

Crown of Thorns starfish (COTs) are predators of Indo-Pacific corals, and population outbreaks can devastate entire reefs. So far, outbreaks have been rare in the WIO but MPA managers should be aware of their impact, so that appropriate action can be taken if needed. They should also be able to explain the significance of COTs to visitors who often notice these large animals when diving and snorkelling.

Adult Crown of Thorns (*Acanthaster planci*), feed exclusively on live corals. They are often seen as a few large individuals, sometimes reaching 60cm diameter in size, in relatively shallow reef areas. COTs prefer branching corals, perhaps because they can gain a firmer foothold on these. They leave clean, white areas of coral skeleton after feeding, which rapidly become overgrown by algae. The 'scars' differ from those of bleached or diseased corals in that there is no damaged tissue around them. Population outbreaks or 'plagues' of COTs can devastate whole reefs with up to 90% mortality of corals. Outbreaks have caused, and continue to cause, big problems on Australia's Great Barrier Reef, resulting in major reductions in coral cover. Other areas where outbreaks are common are the Red Sea, Japan, Palau and Fiji.

To date COTs have rarely occurred in true plague proportions in the WIO. Reefcheck surveys between 1997 and 2001 found no COTs except for one 'low' count in Madagascar. However small outbreaks have been recorded off mainland Tanzania in the mid-1990s (Mnazi Bay) and 2003 (Songo-Songo and Dar es Salaam), in Mauritius (see case study), and in Zanzibar in 2004.

Despite more than 30 years of research on the Great Barrier Reef (GBR) the cause of COT outbreaks is still not clear. Three main theories receive scientific support:

- Fluctuations in COT populations are a natural phenomenon;
- Removal of natural predators has allowed populations to expand; known predators on the GBR are the giant triton *Charonia tritonis*, certain species of pufferfish and triggerfish and the Napoleon wrasse *Cheilinus undulatus*;
- Human use of the coastal zone has increased nutrient flow to the sea, causing an increase in planktonic food for COT larvae.

Note that most of the research carried out on COTs has been on the GBR, and that very little is known about this species' life cycle and population dynamics in the WIO. Even on the GBR, there are major gaps in knowledge and understanding; for example, despite the large numbers that may appear during an outbreak, it is not known what causes the relatively fast decline in numbers, or where they go at the 'end' of an outbreak.

MONITORING COTS

COTs should be included in any regular reef monitoring programme (50m belt transects is the standard method used in the WIO). If numbers are seen to increase, more detailed monitoring of fixed 10 x 10m plots can be carried

out to look at coral colony mortality rates and recovery; monitoring of individual COTs is also possible.

On the GBR, the following system is used for defining outbreaks:

- **Incipient outbreak** - Meaning the density at which coral damage is likely. Occurs when there are 0.22 adults per 2-minute manta tow; or >30 adult and subadults per hectare, where subadults are 15-25cm diameter (2 years old) and adults are >26cm (>3 years old), using SCUBA diving counts. (N.B. starfish may be mature at 2 years or c. 20cm diameter, but for the definition of an outbreak >26cm is used).
- **Active outbreak** - COT densities are >1.0 adults per 2-minute manta tow, and adults are >15cm diameter; or >30 adult only starfish per ha if SCUBA diving.

RESPONSE TO AN OUTBREAK

Control of COTs is difficult, but there are two commonly used techniques for cleaning up infestations:

Physical removal - The easiest and cheapest for shallow water outbreaks; with COTs buried ashore. This method has been used in Indonesia successfully (see *Best Practices Guide* cited overleaf) and in Mauritius (see case study).

Killing individuals by injecting poison - A large mechanical syringe (cf the type used on cattle or sheep) is used and SCUBA diving skills are required. Sodium bisulphate (or dry acid, the swimming pool chemical) is considered to be the most effective, is relatively inexpensive and is harmless to other organisms when properly handled (see case study). Other poisons are copper sulphate, formalin, liquid ammonia, and hydrochloric acid.



Adult COTs, over 40cm diameter, in localised outbreak reported in January 2004 on shallow reefs in Tanzania.

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Note that cutting COTs under water does not kill them and may risk their numbers increasing (starfish can regenerate from single arms). Cleaning up an infestation can be expensive and time-consuming, even if the simplest methods are used, so careful consideration is needed before embarking on this.

Cleanups are probably only worthwhile on reefs that are of particular importance e.g. for tourism or fishing, and experience suggests that they should be carried out only in the following situations:

- Reef damage from COTs or human activities is not already too extensive;
- The area involved is small enough to monitor: 5 ha is manageable, 200 ha is probably too large;
- The COTs population is small enough to control and the clean-up response is quick;
- Monitoring can be maintained after the clean-up.

KEY POINTS FOR THE MPA

- ❑ Make sure that COTs are included in any reef monitoring programme and ask people to report their presence; if the scars are spotted, look nearby for starfish either on or under the corals.
- ❑ If an outbreak appears to be starting, obtain expert advice and gather the data to help you decide if a control method should be used.
- ❑ Handle live COTs with extreme care as the spines are poisonous, and can easily penetrate the skin, and break off causing considerable pain and sometimes infection; if this occurs, soak the affected area in hot water immediately.
- ❑ Make sure that some MPA personnel can respond to visitors' enquiries about COTs; outbreaks in Australia received much publicity and tourists have often heard of this species and want to know if it is a problem in the MPA they are visiting.

Sources of further information

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CORDIO – www.cordio.org – for information on reef monitoring in the WIO

CASE STUDY

COTs outbreaks in Mauritius

In October 2002, COTs starfish were observed in high numbers on a patch reef, 0.6km² in size, between Ile aux Cerfs and the fringing reef, adjacent to the fishing reserve of Trou d'Eau Douce. Ministry of Fisheries personnel demarcated the infested site using a GPS, and surveyed the abundance and distribution of COTs using the Line Intercept Transect (LIT) method. The number, size, depth, associated substrate and association of single or groups of COTs found in a belt 2.5m on either side of the transect tapes were recorded. Four adult COTs were brought from the site to the laboratory for *in vitro* tests and were kept alive in a concrete tank supplied with running seawater. Two of the COTs were marked and injected with dry acid solution, made of 140 gm of sodium bisulphate dissolved in one litre of seawater, using a hypodermic syringe. The other two COTs were injected with seawater as controls. The COTs injected with dry acid were found dead and those injected with seawater were still alive 24 hours after the injections.

The infested area was therefore searched by divers from the Ministry of Fisheries and the 30 COTs found were injected *in situ* with 6 ml of dry acid. The area was checked 48 hours later and all the COTs were found dead or dying, suggesting that injection of dry acid is an effective method of elimination, killing the COTs without affecting any other organisms. As the animals are injected *in situ*, no damage was done to the corals as the COTs do not have to be dislodged from colonies with metal bars or divers' knives.

The following year an outbreak was recorded near Flic en Flac in an area 80 x 50m. In this case, some 200 starfish were removed by hand by the Mauritius Marine Conservation Society, using volunteer divers. Joint initiatives with the Ministry of Fisheries might be appropriate for future outbreaks.



Juvenile and adult COTs. Note that it is relatively rare to see very young individuals because they are so well hidden.

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