



GREEN FINS

CROWN-OF-THORNS SEA STAR CLEANUP

GUIDELINES

Dealing with Crown-of-Thorns Sea Star (COTS) Outbreaks in
an Environmentally Friendly Manner

FOREWORD

Reef-World, the team behind Green Fins, has created these guidelines to help Green Fins members and other marine tourism operators assess when to conduct Crown-of-Thorn sea star (COTS) cleanups and how to do so in an environmentally friendly way.

If you're facing a COTS outbreak in your area and are organising a cleanup, please refer to these guidelines to ensure you and your team are protecting the environment by following environmental best practice. This guidance gives some basic ecological information about COTS as well as tips to help ensure you don't cause any further damage to marine ecosystems during their removal. Please make sure all participants are fully briefed on the following information before you begin your COTS cleanup.

Thank you for helping to protect our precious coral reefs by managing COTS outbreaks in a responsible and environmentally friendly manner.



THE REEF-WORLD
FOUNDATION



GREEN FINS
INTERNATIONAL
COORDINATOR



Coral Reef Image Bank/ Erik Lukas



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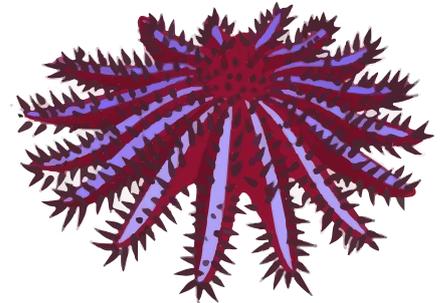




ABOUT CROWN-OF-THORNS SEA STARS

What are Crown-of-Thorn sea stars (COTS)?

Crown-of-Thorns sea stars (*Acanthaster planci*) - also known as Crown-of-Thorns starfish or COTS - are a normal part of healthy Indo-Pacific coral reefs and can occur at tropical and subtropical latitudes too.



How do COTS differ from other sea stars?

Like other sea stars, COTS belong to the Asteroidea group of organisms. However, they differ from other sea stars in several ways:

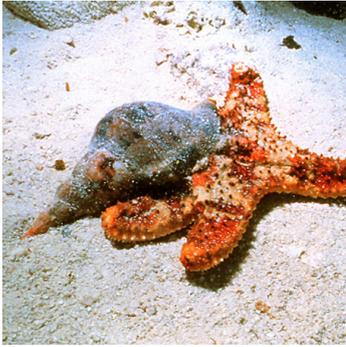
	TYPICAL SEA STAR	CROWN-OF-THORNS SEA STAR
Size	Adults usually grow 12-25cm in diameter.	Adults usually measure 30-40cm in diameter. Can grow as big as 70cm!
Arms	Five (with organs, guts, nerves, gonads etc. repeated in each arm).	Between seven and 21 in adults. Usually 14-18.
Spines	Short and blunt.	Long, sharp and venomous
Regeneration	Can regenerate quickly. It's been known for two separate sea stars to grow from the pieces of one sea star!	Can regenerate damaged arms. They may be able to regenerate from fragments or a detached arm into a new individual if that fragment contains part of the central disk.

WARNING: COTS SPINES CONTAIN VENOM AND CAN PUNCTURE SKIN. HANDLE WITH CARE

Fast Facts

- COTS get their name from the thorny spines found all over their body and arms which are used to help them move and defend themselves from predators.
- Males and females look identical and they come in a range of different colours, including purple, blue, red and grey.
- They are "radially symmetrical", which means they are symmetrical around a central axis and can move in any direction.
- They move by extending an arm and attaching tiny suckers under their arms to the substrate before contracting to pull the COTS forward.
- COTS' main food source is coral, especially fast-growing species such as *Acropora* species.

- They feed once or twice a day and the process - called "eversion" - which can take several hours. The COTS pushes its stomach out through its mouth and turns it inside out, secreting digestive enzymes into the coral tissue which is digested and absorbed as the COTS pulls its stomach back inside its body.
- When a COTS feeds, it extracts the colourful live tissue and leaves the coral skeleton so a white feeding scar will be visible on the reef. These scars are often the first sign of COTS on your reef.
- Juvenile COTS and adults in the process of feeding are particularly vulnerable to predators, including:



Triton's trumpet or giant triton sea snail (*Charonia tritonis*)

***Vulnerable**



White-spotted pufferfish (*Arothron hispidus*)



Titan triggerfish (*Balistoides viridescens*)



Painted shrimp (*Hymenocera picta*)



Frogfish (*Antennariidae*)



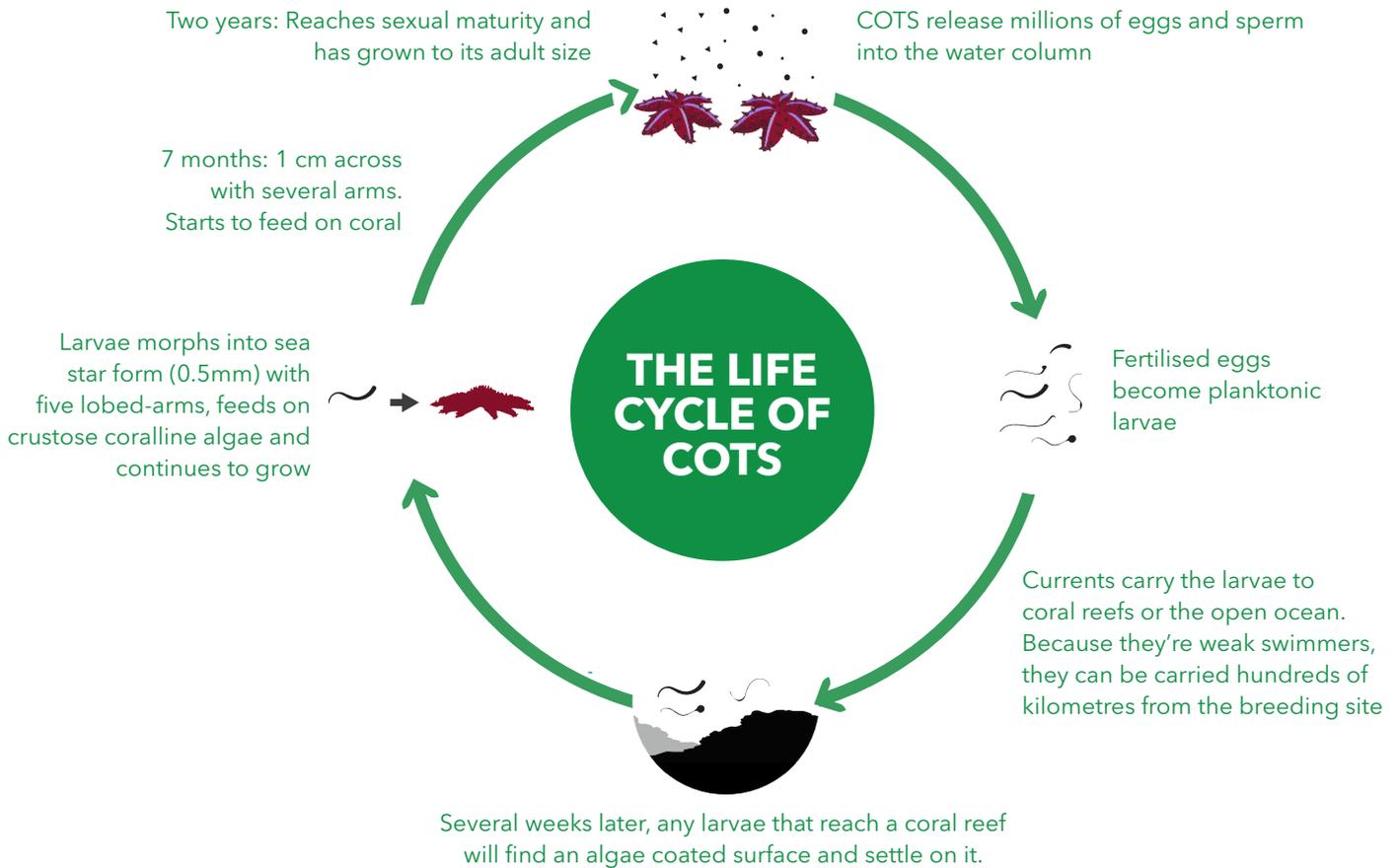
Toadfish (*Batrachoididae*)



Napoleon or Humphead wrasse (*Cheilinus undulatus*)

***Endangered**

- As well as their long, sharp spines, COTS contain chemicals called saponins within their soft tissues, which taste unpleasant and aggravate wounds.
- For humans, a wound from a COTS spine can be severe. The pain is intense and long-lasting and the injury may lead to swelling, secondary infection and, in some instances, allergic reactions or vomiting.
- Most COTS do not live past eight years.



Are COTS always harmful to reefs?

Although a known coral predator, COTS' natural role helps maintain coral diversity in a balanced ecosystem. This is because, by eating the faster growing coral species like *Acropora*, they allow different, slower growing corals to grow, forming a diverse reef. However, if the COTS populations consume corals faster than they can grow, the ecosystem becomes unbalanced.

It's important to note that occasional outbreaks can still help to increase coral diversity but frequent or persistent COTS outbreaks can exceed coral recovery rates causing extensive damage.

Why do COTS outbreaks occur?

The science behind COTS outbreaks is not yet fully understood. There are different theories about the causes of COTS outbreaks, which are probably influenced by a variety of factors and may vary between reefs. However, there seems to be a correlation between the severity of outbreaks and reefs more heavily impacted by human activities. This indicates that reefs under pressure from unmanaged tourism may be more susceptible to COTS outbreaks.

Human activity results in an increase in nutrients (through agricultural land run-off, deforestation and sewage outflow) which cause blooms of phytoplankton (microscopic marine plants). Being a key food source for COTS larvae, these phytoplankton help populations thrive. Another contributing factor is the overfishing of important predators that usually keep COTS in check. It may be that a combination of reasons cause an outbreak.

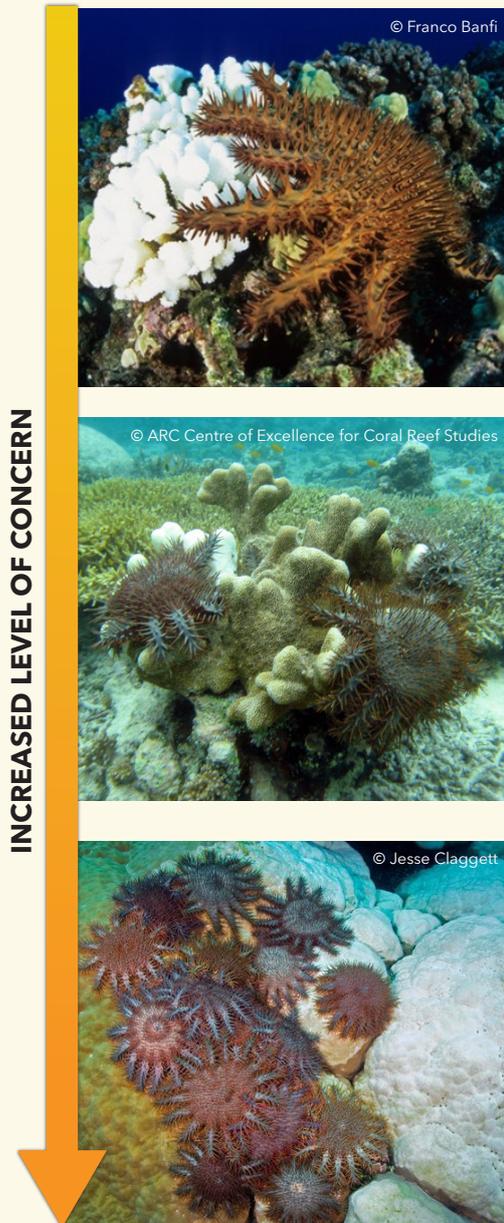
Lastly, many of the predators of COTS are targeted fisheries or trade species with declining populations, adding to the lack of control of COTS populations.

Whatever the cause, it's better to prevent a COTS outbreak than to try and control one so it is vital to be aware of the warning signs.

Signs of a COTS outbreak

COTS outbreaks are affected by both the COTS population and the overall health of the reef. They can be difficult to define because some reefs with high amounts of live coral cover can sustain large COTS populations without permanent damage while reefs with low live coral cover may be forever changed by the same COTS population size.

During a COTS outbreak, high numbers of COTS gather in a small area and, at these high concentrations, can quickly destroy large areas of reef. There are certain signs that indicate a COTS outbreak is happening on your reef and that you may need to take steps to control it. These include:



- **Several feeding scars**

When COTS feed on reefs, they extract the coral's colourful live tissue and leave behind its white calcium carbonate skeleton. This leaves white scars which roughly match the size of each COTS' central disk. The appearance of several feeding scars indicates you may be facing an outbreak.



TIP: If you think you have seen COTS scars on your reef, search nearby for COTS (especially the underhang of coral where COTS usually hide during daytime) because other types of predators and coral diseases can also create similar white scars.

- **Multiple sizes**

Finding COTS of multiple sizes on the reef - including juveniles (the size of your hand) and adults (larger than the size of your hand) - is another indicator of a possible outbreak.

- **More than 15 COTS per hectare**

As a rough guide, the Great Barrier Reef Marine Park Authority (GBRMPA) suggests that a COTS population is at outbreak level when you observe more than 15 sea stars per hectare during the daytime. This is equivalent to seeing roughly two COTS during a 20-minute swim.

- **Aggregations**

An aggregation - when COTS form groups of two or more - also indicates there may be a COTS outbreak on your reef. Usually, COTS are nocturnal: hiding during the daytime and feeding at night. However, when an outbreak occurs, they compete with each other for food and are forced to also feed during the daytime; meaning COTS may be seen on the reef both day and night.



PREVENTING AND MANAGING COTS OUTBREAKS

If you've noticed all the above signs of a COTS outbreak on your reef, acting fast is vital: preventing an outbreak when you've spotted the early signs is much easier and more effective than trying to manage an outbreak which has already become out of control. The following section includes more guidance on how to conduct a COTS cleanup.

WARNING: COTS SPINES CONTAIN VENOM AND CAN PUNCTURE SKIN. HANDLE WITH CARE

CONDUCTING A COTS CLEANUP: DOS AND DON'TS

Please be aware of the following dos and don'ts when it comes to COTS cleanups:

- ✓ **Do speak to your community.** Reach out to other operators, ask local staff and fishermen to determine whether your reef is experiencing an unusually large number of COTS or if outbreaks have been experienced in the past.
- ✓ **Do determine whether your reef is healthy, with extensive coral cover, or if it is already threatened by other impacts,** such as bleaching, sedimentation, trash etc?
 - Remember, healthier reefs are better able to recover from a COTS outbreak.
- ✓ **Do assess the COTS population in your proposed cleanup site to see if it is sustainable or at outbreak level.**
 - Removing COTS from the reef when populations are low will upset the natural balance of the ecosystem and may cause more damage than good. For this reason, please only conduct a cleanup if you have identified an outbreak (based on the signs outlined above).
- ✓ **Do make a long-term commitment to managing the COTS population at your proposed site.**
 - For control to be effective, you will need the time and resources to monitor coral health (see below) and COTS populations multiple times a year for at least the next year.
- ✓ **Do try to conduct COTS cleanups between midday and early evening if possible**
 - COTS tend to be harder to find on the reef in the mornings and cleanups are recommended during daylight hours. As with any dive, be sure to check the conditions. COTS cleanup dives should only take place when there are mild currents.
- ✓ **Do conduct a reef health assessment if you are able to as this is good practice alongside a COTS cleanup.** Operators who have the resources and would like to conduct reef health assessments should refer to the GBRMPA guidelines for more information.
- ✗ **Do not chop up the COTS.**
 - Historically, some fishers and conservationists have tried to control the population size of this predator by chopping it in half or into smaller pieces. COTS may be able to regenerate arms that have been removed. It is also thought they can regenerate from a fragment if that fragment contains part of the central disk. As such, chopping up COTS in an attempt to control a population outbreak is not recommended. It is not the most effective solution and can potentially make the problem worse.



HOW TO CONDUCT A COTS CLEANUP

If you have determined that your reef is threatened by a COTS outbreak and you are able to continually monitor/regulate the situation, you may need to take steps to keep the COTS population under control.

Please note: chronic COTS outbreaks are caused by high levels of larval COTS settling and surviving on the reef rather than the survival of individual adults. For this reason, don't worry if you don't manage to remove every COTS during your cleanup. Your focus should be on reducing the population size to below outbreak levels.

Considerations

- **Timing:** Check the conditions and organise your COTS clean up when there are milder currents. COTS tend to be harder to find on the reef in the mornings so cleanups are recommended during the daylight hours they can be found (midday to early evening).
- **Permissions:** Before conducting your COTS cleanup, make sure you have permission from the relevant authority or governing body. In some locations, where the collection of marine life is banned, prior permission must be given for COTS cleanups to take place.
- **First aid:** Make sure you have a certified first aider available as COTS stings can be severe and must be taken seriously. Seek further medical attention if the affected area does not improve within 24 hours.
- **Participants:** due to the potential severity of COTS stings, only experienced divers (usually Divemaster and above) should take part in COTS cleanups. Many dive shops do not allow guests to take part for this reason.
- **Briefing:** make sure all participants are fully briefed and understand how to conduct a COTS cleanup without causing potential harm to the reef (as outlined in this document).
- **Get in touch with your local authorities or marine research institutions to see if they are collecting data on COTS populations.**

Equipment

Make sure you are fully prepared before the cleanup begins with everything you will need. Depending on your plan, this might include:

- Scuba or snorkel gear
- Map of the area
- GPS (if available)
- Compass
- Mesh bag for collecting COTS
- Drinking water (encourage participants to bring their own reusable water bottles that you can refill)
- First aid kit and certified first aider

Staff

3 x snorkellers or scuba divers

1 x certified first aider should be on hand

Briefing

It's important to make sure your dive/snorkel team has all the equipment it will need and is fully briefed before beginning the cleanup and are aware of any essential information, including your COTS cleanup dos and don'ts:

- ✓ Do fill in data forms (if relevant/appropriate)
 - If you're asking team members to complete data forms, be sure to explain how they should fill these in
- ✓ Do work together
- ✓ Do ensure the collected COTS are properly disposed of in the allocated place
- ✓ Do be aware of the seriousness of being stung by COTS and make sure the whole team is clear on the safety protocols if a sting occurs



- ✓ Do be aware of your equipment, fins and buoyancy
- ✗ Don't touch or break the coral
- ✗ Don't leave any waste from the event itself (such as wrappers from snacks etc.)
- ✓ Do take before and after photos (if you have an additional team member available to document the event)
 - If you're not able to take underwater photos, you could take a group photo at the end of your cleanup

There are certain additional points you'll need to consider to ensure you avoid damaging the fragile marine ecosystem while conducting your COTS cleanup. Please be sure to ensure all participants are thoroughly briefed on the following information before you go begin:

Maintain good neutral buoyancy throughout the dive

If you're diving while conducting your COTS cleanup, be aware your buoyancy may change as you collect more COTS and your bag becomes heavier. So, make sure you're adjusting your buoyancy to maintain neutral buoyancy and stay clear of the reef throughout the dive.

Watch your fins

Watching your fins so you don't contact the reef or stir up any sediment is just as important - if not more so - during a cleanup than a normal dive. Although your attention will be focused on finding and collecting COTS on the dive site, please make sure you're still aware of all your equipment, especially your fins, throughout the dive.

Don't touch

Be careful not to touch, move or manipulate marine life in your attempt to collect COTS from the reef. This is particularly important if team members are wearing gloves as they can lead to a false sense of protection.

Ensure equipment is attached, streamlined and gauges are tucked in

If your equipment is dangling, you risk making damaging contact with the reef. Please make sure everything is tucked in and fully secure.

Assess the environment before beginning removal

Heavy swell or currents will make avoiding environmental damage during collection very difficult. So, it's important to assess the environment before you begin your COTS cleanup to ensure conditions are suitable. If the current is too strong or there's too much surge, it's best to postpone until conditions are better.

Hold your COTS collection bag so that nothing trails or touches the bottom

Make sure you're not damaging the marine environment by allowing your bag to touch or drag along the bottom. Ensure you're carrying the bag clear of the reef and nothing is trailing or dragging.

Dive in a head down position

This will help you avoid stirring the sediment or contacting the bottom with your fins.

Work slowly and carefully in buddy teams

During your underwater cleanup, work in buddy teams and allocate each diver a specific role. Work slowly and carefully and be careful not to touch, knock or damage the reef during your collection.



COTS COLLECTION METHODS

There are two main methods of controlling a COTS outbreak. These are:

1) Injection In-Situ

This is the preferred method because it minimises the risk of personal injury and coral damage. It uses a modified drench gun to inject each COTS with a single-shot of bile salts, vinegar or multiple shots of sodium bisulphate. These solutions are extremely toxic to COTS but are not known to have any negative impact on the wider marine environment.

For full details of injection methodologies and recommended doses of vinegar, sodium bisulphate or bile salts , please refer to the [Great Barrier Reef Marine Park Authority \(GBRMPA\) Crown-of-thorns Starfish Control Guidelines](#) before using this technique. GBRMPA also provides useful videos on technical guidance, equipment assembly and maintenance and effective COTS removal methodology (see references).

Please note:

- Injection with bile salts or vinegar are more efficient because they only require one or two injections per starfish while sodium bisulphate requires many injections per starfish.
- Modified drench guns can be obtained from NJ Phillips distributors globally.
- Bile salts are a specialised product and so can be hard to source.
- For more information on suppliers, please contact GBRMPA.
- Sodium bisulphate can be purchased from chemical or swimming pool suppliers.
- Consider the size of the needle before ordering e.g. some Green Fins members suggest at least 18 gauge.
- Please be sure to adhere to safety measures such as keeping the needles capped when not in use.
- Note, some Green Fins members have found it valuable to mount syringes on a stick to maintain physical distance from COTS during injection.
- Another useful tip is to put food colouring in with the vinegar so you can verify the injection has successfully gone into and not through the COTS.
- For more information on suppliers, please contact GBRMPA.

2) Removal and Burial Ashore

This method is less preferable than the injection method because there is a higher risk of damaging the reef or experiencing painful personal injury from venomous COTS spines. It is labour-intensive but low-cost.

- Snorkellers and divers remove COTS from the reef with spears or tongs and place them in baskets/bags until they can be returned to the boat or the shore.
- It is essential that participants do not contact or damage the reef.
- There is a high risk of injury both while removing the COTS and while carrying them in the baskets or bags.
- Protective gear should be worn and precautions taken to minimise injury wherever possible.
- Spears and tongs should have handles and be slightly less than a metre in length.
- Baskets or bags should be lined so that harmful COTS spines cannot pierce the handler.

It is important to remove COTS from the water as quickly as possible and avoid re-immersion. Once you've collected the COTS and returned to shore, you'll need to ensure they can be disposed of responsibly - they are usually buried. Here are a few points to consider:

- To prevent eggs and sperm from the collected COTS running back down into the water, make sure you have a bucket on the boat to put the COTS in. Don't fill the bucket with water.
- Any COTS must be buried above the high tide level so there is no risk of further contact with the sea.
- They must also be buried deep enough that they will not cause harm to people or animals digging in the area.



MONITORING THE RESULTS OF YOUR COTS CLEANUP

Once you've undertaken your cleanup, it's important to monitor how effective it was. One week after the cleanup, return to the site and complete another survey (collecting the same data as before) to determine the current state of the COTS population. Continue to monitor the area regularly and organise additional cleanups as required to keep the outbreak under control.

DOCUMENTING YOUR COTS CLEANUP

It can be helpful to document the success of your COTS cleanup: take before and after photos of the site as well as taking photos during the event (if it is possible for the team to do so safely).

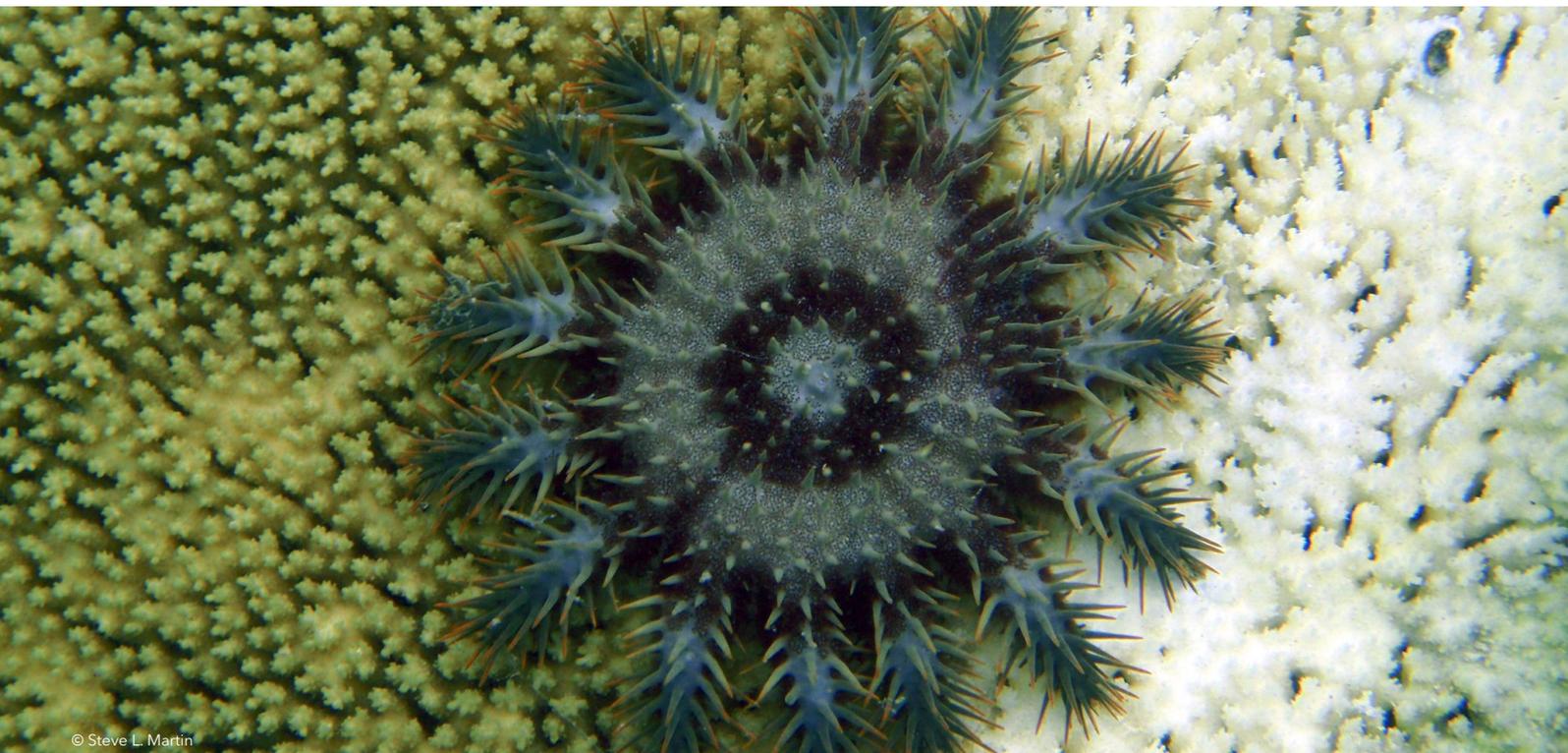
Reporting your findings can help local government bodies, research institutions or other organisations that may be collecting data. Make sure all data forms have been correctly filled out and returned to the appropriate organisations or government bodies.



TOP TIP FOR GREEN FINS MEMBERS: tag Green Fins on [Twitter](#), [Facebook](#) or [Instagram](#) so your pictures can be shared with the rest of the Green Fins network.

 @GreenFins   @Green_Fins

Thank you for helping to protect the marine environment by following these simple guidelines when managing COTS outbreaks on your reef.



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THE REEF-WORLD
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The Reef-World Foundation leads the global implementation of the UN Environment Programme's Green Fins initiative, which focuses on driving environmentally friendly scuba diving and snorkelling practices across the industry globally

Please visit www.reef-world.org and www.greenfins.net or follow us on social media:   @GreenFins   @Green_Fins

Contact the Green Fins teams on info@greenfins.net

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