

CROWN OF THORNS STARFISH





**Great Barrier Reef
Marine Park
Authority**

P.O. Box 1379, Townsville, Qld. 4810

THE CROWN OF THORNS STARFISH

(Acanthaster planci)

An information kit prepared by
the Great Barrier Reef Marine Park Authority

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INTRODUCTION

Recent media coverage has presented a rather alarming picture of the crown of thorns starfish. Newspaper headlines have included:

"Threat to the Reef"

"Reef park a farce in the face of starfish threat"

"Reef killer plague".

Compare these headlines with some recent titles of scientific papers on crown of thorns starfish, or Acanthaster planci by its scientific name:

"The crown of thorns starfish; more sinned against than sinning"

"Recovery of coral reefs on the Great Barrier Reef following attack by Acanthaster"

"Crown of thorns: Great Barrier Reef not under threat".

Australians are still being told, with regularity, that their Great Barrier Reef is doomed. Back in 1970 readers of the Brisbane Courier Mail were told that the Great Barrier Reef would be completely devoured by crown of thorns starfish in 20 years. Only a week earlier the newspaper had reported that 99 per cent of coral populations had been killed. That the Great Barrier Reef has not collapsed is self evident, but the prophets of doom are still hard at work.

So are the scientists. And while there is concern at the possibility, there is no clear scientific evidence to prove that the crown of thorns starfish poses a threat to the rich and diverse corals which live on the 2500 odd reefs that make up the Great Barrier Reef.

Scientists have observed the recovery of reef areas once left denuded by starfish. They have seen parts of a reef ravaged while other, coral rich areas of the same reef have been left untouched. And they have suggested that, far from being a menace, the crown of thorns could be playing an important role in reef ecology.

Since plagues were first recorded two decades ago a vast storehouse of scientific literature has built up on the subject. Although there are still many areas of disagreement all researchers say that the question is a complex one, and its study is extremely difficult.

The published scientific papers give a less emotive and more balanced perspective on the crown of thorns question than has been presented to most Australians. It's a viewpoint that has too often been ignored by the media and some experts.

The Great Barrier Reef Marine Park Authority has prepared the following background report on the crown of thorns phenomenon, based entirely on published scientific literature, to present the situation as it now exists. The report is representative of the wide debate on the subject and details work that has been done, is in hand, and which lies ahead.

The Authority is the agency responsible for management of the Great Barrier Reef Marine Park. It has approached the crown of thorns problem from a number of different angles. It has been conducting a voluntary observer reporting program since 1982, has been funding research into management of the starfish, and has supported and encouraged research into the behaviour and population dynamics of the animal as well as its effect on coral reefs and their subsequent recovery. It has also convened advisory committees of experts to examine the available information on the phenomenon and to advise on appropriate programs of research.

Crown of thorns has been the subject of quite considerable investigation and consideration by highly qualified people. It should be remembered, however, that it is only one of a number of phenomena affecting the Great Barrier Reef. The Authority has many other areas of responsibility involving scientific research and monitoring work, and it believes that funding of research into crown of thorns should be considered in the context of the overall research program.

WHAT IT IS AND HOW IT LIVES

The crown of thorns starfish is a rather magnificent starfish, typically 25 to 35 cm in diameter when adult. It has up to 23 arms. The poisonous spines which cover it are responsible for its common name.

Its life expectancy is unknown, but is believed to be between three and five years. Juveniles are rarely found because they hide themselves among corals and the other animals and plants of the Reef. So it's unusual to see a crown of thorns starfish smaller than 10 cm. Some as big as 60 cm have been observed.

The small reef building animals, coral polyps, are the main food source for the crown of thorns, although it also eats sea anemones, algae and possibly clams. The starfish moves across a reef, settles on a patch of coral and then pushes its stomach out through its mouth to cover its prey. Digestive juices break down the tissue to reduce it to a kind of polyp soup.

After feeding, it leaves only a white coral skeleton which is soon covered by algae, other corals or reef settling organisms. The feeding rate for an adult crown of thorns is believed to be around five to six square metres of coral per annum.

The starfish often occur in large numbers called aggregations. Aggregations can be clusters of hundreds, thousands, or in extreme cases more than a million starfish. In surveys conducted by the Authority and by some other scientists the conservative number of 40 or more starfish in a cluster has been used as the benchmark figure to record an aggregation.

In low population densities it appears that crown of thorns starfish feed by night, but in dense aggregations it can be a daytime feeder. Some scientists say that up to 90 per cent of starfish in dense aggregations feed by day, while others have put the figure at 12 per cent. Still others believe the figure is between 30 and 50 per cent.

DISTRIBUTION

Crown of thorns starfish are certainly not exclusive to the Great Barrier Reef. They appear to occur wherever corals occur and can be found from the Red Sea to Japan, from East Africa to Hawaii.

In Australia they occur from the Dampier Archipelago off the north west coast of Western Australia to Byron Bay and Lord Howe Island off New South Wales.

A related species is also known to occur on the seabed between reefs of the Great Barrier Reef, but it is not known to specifically attack coral. A third species, so closely related to Acanthaster planci that some scientists consider it to be the same species, occurs off California and Panama, but has not been observed off Australia.

Acanthaster planci has been recorded at the following places:

Australia:	Malaya
Great Barrier Reef	Siam Gulf
Western Australia	Philippines
Fiji	Taiwan
Tahiti	Palau
Papua New Guinea	Ponape
Ryukyus	Truk
Miyako Island	Marshall Islands
Okinawa Island	Gilbert Islands
Mariana Isles	Admiralty Islands
Guam	New Britain
Sudan	New Hanover
Comoro Islands	Buka
Mauritius	New Hebrides
Kenyan Reefs	Solomon Islands
California Gulf	Western Somoa
Panama	Cook Islands
Seychelles	Hawaii
Ceylon	Society Islands
Phuket	Tuamotu Archipelago
Borneo	Saipan
Johnston Island	Maldives
Bali	

HISTORY

Acanthaster is believed by some scientists to have existed over at least the past 35 million years, which would make it considerably older than the Great Barrier Reef itself. Scientific opinion is that the starfish is certainly as old as the Reef if not older. Crown of thorns was first described by Rumphius in 1705 and was classified in 1758.

The presence of crown of thorns spines in a series of sediment cores offers some evidence that the starfish is not a new phenomenon. There is a school of thought which maintains that population explosions are a unique phenomenon induced by human activity. It claims that there is very little evidence to suggest that outbreaks occurred before the 1950s, and that outbreaks since then are a result of human factors.

However, numerous scientists accept the historical records which indicate outbreaks before man became a factor in reef ecology. Many subscribe to the view that crown of thorns outbreaks are a natural and recurring phenomenon.

In Australia the starfish was first recorded on the northern end of the Great Barrier Reef in 1921. A single specimen was recorded at Low Island, near Cairns, in 1932. The Marine Park Authority commissioned an oral history study of reef users dating back to the first two decades of this century. The project is complete, and early analysis indicates that while some people say they have seen crown of thorns starfish right back into the 1920s, others, working in the same area at the same time, say they saw none. Controversy on this subject is not new.

FREQUENCY: SURVEYS TO NOVEMBER 1984

The Marine Park Authority monitors crown of thorns outbreaks in a number of ways. It conducts scientifically-based surveys and spot checks in specific areas. In addition to this it operates a system of voluntary reporting by reef users. Divers, tourist operators and charter vessel operators are encouraged to fill out crown of thorns questionnaires available from the Authority. The limitation with this non scientific input is that reef users tend to report sightings of starfish but neglect to report when they see no starfish, records which are just as valuable.

The Authority now has data on crown of thorns going back to 1952. A total of 516 reefs has been surveyed in the period to the end of 1983 or about 20 per cent of all reefs along the Great Barrier Reef.

Analysis of reports for the twelve months to November 1984 indicates that on the reefs for which reports were received:

- . no starfish were sighted on 57% of these reefs;
- . between 1-9 starfish were sighted on 18% of these reefs;
- . between 10-39 starfish were sighted on 9% of these reefs;
- . aggregations, 40 or more starfish, were sighted on the remaining 16% of these reefs.

The Great Barrier Reef Marine Park Authority welcomes assistance from all reef users in monitoring crown of thorns.

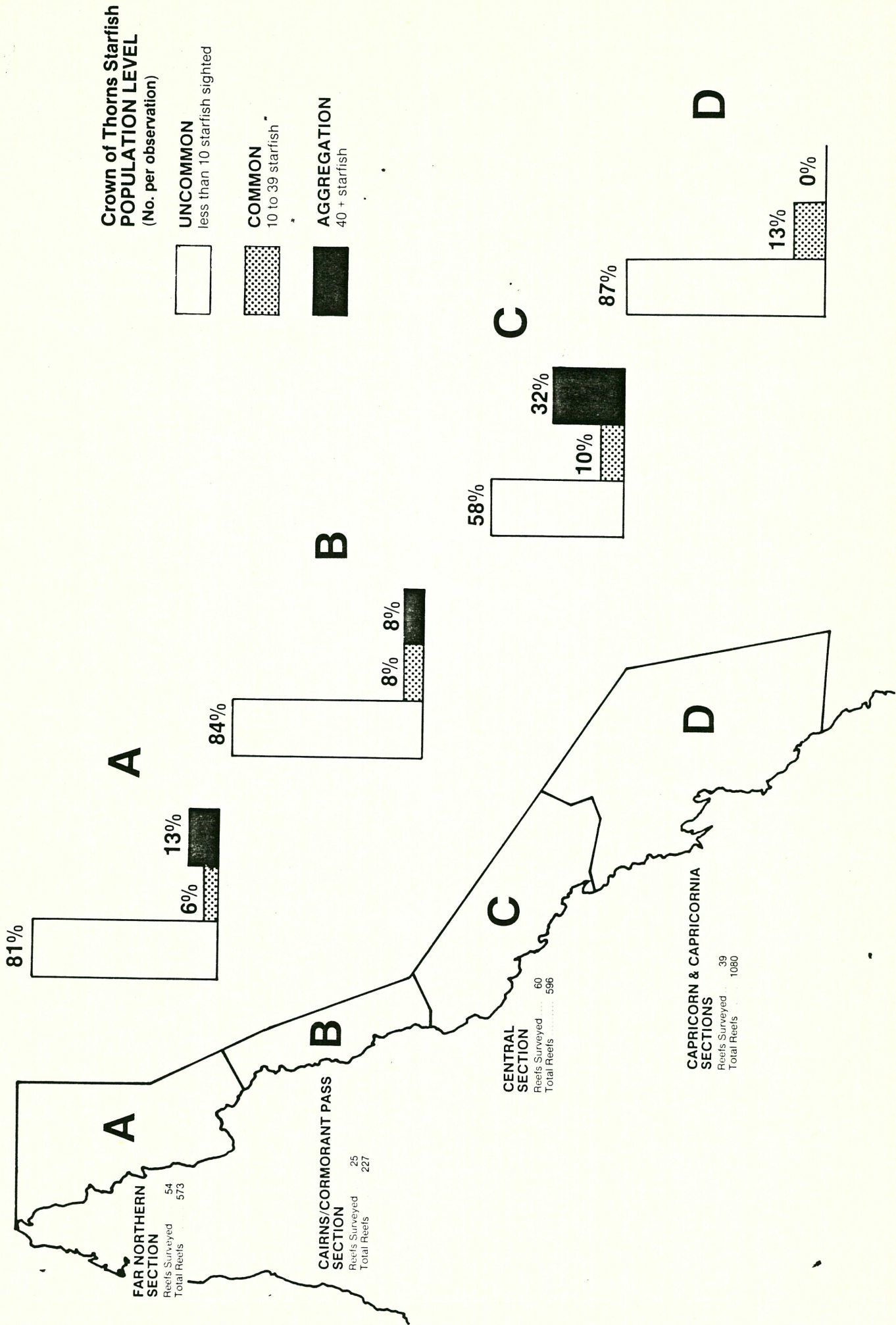
Editorial note:

[3 maps indicating survey findings for 1982, '83, '84 are attached



DISTRIBUTION OF CROWN OF THORNS STARFISH ON REEFS THROUGHOUT THE GREAT BARRIER REEF REGION

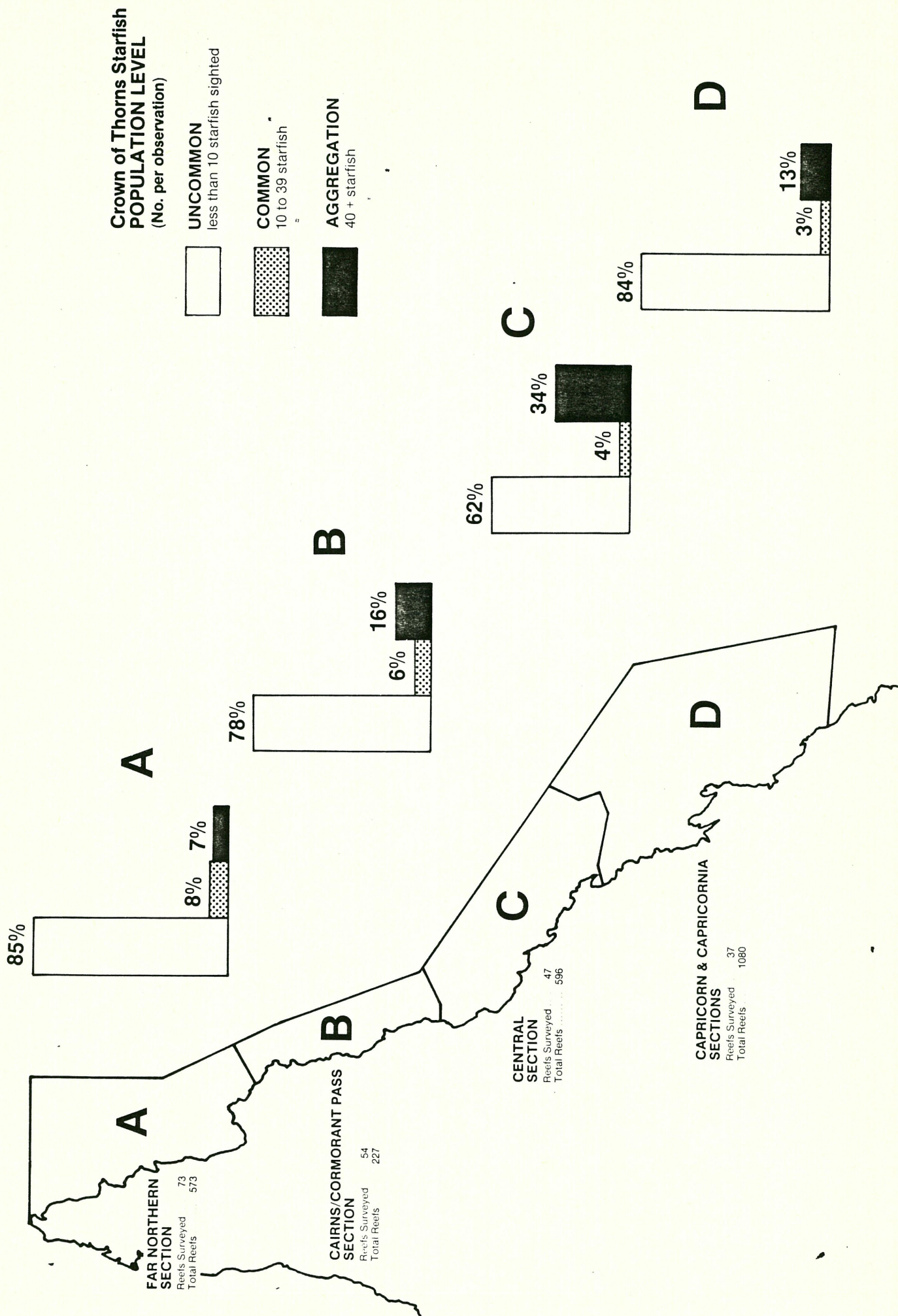
1984





DISTRIBUTION OF CROWN OF THORNS STARFISH ON REEFS THROUGHOUT THE GREAT BARRIER REEF REGION

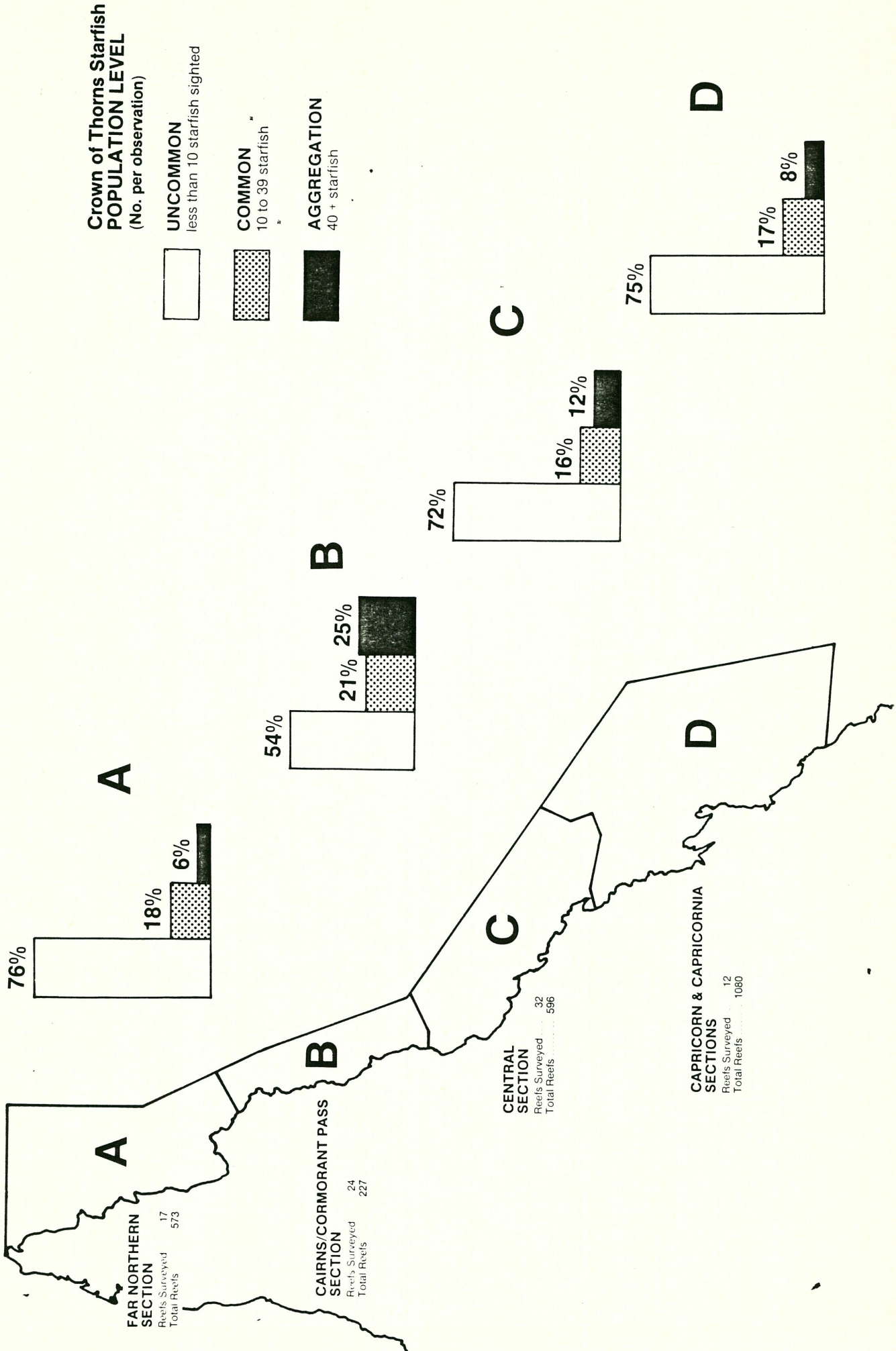
1983





DISTRIBUTION OF CROWN OF THORNS STARFISH ON REEFS THROUGHOUT THE GREAT BARRIER REEF REGION

1982



IS THE GREAT BARRIER REEF BEING DESTROYED?

On the contrary, there is a wide body of scientific opinion supporting the argument that crown of thorn does not pose a threat to the Great Barrier Reef and has never done so.

Dr Frank Rowe of the Australian Museum, an international authority on echinoderm systematics and distributions, and Mr Lyle Vail, a biologist, say that although there are reefs which are heavily infested from time to time there is clearly and affirmatively no crown of thorns plague destroying the Great Barrier Reef.

Writing in "Search ", the journal of the Australian and New Zealand Association for the Advancement of Science, they say: "Crown of thorns may have been associated with the Reef as a whole for as long as it has been in existence. The effect of the starfish on the Reef needs to take this into account before claims are made about the imminent collapse of the Great Barrier Reef. Rather than creating alarm and despondency by predicting the imminent destruction of the reef, more energy should be put into examining the problem rationally."

It should not be implied that the presence of crown of thorns starfish in big numbers on one part of a reef means that the entire reef will be affected. Even if the worst possible interpretation of existing data is made it is apparent that many recent statements have exaggerated the situation. On the majority of reefs surveyed no or few starfish were observed.

A 1975 report of the Advisory Committee on Research on the crown of thorns starfish says that the observed increase in numbers of starfish on some reefs over the last decade may not reflect a real increase in crown of thorns numbers but may be the result of an increased number of observers, better monitoring techniques and the greater publicity given to the findings.

While there is a small body of scientific opinion asserting that large scale aggregations are a recent event, it has been pointed out that it is only during the last 20 to 30 years that scientists have had the chance to closely study demographic processes in reef communities.

There are two reasons for this. Firstly, it is only in relatively recent times that major marine research institutions have been located close to coral reefs. Until this happened, tropical marine communities were investigated by scientists on irregular, and often infrequent, expeditions. With major research institutions now located in coral reef areas and with island research stations on the Reef, scientists can monitor reef activities far more closely.

Secondly, the advent of scuba diving equipment has made reef research far easier and underwater studies much more extensive.

It can also be stated that with the boom in diving as a recreation, once remote areas of the Great Barrier Reef are now being visited more often, so there is a greatly increased likelihood of crown of thorns sightings.

ARE INDIVIDUAL REEFS BEING DESTROYED?

Some reefs, and even some groups of reefs, have had almost all the stoney corals devoured by crown of thorns starfish. This happened to Green Island Reef in 1965-67 and, again in 1979-81.

But it should be noted that the existence of a crown of thorns aggregation on a reef does not necessarily mean total coral destruction is inevitable.

Lizard Island, for example, has recorded aggregations possibly as early as 1952, but certainly in 1966, 1977 and 1983. Yet the latest survey indicates that the condition of its coral is reasonable.

On most reefs that have suffered from a crown of thorns aggregation there is little or no evidence to suggest permanent damage.

CAN A REEF RECOVER AFTER CROWN OF THORNS?

An area of coral reef that has been attacked by crown of thorns starfish is certainly not a pretty sight, but a starfish attack does not spell the end for an area of coral. Recovery starts as soon as the starfish leaves a patch of coral.

Some scientists believe that recovery may be delayed, or prevented altogether in some areas, while in other areas it could take up to 40 years.

Most, however, support a more rapid rate of recovery and conclude from all available evidence that, although the process would be slower on some reefs, there is no indication of permanent exclusion of hard corals.

Bob Pearson, a scientist responsible for much of the early survey work on crown of thorns, says that small corals most often take two to three years to regenerate, with larger corals taking seven years. The full richness of the reef is usually restored, he says, within 20 years.

Research by scientists at the Australian Institute of Marine Science suggests that some reefs have largely recovered approximately 10 years after starfish damage, although the original species distribution might not be achieved in this time.

THE POSSIBLE CAUSES OF OUTBREAKS

There are two main schools of thought on the cause of a crown of thorns outbreak: That it's a natural occurrence, or that it results from human activity.

Natural Occurrence

The theory that is, perhaps, most developed is based on laboratory studies which have found that larval survival and growth rates can be enhanced by certain conditions. Lower salinity and higher water temperature in the period following starfish spawning are factors which interact to promote a high survival rate, according to this theory.

This theory has been further developed by overseas research which links starfish outbreaks with heavy rains after long, dry spells. It is contended that the increased run-off from land caused by heavy rains not only lowers sea-water salinity, but also increases nutrient levels supporting growth of phytoplankton, the food source of starfish larvae.

At this stage it is generally felt that sufficient evidence does not yet exist to demonstrate this contention. However, conditions of lowered salinity and higher water temperature occur from time to time in regions off high land where seasonal rainfall run off occurs. It's possible that this could account for the concentration of infestations on reefs near a land mass or near high islands. But it must also be pointed out that outbreaks do occur on oceanic reefs.

The natural occurrence argument is supported by largely circumstantial evidence of major outbreaks of crown of thorns in times gone by. This evidence includes anecdotal references in older scientific literature, personal accounts of old-time residents and the existence of specific references to the starfish in the folklore of various Pacific island communities.

Human Activity

This theory proposes that dramatic increases in starfish populations, as opposed to low numbers of starfish in isolated areas, are a new phenomenon caused by human intervention. The primary argument is that people have removed some of the natural predators of the starfish, in particular the groper and the giant triton. While the groper has been subject to intensive fishing, the triton was collected early this century for its shell.

However, it has been demonstrated that the crown of thorns is not the triton's most preferred prey, and when it does graze on the starfish its feeding rate is slow. It consumes about one starfish a week. There is no evidence to suggest that the triton ever existed on the Great Barrier Reef in large numbers.

The groper and other fish that have been observed feeding on the crown of thorns, including puffer fish and trigger fish, are also of questionable effectiveness in controlling crown of thorns numbers. There has been no demonstration of predator effectiveness in this respect.

Propositions that big numbers of tritons be introduced to the Great Barrier Reef are based on the assumption that the Reef is facing imminent destruction. They have no regard for the side effects on other marine animals which may be the triton's preferred prey. Australians are all too aware of the problems which can result from introducing predators into an ecosystem.

Secondary arguments in support of this theory are that other human activities have created conditions favourable to the crown of thorns.

It has been put forward that chemical pollution has reduced the predators of larval crown of thorns. But a meeting of Australian experts in chemical marine pollution held in May 1984 agreed that there was little evidence of chemical pollutants in high concentrations in Great Barrier Reef waters.

It was suggested, in the 1960 s, after a study in Micronesia that increased blasting and dredging created conditions favourable to larvae, but the theory was criticised on a number of grounds. These included a lack of evidence and the fact that infestations have occurred in areas that have never suffered such actions. Also, extensive dredging, bombing and blasting in the Pacific during the World War II did not appear to result in large scale crown of thorns outbreaks.

People supporting the theory that increases in the population of crown of thorns are caused through human activity also raise the contention of coastal run off after long, dry spells. They say that increased clearing of land near coastal areas for farming and development results in an increased level of nutrients flowing into the water with rainfall, thus enhancing phytoplankton growth which may be the main source of food for larval starfish.

There appears to be insufficient evidence at present to either prove or disprove possible links between human activity and starfish population explosions.

CAN CROWN OF THORNS BE ELIMINATED?

It is still being suggested by some that a massive program aimed at eliminating the crown of thorns starfish should be undertaken. Research conducted for the Authority has concluded that any large-scale control attempts are not feasible. This is supported by world-wide experience.

For example the Japanese government has spent more than \$4 million (Australian) over the past ten years to kill ten million starfish. The operation was conducted over comparatively small reef areas around Japanese islands. It has been concluded that such programs are useless.

There are various methods of killing the starfish. The two that have been utilised most are hand collection or, most effectively, injection with a copper sulphate solution.

In ideal circumstances a single diver can inject 124 starfish per hour. But since in an extreme case a reef can have more than two million starfish it cannot be recommended that such a program be started when this would seem to offer only a temporary check on numbers.

It must also be pointed out that even in large populations a high proportion of starfish is hidden under coral ledges, in crevices and in the base of coral thickets. Once it becomes necessary to search for starfish the treatment rate drops. In the long running control attempt in the U.S. Trust Territories the average collection rate was less than was achieved in Australia.

It would be irresponsible to recommend the commitment of substantial public funds to a large-scale control program when there is every reason to doubt both its effectiveness and the need for it in the first place.

The Marine Park Authority does provide technical advice and encouragement to tourist operators who wish to undertake control of starfish in limited areas.

WHAT IS BEING DONE?

Research into crown of thorns starfish has been conducted by many government-financed institutions around the world since the 1960s. In Australia the Authority has been investigating the starfish since 1977 as a major part of its research program.

Various organisations, including the Great Barrier Reef Marine Park Authority, the Australian Institute of Marine Science, the James Cook University of North Queensland, the Queensland Department of Primary Industries and the University of Queensland also are conducting research into the biology and ecology of the crown of thorns. Biologists now believe that when starfish larvae hatch they may drift in the ocean currents for up to a month before settling on a coral reef. Indications are that ocean currents can carry an object as far as 400km in a month.

Findings suggest that what some scientists have thought were purposeful migrations southwards by adult starfish plagues may in fact be the result of the passive transport of larvae by currents. Some scientists believe adult starfish move from reef to reef while others do not believe the available evidence supports either theory.

Biologists know how and when the starfish breeds, its growth patterns, food preferences, feeding habits and some of its natural predators. Research has also shown that many reefs can recover reasonably well within 10 to 20 years after major damage.

Research has been funded through the Advisory Committee on Research into crown of thorns starfish, the Australian Research Grants Scheme, the Marine Sciences and Technologies Grants Scheme, by the Australian Institute of Marine Science, the James Cook University, the Marine Park Authority itself, and other institutions.

The Marine Park Authority has funded projects on aspects of reef ecology and dynamics relevant to the crown of thorns phenomenon, including projects on surface and sub-surface water movements in the Great Barrier Reef Region. It is also undertaking a collaborative study with James Cook University and the Australian Institute of Marine Science to develop flow models for the central Great Barrier Reef Region. These models are essential to understand the likelihood of larvae material reaching other reefs in a given time and to better understand physical mechanisms such as water currents, that may influence distribution of eggs and larvae of the starfish.

Among other projects, the Australian Institute of Marine Science is currently examining coral recruitment, predation and reef inter-connectivity. The results of these studies will have a bearing on the understanding of the distribution and abundance of crown of thorns starfish. James Cook University is doing work on coral reproduction in crown of thorns affected areas.

Because of conflicting scientific opinion about so many aspects of the crown of thorns phenomenon, the Marine Park Authority has established an expert committee to advise on the starfish. The Crown of Thorns Starfish Advisory Committee met for the first time on April 12, 1984.

It consists of 13 experts, including representatives of the James Cook University, the University of Guam, the University of Queensland, the Australian Institute of Marine Science, the Lizard Island Research Station of the Australian Museum, the Queensland Department of Primary Industries, the Australian Coral Reef Society, the Great Barrier Reef Consultative Committee and the Marine Park Authority itself.

The terms of reference of the committee are:

- . to review research results,

- . to advise on future research and monitoring
- . to advise on possible research programs or projects relevant to management and understanding of the relationship between the starfish and coral reefs, and, to advise on a program to keep the public informed on the situation.

The Committee represents a broad range of scientific opinion. It has recently reported to the Authority. [See attached extract from the Committee's Report.]

REPORT OF THE CROWN OF THORNS STARFISH
ADVISORY COMMITTEE

EXECUTIVE SUMMARY

3 December 1984

Summary:

- S1. Since 1966 there has been public concern about the long-term risk to the Great Barrier Reef as a consequence of large populations of the crown of thorns starfish Acanthaster planci. The view of the Committee is that the destruction of hard coral by aggregations of A. planci poses a serious threat to the organisation and functional relationships within some reef communities within the Great Barrier Reef, at least in the short term.
- S2. Large numbers of crown-of-thorns starfish have been reported from many of the major reefs lying between Princess Charlotte Bay (latitude 14°S) and Townsville (latitude 19°30'S) since 1979. In addition, some reefs outside this region have also carried large numbers of A. planci since 1979. In the absence of detailed information on the condition of the hard coral cover of each affected reef there is a difference of opinion among Committee members about the actual extent of coral destruction that has occurred. Many of the reefs carrying major A. planci populations during the last five years are known to have carried large populations during the 1960s and early 1970s.
- S3. Present evidence is inadequate for scientists to agree on the nature and significance of the phenomenon of aggregations of large numbers of crown of thorns starfish and thus on the extent of any consequent risk. However the Committee recognises that the presence of very large numbers of crown of thorns starfish is a major management problem in some areas of the Great Barrier Reef.
- S4. The Great Barrier Reef has been included on the World Heritage List. In view of this, effective countering of any established threat to the integrity of the Great Barrier Reef should be regarded as a national priority.
- S5. Until more information is available direct management intervention in the crown of thorns starfish phenomenon should continue to be limited to tactical control measures designed to protect corals at specific sites of importance for tourism or scientific research. The Committee supports the position and the actions taken by the Authority in this regard so far. The view was expressed by one Committee member that there was a need for more extensive measures. Nevertheless experience in Japan and the US Trust Territories is that attempted large scale eradication programs have limited value in controlling major populations. In the absence of a more efficient technique, control even on a local scale is often not achievable.
- S6. The current level of research activity is unlikely to lead to a short term (3-5 years) resolution of the questions raised by the presence of very large populations of crown of thorns starfish on the Great Barrier Reef.

- S7. The Committee recognises the need for further research and has identified a number of specific research areas which, if addressed now should help within 3-5 years to improve understanding of the degree of threat to the Great Barrier Reef. Nevertheless the Committee stresses that such research cannot be guaranteed to answer questions relating to the desirability or feasibility of control measures.
- S8. The Committee identified a number of research initiatives which should be taken immediately and considers that there is an urgent need for a co-ordinated program of crown of thorns starfish research in Australia. This is addressed in the Recommendations.

Recommendations

This section brings together the recommendations contained in the body of the report. The number of each recommendation is located in the right-hand margin. The section of the report where further supporting discussion is to be found and the page number is given in brackets.

The committee recommends a risk analysis study be undertaken by the Authority to contribute to assessment of the need for control of crown of thorns starfish. R1

The committee recommends that the Authority continue to monitor the effectiveness of current control techniques and notes that the Authority has budgeted approximately \$7,000 for this purpose in the 1984/85 financial year. R2

The committee recommends assessment of the feasibility of developing more efficient techniques such as biological control by predators or pathogenic organisms (estimated cost \$55,000 per annum over three years). R3

The committee recommends that a workshop be held to review techniques for monitoring crown of thorns starfish and coral condition (estimated cost approximately \$25,000). R4

The committee recommends that the Authority continue its survey based upon general user reports and supervised surveys of a selected sample of reefs using the most appropriate available techniques. The committee notes that the Authority has allocated approximately \$63,000 in its 1984/85 budget for such surveys. R5

The committee recommends a study of oral history of human use and of experience of the Great Barrier Reef (estimated cost \$30,000). R6

The committee recommends a study of surface sediments and soft sediment cores to evaluate evidence of prior major occurrences of crown of thorns starfish populations (estimated cost approximately \$70,000 per annum over three years). R7

The committee recommends that priority be given to analysis of existing data and a modelling studies (estimated cost approximately \$55,000 per year over four years). R8

The committee recommends that research funding at an estimated cost of \$500,000 per year over 3 years, be allocated to support high priority projects, including any identified during the modelling studies. R9

The committee recommends research, including modelling, to test hypotheses regarding human factors which may trigger or exacerbate population outbreaks of crown of thorns starfish (estimated cost \$250,000 over three years). R10

The committee recommends an investigation to determine whether use of geological techniques of climate reconstruction can identify the frequency of occurrence of periods when factors including temperature and salinity resemble those prevailing at the outbreak of recent major crown of thorns populations (estimated cost \$50,000 per annum over three years).

R11

The committee recommends research to evaluate the economic and social consequences of major populations of the crown of thorns starfish (estimated cost \$50,000 per annum for three years).

R12

The committee recommends that the Great Barrier Reef Marine Park Authority be recognised as the government agency responsible for reporting on and coordinating research and monitoring results on the crown of thorns in the Great Barrier Reef Region, with a responsibility to interact with funding agencies and research institutions to maximise efficiency in use of available funds and resources.

R13

The committee recommends that a senior scientist be appointed by the Great Barrier Reef Marine Park Authority on a five-year contract and supported with adequate funding (approximately \$85,000 per annum) to develop and coordinate a major program of research recommended in this report.

R14

The committee recommends that the Great Barrier Reef Marine Park Authority appoint an advisory committee to provide guidance to the research coordinator and advice to the Authority on development and coordination of research.

R15

The committee recommends that the various relevant research funding agencies be advised that crown of thorns starfish research is an area of national priority which should be taken into account in the funding of research.

R16

The committee recommends that the research questions identified by the committee be publicised throughout the national and international scientific community (see Attachment 4).

R17

The committee recommends that specific research projects identified in this report and those defined in R8 and R9 be supported by allocation of an amount of approximately \$3 million over five years to the Great Barrier Reef Marine Park Authority to support a coordinated research program. This amount to be additional to funds available to crown of thorns starfish research through existing sources such as the Australian Research Grants Scheme, Marine Science and Technologies Grants and the program of the Australian Institute of Marine Science.

R18

The committee recommends that the Authority should continue its present information program and keep the public and the media informed on the situation regarding distribution and research relating to crown of thorns starfish. R19

MANY QUESTIONS STILL HAVE TO BE ANSWERED

Significant results have already been achieved with research into crown of thorns starfish, but more work needs to be carried out particularly on the biology and ecology of the animal. Its likely occurrence on the Great Barrier Reef still cannot be predicted, and there is still no definite answer to the question: "Why are there recurring outbreaks of the starfish on the Great Barrier Reef?"

The crown of thorns is a difficult subject for research, more difficult than has generally been portrayed in the media to date. Decisions about crown of thorns management cannot be made until we are more familiar with the animal and until there are fewer gaps in knowledge.

Areas which have still not been settled include:

- . dispersal of larvae in Reef waters, and the effects of water current on dispersal - growth rates 'in situ', longevity in the field and mortality rates - including predation rates - reasons behind some reefs being apparently more prone to infestations than others, and why some reefs close to infested reefs have never been touched;
- . Immediate research objectives include finding out about the movement of populations, both adult and juvenile, tracing the location of juvenile starfish and finding methods of predicting the occurrence of destructive aggregations.

The crown of thorns has proven to be an extraordinarily difficult animal to track. To date tagging, marking or otherwise identifying individual starfish is an exercise which results in failure. Juveniles are extremely

difficult to locate. It has not yet been positively determined which conditions are most attractive to larvae when settling, and larval life span is still uncertain.

It's possible that crown of thorns may play a positive role in coral reef ecology. Some scientists believe this predator is necessary to maintain the large variety of coral species that exist along the Great Barrier Reef.

By eating the living corals the starfish are creating space for young corals, and other sedentary reef animals, to establish themselves. It could be said that the starfish prune the reef corals to allow different species to compete for the limited space available.

Scientists still don't know why it is that some reefs appear to survive attack by crown of thorns very well while others don't. It is generally thought that the starfish evolved with coral reefs, but its place in the system is unclear, as is the place of crown of thorns population explosions.

Until science has a far clearer picture on crown of thorns, its effect on the Reef and whether it's a natural or unnatural occurrence, it would be extremely unwise to embark upon any generalised programs of management to either drastically reduce numbers or wipe the species out entirely.

COLOUR SLIDES

SLIDE NO. 1

When present in large numbers on a reef, crown of thorns often feed in dense groups. In this photo, a dense group is feeding on a plate coral (Acropora), a favoured food species.

SLIDE NO. 2

Diver injecting crown of thorns starfish with a solution of copper sulphate during an experiment to test the effectiveness of control methods.

SLIDE NO. 3

Rich reef edge coral growth, mainly plate and staghorn corals, on Michaelmas Reef, in the Cairns Section of the Great Barrier Reef Marine Park (January 1984).

SLIDE NO. 4

Diver examining staghorn coral in an area affected by crown of thorns starfish. Algae has grown on the coral skeleton left after the living coral polyps have been eaten by the starfish. Branches not affected are still growing providing a focus for regeneration of this patch of coral.