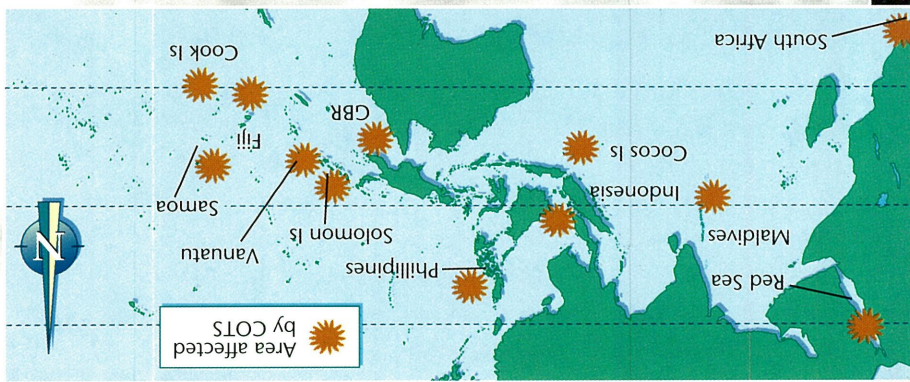


COTS outbreaks are an Indo-Pacific phenomenon. Researchers have found increasing numbers on many coral reefs.



arine scientists have recently announced another outbreak of crown-of-thorns, the coral-eating starfish researchers call COTS. The outbreak has started again where previous outbreaks began, in the Cairns section of the Great Barrier Reef Marine Park. While small numbers of COTS can be found at any time along most of the length of the Great Barrier Reef, some reefs in the Cairns section of the Marine Park now have three to eight times as many starfish as can be sustained by the live cover of corals. Just as areas of land can be badly damaged by bush fires, so this part of the Great Barrier Reef is suffering across a widespread area but the damage is patchy.

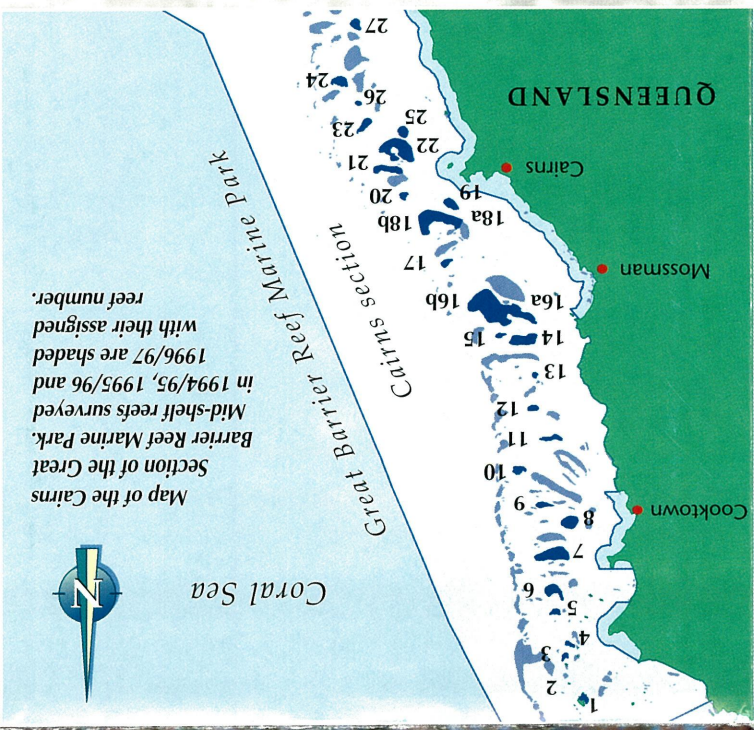
COTS researchers work closely with their counterparts in other countries, and it appears that this outbreak is not unique. Tropical areas around the Indo-Pacific are affected – outbreaks are being recorded in the Red Sea, South Africa, Maldives, Indonesia, Vanuatu, Cook Islands and Fiji. Sharing research results is adding to the common pool of knowledge, and we may be able to observe a whole cycle, and control specific areas. We are no longer watching helplessly as we were in the 1960s.



This time, Reef managers and the research community are ready. Work over the past ten years is paying off.

■ We have developed new survey techniques to allow the early detection of any increase in populations of small, juvenile COTS. Previously we only realised they were increasing in numbers when large adults suddenly appeared on a reef.

■ Because we are detecting juveniles at an early stage, we may be able to pinpoint some of the factors which may trigger significant outbreaks of COTS.



Scientists and managers of the Great Barrier Reef have a contingency plan now being activated to deal with this outbreak, including localised control measures, an expanded observer network and new research initiatives.

Marine scientists classify reefs into four conditions according to the number of COTS found in a certain area:

- Non-outbreak – there are less than 30 COTS per hectare of reef
- Incipient-outbreak – high densities of juveniles are found which are likely to survive and reach maturity
- Spot-outbreak – high density populations of COTS in parts of a reef
- Active-outbreak – there are more than 30 mature COTS per hectare of reef.

Top: A juvenile starfish eats a mushroom coral. COTS consume as much as their own body diameter in coral in 24 hours.

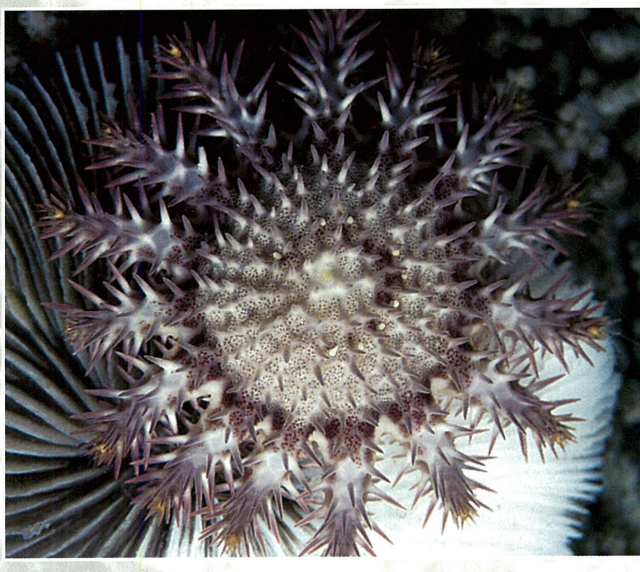


Photo: Stella M. Cove

## How you can help

Researchers have asked the general public, and especially tourist operators and their staff, to help them and the response was immediate. A network of information gatherers called COTSWATCH has been running since 1993. Divers, snorkellers, charter boat operators and tour guides count COTS underwater and fill in a simple reply-paid form (below) showing where starfish are sighted, and just as importantly, where none are seen. Forms returned to the Great Barrier Reef Marine Park Authority are entered into a computer database. The efforts of individuals have proved to be of vital importance in alerting scientists so that they could investigate the early stages of the current outbreak and help prepare for it.

## Who are the scientists?

Research and monitoring are being carried out by scientists from the Cooperative Research Centre for the Ecologically Sustainable Development of the Great Barrier Reef (CRC Reef), the Great Barrier Reef Marine Park Authority (GBRMPA), the Australian Institute of Marine Science (AIMS), the Queensland Department of Environment (DoE), the tourism industry, and many other organisations giving valuable assistance.

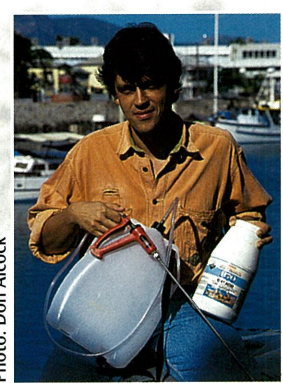


Photo: Don Atcock

Udo Engelhardt, a GBRMPA/CRC Reef scientist, spearheads the research team investigating the latest outbreak of COTS on the Great Barrier Reef.



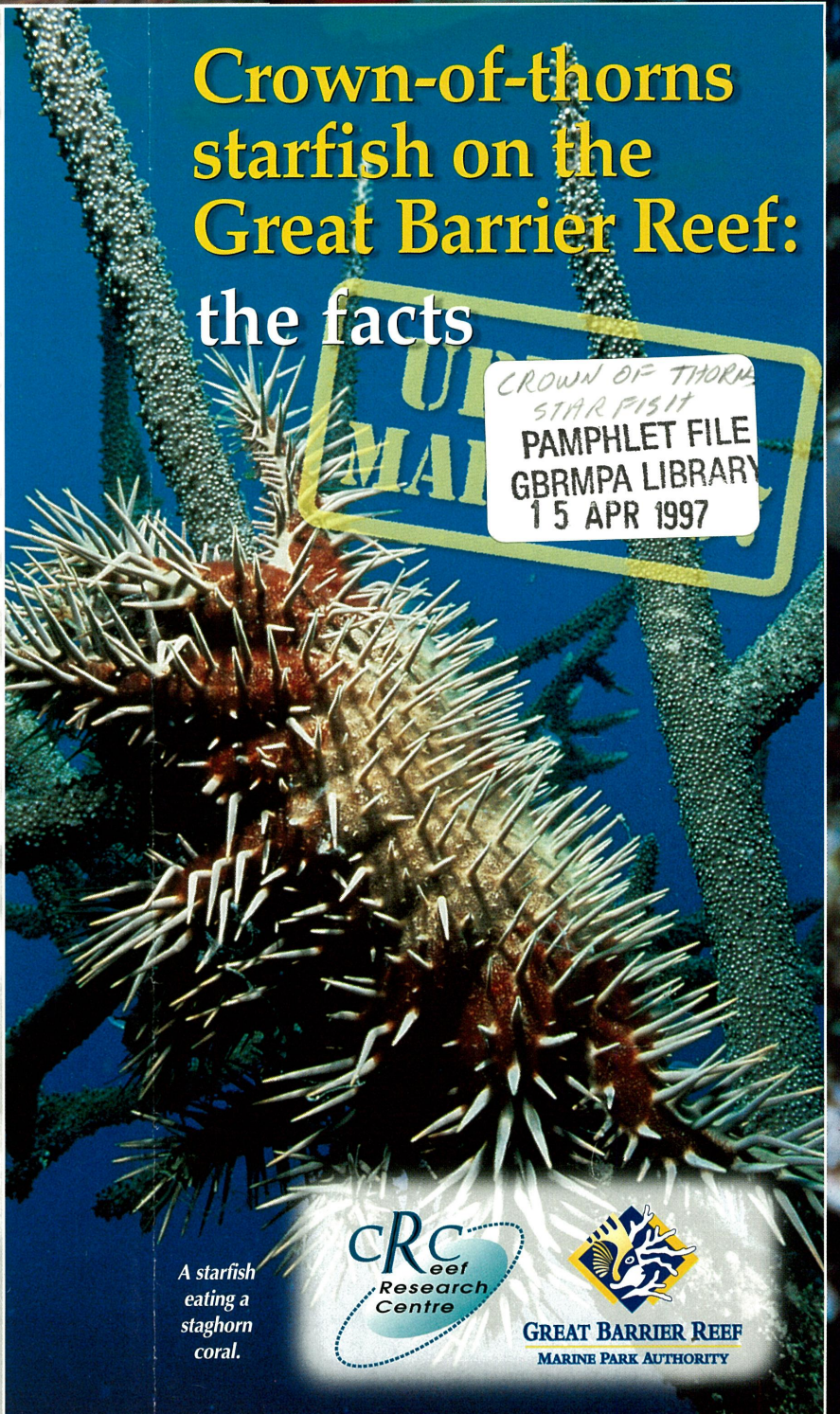
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## Crown-of-thorns starfish on the Great Barrier Reef: the facts



A starfish eating a staghorn coral.



## The history of COTS outbreaks

Visitors to the Great Barrier Reef have only observed COTS outbreaks since the introduction of SCUBA equipment in the 1950s, but it has been shown that these population increases may have occurred for many decades. Oral historians from James Cook and Griffith Universities have interviewed trochus divers from the Torres Strait who knew about COTS in the early part of the century, but were never concerned, regarding them as a natural part of the environment.

Since COTS were first recorded in large numbers at Green Island in 1962, outbreaks have followed a pattern. They spread south to the Innisfail region between three and five years later, to reefs off Townsville five to eight years later, and to the Whitsundays 10 to 12 years later, by which time the northern part of the Great Barrier Reef is already in recovery mode. Outbreaks occur predominantly on mid-shelf reefs, and on these reefs outbreaks are extremely variable, ranging from slight to very severe.

During the last outbreak in the late 1970s and 1980s, approximately 17% of the 2900 reefs that make up the Great Barrier Reef were affected by starfish. Of those, only 5% of reefs were classified as having severe outbreaks.

## The Current Situation

In 1994, CRC/GBRMPA fine-scale surveys detected the first signs of new outbreaks of COTS on some reefs in the Cairns Section. Since then, regular follow up surveys have shown that most



Photo: Udo Engelhardt

GBRMPA/CRC researchers record detailed information on the sizes and probable ages of starfish observed during fine-scale surveys.

mid-shelf reefs in this area of the Marine Park currently support active spot or reef-wide outbreaks. Recently, populations of small juvenile starfish have been found in the southern parts of the survey area suggesting that the outbreaks are spreading in a pattern similar to the one observed in the 1960's and 1980's. Future surveys will continue to assess the likely spread of outbreaks and their effects on coral communities along the GBR.

## The biology of COTS

Typically, COTS spawn in late spring and early summer when the water temperature reaches about 28°C. Each mature female may produce up to 100 million eggs in a single spawning season. While drifting in the ocean currents, COTS larvae feed on microscopic algae. After several weeks of drifting between the reefs, the small larvae finally settle amongst the coral "rubble", where they continue to feed on types of algae. When they reach the age of six months, their diet changes and the coral itself becomes their main food source.

COTS reach sexual maturity after two to three years and can live for 12 to 14 years. However, during an outbreak when food becomes scarce, their life span is much shorter. Often the starfish die of starvation after just a few years.



Top left: Snorkelling over coral is a major tourist attraction and local control measures are used at these sites.

Top right: Starfish, especially small ones, hide underneath the coral in crevices during the day and feed actively at night.

Left: An adult starfish beside the coral it ate the previous night. The starfish has digested all the flesh, leaving only the bleached limestone skeleton.

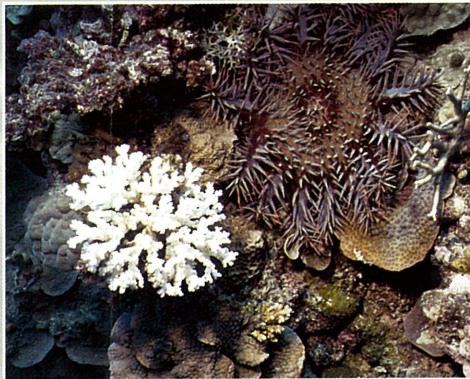


Photo: Dave & Noreen Downs

## How corals recover

Large aggregations of COTS may eat most of the hard corals on a reef, although remnants are often left behind which can regenerate. Following the mass spawning of coral in the following October or November, various hard coral species start to recolonise the reef. Staghorn and table corals are amongst the first to re-establish themselves.

Within 10 to 20 years, reefs can have good coral cover again, although the corals are predominantly the fast growing varieties. Massive coral takes longer to regrow and must compete with the faster growing corals for light and space. Some reefs which were affected by COTS two decades ago have now recovered so completely that they are major tourist attractions.

## COTS Outbreaks – Are they Natural?

Research conducted in the 1980's has shown that the starfish has an in-built natural ability to undergo sudden population explosions. The ability to produce great numbers of offspring in a single spawning season suggests that outbreaks may occur naturally following particularly good spawning years.

Whilst outbreaks are likely to be a natural phenomenon there remains some uncertainty over the possible role of certain human activities that may affect both the frequency and intensity of outbreaks.

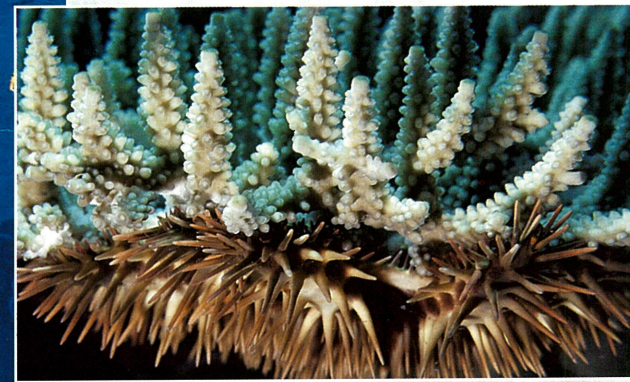
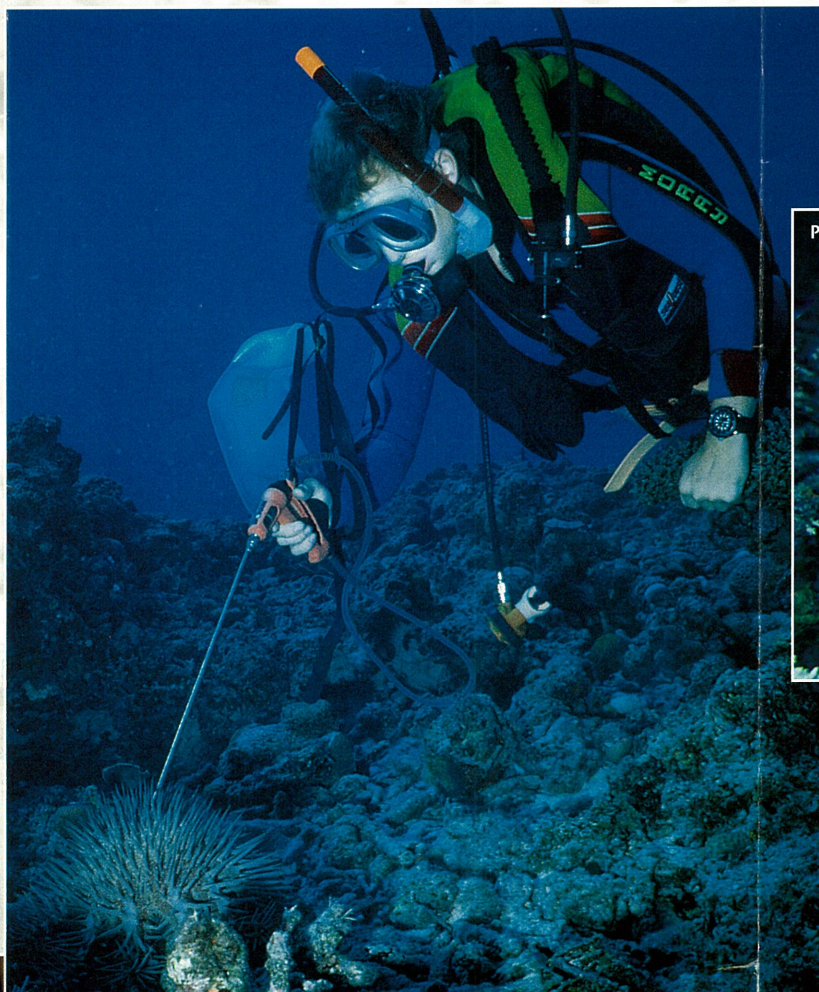


Photo: Stella M. Covre

Overfishing of the starfish's natural predators and possibly increased food supplies for COTS larvae due to higher nutrient levels in coastal waters have been suggested as possible links between human activities and outbreak phenomenon.

Current research is trying to establish whether or not the observed frequency of 15-17 years between outbreaks on the GBR can be sustained by coral communities. Outbreak intensity is also a critical factor in that it determines the degree to which slow growing corals (the massive corals) may be affected. Generally, the massive corals are not a preferred food of the starfish and hence may only be eaten during particularly severe outbreaks.

## GBRMPA policy

The Great Barrier Reef Marine Park Authority has a general policy of not interfering with natural processes, and there is a strong belief within the science community that COTS are most likely to be a naturally occurring phenomenon. They are not a pest accidentally introduced to the environment, like the rabbit on land or the Japanese sea-star carried into Australian waters in ships' ballast. However, because of the remaining uncertainty about the possible role of human activities, controls are

limited to small-scale clearing of COTS in areas that are important to research or tourism, such as around permanent pontoon sites. Managers can respond quickly to rising numbers and issue permits to conduct controls so that tourist operators can start straight away. GBRMPA and the CRC Reef Research Centre have also produced a training manual setting out exactly how to inject COTS with a lethal, yet environmentally friendly chemical called 'Dry Acid' (sodium bisulphate, normally used to clean swimming pools and quite harmless to surrounding corals).



Photo: Stella M. Covre

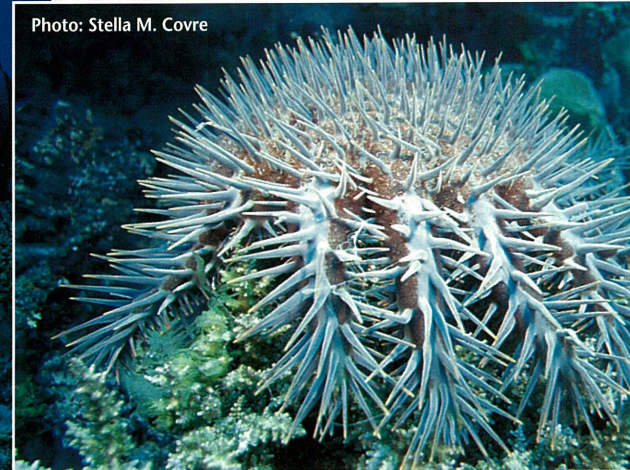


Photo: Stella M. Covre

Left: A scientist injects an adult starfish with lethal 'Dry Acid', an environmentally acceptable method of control.

Top: A juvenile starfish, about one year old. Very small COTS feed on algae but at about one cm in diameter they switch to eating coral and begin to grow very rapidly.

Bottom: An adult starfish in feeding position, sitting on top of a coral and turning its stomach inside out to envelope its food.