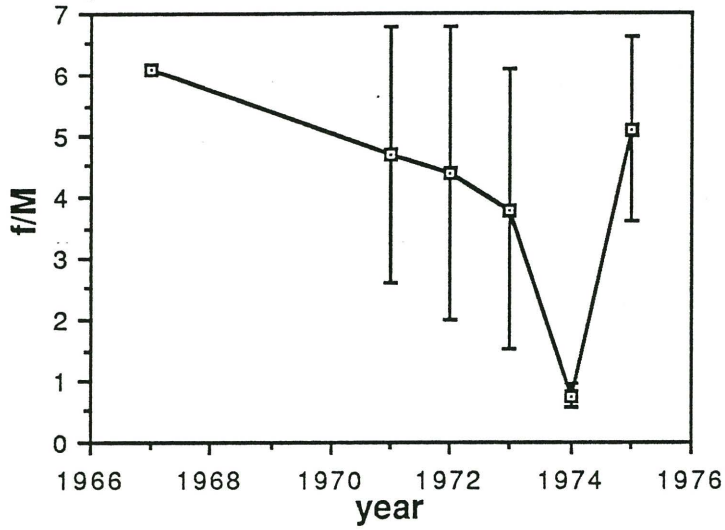


Fig 8.11: Mean weight (kg) of fish per Man caught in Mackay spearfishing competitions.

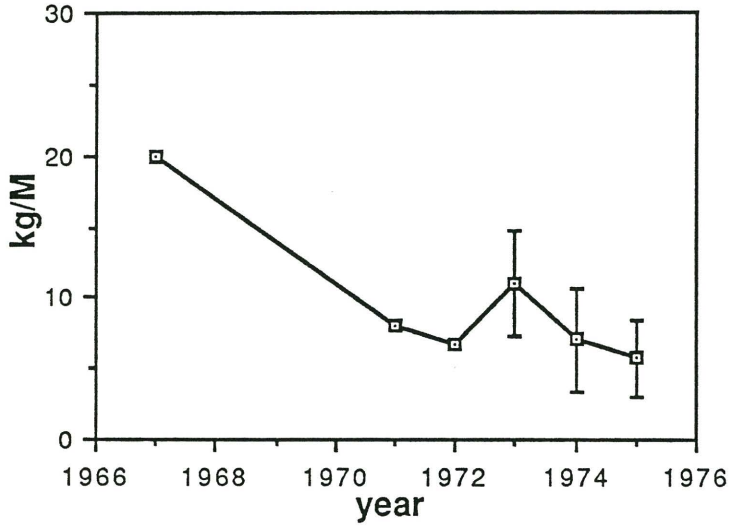


Fig 8.12: Mean Weight (kg) of fish caught in Mackay spearfishing competitions.

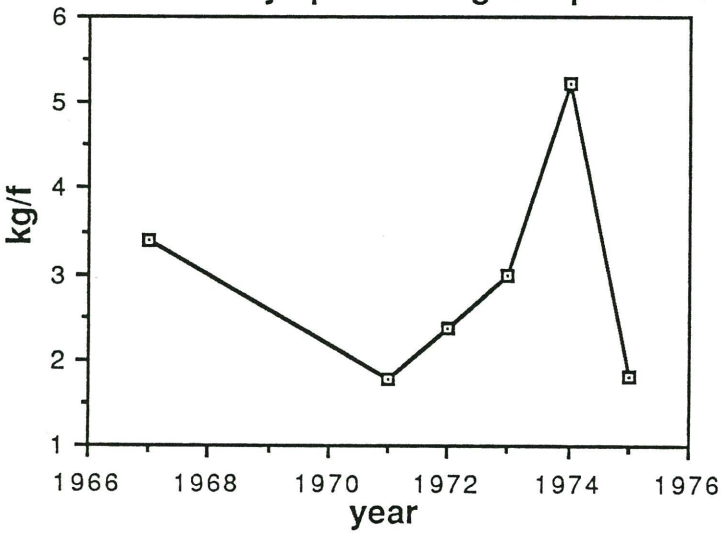


Fig 8.13: Combined catch effort data for Mackay spearfishing competitions.

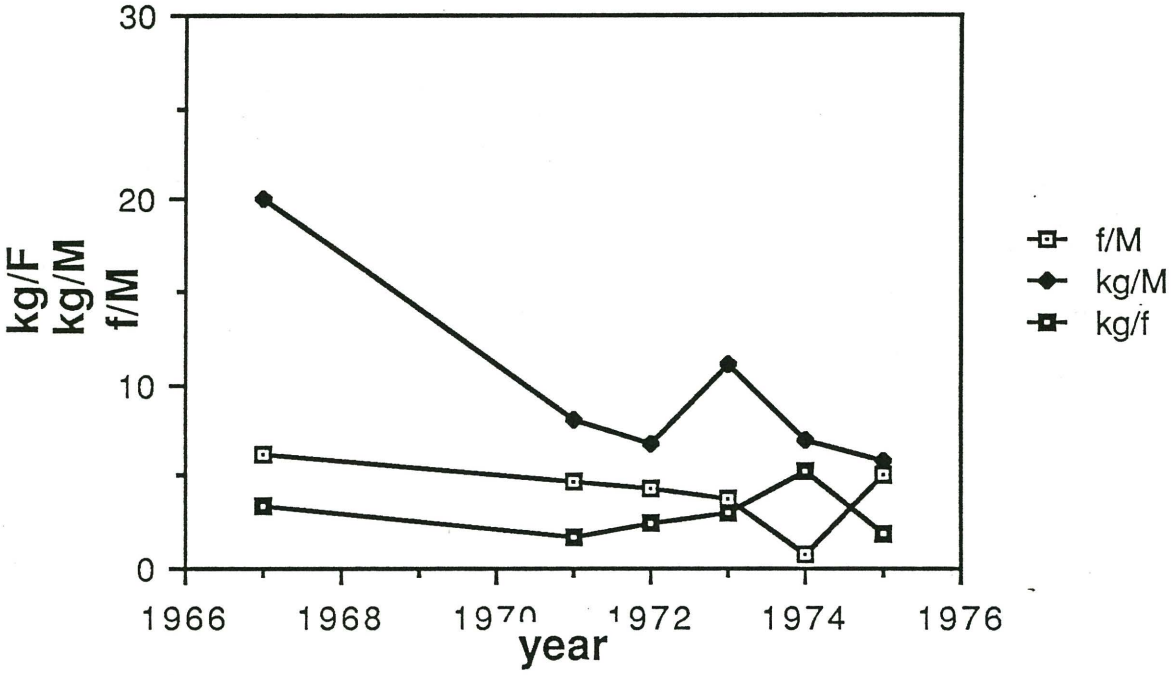


Fig 8.14: Mean weight (kg) per fish of common species caught in Mackay competitions.

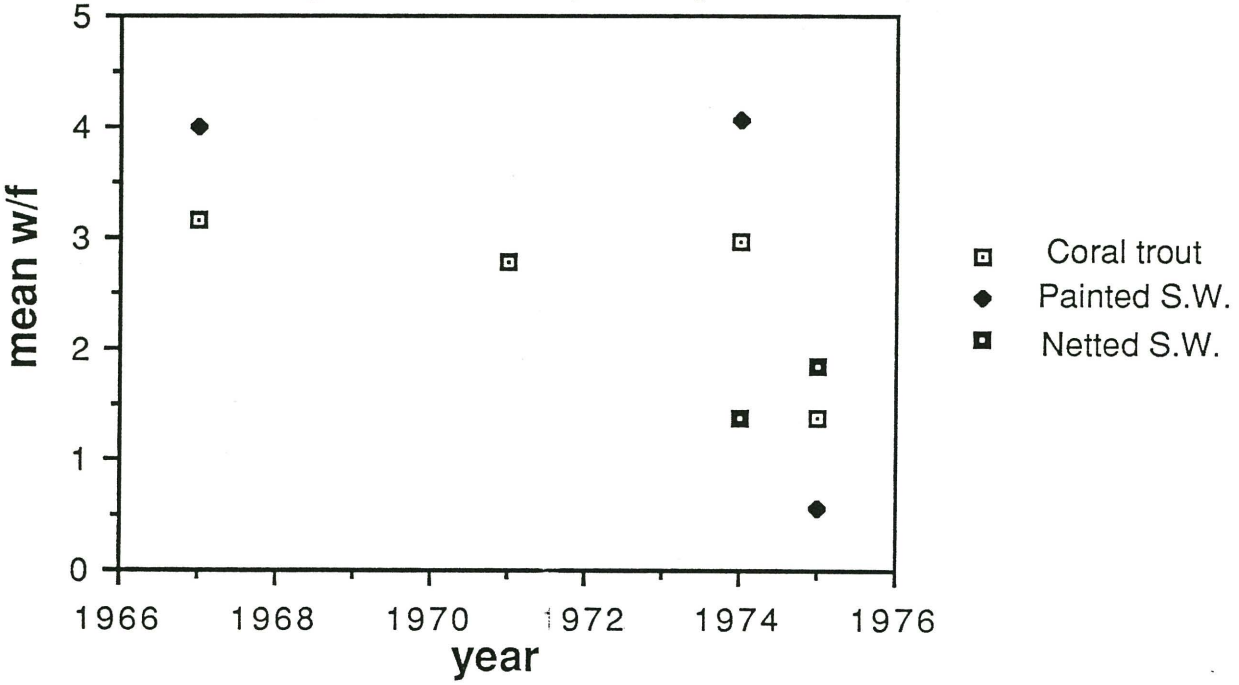


Fig 8.15: Mean number of fish per man and per hour for Bundaberg spearfishing competitions.

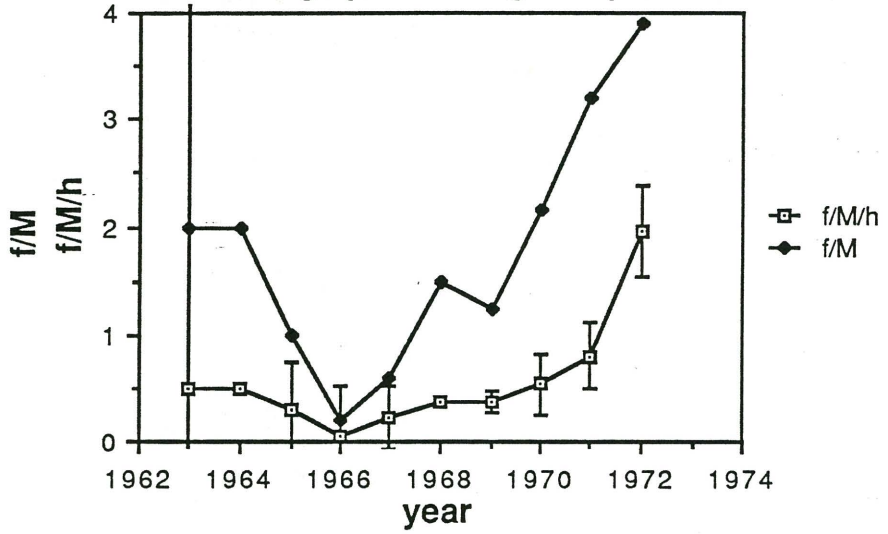


Fig 8.16: Mean weight of fish per man per hour for Bundaberg spearfishing competitions.

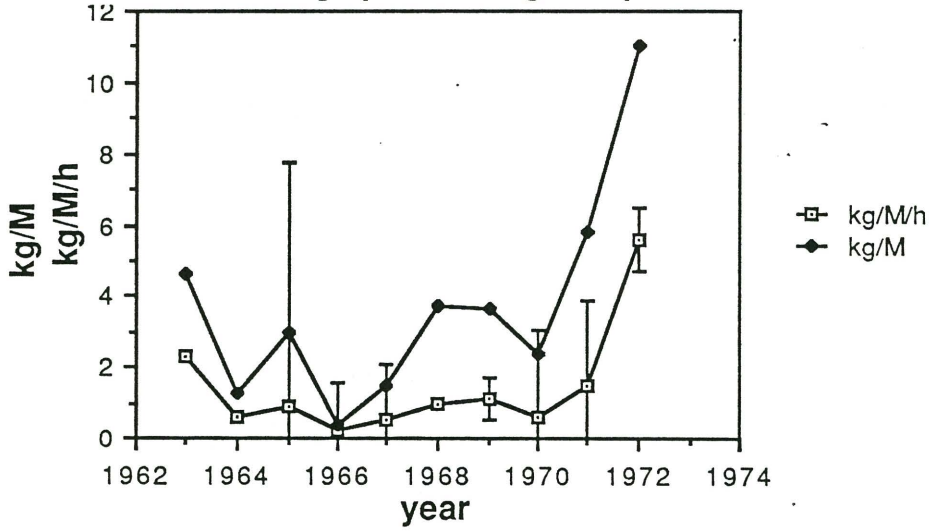


Fig 8.17: Mean weight (kg) per fish for Bundaberg spearfishing competitions

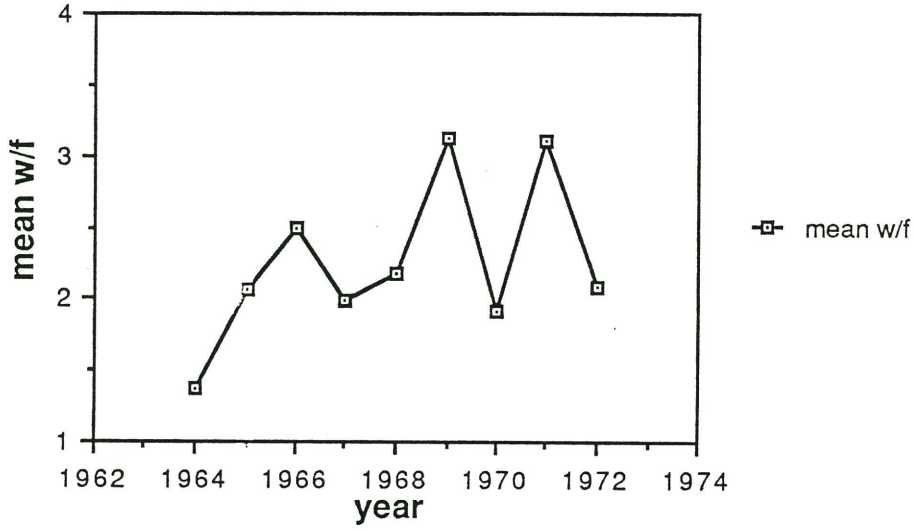


Fig 8.18: Combined catch effort data for Bundaberg spearfishing competitions.

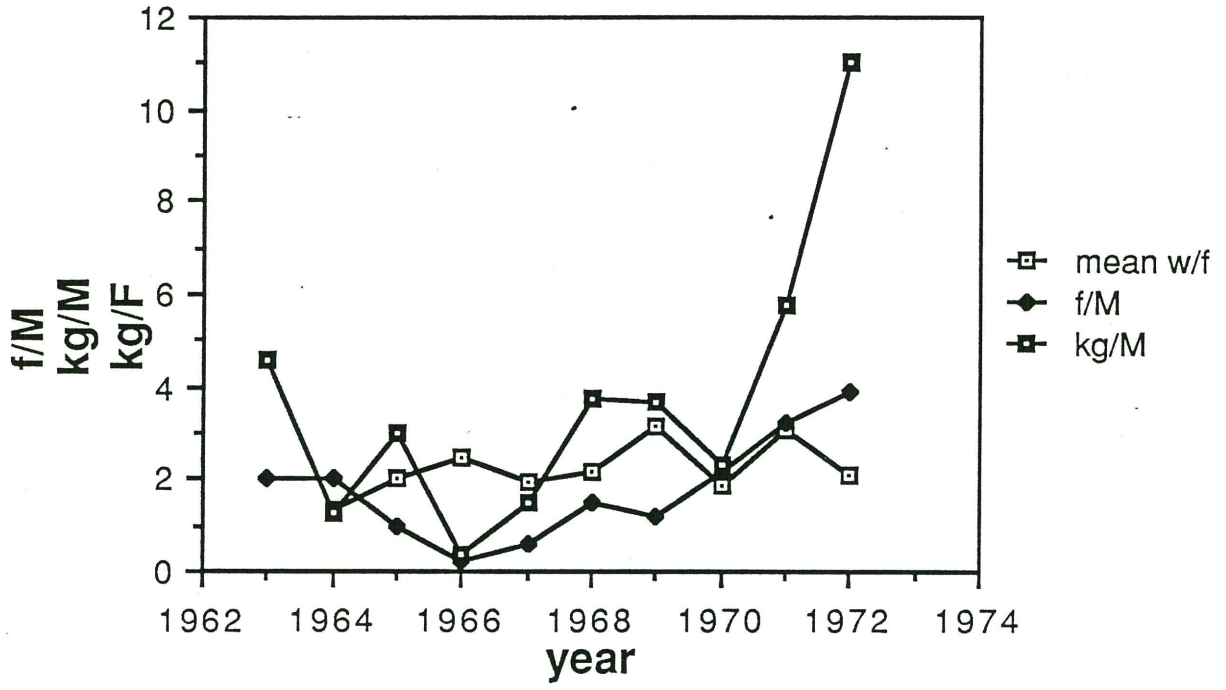
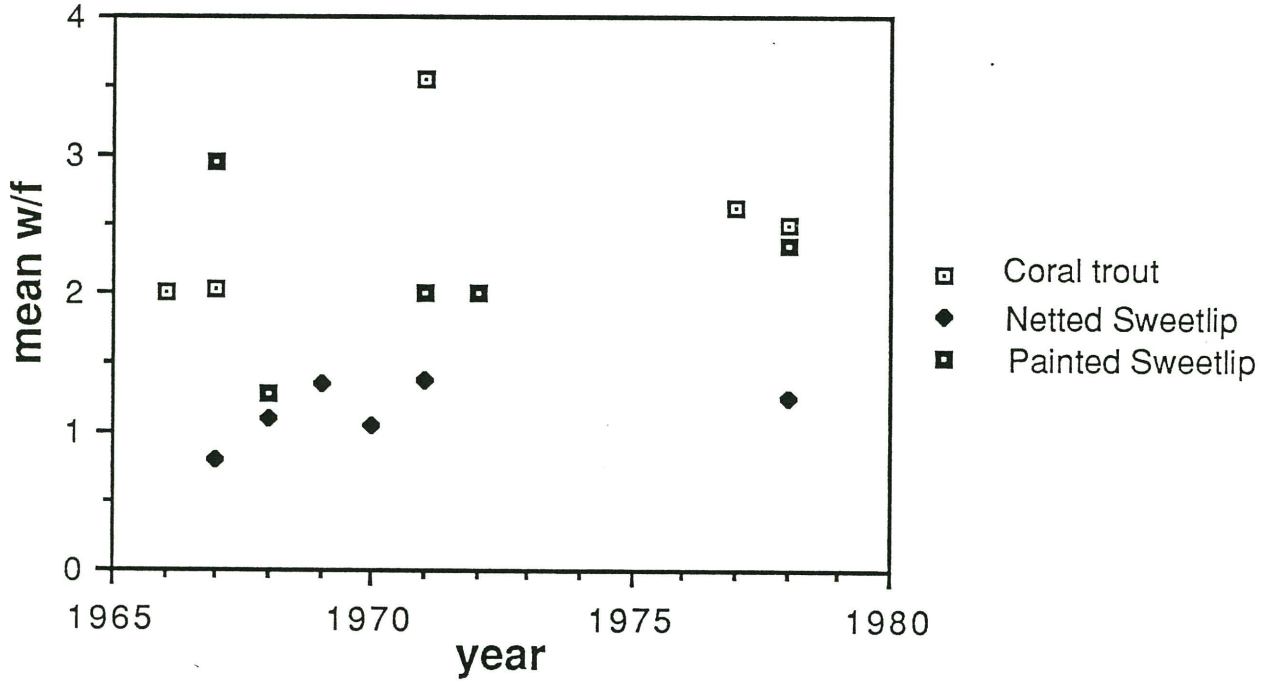


Fig 8.19: Mean weight (kg) per fish for common species caught in Bundaberg competitions.



and 1972 was found (Fig 8.17).

Coral trout, Netted Sweetlip and Painted Sweetlip were all commonly taken in competitions off Bundaberg. The mean weight of all these species has remained relatively consistent over the years (Fig 8.19).

8.5 DISCUSSION

i Regional Differences

Referral to table 8.1 would suggest that although the mean weight per fish is similar for all areas, catch rates differ considerably. Catch rates for Bundaberg competitions are significantly lower than the other areas. However due to the high variance associated with these estimates, it is impossible to guage whether fish are indeed scarcer on reefs off Bundaberg (i.e. the Capricorn-Bunker group). In addition factors such as skill need to be considered.

Comparison of the competitive and recreational results from Bundaberg show similar catch rates but a significantly lower weight per fish for recreational spearfishing. Spearfishermen with the motive of getting fish for eating may go for greater numbers than size. Actual comparison of the mean weight of Coral trout and netted Sweetlip show no real differences for the two modes of spearfishing.

Table 8.1: Summary catch effort statistics by area for spearfishing competitions.

AREA	F/M SE	KG/M SE	KG/ F SE	Tot Wt
Cairns	5.6 ± 1.6	8.9 ± 6.9	2.5 ± 0.5	353.4
Ayr	2.4 ± 0.7	7.8 ± 3.9	2.9 ± 0.9	162.9
Mackay	4.2 ± 1.0	9.7 ± 4.8	2.7 ± 1.2	689.3
Bundaberg(comp)	1.8 ± 1.1	3.7 ± 2.9	2.3 ± 0.5	187.1
non-competitive	1.4 ± 0.3	2.7 ± 0.1	1.6 ± 0.1	

The A.U.F.Q. have long worked to maintain spearfishing with conservation of fish stocks in mind. Spearing of the estuary cod Epinephalus tauvina and the Queensland groper Pomicrops lanceolatus of this species was banned by the A.U.F. in 1967. The largest recorded specimen of the Queensland groper weighed 233.1 kg and was speared at Lady Elliot island in 1966.

The scoring system used today has a minimum weight of 1 kg for all species and a point system which emphasizes a diversity of species rather than the heaviest catch. This design has the effect of spreding fishing pressure out over a number of species and taking the pressure off 'target species'.

The actual total landings of fish per annum (Table 8.1) is insignificant in comparison to Amateur line fishing and charter boat operations.

CHAPTER 9: CHARTER BOATS.

9.1 INTRODUCTION

Charter boats have become an increasingly economically important characteristic on the G.B.R. Most visitors to the G.B.R. 'experience the reef' via these boats. A number of activities such as diving, reef walking, photography, cruising, resort access, are engaged in on these charters. However reef fishing is by far the principal activity engaged in. As such it represents a considerable amount of fish being caught. Hundloe et.al (1987), calculated from 48 charter boats surveyed, a total weight of 263,000 Kg of reef fish caught for 1984. They extrapolated this value to include all 83 boats on the G.B.R, to arrive at a value of 450,000 Kg of whole fish.

9.2 SOURCES OF INFORMATION

Data is taken from a survey of Charter boats from the Institute of Applied Research (Unpub reporrt to GBRMPA)
This report surveyed the number of Charter Boats in Queensland listed by the Queensland deIpartment of Harbours and Marine as at August 1984. A total of 435 vessels were listed excluding bareboats, and of this number 243 boats are listed as being owned by individuals or firms with residential or business addresses on the Mainland adjacent to the reef region. Estimates of the extent of fishing activity associated with each charter boat were gained in the survey giving areas fished, annual amount of fish caught most commonly caught species, and number of visitor days.

9.3 METHODS

The above data source has been summarised to provide annual estimates of fishing activity for each home port region and the fisheries section in which they lie. Only catches of demersal species have been used. The most commonly caught species are coral trout, sweetlip, red emperor, spanged emperor. Pelagic fish such as Mackerel and other game fish have not been considered as the aren't relevant to the aims of this study.

The annual number of fish, weight of fish, number of fishing days has been compiled where available for each boat.
These terms are defined below.

1. Number of fish: Number of fish caught per annum.
2. Weight of fish: Whole wet weight of fish caught per annum.
3. Fishing days: This is based on the the number of visiting days for each boat. Visitor days refers to the number of persons on board charter boats as paying customers regardless of the length of stay on board. For example a passenger undertaking a half-day trip would be considered to generate one visitor day. If the vessel is primarily used for fishing then this can be regarded as being equivalent to fishings days. Otherwise the estimates of fishing days is based on the the number of charters which went out fishing.

Catch per unit effort (CPUE) data has been calculated both as Number and as weight per fishing day (i.e. per person per day) and average weight per fish has been calculated. These figures aim to provide a indication of the 'state' of the fish population.

However not all information was available for each boat (i.e Number and weight of fish, but not fishing days available). Consequently the mean of each of the above measures has been calculated based on the number of boats for which the data was available. Estimated figures are also calculated for the total number of charter boats per region to gain an idea of the total annual catch by charter boats in the area.

In the accompanying figures (Figures ???) the mean value is shown with the vertical bars representing the S.E. error associated with each.

This data represents the best annual estimate of annual production for each charter boat surveyed. It has not been possible to, survey all charter boats in the region so that total figures should be considered as underestimates. These results should however be interpreted as indicationg relative regional differences in catch rather than absolute values. Many other factors need consideration such as actual hours spent fishing, area fished, knowledge of skipper, skill of passenger, differences in bait and gear etc.

9.4 RESULTS

Table 9.1 provides a breakdown of Charter boats by home ports.

i. Northern Fisheries Section

A total of 8500 fish were recorded as being caught by 6 boats in the Northern fisheries section, and an estimated total weight of 2620 kg of fish from some 8 boats. On the basis of the available number of fishing days an estimated mean number of 7.12 fish and 3.96 kg of fish are caught per person per boat per day. There is little difference in these estimates for the individual ports of Cairns, Innisfail, and Port Douglas (Fig 9.1). An estimated weight per fish of 1.82 ± 0.86 was calculated from the availabls data.

ii. Central Fisheries Section

The Central section has the greatest number of Charter boats with 31 boats primarily involved in reef fishing. Thirteen work out of Townsville and an equal number out of Shute Harbour and Airlie Beach. Mission Beach, Cardwell, and Lucinda each have one Charter boat operating out of them and Bowen two.

A total weight of 131490 kg of fish was caught by 20 boats and a total number of 68210 fish from 21 boats were caught in 1984. Catch rates of 6.76 ± 3.7 fish per day 13.8 ± 10.4 kg of fish per day were estimated for this section. The number of fish caught per day was relatively equivalent for all individual ports, but the weight of fish caught per day by Townsville boats was significantly higher (Fig 9.3). Individual ports differed minimally from an estimated mean weight of 1.92 ± 0.8 kg per fish for the Central Section (Fig 9.3).

iii. Capricornia Fisheries Section

Twenty one Charter boats operate in the Capricornia section, 13 of these out of Gladstone, 4 out of Bundaberg, and 2 out of Rosslyn bay. A total number of 14900 fish from 2 boats and a total weight 54870 kg were caught by 11 boats in 1984.
A mean catch rate of 6.86 ± 3.6 kg per fish per day was estimated based on records from 9 boats. This value was significantly lower for boats operating out of Gladstone (Fig 9.3). A mean weight of 1.35 ± 0.01 kg per fish was calculated for the Capricornia Section, which was consistent for all ports.

DISCUSSION

i. Regional Differences

There is little difference in the mean weight per fish calculated for the Northern, Central and Capricornia Sections (Fig 9.4). Likewise catch rates of number of fish per day for Northern and Central fisheries Section show minimal differences (7.12 and 6.76 respectively). However estimates of weight of fish caught per day differ 3-fold (Fig 3.4). These estimates should be dis-regarded as the other two calculations of catch per unit effort are so consistent.

Most obvious are the regional differences in total numbers and weight of fish caught.

From the available data a mean number of 1416 fish and 2620 kg of fish were caught in the Northern Section in 1984. Based on these values, it could be expected that an estimated total of 28320 fish and 581200 kg of fish could be caught by the 20 boats operating in the Northern Section (Table 9.2).
Likewise for the Central section an estimated total of 2114510 fish and 4076190 kg of fish could be caught by the 31 boats operating. For the 21 boats in the Capricornia Section an estimated 312900 fish and 6570900 kg of fish could concievably be caught.

Clearly the amount of fish taken by Charter boats is substantial, most notably in the Central Section. If added to the the recreational fisheries it becomes even more so

Fig 9.1: Mean catch effort data for fish caught by charter boats in the northern section.

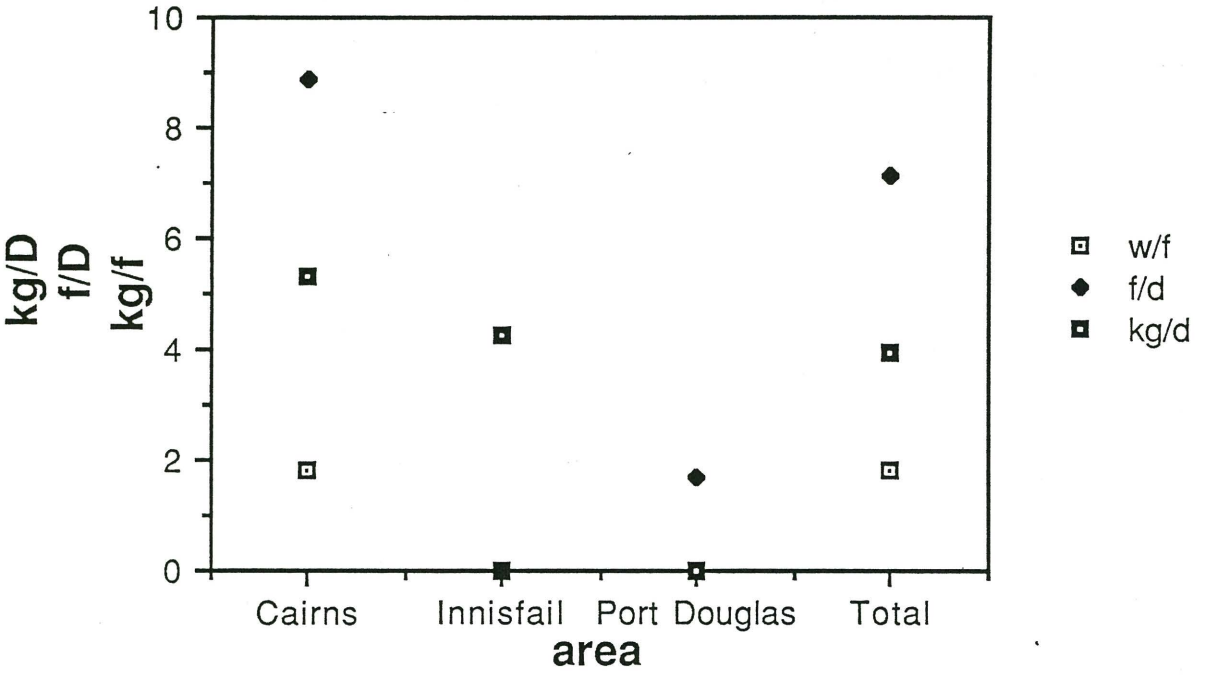


Fig 9.2: Mean Catch effort data for fish caught by charter boats in the central section

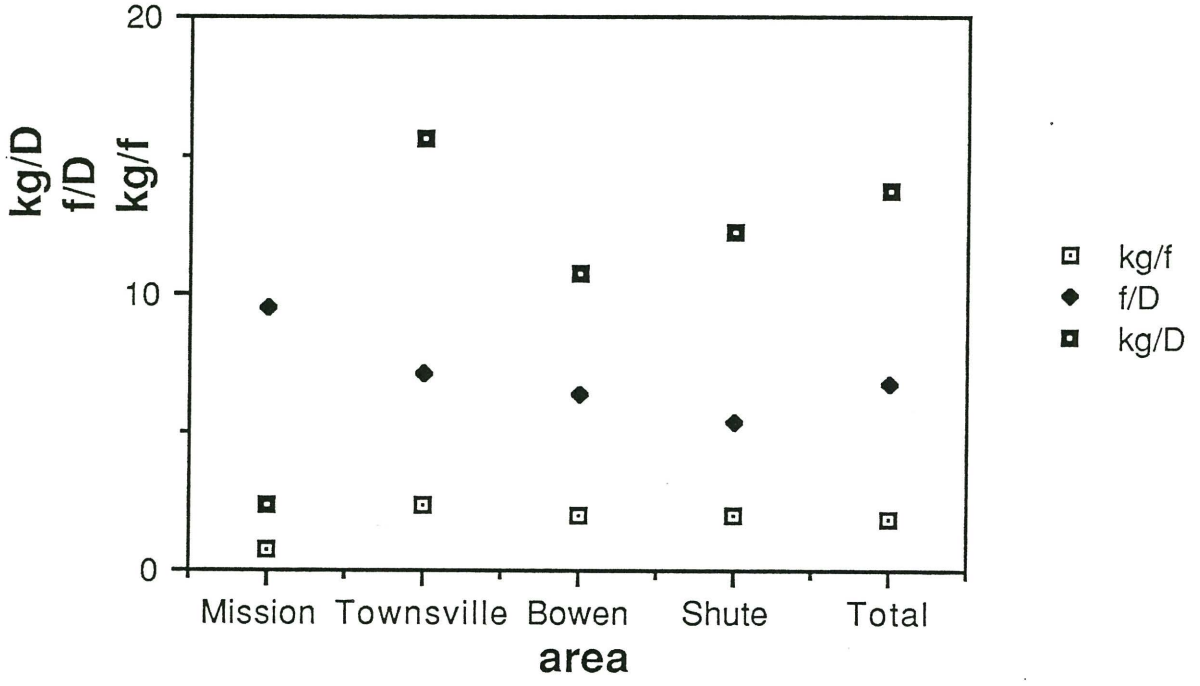


Fig 9.3: Mean catch effort data for fish caught by charter boats in the Capricornia Section

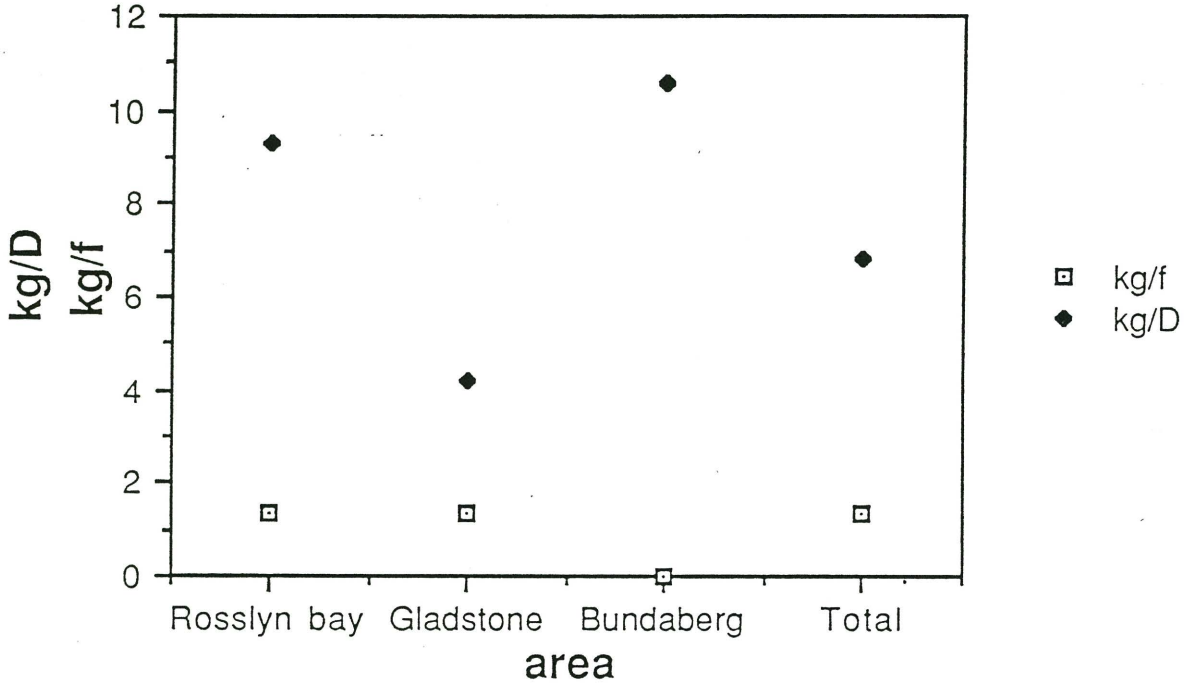


Fig 9.4: Regional comparison of catch effort for fish caught by Charter boats.

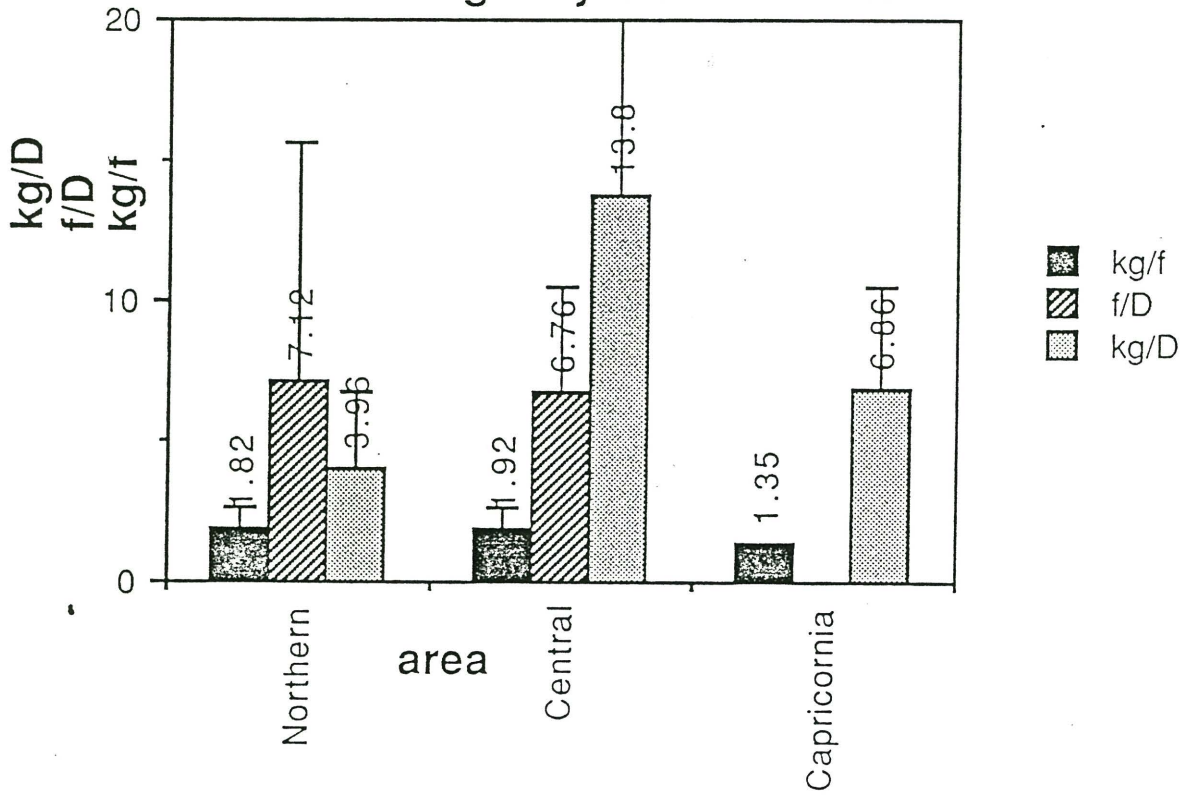


TABLE 9.1: TOTAL ANNUAL CATCH AND CATCH RATES OF CHARTER BOATS BY HOME PORT AND BY FISHERIES SECTION.

HOME PORT	TOT No. BOATS	No. FISH	Wt. FISH	No. DAYS	WEIGHT PER FISH	FISH PER DAY	WEIGHT PER DAY
PORT DOUGLAS							
Total	4	1600	1000	3820	n.a.	1.71	0.4
Number boats		1	1	3		1	
Average		1600	1000	1273			
Std.Dev			782.5				
CAIRNS							
Total	13	6900	14320	1571	5.48	26.8	10.58
Number boats		5	5	4	3	3	2
Average		1380	3580	392.7	1.82	8.9	5.29
Std.Dev		953	2360	36.2	0.85	9.1	3.90
INNISFAIL							
Total	3	0	5640	1285			12.82
Number boats		0	3	3			3
Average		0	1880	428			4.27
Std.Dev			967	190.8			0.59
TOTAL							
Total	20	8500	20960	6291	5.48	28.51	23.8
Count		6	8	9	3	4	6
Average		1416	2620	699	1.82	7.12	3.96
Std.Dev		874.6	2032	703.6	0.86	8.48	2.85
CENTRAL							
MISSION BEACH-LUCINDA							
Total	3	11500	9200	380	1.87	9.47	2.37
Number Boats		3	3	1	3		
Average		3833	3066	380	0.69	9.47	2.37
Std.Dev		1681	2786		0.37		
TOWNSVILLE							
Total	13	36510	101100	6570	13.93	63.94	155.7
Number Boats		8	10	12	6	9	10
Average		4563.7	10110	547.5	2.32	7.1	15.57
Std.Dev		4366	10339	256.3	0.45	4.33	11.57
BOWEN							
Total	2	1860	3140	280	3.97	6.42	10.71
Number Boats		2	2	1	2	1	1
Average		930	1570	280	1.98	6.42	10.71
Std.Dev		870	1430		0.3		
SHUTE HARBOUR							
Total	13	16940	18050	2695	10.13	21.64	24.4
Number Boats		7	5	4	5	4	2
Average		2420	3610	741	2.0	5.41	12.2
Std.Dev		2575	4085	933	0.80	2.29	0.3
TOTAL							
Total	31	68210	131490	10695	32.69	101.47	193.2
Number Boats		21	20	18	17	15	14
Average		3428	6574	566	1.92	6.76	13.8
Std.Dev		3400	8473	500	0.79	3.7	10.4

TABLE 9.1 CONTINUED

CAPRICORNIA							
ROSSLYN BAY							
Total	2	6700	23000	1500	1.34		9.3
Number Boats		1	2	1	1		1
Average		6700	11500	1500	1.34		9.3
Std.Dev			2500				
GLADSTONE							
Total	13	8200	26350	4242	1.36	23.0	20.98
Number Boats		1	6	6	1	1	5
Average		8200	3893	707	1.36	23.0	4.19
Std.Dev			967	741			2.2
BUNDABERG							
Total	4		5520	515			31.54
Number Boats			3	3			3
Average			1840	171			10.57
Std.Dev			1177	89			2.15
TOTAL							
Total	21	14900	54870	6257	2.7		61.82
Number Boats		2	11	10	2		9
Average		7450	4988	625	1.35		6.86
S.E.		750	4550	688	0.01		3.60
grand total	72						

Table 9.2: Expected total number and weight of fish by for all boats in each fisheries section based on actual mean values.

CPUE	NORTHERN SECTION				CENTRAL SECTION				CAPRICORNIA SECTION			
	TOTAL	MEAN	S.D	N	TOTAL	MEAN	S.D	N	TOTAL	MEAN	S.D.	N
F/D												
OBSERVED	8500	1416	874	6	68210	3428	3400	21	14900	7450	750	2
EXPECTED	20 BOATS				31 BOATS				21 BOATS			
TOTALS	28320				2114510				312900			
KG/F												
OBSERVED	29060	2620	2032	8	131490	6574	8473	20	54870	4988	4550	11
EXPECTED	20 BOATS				31 BOATS				21 BOATS			
TOTALS	581200				4076190				6570900			

PART 4: DISCUSSION

CHAPTER 10: REGIONAL FISHERIES DISCUSSION.

10.1 INTRODUCTION

This study has focused on the commercial fin fishery and it's relevance to the Acanthaster phenomenon,as well as considering the available spearfishing data.
However in more recent years the major source of fishing pressure has come from the recreational fishery and the increasing number of Charter boats operating.In Queensland, in the period from 1968 to 1979, registrations of private motor boats increased from 20,638 to 72001, an increase of 350 percent (Craik, 1985).

This chapter is divided into two parts. First is a comparative discussion of differences in catch rates of the various methods of fishing and regional patterns. Secondly production of all methods is then amalgamated to gain a total fishing pressure per region perspective.

10.2 COMPARISON OF CATCH RATES BY METHOD.

Table 10.1 provides a comparison of catch rates and total production by region of the differing modes of fishing The amateur results are taken from a survey of recreational boat users in 1980 by Driml et al (1982 through report to GBRMPA)

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COMPETITIONS.
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COMPETITIONS.
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COMPETITIONS.

PEARFISHING

EARFISHING

COMPETITIONS.
COMPETITIONS.
N AYR

PEARFISHING

SPEARFISHING

EARFISHING

FISHING

IN MACKAY

G SPEARFISHING

G SPEARFISHING

FISHING

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N BUNDABERG

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ER BOATS IN
R BOATS IN
ER BOATS IN
H CAUGHT BY

9.1 MEAN CATCH EFFORT DATA FOR FISH CAUGHT BY CHART
THE NORTHERN SECTION.
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THE CAPRICORNIA SECTION.
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CHARTER BOATS.

ABBREVIATIONS USED IN THE TEXT.

A.F.S.	AUSTRALIAN FISHERIES SERVICE.
COMMONWEALTH	D.P.I. COMMONWEALTH DEPARTMENT OF PRIMARY INDUSTRIES. (See also Q.D.P.I.)
C.P.U.E.	CATCH PER UNIT EFFORT.
COT	CROWN-OF-THORNS STARFISH.
C.S.I.R.O.	COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION.
F.I.R.T.A.	FISHING INDUSTRY RESEARCH TRUST ACCOUNT.
G.B.R.M.P.	GREAT BARRIER REEF MARINE PARK.
G.B.R.M.P.A.	GREAT BARRIER REEF MARINE PARK AUTHORITY.
N.F.B.	NORTHERN FISH BOARD.
Q.C.F.O.	QUEENSLAND COMMERCIAL FISHERMEN'S ORGANISATION.
Q.D.P.I.	QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRY.
Q.F.B.	QUEENSLAND FISH BOARD
Q.F.M.A.	QUEENSLAND FISH MANAGEMENT AUTHORITY.

NCEPTUAL FRAMEWORK

fulfill two purposes.
tigates the consequences of commercial
rs of the Crown of Thorns starfish,

eks to establish the framework for a
ted information on the Great Barrier

al framework needed to impliment these
e following sections.

FOR THE STUDY OF THE CONSEQUENCES OF
E OUTBREAKS OF ACANTHASTER.

rs a number of hypotheses have been
he occurrence of 'outbreaks' of large
the coral feeding asteroid Acanthaster
ive damage to coral reefs (Endean &
982; Moran, 1986).
that focus on man-induced causes of
moval hypothesis produced by Endean
most attention in the scientific

that outbreaks are unique events which

PART 1: INTRODUCTION

CHAPTER 1: RATIONALE AND CO

1.1 AIMS

This study seeks to
(1). Specifically it inves
fishing on possible predato
A.planci.
(2). More broadly it se
database of fisheries rela
Reef.
The rationale and conceptu
two aims are outlined in th

1.2 RATIONALE AND FRAMEWORK
FISHING PRESSURE ON POSSIBL

1.2(i) RATIONALE

Over the last 25 yea
formulated to account for t
feeding aggregations of
planci. which causes extens
Stablum, 1973; Birkeland, 1
Of all the hypotheses
A.planci, the predator re
(1969) has recieved the
literature (Moran, 1986).
This hypothesis emphasizes

ught and landed, and some measure of fishing effort. Also
of licensed fishing vessels and their general fishing
ristics is imperative.
thermore managements ability to assess the database will
ne quality and timeliness of research commissioned and
ess of resultant policy (Beurteaux, 1987).

ESTABLISHING A DATABASE

mpiling such a database as would be of use to management
s in Queensland one has to first identify the sources of
on and secondly assess there accuracy.
the case of Queensland this is notoriously difficult and
rstanding of the history of Queensland fisheries is
. This is outlined in section 2.4.
of comprehensive records from any one data source has
in the compilation of a number of information sources
ffer widely in their accuracy and comprehensiveness and
n must be interpreted differently and with caution.

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Furt
affect th
the succe

1.3(ii) E

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decisions
informati
In t
an under
essential
The lack
resulted
which dif
so in tur

K.

nt and accurate catch records
lly envisaged as drawing on a
nd then attempting to collate
database.
envisaged to best evaluate
Thorns outbreaks and fishing

erpective provides the major
ifferences of Queensland fish
trends and examines how they
f Thorns. This perspective is
section.
l perspective focuses on the
emersal reef fish at a reefal
fic localities, Boult reef in
s area reefs is made.

ity of data at the completion
eptual framework had to be
ginal conceptual framework is
other data sources become
framework be utilised. These
completion and relevance to
3.

E
figures for the commercial

1.4 CONCEPTUAL AND DATABASE FRAMEWOR

(i) ORIGINAL CONCEPTUAL FRAMEWORK

Due to the lack of any consiste
for Queenland this study was origina
number of sources of information, a
them into a cohesive, and meaningful

Two differing perspectives were
any relationship between Crown of
activities on the G.B.R.

Firstly a long term regional p
focus on regional and temporal d
production. It identifies general
may relate to outbreaks of Crown o
more fully outlined in the following

Secondly a detailed biologica
relationship between A.planci and d
level. A detailed study of two speci
the Capricorn Bunker group and Cairn

However due to the unavailabil
of this study the original conc
abandoned. As it stands the ori
still sound. In the event these
available it is recommended this
projects, their estimated time of
management are detailed in Chapter 1

(ii) A LONG TERM REGIONAL PERSPECTIV

Catch records and production

he following as they might

vidual species in Queensland.
isheries production, catch
industry differences.
gures for individual species
ueensland Fish Board (Q.F.B.)
records are available after
s were investigated (Q.F.M.A,

fishery will be used to assess t
pertain to A.planci outbreaks.
(a). Queensland total production
(b). The relative importance of indi
(c). Regional contrasts of f
composition, fishing techniques, and
Commercial annual production fi
by landing region are taken from Q
annual reports from 1957 to 1981. No
this date though a number of source
and fish processors).

CHAPTER 2. AN OVERVIEW OF QUEENSLAND FISHERIES.

2.1 INTRODUCTION

Contrary to popular belief Queensland coastal waters are no
as rich in quantity of fish as generally believed although th
diversity of fish species cannot be disputed. The Queenslan
fishery is characterised by a variety of fishing methods an
products which are influenced by the length of coastline and th
largely tropical element (Williams, 1980).

The commercial fishing industry in Queensland is one of th
largest in Australia coming second in value only to Wester
Australia.The extent of the the fish caught by amateur fisherme
in Austalia has not been determined but in 1976-77 an estimate
27% of fresh & frozen food was caught by leisure fishermen.

However unofficial sources within the industry suggest th
total value of production may be as much as 2-3 times th
official figure. It is estimated that greater than 50% of th
catch is traded on the black market.
There are a large number of amateur fishermen who because of th
quantities involved sell all or at least part of their catch.Thi
group could be described as professional amateurs and thei
activities can impinge heavily on operations of the commercia
fishermen.

Management policies are needed to overcome resourc
depletion, to conserve the income of commercial fishermen and t
resolve conflicts between recreational and commercial fishing.

The most important edible fish caught around Queensland ar
mullet mackerel, bream, whiting and giant perch (barramundi).
In general it appears that the traditional fisheries are nearl
fully exploited.

Seefried (1983) noted the following characteristics abou
the Queensland fishery.Over the 5 year period 1976 to 1981.
1/Fin fish production has remained reasonably static and in som
cases has declined (Emperor, Snapper, Threadfin salmon, Whiting,
and Flathead).

2/Barramundi production peaked in 77-78 78-79 but has since declined by about 50%
3/Tuna fishing is at present almost nonexistent.
4/Overall fish production has declined since a peak in 74-75.

2.2 METHODS OF REEF FISHING

Reef fish are taken by fishermen engaged in a number of fisheries(e.g. prawn, and mackerel) and in most cases reef fish provide only a supplement to other fishing methods.
Most vessels are capable of being used for reef fishing and the majority of these carry line fishing licenses. Approximately 138 master fishermen claimed reef fishing was their primary income whilst some 300 licenses are held in Queensland (Williams, 1980).

Optimum locations sought by commercial fishermen are areas clear of and generally about one half mile from the reef rim drop-offs in depths of between 4 and 14 fathoms adjacent to submerged reef, bommies and reef outcrops.
The fish are taken by handlines which are rigged and baited

o the conditions and fishermens preferences. The ught is largely determined by an individual experience and skill.
lk of commercial reef catch is held on ice and fresh fish.

DIFFERENCES IN LINE FISHING OPERATIONS.

shing by handline is carried out along the entire hough few fishermen work north of Cape Flattery.
exists regarding number of people in the industry.
80) found 156 professional fishermen were registered eef fishermen in 1979 (or 5.9 % of total number of fishermen in Queensland) and 112 in 1980 (4.9 %).
ority of fishermen were found to work in one 'fishing lthough 25% operated in two. Many were reported as reef fishing secondary or tertiaryform of fishing.
ge of parttime fishermen was estimated at 12 %.

AND STRUCTURE OF FISH MARKETING IN QUEENSLAND.

ction provides a general outline of the background the Queensland fishing industry has developed over years and gives an understanding of the problems ith consistent data records.

and Fish Board.

1982 marketing of fish was controlled by the fish ement Act 1972 which established the Queensland Fish B.) as the statutory marketing authority for the stry.
eensland Fish Board (Q.F.B.) established in 1973 was for the marketing of fishermens catch in certain

according t
quantity ca
fishermen's
The bu
unloaded as

2.3 REGIONAL

Reef fi
east coast t
Little data
Williams (19
as primary r
professional
The maj
area' only a
considering
The percenta

2.4 HISTORY

This se
along which
the last 30
associated w

(i). Queensl

Until
supply manage
Board (Q.F.
fishing indus
The Que
responsible

Queensland which had been declared fish supply
Previously from 1966 to 1973 the north Queensland
ad been responsible for the marketing of fish north
on.

n March 1982, the Queensland Fishing Industry
and Marketing Bill was passed mainly as a response
financial situation of the Q.F.B., and the demands
ning industry to reorganise the marketing of fish.
ded provision for the institution of a new authority
ueensland Fish Mangement Authority (Q.F.M.A.). The
e Q.F.M.A responsible for the co-ordination and
marketing, production, licensing, product quality
nd fish promotion (Queensland Statutes, 1982). It
vision for the compilation of monthly returns from
esalers and processors in order to provide an
h data base.The Q.F.B.'s regulatory functions were
Q.F.M.A.,however the board was retained to operate
of a trader on an equal footing with the private
iving fishermen the choice of selling their product

sections of
districts.
Fish Board ha
of Rockhampto

On 25th
Organisation
to the poor
from the fish
The act inclu
termed the Qu
act made th
control of
standards, a
also made pro
seafood whol
accurate cato
ceded to the
in the role
industry.By g

licensed processors or
ket sales would be reduced

ely associated with the
Industries (Q.D.P.I. who
he Queensland Commercial

y also lobby the State
the final say reguarding
dational Fishing Industry
to being during 1986 when
ith the former national
F.I.C.).
fishing industry is shown
r (1986, Ed. Hundloe).

Scarborough, Townsville,
re than 50 % of the catch

ired all fish and seafood
and destined for sale in
oard.
the boards marketing
g the black market.
arketing and Organisation
ndations of the commitee
of selling their product
tives or licensed private

n analysis of
ensland examining number
period spent fishing.

through the Fish Board, or other
wholesalers it was hoped that black mark
(Seefried, 1983).

Today the Q.F.M.A. is intimate
Queensland Department of Primary I
appoints it's members and with th
Fishermens Organisation (Q.C.F.O.).
The fishing Industry in Queensland ma
minister for Primary industry, who has
state fisheries policy, through the N
Council (N.F.I.C.). The N.F.I.C. came in
fishermen expressed dissatisfaction w
body, the Australian Fishing Council (A.
The current structure of the Queensland
in figure 2.1 taken from Gray and Spence

(ii) Black Market.

In major ports such as Southport,
and Cairns it has been estimsted that mo
is traded on the black market.
The fish supply management act 1972 requ
caught within the fish supply district
Queensland to be delivered to the fish b
However due to dissatisfaction with
performance fishermen have been supplyin
The 1982 Queensland Fishing Industry M
act has incorporated some of the recomme
so that fishermen now have the choice
thru the fish board, fishermen's coopera
processors and wholesalers.

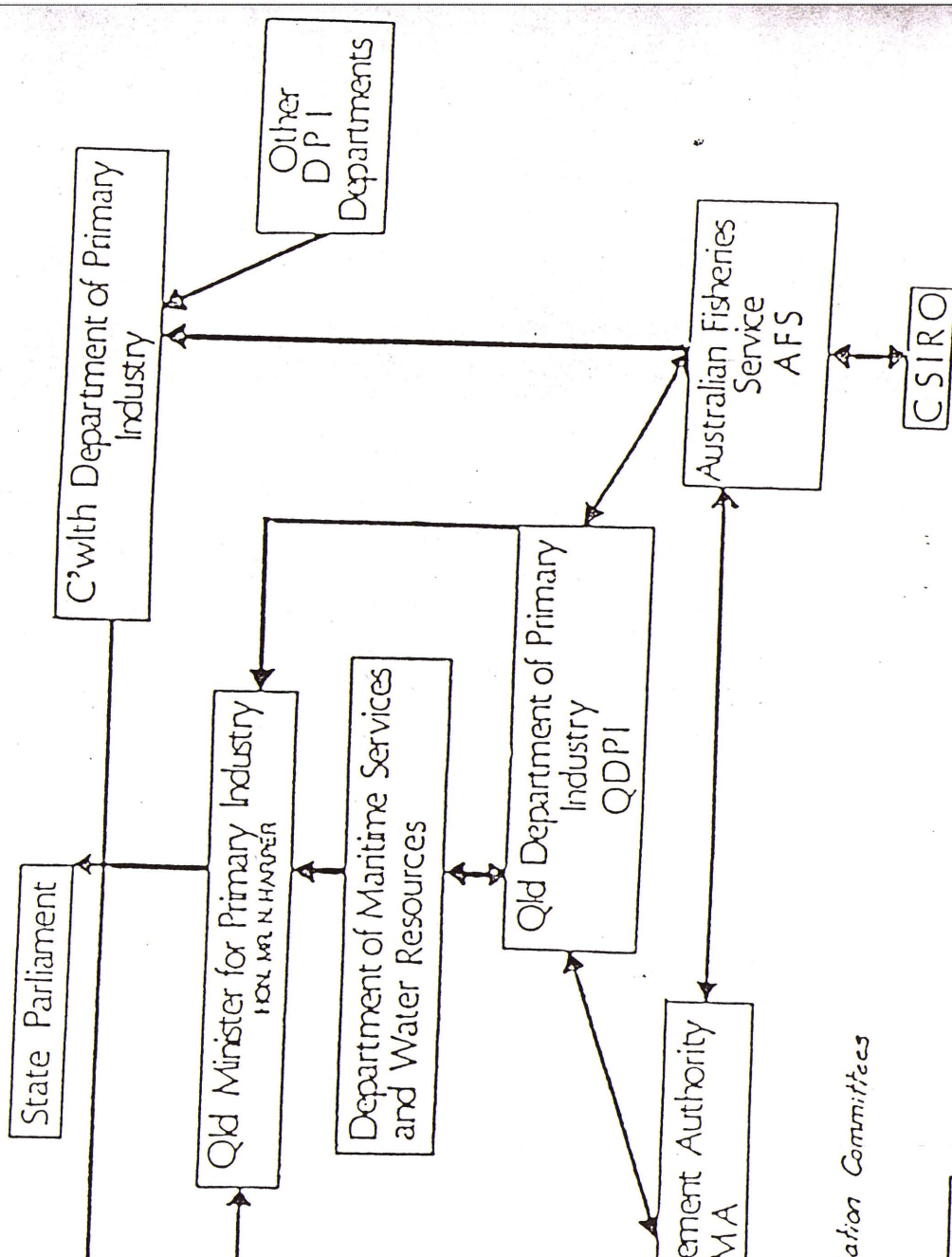
2.5 OTHER STUDIES

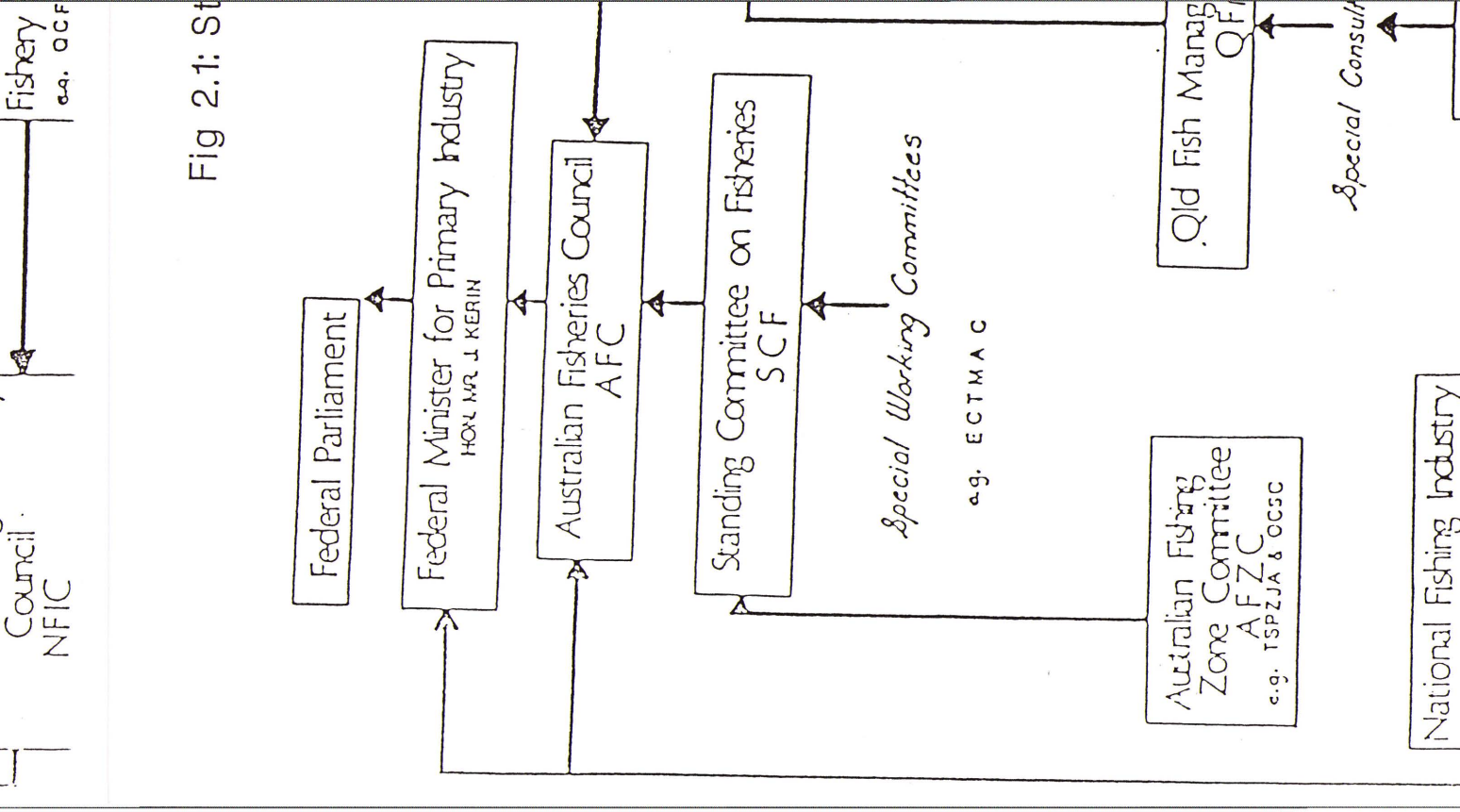
Williams (1979, 1980) undertook a
of commercial fishing operations in Que
of fishermen, areas fished, mobility

shing activities.
nature of the Commercial
e been compiled by
.F.O (1977) and by GBRMPA
the Cairns Section are
cpherson (1978), Q.D.P.I.
MPA (1981).
characteristics of the
in the Great Barrier Reef
l, 1980; Hundloe, 1981;
0; Driml et al, 1982,
These studies provide
capital and recurrent
hes, and consumption of

location of home port, and subsidiary fi
Reports describing the general
fisheries in the Capricornia section hav
in a joint effort by Q.D.P.I. and Q.C
(1979. Fishing related activities in
desribed in publications by Haysom and M
(1980) and zoning recommendations by GBR
Information on the economic
recreational and commercial fisheries
region are detailed in Hundloe et a
Hundloe et al, 1981; Driml, 198
Bandaranaike, 1981; and Jensen, 1979.
regional and total estimates of
expenditure, incomes, values of catc
seafood.

ructure of Queensland Fish Marketing.





PART 2: METHODOLOGY

PTER 3: METHODOLOGY FOR COMMERCIAL FISHERY ANALYSIS.

INTRODUCTION

The analysis and subsequent outcome of a study is affected the quality and consistency of the available data sources. objectives of looking at the commercial fishing industry on Great Barrier reef with respect to Crown-of-thorns starfish reaks was to gain a long term regional perspective. secondary objective was to establish a conceptual framework the establishment of a relevant fisheries database that would f use to the GBRMPA. Intrinsic to both these objectives is identification of all available data sources of relevance. rdingly other data sources and future developments pertaining ommercial fishing are outlined in chapter 13.

SOURCES OF INFORMATION

Annual Queensland Fish Board records of landings by Port the only data available for analysis. These records list the l quantities of fish and shellfish recieved at various Q.F.B. ets and agencies throughout Queensland. Data was collated until 1957 and up to 1981 when the major responsibilities of Queensland Fish Board became largely defunct.

Records of all species landed at Fish Board Landing Ports stored in a database at the GBRMPA from 1974 till 1981 in illment of the secondary objective of a relevant database.

As far as the primary objective concerning the investigation the consequences of fishing with repect to Acanthaster reaks, annual landings of five commercially important

rsal reef species were selected for analysis. The justication
species selection is outlined below.

JUSTIFICATION OF SPECIES SELECTION FOR ANALYSIS

Apart from the Spangled Emperor Lethrinus nebulosus, which
been identified as a possible predator or at least an active
rtunistic scavenger of the Crown of thorns (Birdsey 1977,
b GBRMPA), no other commercially sought or caught species
been identified as likely predators.
justification for the inclusion of the other 4 species is as
ows.
ll are large resident demersal fish on coral reefs.
ll are benthic omnivorous feeders.
ll are commercially caught fish on coral reefs.

From this it can be inferred that all species would suffer
quivalent degree of fishing pressure. Any severe depletion of
e demersal fish stocks, which are the most likely piscivorous
ators of Crown-of-Thorns, can best be inferred from analysis
atch rates of these species on reefs. Ideally information is
needed on the relative composition of each species at reefs
arious localities. However no data was available at the time

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by Q.N.P.W.S. at Boult reef is

bove criteria, landings of the
sed. Annual and regional patterns
re any significant relationship to
outbreaks.
Lethrinus chrysostomus; Emperor,
, Plectropomus sp.; Morwong,
, Lutjanus malabaricus were all

n available on each species is
ode and common species names given
Queensland Department of Primary
mended Marketing Names for Fish"

R

s nebulosus DPI CODE: 4066
YELLOW SWEETLIP

o 860mm it is common fish in
e north. Although it is a good
ind as ready sale as it should,
entage recovery of fillets is

ostomus DPI CODE: 4064
TRICKY SNAPPER

of writing, though a study
presently being undertaken.

On the basis of the ab
following species were analys
were examined to see if they bor
the dynamics of Crown of Thorns
The species are Sweetlip, L
Lethrinus nebulosus; Coral Trout
Plectorhynchus pictus; Nanygai
selected for analysis.

The biology and information
summarized below. The species co
are those provided by the Q
industries publication "Recomm
(1995).

1/ EMPEROR

ScientScientific Name: Lethrinus
Other names: SPANGLED EMPEROR; Y
Biology

Reaching a length of up t
offshore waters from Gladston
marketable species it does not f
principally because the perc
relatively low (Grant, 1982).

2/ SWEETLIP

Scientific Name: Lethrinus chrys
Other names: LIPPER; RED THROAT;
Biology

n the Great Barrier reef, it is
tone north. This fish may reach a
9 kg.

baricus and L.sebae DPI CODE:4053
RED EMPEROR; RED JEW; RED SNAPPER

baricus to the true red Emperor
ecies being marketed under the

reefs it forms mixed schools with
anus sanquineus.

The most common Emperor c
taken by line fishing from Glads
length of 900mm and a weight of

3/ NANYGAI

Scientific Name: Lutjanus malaba
Other Names: SCARLET SEA PERCH;
Biology

The similarity of L.mala
L.sebae has resulted in both sp
same name.

More common on the northerly
the saddle tailed sea perch Luti

ecies

ought

nt on
.
this
and

f the
Great

ecies
into
an be
acent

4/ CORAL TROUT

Scientific Name: Plectropomus spp. DPI CODE: 544

Biology

Plectropomus leopardus is the most commonly caught sp
of trout with P.maculatus more common on inshore areas.
Growing to at least 480mm, Coral trout is a commonly s
species owing to it's premium market price.

5/ MORWONG

Scientific Name: Plectorhynchus pictus DPI CODE: 502
Other names: Painted sweetlip

Biology

Probably the commonest Morwong, P.pictus is abunda
reefs and in estuaries along the entire Queensland coastline
However a number of more edible species are marketed under
name including P.goldmanni, P.chaetodonoides,
P.flavomaculatus.

3.4 REGIONAL SECTIONS

Some 31 processing plants were under the control o
Q.F.B. Seventeen of these are within the bounds of the
Barrier Reef Marine Park.

To best reflect any regional differences in sp
composition and catch rates the G.B.R has been partitioned
four 'Regional Fisheries Sections' (Table 3.1). These c
regarded as the primary catch area for fish processed at adj

s.
on of
ta is
eater
ction

tions
. The
A Far
l and
BRMPA

f the
ction

shore based processing plants within these Fisheries Section
The broad spatial scale adopted is a result of the resoluti
the available data. As no actual catch per unit area da
available the best that can be inferred is that there was gr
likelihood of the fish being caught within the Fisheries Se
adjacent to the port of landing than any other Section.

The Northern, Central, and Capricornia fisheries sec
are based on the the GBMRPA zoning sections of the G.B.R
Northern Fisheries Section incorporates both the GBRMP
Northern and the Cairns-Cormorant pass Sections. The Centra
Capricornia Fisheries Section are identical to those G
zoning sections of the same name.
The Southern Fisheries Section lies outside the bounds o
Great Barrier Reef, but the processing plants in this se
still process fish caught from the reef and shipped down.

A STORAGE

ta was compiled into a cohesive database using a modified
eal database known as 'Paradox'. This software package was
for the ease of manipulation. Data of all Q.F.B. records
es by port from 1974 till 1981 are compiled whilst prior
s only those species of relevance to this study are
d. This data along with the Crown-of-thorns database(see
10.2) is stored at the G.B.R.M.P.A. on the UNIX based
ne.

3.5 DATA

Dat
relation
chosen f
by speci
to this
collated
section
mainfram

1. REGIONAL SECTIONS AND QUEENSLAND FISH BOARD DEPOTS.

TABLE 3.

. FISHERIES SECTION	FISH BOARD DEPOT
HERN SECTION York - Tully	Cairns Port Douglas Innisfail
AL SECTION - Mackay	Ingham Paluma Townsville Ayr Homehill Bowen Proserpine Mackay
CORNIA SECTION y - Maryborough	Yeppoon Rosslyn Bay

REGIONAL
1. NORTH Cape
2. CENTR Tully
3. CAPRI Macka

	Rockhampton
	Gladstone
	Bundaberg
	Pialba
	Maryborough
	Tin Can Bay
ERN SECTION	
orough - Brisbane	Brisbane
	Caloundra
	Cleveland
	Dobby Creek
	Mooloolaba
	Sandgate
	Scarborough
	Southport
	Tewantin
	Wynnum

4. SOUTH
Maryb

examine both the spatial and
n of the above species. The
ed in 3.5 are used to best
n terms of combined annual
rocessing plant differences.
Section are examined in the

landings of fish by region,
total landings of individual
les regional tables of annual
ng plant.
ined total of fish fillet and
of 24 years from 1957 until
t. Figures had to be modified
fish, and to convert figures
ms.
Catch per Unit effort (CPUE)
ation regarding actual fishing
nding data. In addition other
makes any detailed analysis
ned in section 3.7.
concerned with spatial and
the way in which they relate
arfish.

A

. data had to be overcome to
is. These are outlined below
e results and to forewarn the
in the data. The absolute
n their face value but rather
f long term trends in the

3.6 METHODS OF ANALYSIS

The Q.F.B. data has been analysed to
temporal trends in annual productio
regional Fisheries Sections defin
examine differences which exist i
landings, species composition, and p
These results of each Fisheries
following 4 chapters.
Table 4.1 shows the combined total
whilst Table 4.2 demonstrates the
species by region. Appendix A provid
landings of fish species by processi
The figures used are the comb
whole fish production over a period
1981 when the Q.F.B. became defunc
to convert fish fillets to whole
prior to 1974 from pounds to kilogra
No attempt is made at any
analysis due to a paucity of informa
effort concurrent with the Q.F.B la
inconsistencies in the landing data
impossible. These problems are outli
Rather the analysis is more
temporal patterns of production and
to 'outbreaks' of Crown-of-thorns st

3.7 INTERPRETATION OF FISH BOARD DAT

Inconsistencies in the Q.F.B
build a cohesive database for analys
as an aid to interpretation of th
reader of the inaccuracies inherent
figures given should not be taken o
should be taken as an indication o

over the last 24 years.

her private processing plants
14).

of fish were separated into
viously only finned fish had
be viewed both as a change in
h in the processing and the
tor of two has been used to

to kilograms(kg) in 1974.

Northern Fish Board (N.F.B.)
kets north of Rockhampton.
or the two Fish Boards over
mposition should be viewed in
tion.

Estimates of the black market and ot
need to be investigated(see Chapter

1. From the Year 1970 on landings
fillets of fish and finned fish. Pre
been recorded. This change can
policy and changes in technology bot
catching of fish. A conversion fac
convert fish fillets to whole fish.

2. Records changed from pounds(lbs)
A conversion factor of 2.2 is used.

3. In the years 1966 till 1973 the
was in operation controlling mar
Landings were recorded separately f
these years. Any change in catch co
light of these changes in administra

4. On 31st January 1973 the landing ports governed by th
Northern Fish Board were ceded back under the aegis of th
Queensland Fish Board. Consequently data provided by the Northern
Fish Board in 1973 is for the 7 months ended 31st January 197
whilst data from the Queensland Fish Board is recorded as th
Year ending 30th June 1973.

5. In 1976, the end of the financial year was changed from th
30th June back to the 30th April. Therefore data in 1976 from th
fish Board is for the ten months ending 30th June 1976.

6. Over the years the Fish Board depots recorded in the Annua
Q.F.B. reports have varied considerably due to some plants
becoming operational and others obsolete.

7. The Queensland Fish Board stoppped official recording of fis
landings after 1981 once its powers were revoked under th
Queensland Fishing Industry Organisation and Marketing Bil
(1982). Consequently analysis occurs only up till 1981 as dat
was unavailable after this time.

8. Landings of Coral trout were not recorded until after 1963.
This should be considered when looking at total landings for
Fisheries Section.

METHODOLOGY FOR CROWN-OF-THORNS STARFISH ANALYSIS.

CTION

aks of the Crown-of-thorns starfish were first the G.B.R. in 1962 at Green Island. Since that time and often emotional debate has been generated the causes of the Acanthaster phenonemon, including a committees of inquiry. Considerable information now the distribution and intensity of Crown-of-thorns over the last 25 years. This is the result of s made both by scientists and the general public.
(1997) noted a number of characteristics of outbreaks R. which provide a useful background for the ensuing

s which have occurred in the region are probably the ve in the world having been reported in an area from eefs to those near Princess Charlotte Bay, a distance 0 km.
es of extensive outbreaks have occurred on the G.B.R. ere first recorded at Green Island in 1962, and various parts of the G.B.R. until 1977. No reports s were then recieved until the end of 1979 when ere again reported at Green Island. This second series s is still occurring at present.
er of problems exist in gauging the extent of d how they can be related to fisheries information. it is not known whether outbreaks occurred in the to 1979 of whether this reflects the fact that no urveys were undertaken during this period (Moran, e problems and associated caveats are outlined in

S IN THE ANALYSIS OF COTS AND THE DYNAMICS OF THE INDUSTRY.

CHAPTER 4: M

4.1 INTRODUC

Outbrea
recorded on
extensive
concerning t
number of
exists on
outbreaks o
observations

Moran (
on the G.B.
analysis.
(1) Outbreak
most extensi
the Swain re
of about 120
(2) Two seri
Outbreaks we
continued on
of outbreaks
outbreaks we
of outbreaks

A numb
outbreaks an
For instance
period 1977
scientific s
1987). Thes
section 4.3.

4.2 PROBLEM
FISHING

stigation of this nature is necessarily limited in
sions due to inconsistancies in the data. These
ise largely from differences in the resolution of
ch these processes have been measured. This makes any
analysis of a relationship between fishing pressure
mics of Acanthaster outbreaks impossible due to the
nfounding factors.

vailable only for landing ports. No data is available
as even at a regional level let alone at a specific
. Consequently catch areas have had to be inferred as
reefs being proximate to the various landing ports.

erm data exists giving the number of fishermen in the
Many primary Mackerel and trawler fishermen, reef
rily . This makes it very difficult to gauge any CPUE
estimation is further confounded by changes in the
ology of both fishing methods and of processing.

An inve
it's conclu
problems ar
scale at whi
conclusive
and the dyna
following co

1. Data is a
on catch are
reefal scale
being those

2. No long t
'industry'.
fish secondar
figures. Any
in the techn

thorns starfish exist. The
reefs which happened to be
me.These observations were
ish were on the reef.
inferred is to examine
a particular region with
ccurred. Even such a basic
by the vagaries of scale.
Capricorn/Bunker group is
ch to look at outbreaks no
If however the area under
ate the Swains complexes a

any interpretation of a
arfish and fishing. Namely
utbreaks or did outbreaks
the fishing industry.

abase of Crown-of-thorns
analysis. This database
fname, reef-ID, sample ID,
servation, and habitat.

comparative analysis has
atabase from AIMS has been
ratified in the following

ic 'COT' areas based on the
visions of the three reef
ly in section 2.1. This is
of Crown-of -thorns for
andings of the appropriate
ion landings are used for

3. No absolute counts of Crown-of-
database consists only of sightings at
visited at a particular period of ti
largely based on information that Starf
Consequently the best that can be
trends in the annual landings for
respect to whether or not an outbreak o
analysis as this is again confounded
For instance if an area such as the
deemed to be a scale appropriate at whi
evidense for outbreaks would be found.
consideration was widened to incorpor
relationship could be inferred.

4. A catch 22 situation exists with
relationship between Crown-of-thorns St
did fishing pressure exacerbate the o
bring about a change in the dynamics of

4.3 SOURCES OF INFORMATION

The AIMS modified GBRMPA dat
observations was made available for
records the following data; date, ree
number of Crown-of-thorns, method of ob

4.4 METHODOLOGY

Due to problems outlined above,
been kept simple. The Crown-of Thorns d
used in the analysis. Data has been st
manner.
1. Data was broken into 5 geographi
GBRMPA zoning sections. These are subdiv
based fishery sections defined previous
to facilitate comparison. Observations
each area are compared against annual la
fisheries section (i.e. Northern secti

nd the Cairns section).
ure 4.1.

both the Crown-of-thorns Far Northern ar
These are shown in table 4.1 and in figu

TABLE 4.1 : GEOGRAPHIC EXTENT OF FISHING AND COT SECTIONS.

FISHING SECTION	CROWN-OF-THORNS SECTION
1.Northern Section Cape York to Tully	1. Far Northern Section 2. Cairns Section
2. Central Section. Tully to Mackay	1. Central Section. Tully to Mackay.
3. Capricornia Section. Mackay to Bundaberg.	1. Capricornia Section 2. Capricorn/Bunker Section

2. The Crown-of-thorns data was further broken down into observations by method. This removed any inconsistencies and shortcomings of the various methods allowing a more resolute comparison. From the six methods used in the AIMS/GBRMPA database, the were futher lumped into the following categories.
A. Observations by Scientists.
B. Observations by Non-Scientists.
C. Observations by Manta-towing.

Using the above data a relative index of Crown-of-thorns activity/observations has been calculated for each area over each calendar year (COT Index).
This index is based on the number of reefs in an area observed to have Crown-of-thorns starfish on them over the total number of

surveyed in that area for that year.

Number of Reefs with Crown-of Thorns
Total Number of Reefs surveyed.

This index has several flaws and caution is required in the interpretation of the results. The figures to follow contain boxes underneath which provide the figures on which the indices are based and should be used to interpret the figures.
Indices have been calculated only for greater than three observations for an area in a year. However the problem arises, where if for example 3 reefs were surveyed in an area and all 3 were recorded as having outbreaks of Crown-of-Thorns an index of 1.0 would be calculated. However if in another year 46 reefs were surveyed and Crown-of-thorns were observed on 20 of these reefs a lower index value would be calculated, even though a greater number of reefs were surveyed.

ty of reefs to landing ports has also been used to evidence for a relationship between the two s is based on the assumption that those reefs ng ports are likely to recieve greater fishing c their proximity and ease of access. Reefs have into four distance categories based on their major poulation centres. These categories are: <30 0-90 km, >90 km.

ty' of outbreaks is also examined by breaking the o a 5 class abundande scale. As a number of re for a reef were often made for one year, the of Crown-of-thorns seen irrespective of method is ance scale used is as follows.

sh
sh
sh

e had observations of greater than 100 individual y one time are also considered. Regardless of the vation used, populations of this size are to be roken. The basis for this rationalisation is shown ken from Moran (1987) showing various definitions ing and normal reef. Names of the reefs are given ir distance from port and the amount of fishing roceive. Reefs which have had recurring outbreaks

NITIONS OF AN OUTBREAKING AND NORMAL REEF (from

ition	Reference
1000 m	Endean & Stablum, 1975b

3. The proximit
further examine
phenomena. This
closer to landi
pressure due t
been subdivided
distance from
km, 30-60 km, 6

4. The 'intensi
data down into
observations wer
maximum number
used. The abunda
A: 1 Starfish
B: 2-9 Starfish
C: 10-49 Starfi
D: 50-99 Starfi
E: > 100 Starfi

Reefs which have
Starfish at any
method of observ
considered outbr
in table 4.2 ta
of an outbreaki
along with thei
activity they
are also shown.

TABLE 4.2: DEFIN
Moran 1987).

Defini
OUTBREAKING
14 starfish per

20 min. swim	Pearson & Endean, 1969	40 starfish per
20 min. swim or manta tow	Chesher, 1969a	100 starfish per
1 min. spotcheck	Pearson & Garrett, 1976	10 starfish per
		NORMAL
100m of reef	Dana et al., 1972	1 starfish per 1
km of reef	Endean, 1974	6 starfish per k
km of reef	Chesher, 1969a	4-5 starfish per
er km of reef	Ormond et al., 1973	5-20 starfish pe
arfish per 1000 m	Endean & Stablum, 1975b	Less than 14 sta
arfish per 20 min. swim	Pearson & Endean, 1969	Less than 10 sta
arfish per 20 min. swim	Chesher, 1969a	Less than 20 sta

undertaken, to examine
f-Thorns and Fishing
llowing reasons.
, so the best that can
e area can be defined.
ed observations at one
ute number of crown of
ear which have played

sed in the analysis of
n the fisheries year
observations are based

when the Acanthaster
obvious in the Cairns
ed in 1966 through to
blic concern, and then
s after interest had
ade when concern arose

5. Exploratory Time series analysis was
any causal relationship between Crown-o
pressure, but then abandoned due to the fo
1. Landing data is used not catch area data
be inferred is a general region. No absolut
2. The Crown-of-thorns data represents bias
point in time which do not give the absol
thorns or even the number of reefs in a y
host to the starfish.
3. Different temporal scales have been u
the data. The fisheries data is based o
ending 30.04 of each year whilst Starfish
on calender years.
4. Observations were made at times
'phenonenom' was topical. This is most
section with observations being concentrat
1971 when the phenonema first became a pu
no observations made for the next 9 years
~~died.~~ A spate of observations were then m
again.

waned.

PART 3: ANALYSIS OF COMMERCIAL FISHERY AND CROWN-OF-THORNS STARFISH.

CHAPTER 5. THE NORTHERN FISHERIES SECTION.

5.1 INTRODUCTION

The Northern Fisheries Section has 2 major processing plants at Cairns and Innisfail which process the majority of the fish landed from this region. A third processing plant at Port Douglas was initiated in 1979. This section incorporates the Far Northern and the Cairns to Cormorant Pass Section (Fig 5.1).
It extends from Two mile opening in the North to the passage South of Beaver and Taylor Reefs in the South. It covers an area of some 36,000 square kilometres with a total of 211 reefs of a variety of types.

In the Northern Fisheries Section, Williams (1982) recorded 6 primary fishermen and 8 Mackerel fishermen. These fishemen were spread over a large geographic area with 2 ~~four~~ fishermen in the following home ports; Cairns, Port Douglas, Cooktown. It would be envisaged that these operations would have largely non-overlapping territories.
The combined total production of reef fish caught in the Northern Fisheries Section is shown in table 4.1 and fig.4.1, whilst table 4.2 provides a breakdown by species of fish landed for the Northern Section. Appendix A1 has a full listing of species landed by port.

5.2 ANNUAL PRODUCTION TRENDS

Fig 5.3 clearly demonstrates how the combined landings have

Fig 5.3 clearly demonstrates how the combined landings have varied over the 25 years examined with an eleven fold maximum range of
landings between years. Total Landings for 1967 jumped 4-fold from the previous year to 55 tonnes. This tonnage was sustained again in 1968, but landings fell steadily for the next 3 years. In 1972 landings increased significantly to 46 tonnnes but fell to 16 tonnes the following year (N.B. Fish landings for 7 months only). Landings again increased steadily over the next 3 years reaching a peak production of 50 tonnes in 1978. Landings fell again substantially after this time.

5.3 SPECIES COMPOSITION

Coral trout (fig. 5.4) has been the most heavily landed reef fish in this region subsequent to 1963. Landings have fluctuated considerably peaking in 1968 with 32 tonnes of fish processed and 1970 when 35 tonnes were landed. A minimum tonnage of 8 tonnes was reached in 1973 but landings again increased over the next 5 years to a maximum of 31 tonnes of fish processed in 1978.
These yearly patterns of landing are similar for the the two major processing plants (figures 5.4) and also reflect those patterns observed for the total landings of reef fish landed for the Northern Fisheries Section.

Sweetlip (Fig. 5.5) in the Northern section
ly from a peak of 18 tonnes in 1958 to only 7
ocessed the following year. Landings continued
ext four years to a low of 3 tonnes in 1963.
atically over the years 1966 through to 1968
tonnes of fish were landed. Apart from 1972 a
andings of Sweetlip was to be seen over the 5
tonnes). Landings increased steadily after
m landing of 13.5 tonnes in 1976. Landings for
r 1977 to under 10 tonnes of Sweetlip landed

Emperor in the Northern Section (fig. 5.6)
er 3.5 tonnes for the years 1957 through to
nearly 4-fold over the next two years to a
in 1968. Landings fluctuated widely over the
h the greatest tonnage of Emperor being landed
s). Landings dropped over the next 4 years to
ximately 4.7 tonnes of processed fish, which
gh until 1980, after which time landings of
Innisfail was the major port of landing for
il 1978 after which time Cairns And Port
major ports of landing.
Morwong (fig. 5.7) have been minimal in this
being under one tonne.
tonnes of Nanygai (fig. 5.8) is recorded as
the Northern section in 1967 after a 5 year
al landings. After 1967 landings levelled out
ound 0.4 tonnes for the next 5 years. Landings
this, the most dramatic rise being from 1.3
.7 tonnes in 1978.

Landings of
decline substantial
tonnes of fish pro
to fall over the ne
Landings jump dram
when a total of 16
sharp decline in 1
years to 1973 (3.4
this till a maximu
all years fell afte
per annum.
Landings of
remained under und
1966 but increased
peak of 11.5 tonnes
following years wit
in 1975 (13.4 tonne
a plateau of appro
was sustained throu
Emperor increased.
this species up unt
Douglas became the
Landings of
region, nearly all
A peak of 1.7
being landed for
period of no offici
at a plateau of ar
rose steadily after
tonnes in 1977 to 3

H BY REGION.

as
nehill, Proserpine,

dstone, Bundaberg,
yn Bay, Tincan Bay

SOUTHERN
399
870
112
542
440
702
320
446
538
955
090
490
811
053
245
582
773

(Kgs)

TABLE 5.1: COMBINED TOTAL LANDINGS OF REEF FISH

Northern Section: Cairns, Innisfail, Port Dougl
Central Section: Ingham, Townsville, Bowen, Hom
Mackay
Capricornia Section: Rockhampton, Yeppoon, Gla
Maryborough, Pialba, Rossl
Southern Section: All Brisbane Fish markets.

YEAR	FISHERIES SECTIONS			
	NORTHERN	CENTRAL	CAPRICORNIA	S
1957	15302	27997	35270	4
1958	19007	26518	53833	8
1959	8361	13251	55426	7
1960	7485	6604	64111	10
1961	7630	8025	27391	4
1962	8485	21269	38125	4
1963	20292	40323	55512	3
1964	19162	30701	72215	3
1965	28004	27181	73028	6
1966	18570	23921	70942	20
1967	55441	51323	61980	6
1968	56460	49440	35594	5
1969	43694	52160	38864	5
1970	49071	143740	94999	13
1971	33928	162674	115061	13
1972	46498	172952	93042	5
1973	16382	205394	97864	13

1975	36883	237382	92344	6
1976	41657	162506	88251	24
1977	50138	178016	91216	31
1978	48182	95602	59193	29
1979	35550	204543	72769	31
1980	29851	246046	94161	479
1981	34810	235715	64601	61

TABLE 5.2: TOTAL LANDINGS (Kg) OF REEF FISH BY REGION. 9 Species

Northern Section: Cairns, Innisfail, Port Douglas
Central Section: Ingham, Paluma, Townsville, Bowen, Homehill, Proserpine, Mackay.
Capricornia Section: Rockhampton, Yeppoon, Gladstone, Bundaberg, Maryborough, Pialba, Rosslyn Bay, Tincan Bay
Southern Section: All Brisbane Fish Markets.

YEAR	SPECIES	FISHERIES SECTIONS			
		NORTHERN	CENTRAL	CAPRICORNIA	SOUTHERN
57	Morwong	481	333	3443	300
57	Nanygai	0	0	78	2275
57	Sweetlip	14821	27475	27634	1529
57	Emperor	0	189	4115	295
58	Morwong	538	163	3882	424
59	Nanygai	0	3	124	5440
58	Sweetlip	18013	25578	45166	2524
58	Emperor	456	774	4660	482
59	Morwong	117	143	714	995
59	Nanygai	845	0	286	2473
59	Sweetlip	7355	12257	47948	3278
59	Emperor	45	851	6478	366
60	Morwong	90	119	1678	290
60	Nanygai	0	0	336	3947
60	Sweetlip	5945	6032	53994	2755
60	Emperor	1450	453	3103	3351

61	Morwong	41	33	255	194
61	Nanygai	101	20	72	2543
61	Sweetlip	5200	7487	22462	1281
61	Emperor	2289	485	5101	423
62	Morwong	21	151	1363	133
62	Nanygai	1	20	77	2629
62	Sweetlip	4913	19407	45290	1568
62	Emperor	3550	1691	13394	372
63	Morwong	11	65	1963	52
63	Coral trout	14735	19570	11357	683
63	Nanygai	0	0	104	584
63	Sweetlip	3046	19062	35719	1919
63	Emperor	2490	1625	6370	82
64	Morwong	3	108	408	87
64	Coral trout	13555	14166	11820	73
64	Nanygai	4	0	437	1939
64	Sweetlip	3647	15310	51032	1119
64	Emperor	1954	1117	8517	229

TABLE 5.2: CONTINUED

YEAR	SPECIES	NORTHERN	CENTRAL	CAPRICORNIA	SOUTHERN
65	Morwong	0	132	438	78
65	Coral trout	17555	10153	22150	538
65	Nanygai	0	0	397	3192
65	Sweetlip	7932	14890	41869	2406
65	Emperor	2517	2006	8175	324
66	Morwong	51	53	387	359
66	Coral trout	12416	11357	22601	8002
66	Nanygai	0	0	548	4577
66	Sweetlip	4042	11204	39529	7589
66	Emperor	2060	1307	7876	428
67	Morwong	2	205	70	125
67	Coral trout	32891	23369	15961	428
67	Nanygai	1745	26	429	3596
67	Sweetlip	12880	23589	39112	1728
67	Emperor	7923	4135	6407	213
68	Morwong	24	45	18	276
68	Coral trout	28652	20989	9498	46
68	Nanygai	288	15	90	3361
68	Sweetlip	15951	24739	21232	1100
68	Emperor	11545	3651	4756	707
69	Morwong	12	113	280	272
69	Coral trout	21793	23173	9861	71
69	Nanygai	269	0	115	4152
69	Sweetlip	11711	25835	22573	781
69	Emperor	9910	3038	6034	535
70	Morwong	0	67	48	3857

34837	86086	32904	1291
261	19	203	4514
8300	35658	55150	2273
5673	21911	6693	1117
0	46	124	215
15430	83738	41766	961
381	199	506	8964
7828	26178	63166	2013
10283	52513	9499	1091
5	16	117	769
27426	90320	45145	849
10958	21478	42946	3625
8109	61138	4833	339
0	69	107	373
7812	96546	46730	1732
400	0	1171	8348
3381	59249	43256	1895
4789	49530	6600	1425

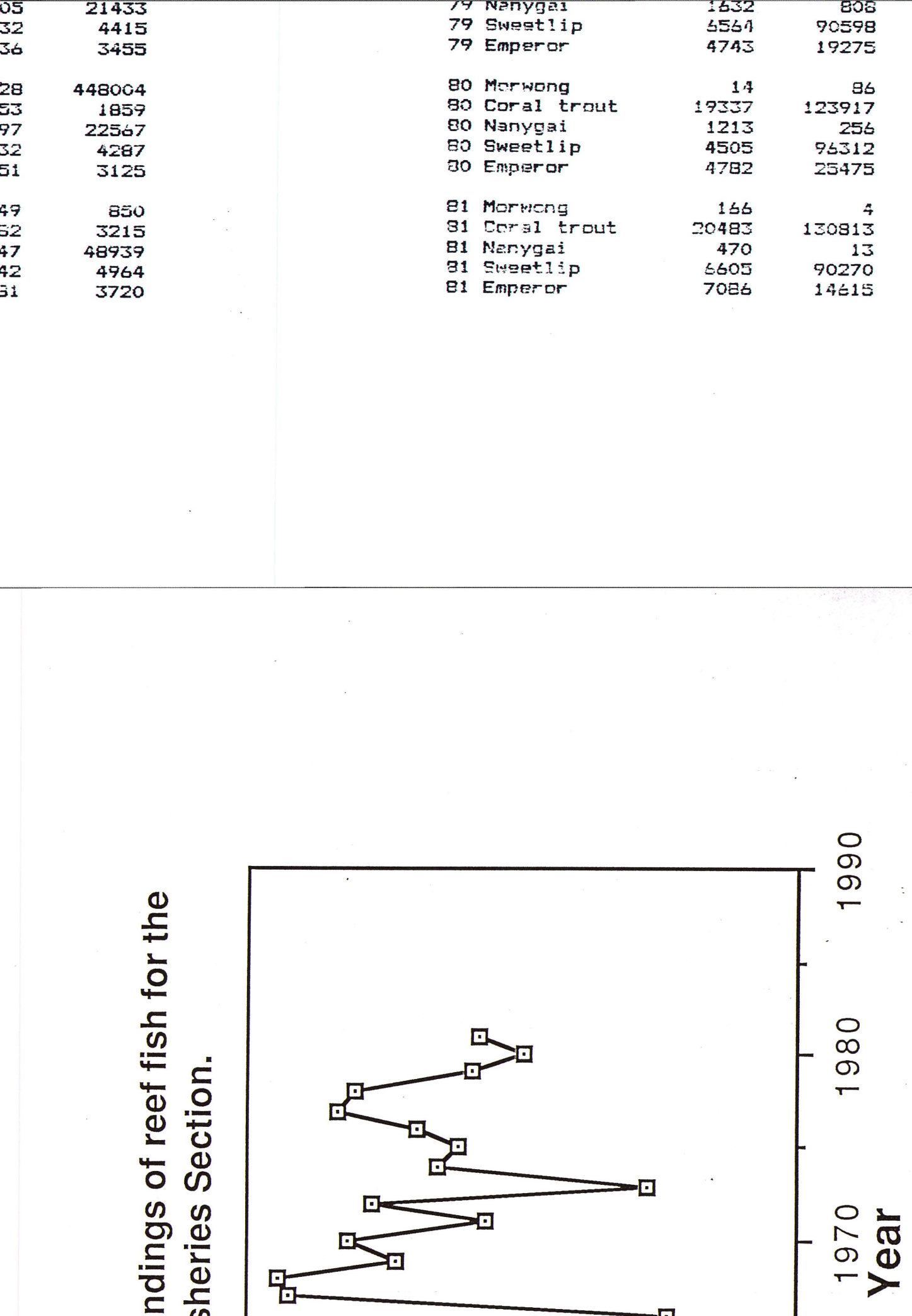
70	Coral trout
70	Nanygai
70	Sweetlip
70	Emperor
71	Morwong
71	Coral trout
71	Nanygai
71	Sweetlip
71	Emperor
72	Morwong
72	Coral trout
72	Sweetlip
72	Emperor
73	Morwong
73	Coral trout
73	Nanygai
73	Sweetlip
73	Emperor

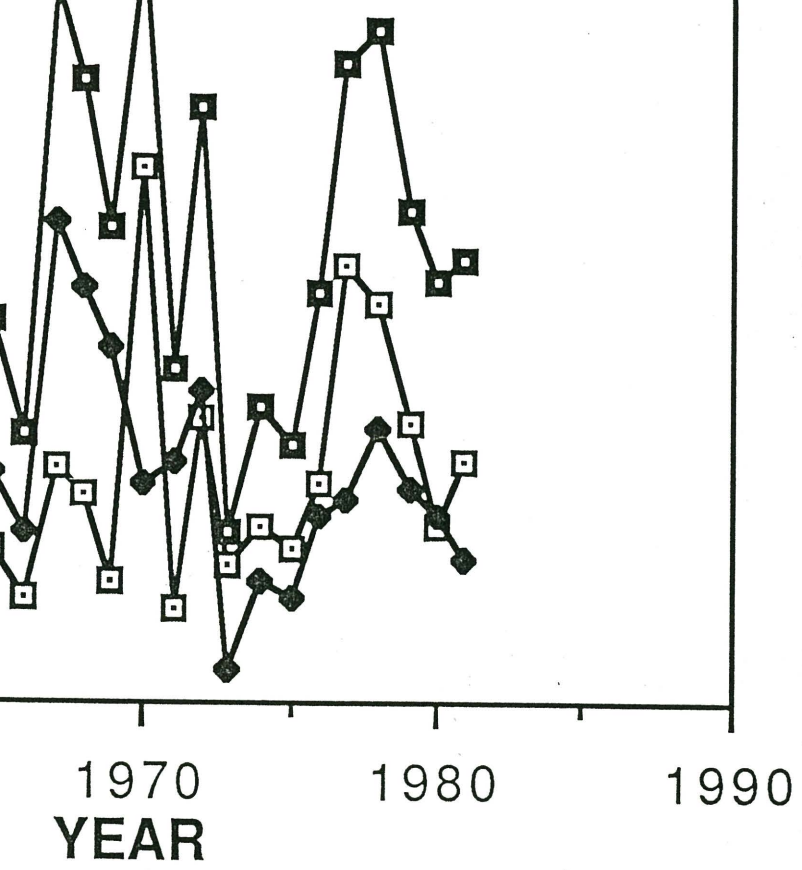
CORNIA SOUTHERN	
71	462
63	2192
0	8
03	3847
63	2387
81	371
03	547
0	0
15	3336
45	2058
58	342
26	566
13	4657
92	17638
62	1246
32	584
92	758
98	24246
71	3197
23	3113
57	724
38	650
99	20164
08	5509
91	2929
34	589
62	1717

TABLE 5.2: CONTINUED

YEAR	SPECIES	NORTHERN	CENTRAL	CAPRIC
74	Morwong	15	6	1
74	Coral trout	13643	104305	371
74	Nanygai	1018	0	
74	Sweetlip	10310	24928	463
74	Emperor	14088	118630	92
75	Morwong	0	7	
75	Coral trout	11706	84699	293
75	Nanygai	1129	0	
75	Sweetlip	10623	36480	511
75	Emperor	13425	116196	118
76	Morwong	3	0	2
76	Coral trout	18816	74095	385
76	Nanygai	907	6	2
76	Sweetlip	13532	69501	392
76	Emperor	8399	18904	99
77	Morwong	22	0	3
77	Coral trout	29467	59166	323
77	Nanygai	1321	174	11
77	Sweetlip	12061	76380	449
77	Emperor	7267	42296	123
78	Morwong	69	23	2
78	Coral trout	30937	10388	223
78	Nanygai	3681	284	9
78	Sweetlip	8529	71735	268
78	Emperor	4967	13172	87
79	Morwong	0	0	1
79	Coral trout	22611	93862	214

05	21433	79 Nanygai	1632	808	14
32	4415	79 Sweetlip	6564	90598	378
36	3455	79 Emperor	4743	19275	119
28	448004	80 Morwong	14	86	1
53	1859	80 Coral trout	19337	123917	334
97	22567	80 Nanygai	1213	256	13
32	4287	80 Sweetlip	4505	96312	463
51	3125	80 Emperor	4782	25475	128
49	850	81 Morwong	166	4	2
62	3215	81 Coral trout	20483	130813	223
47	48939	81 Nanygai	470	13	17
42	4964	81 Sweetlip	6605	90270	257
81	3720	81 Emperor	7086	14615	144





gs of Coral trout in the
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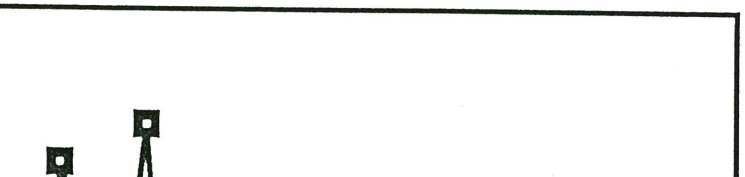
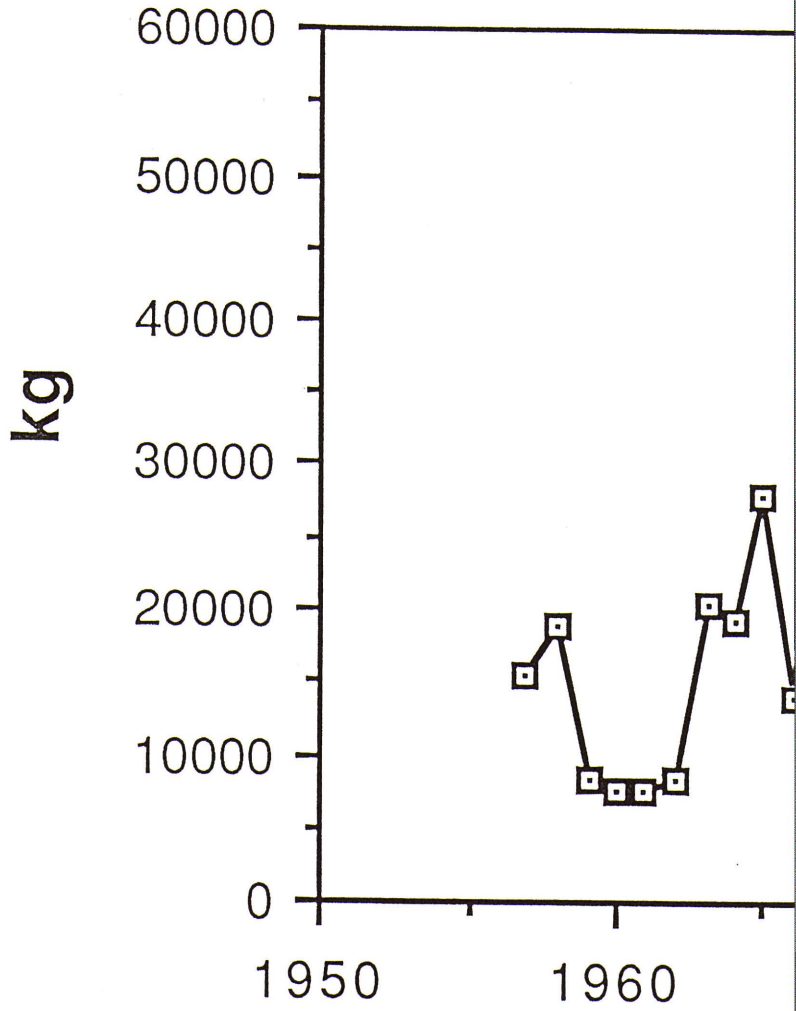
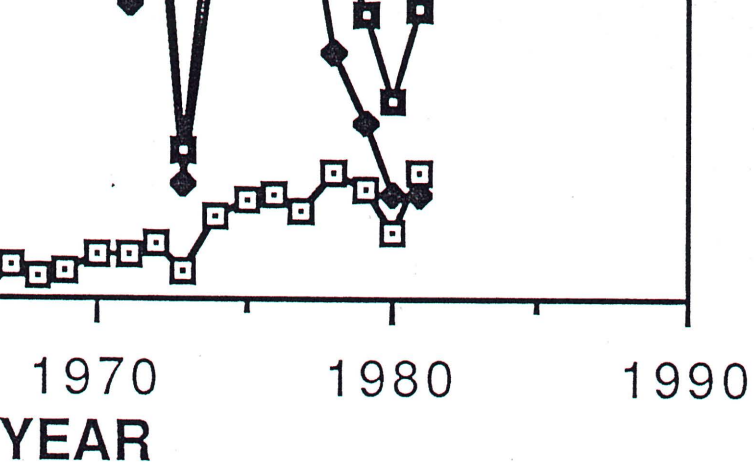
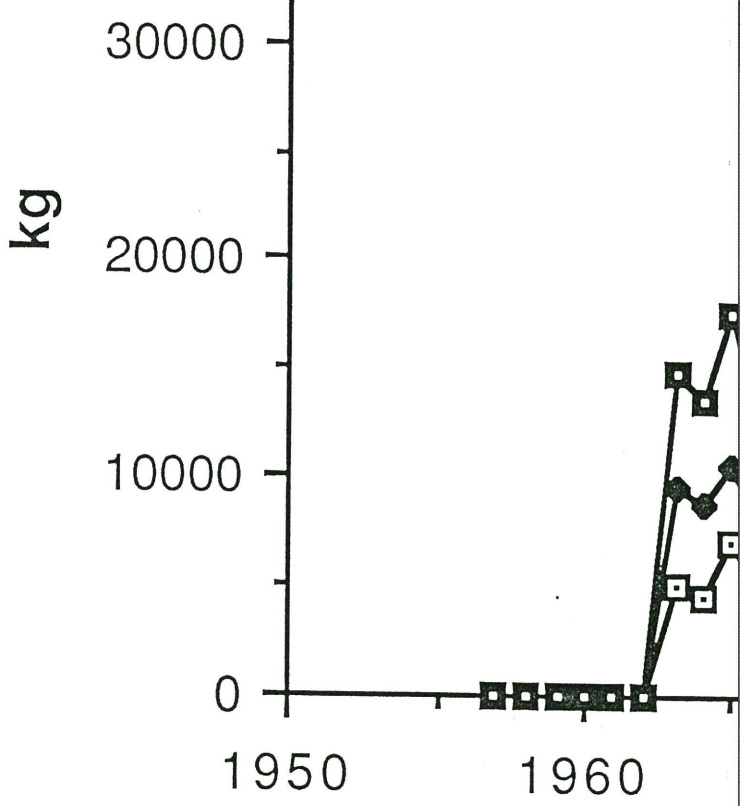


Fig 5.2: Total la
Northern Fis







f Sweetlip in the
sheries Section.

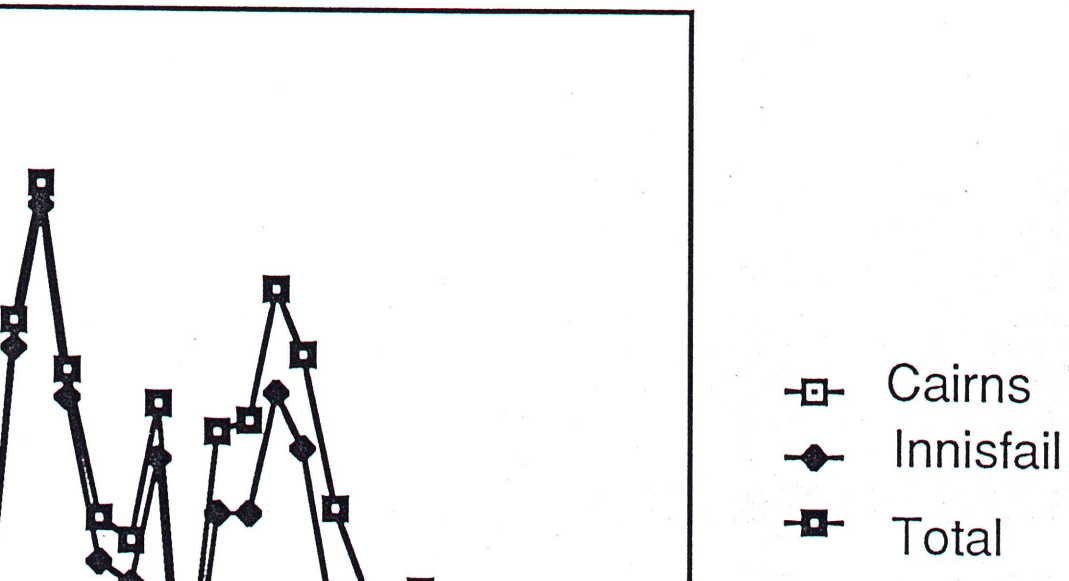
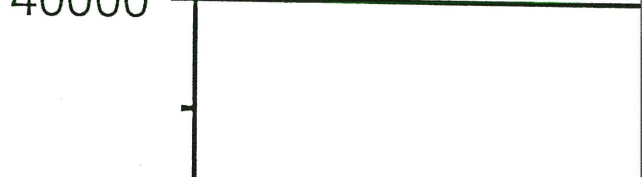
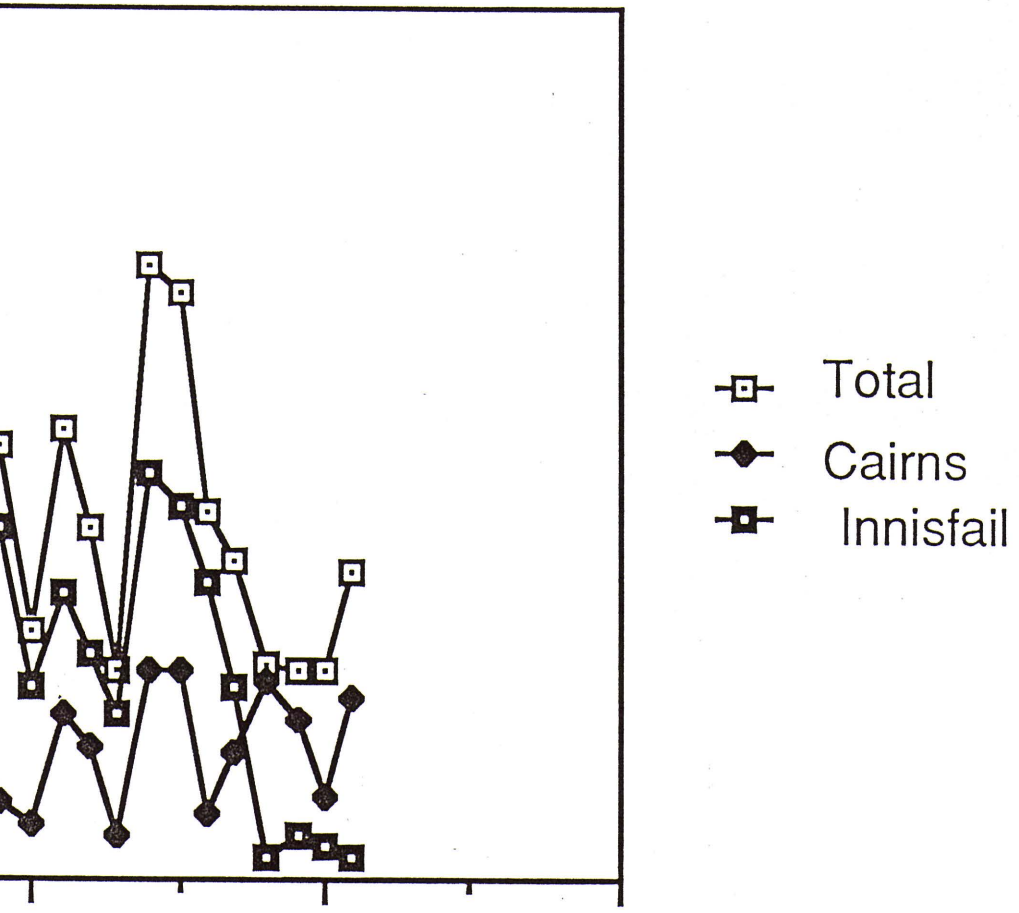


Fig 5.3: Landin
Northern



970 1980 1990
EAR

of Emperor in the
Section.



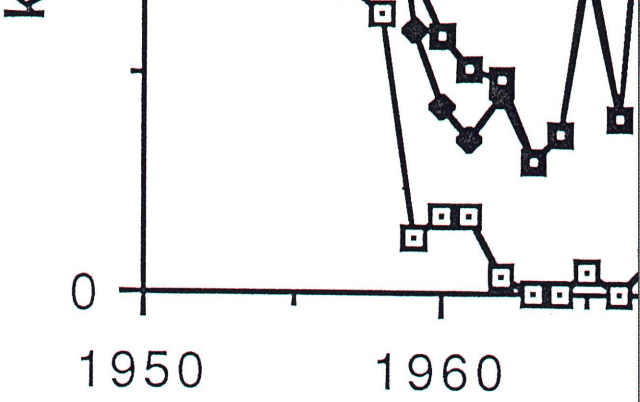
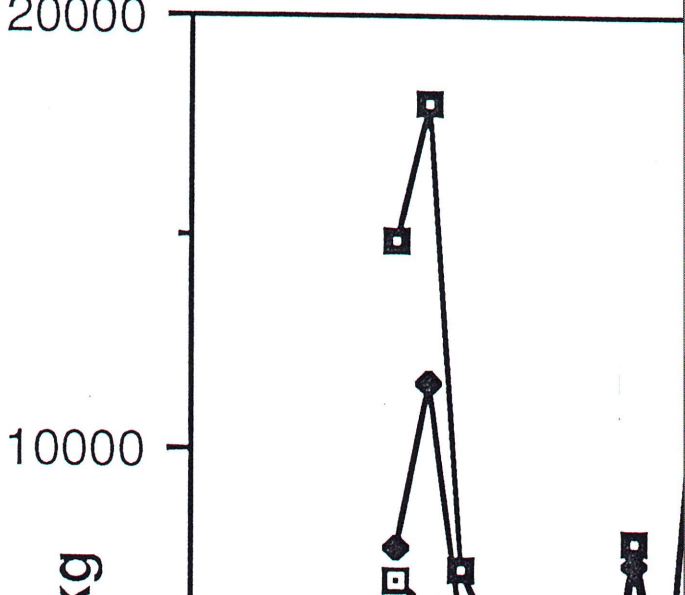
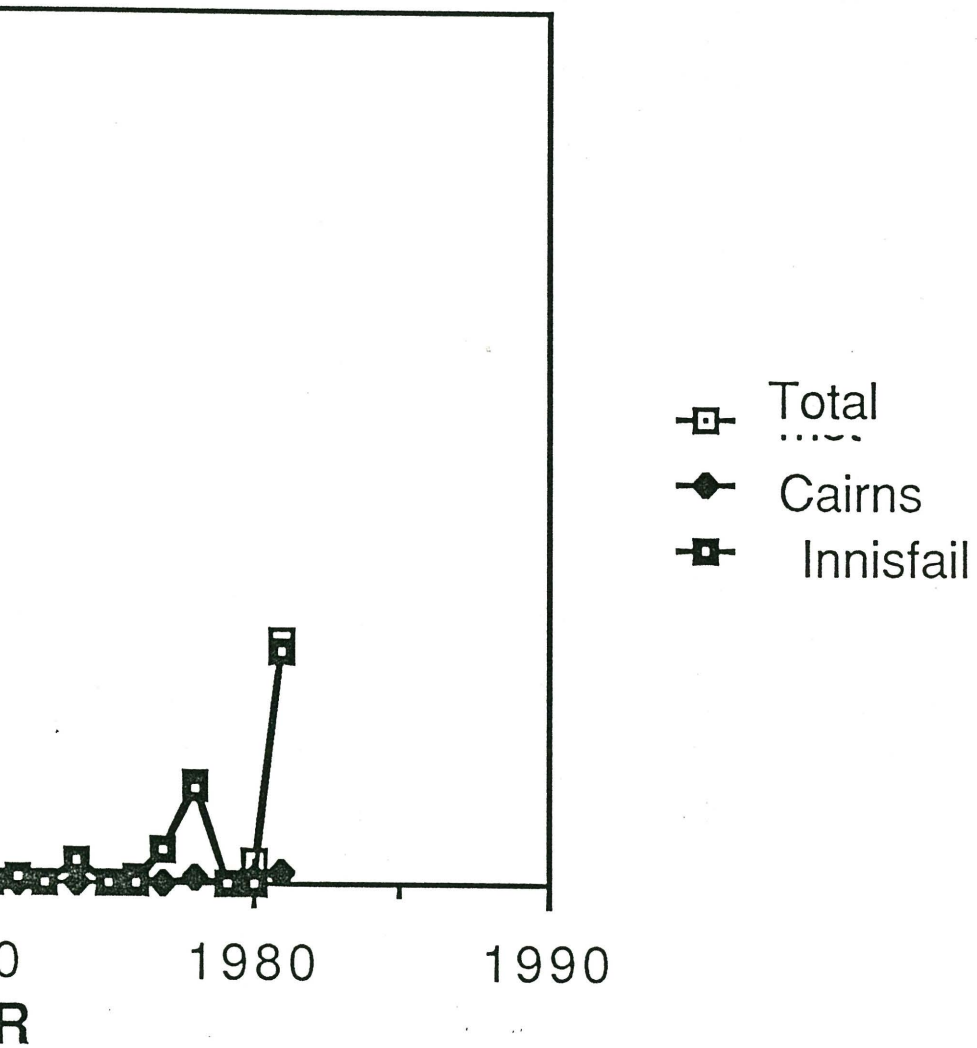


Fig 5.4: Landings o
Northern Fis



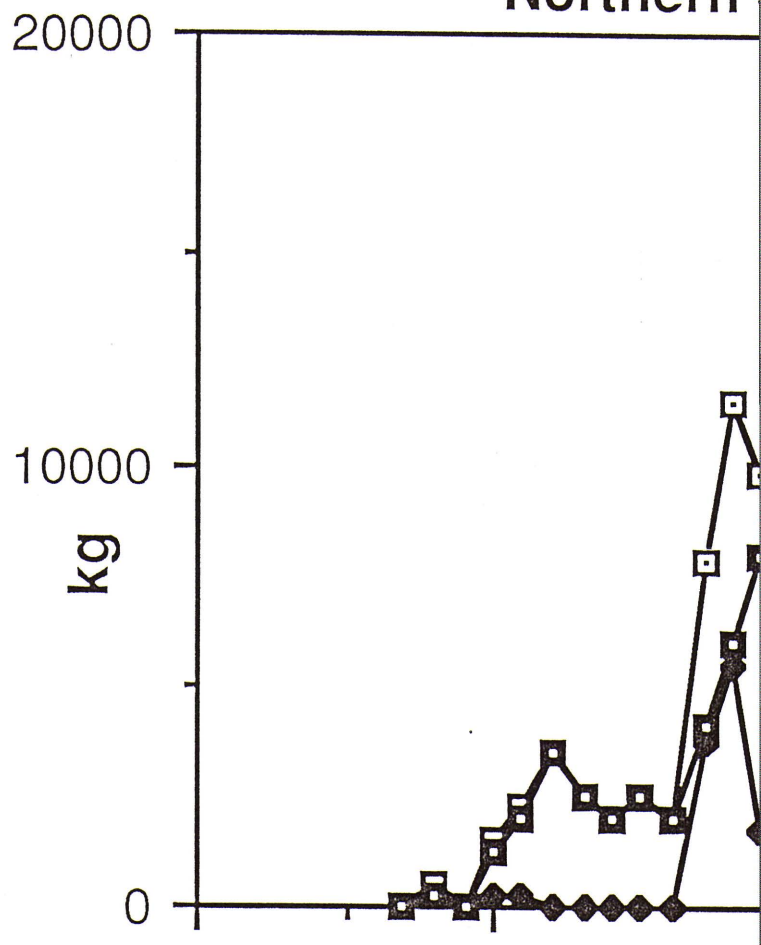
lorwong in the
es Section.

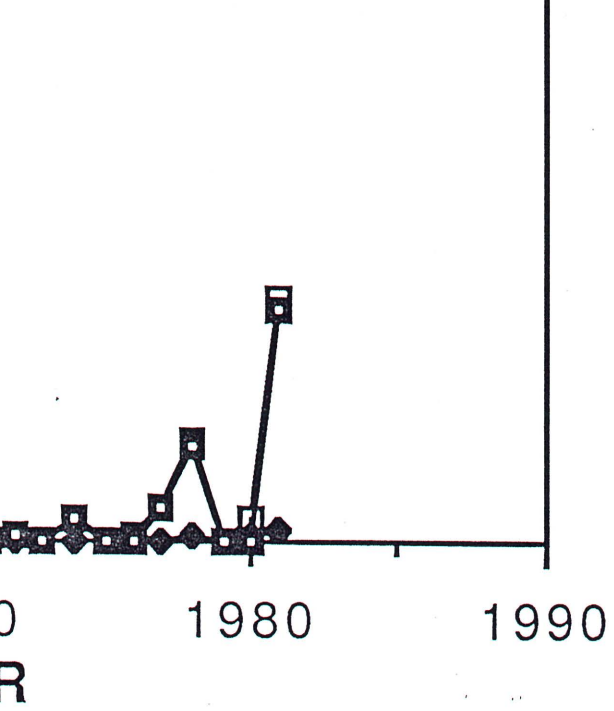


1950 1960 1
YE

Fig 5.5: Landings

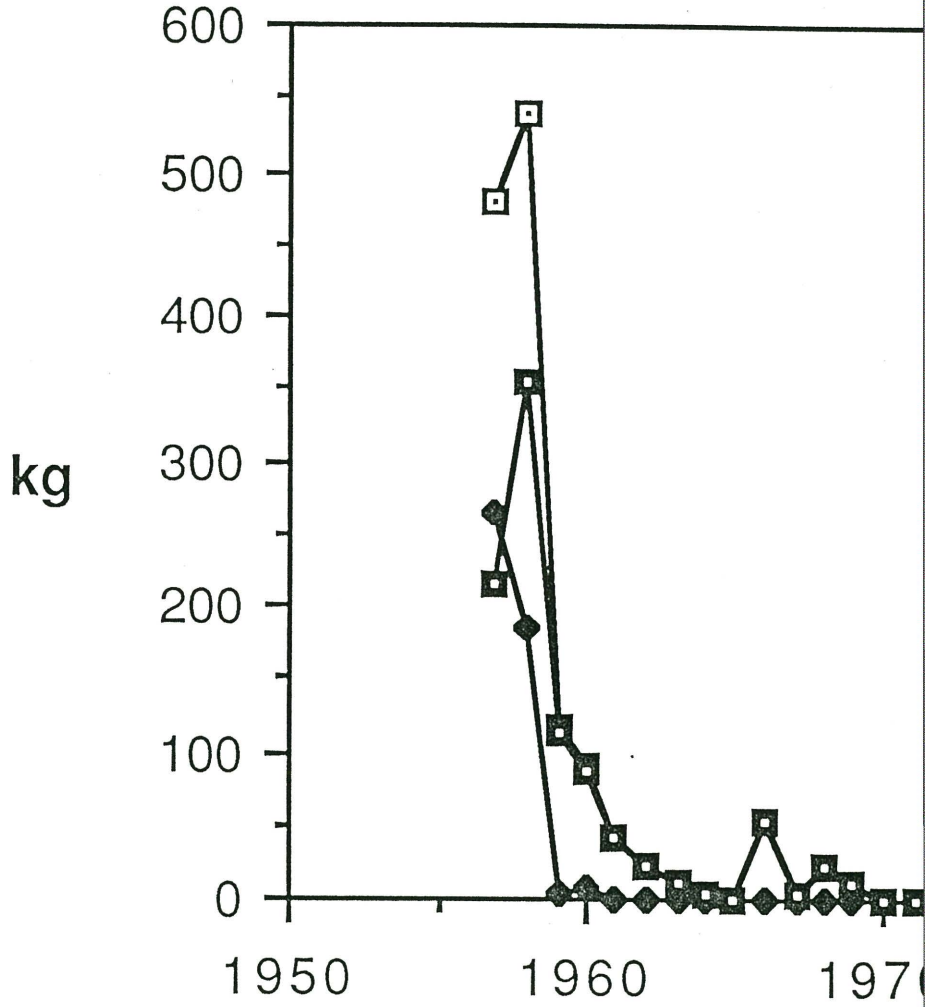
Northern





orwong in the
es Section.

Fig 5.6: Landings of M
Northern Fisheri



1980 1990

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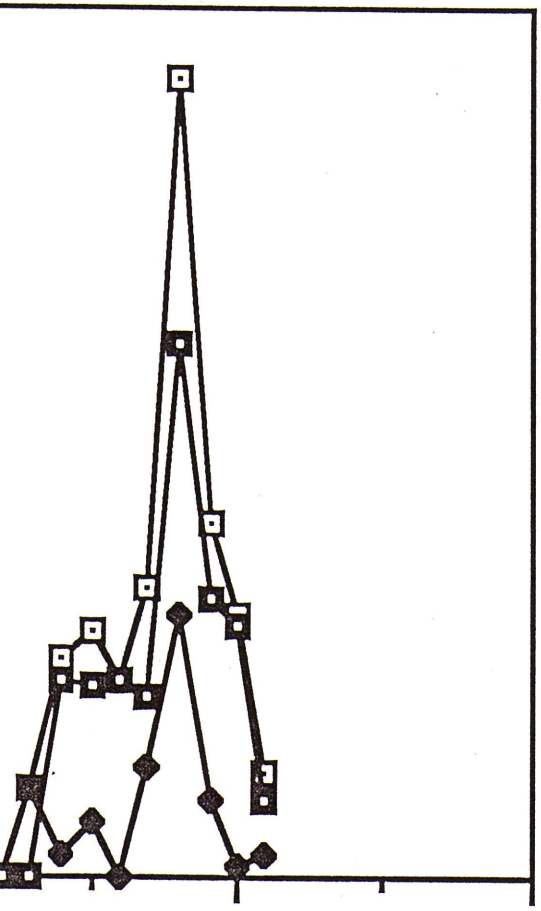
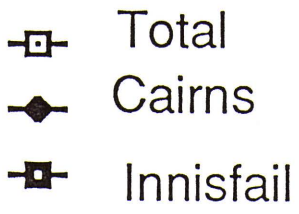
anygai in the
es Section.





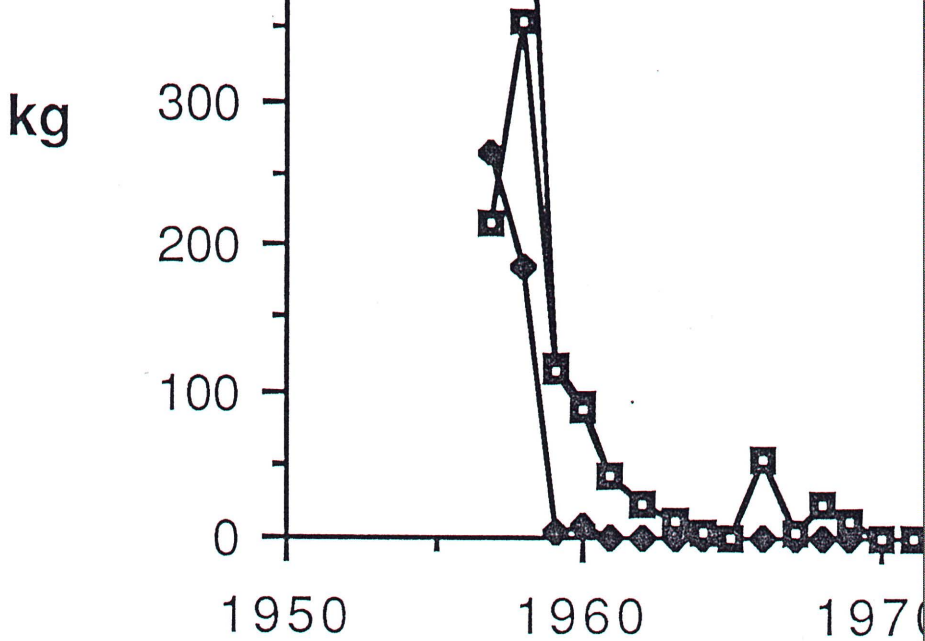
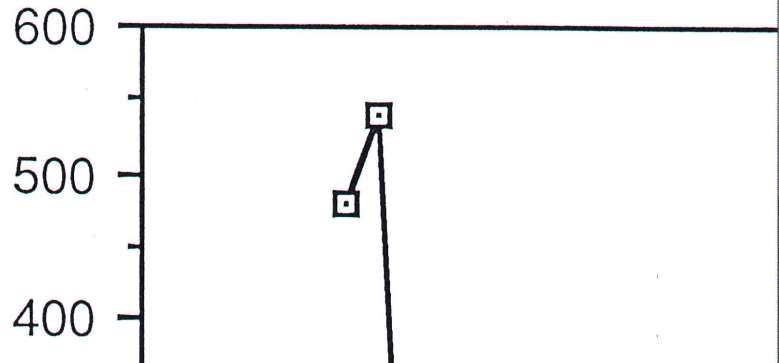


Fig 5.6: Landings of M
Northern Fisheri



OWN-OF-THORNS STARFISH IN THE NORTHERN SECTION

ervations by Method

bservations of Crown-of Thorns starfish have been few in ection and restricted to the years 1980-1984. Non-scientist ations were the most common method (Fig 11.4). Crown-of- starfish were recorded on all 3 of the reefs surveyed in nd likewise with the 5 surveyed in 1983. In 1984, of 3 ations, all made by non-scientists, only one reef is ed as having any Crown of thorns.

served 'outbreaks' have never been severe. All observations n-scientists were of populations numbering under 50 duals (Table 11.1, Appendix Diii).

restricted number of Manta-towing observations in 1980 and ist observations in 1982 similarly identified small ations on a limited number of reefs (Figures 11.3-4).

tbreaks and Fishing

t is impossible to relate the observations made to the of fish landed for this area.

ection is largely uninhabited and a considerable distance any major processing plants. Williams (1980) records no reef fishermen with home ports in this area, and 6.7 % of mary reef fishermen fishing this area in 1979. However the nce of traditional fishing methods is unknown (c.f. Andrew Unpub report).

OWN-OF-THORNS STARFISH IN THE CAIRNS SECTION.

5.4 CR

i. Obs

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1982 a
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ii. Ou

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Smith

5.5 CR

roduction
his section has been the most controversial area being the
rea to have large populations identified in 1962 at Green
as well as having recurring outbreaks. It has been
ed this area is the origin of primary outbreaks with
ks spreading south from this origin (Moran, 1987).
this area has recieved a greater amount of attention and
of observations than any other region.

rvations by Method
servations by Scientists in this area represent the most
ensive dataset available to date, spanning the years 1966
till 1971 and then 1980 through to 1984 (Fig 11.5).
eefs surveyed in 1966, 50 reefs contained outbreaks. Of
0 reefs 12 had over 100 Acanthaster individuals and as
uld definitely be inferred as having outbreaks. Of the
15 reefs had less than 10 individuals, 18 reefs had less
but greater than 10, and 5 reefs had between 50 and 100
uals (Appendix D2i).
tions of Crown of thorns on reefs surveyed from 1967
to 1971 was similarly high (greater than 60%) but the
requency had changed with most observations being of less
individuals. Certainly there were very few observations
could be considered the plague proportions seen in 1966.
00). However whether observers were better trained in

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not prone to over estimation is

of another 'outbreak' were
s in 1977. The following years
nsively covered by all three

fied by all methods is confined
uals and the majority of these
of under 10 individuals (Table
entists in 1980 had populations
and only one reef in 1981 and
portion. Likewise Manta-towing
identify 2 reefs with over 100
in the years 1979, 1983, and
ctor as having greater than 100
d in Table 11.2.

tion Centres.
reefs by distance from major
had Crown-of-thorns starfish
t that those mid shelf placed
jority of outbreaks.
ed observations of over 100
these, Arlington and Feather
5.4). Of these 23 reefs 16 lie
l, whilst the majority of the
from any port.

these subsequent years and were
difficult to say.

Observations of the start
initially made by non-scientist
through until 1984 are comprehe
methods (Figures 5.9-11).
The intensity of outbreaks identi
to populations of under 50 individ
observations identify populations
5.3). Four reefs identified by Sci
of greater than 100 individuals
1982 had populations of this pro
and Non-Scientist observations
individuals in 1981 and 1982 and
1985 only 1 reef in the Cairns se
individuals. These reefs are liste

iii. Distance of Reefs from Popula
Table 5.3 shows the number of
population centres which have
sightings. It is readily apparent
reefs (30- 90 km) have had the ma
Twenty three reefs have ha
individuals on them with two of
having recurrent outbreaks (Table
within 60km of Cairns or Innisfai
remaining 7 lie greater than 90 km

TABLE 5.3: DISTANCE OF REEFS IN THR NORTHERN FISHERIES SECT
WHICH HAVE HAD OUTBREAKS FROM POPULATIONS CENTRES AND INTENS
OF OUTBREAK.

CATEGORIES OF OUTBREAK.

A= 1 Starfish
B= 1-9 Starfish
C= 10-49 Starfish
D= 50-99 Starfish
E= >100 Starfish

NORTHERN SECTION

	<30KM					30-60 KM					60-90 KM					>90 KM				
YEAR	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
1966																1				
1970																	1			
1977																1				
1979																1				
1980																4				
1981																1	2			
1982																1	1			
1983																3	1			
1984																11	3			
1985																				

CAIRNS SECTION.

	< 30 KM					30-60 KM					60-90 KM					>90 KM		
YEAR	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C
1962		1																
1966			1	1		3	3	7	2	8		1	5		1		7	4
1967		1			2		1			1			1		1	1	4	2
1968	2	1				1												
1969	1					4	2	4	1	1								
1970	2					17	2	2				2	2			1	4	2
1971						10		1										
1972																		
1973																		
1974																		
1975																		
1976																		
1977												1					2	
1978	1																	
1979	1									1							4	
1980	1					1	1			1		3	1			2	5	5 1
1981	1					1	12			1							3	5
1982							3	2		2	1		3		1		5	4
1983							3	5				2	1				7	4
1984						2	4	1								1		2
1985						1	1			1								

: REEFS WITH MORE THAN 100 INDIVIDUALS AT ONE TIME

CTION F	DISTANCE
LAIDE	2
INGTON	2
HURS PATCHES	2
THER	2
RA	2
SON	2
IE	2
TT	2
BURY	2
DER	3
KAY	4
ZROY	1
LU CAY	1
INGTON REEF	2
HAN	2
INGTON	2
EAVOUR	4
IE	2
RESTER	4

TABLE 5.4

CAIRNS SEC YEAR	REE
1966	ADE
	ARL
	ART
	FEA
	FLO
	GIB
	HOW
	SCO
	SUD
	RUD
	MAC
1967	FIT
	UPO
	ARL
1969	NAT
1978	ARL
	END
1980	PIX
	FOR

SDON	4		HEL
ISLES	4		TWO
THER	2	1981	FEA
NAMED	4		UN-N
THER	2	1982	FEA
RT	2		PEA
GILLIVRAYS	4		MAC
DER	4	1983	HIL
TFORD	2	1985	THE

STARFISH AND COMMERCIAL

hat the periods 1966-71 and
Crown-of-thorns starfish
he majority of reefs with
midshelf position 30-90 km

al landings of reef fish for
ght of the above discussion
ncreased most substantially
ervations of Crown-of-thorns
was occurring on reefs in
ndings from 1966 to 1967
tonnes. This tonnage was
nes. The subsequent decline
lowed by a concurrent fall
ns after 1971. Landings
ching a low of 16.4 tonnes
andings for this month were
of April 1974, so that the
as marked as it appears in
y after 1973 to a peak of
landed in 1977. Landings
e next three years, before

5.6 DISCUSSION OF CROWN-OF-THORNS LANDINGS.

From the above it is evident th
1979-82 are the periods of major
activity in the Northern Section. Th
definite outbreaks are located in a
from either Cairns or Innisfail.

If we examine the total commercia
the Northern Fisheries Section in li
it is apparent that landings of fish i
at a time when the number of obse
starfish suggested a major 'outbreak'
the Northern Fisheries Section. La
increased from 18.8 tonnes to 55.4
further augmented in 1968 to 56.4 ton
in landings of fish after 1968 was fol
in observations of Crown-of-thor
oscillated over the next few years rea
in 1973. As mentioned the recorded l
only for the 7 months, ending the 30th
decline in landings is probably not
figures 11.2-5. Landings rose steadil
50.2 tonnes of combined reef fish
declined significantly again over th

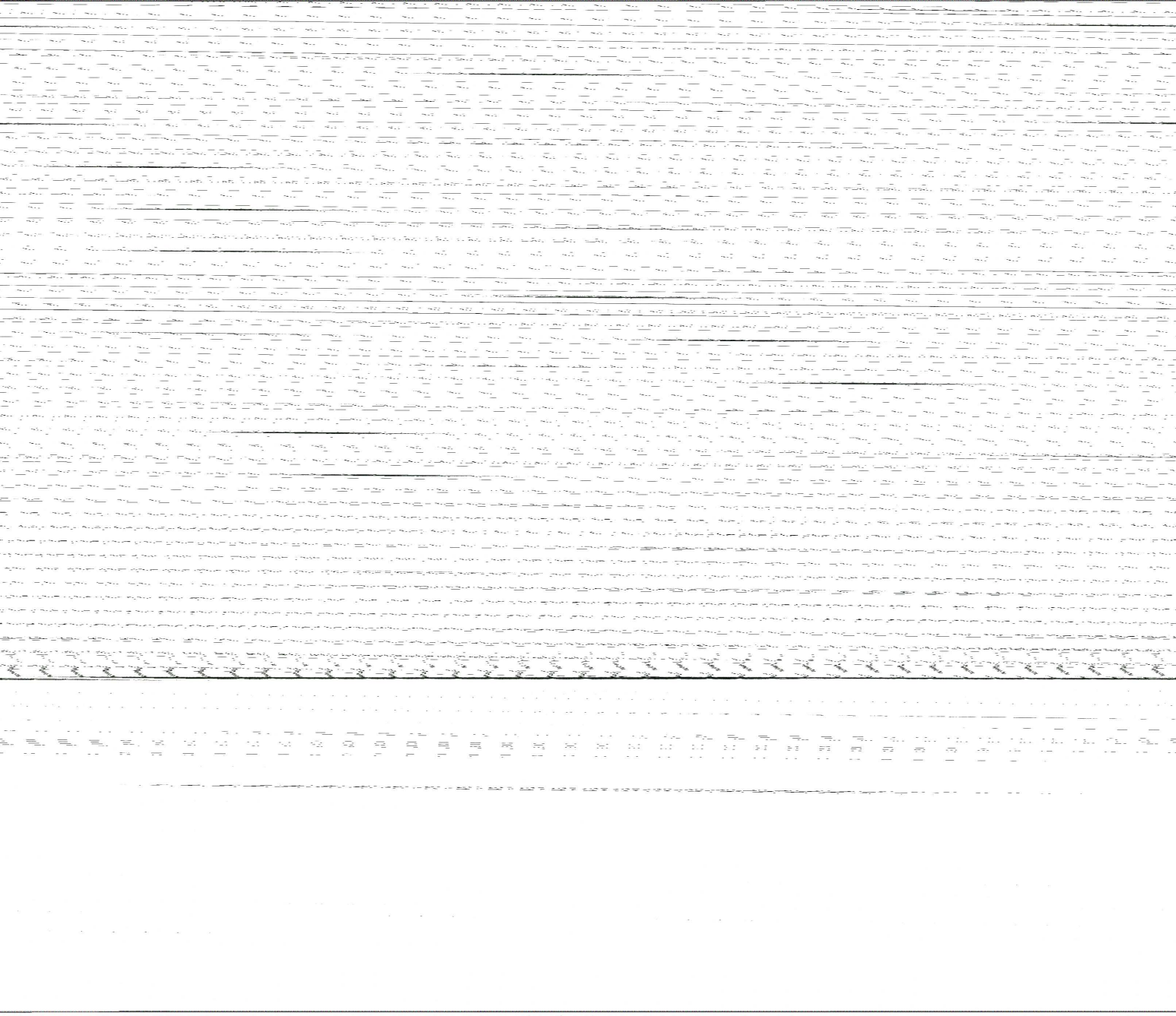
tivity during this time was
By 1980 a maximum number
hem, were recorded.
ndings of reef fish for the
ents. This has the effect
roduction and is possibly a
duction and Crown-of-thorns
the maximum production of
, and a consistently high
a variance of 17.4%
an average tonnage of 36.1
of 10.3 tonnes or 28.7 %.
39.7 ± 7.9 tonnes or 20.1%.
s in 1977.
on yields for both total
n species, for the Northern
the intensity of Crown-of-
section. In terms of total
the greatest production. In
m reef fish production with
in production occurs two
horns sightings.
1970, and Sweetlip in 1958,
e two species make up the

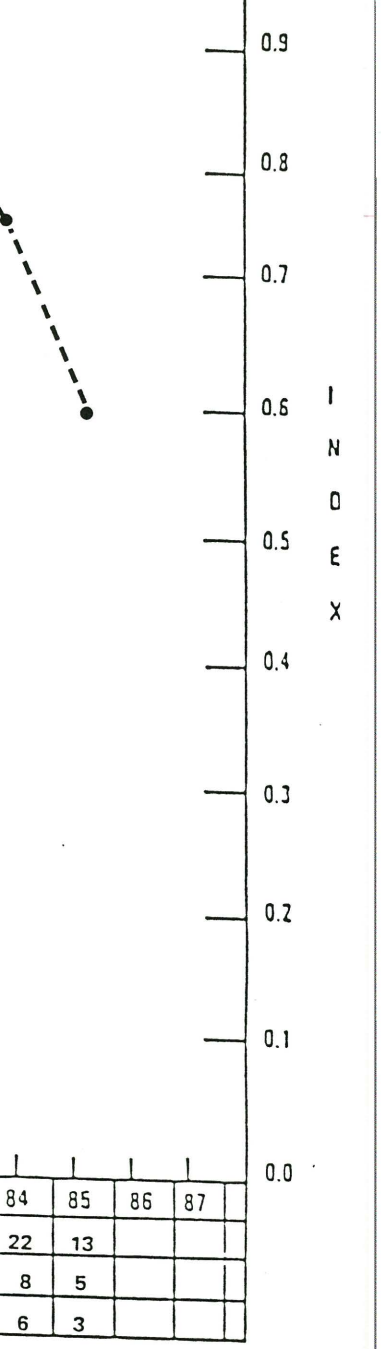
increasing marginally in 1981.
Observed Crown-of-thorns starfish ac
quiescent in this section, until 1979.
of reefs with outbreaks occurring on t
Figures 12.2 shows the total la
Northern Section in five yearly increm
of smoothing the variance in annual p
better time scale to examine fish pro
observations. The period 1967-71 had
fish for the 25 years examined in 1968
average production of 47.7 tonnes with
The following 5 years from 1972-76 had
tonnes of fish landed, with a variance
The period 1977-81 had an average of
It had a peak production of 50.1 tonnes
Fig 12.3 shows the range of productio
combined landings and individual fish
Fisheries Section. This is related to
thorns starfish observations for the
landings, during the 1960's, 1968 had
the 1970's 1977 was the year of maximu
1978 being similarly high. This peak
years prior to the onset of Crown-of-th
Coral trout landings were greatest in
but 1968 was also notably high. These
bulk of the reef fish catch.

The overall picture gained of the combined total landings of fish for the Northern Fisheries Section is of a steady increase in production over a number of years followed by a 'crash, and a then a subsequent rise again. Whether the pattern of a rise in landings over a number of years and then the subsequent 'crash' can be solely attributed to overfishing through stock depletion or to stochastic natural events such as prior bad year class survival is open to question.

The first major outbreaks in the late 1960's would appear to occur simultaneously with dramatic increases in demersal reef fish production. The second outbreak of Crown-of-Thorns in the late 1970's would certainly suggest some causal relationship with a lag phase of some two years. Time series analysis failed to establish any relationship (see 10.5). Data for landings of fish in the Section subsequent to those provided are however crucial to any further examination of the relationship.

Craik (1979) cites the following reefs as being most commonly fished in the Cairns region by amateur fishermen. Tongue, Norman, Saxon, Scott, Hastings, Milln, Flynn, Moore, Michelmas, and Ruby reefs and Stagg patches. However none of these reefs are noted as having major Acanthaster populations on them (Table 11.2). Reefs in the Innisfail area, (Arthurs Patches, Feather, Howie, Gibson, Nathan, and Wardle) which are fished regularly by amateur fishermen have all, excepting Wardle reef, had severe outbreaks.

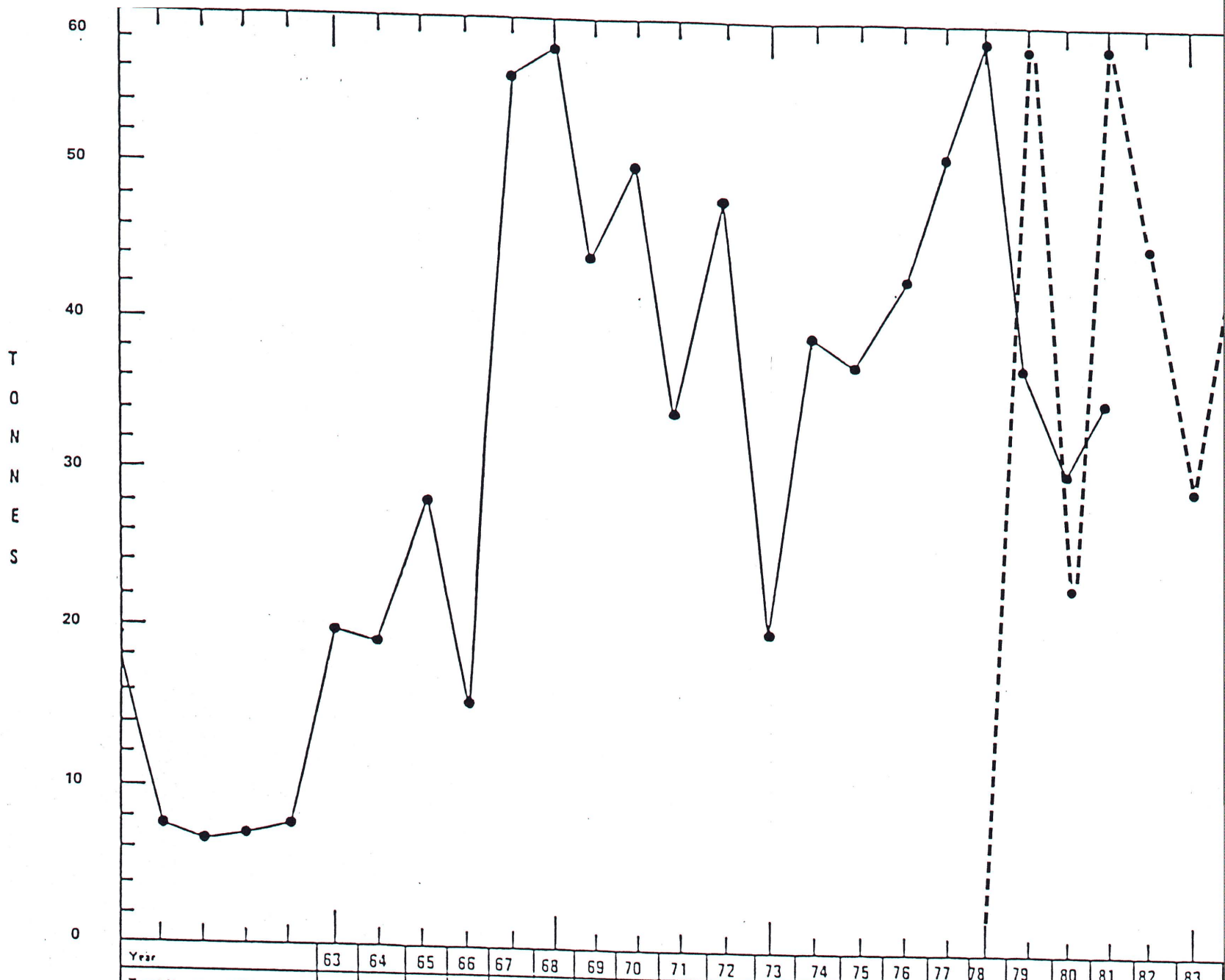




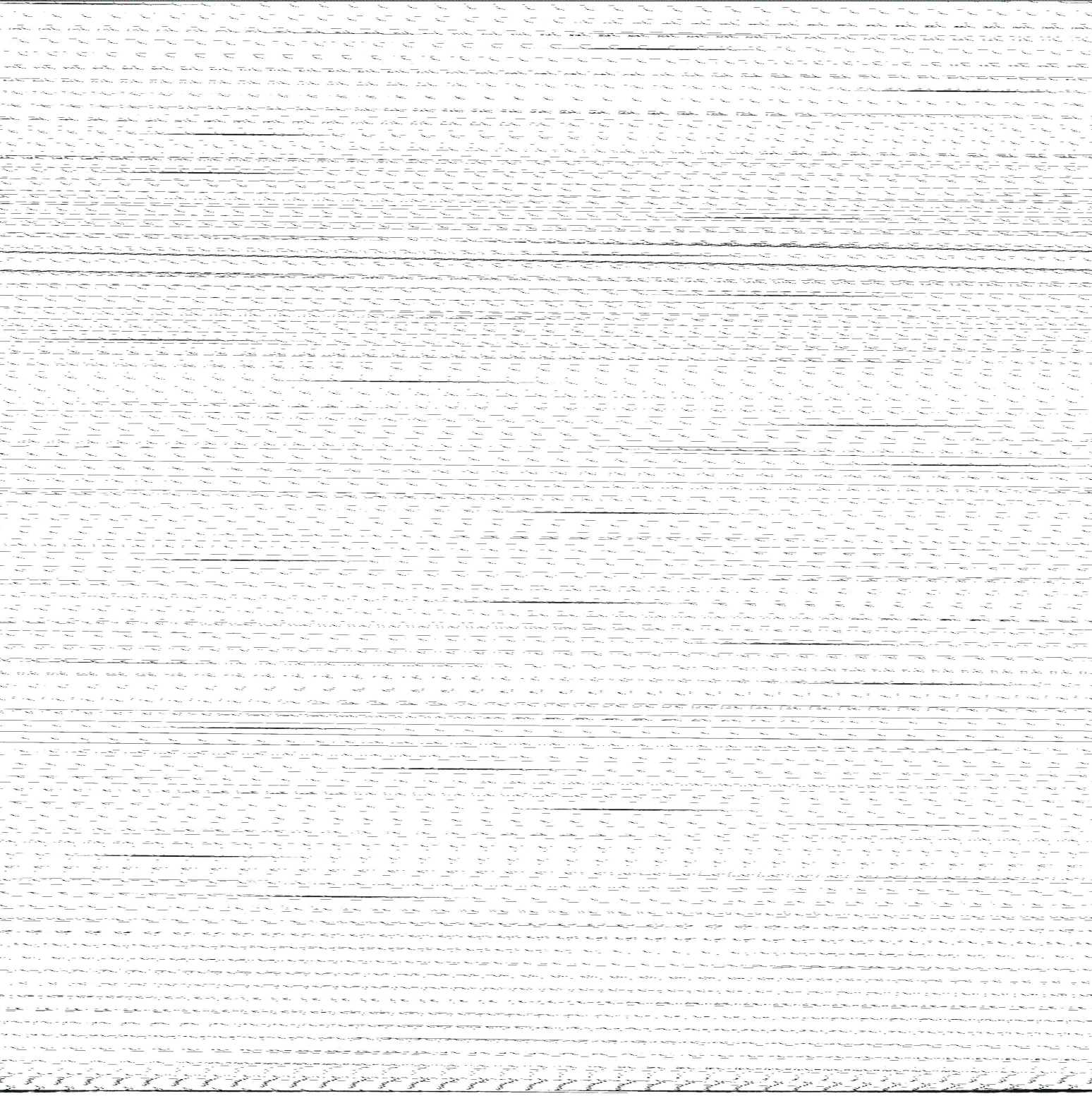
Crown of Thorns

																	6	3	3	3	2

FIG 11.6 MANTA TOW FOR CAIRNS



Year	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
Total Number of Observations																	6	8	3	4	5
Total Number of Reefs Surveyed																	6	8	3	4	4
Total Number of Reefs With																					



CHAPTER 4. THE CENTRAL SECTION.

6.1 INTRODUCTION

The Central Fisheries Section is the same as that designated as the Central Section in the G.B.R.M.P. (fig. 6.1). It extends from Dunk Island in the north to Hydrographers Passage east of the Whitsundays in the south and contains some 220 reefs and a large number of High Islands.

Major shore based Q.F.B. processing factories are present at Ingham, Townsville, Bowen, and Mackay, whilst other plants have operated at Paluma, Ayr, Homehill, and Proserpine at various times. The processing plant at Mackay processes the most fish of any factory on the G.B.R.

The combined total production of reef fish caught in the Central Fisheries Section is shown in table 5.1 and fig 6.1, whilst table 5.2 provides a breakdown by species of fish landed for the Central Section. Appendix A2 has a full listing of species landed by port.

6.2 ANNUAL PRODUCTION TRENDS

The Central Fisheries Section has had the most variable combined annual reef fish landings in comparison to the other Sections, fluctuating 40 fold between the maximum and minimum landings (Fig 6.2). Apart from a substantial decline in annual production of reef fish over the years 1976-78, landings have in general increased. The most significant increase is an almost 3-fold jump in landings of fish from 52.1 tonnes in 1969 to 142.5 tonnes in 1970. Combined landings increased over the following 3 years to 205.3 tonnes of reef fish landed in 1973. Annual landings remained above the 200 tonne level until 1975 with a peak production of 24.8 tonnes in 1974. Landings crashed dramatically in 1976 to 162.5 tonnes of fish landed and then fell further to 95.6 tonnes in 1978. Annual reef fish landings for the Cental Fisheries Section rose again sharply in 1979 to 200.4 tonnes, with a peak production level of 254.9 tonnes following in 1980.

6.3 SPECIES COMPOSITION

The most noticable feature about the Central Section is that landings of all the species examined have increased significantly over the years examined. The majority of reef fish landings have been processed through the Mackay Fish depot, with Townsville also handling significant quantities.

Coral trout is the most commonly commercially landed fish in the Central Section (Table 5.2). Landings increased nearly 4-fold from 1969 to 1970, jumping from 23.1 to 86.0 tonnes (fig. 6.2). Annual landings of Coral trout steadily increased over the next 4 years to a plateau of 104 tonnes of fish landed in 1974. Annual production of Coral trout declined by an order of magnitude during the next 4 years to a minimum of 10.3 tonnes of fish landed in 1978. Landings improved markedly over the next 3 years to a maximum annual production for the Central Fisheries Section of 130 tonnes of fish landed in 1981.