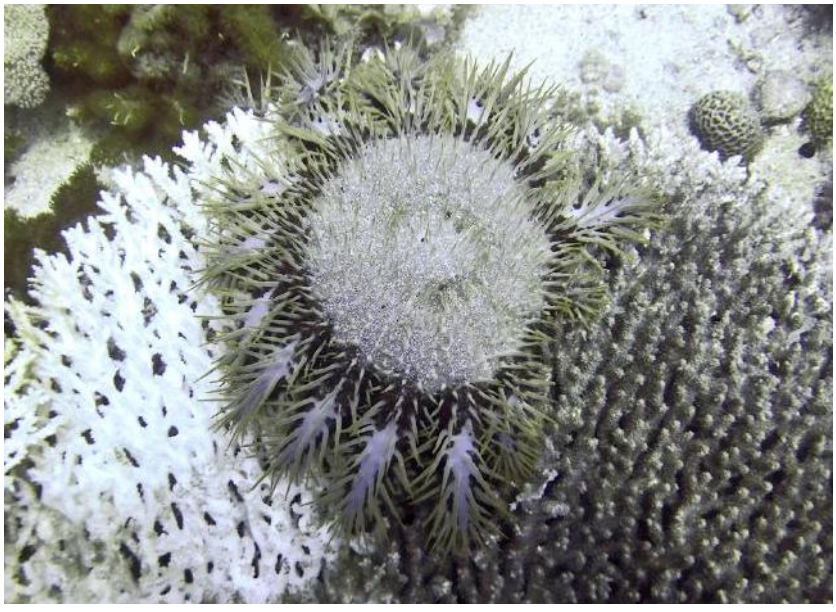
Malapascua Island
Logon, Daanbantayan
Cebu 6013
Philippines
SEC Registration No : CN201625259
---
http://www.peopleandthesea.org info@peopleandthesea.org

ASSESSMENT OF CROWN-OF-THORNS (DAP-AG) SEASTAR POPULATION AROUND THE ISLAND OF MALAPASCUA, DAANBANTAYAN, PHILIPPINES

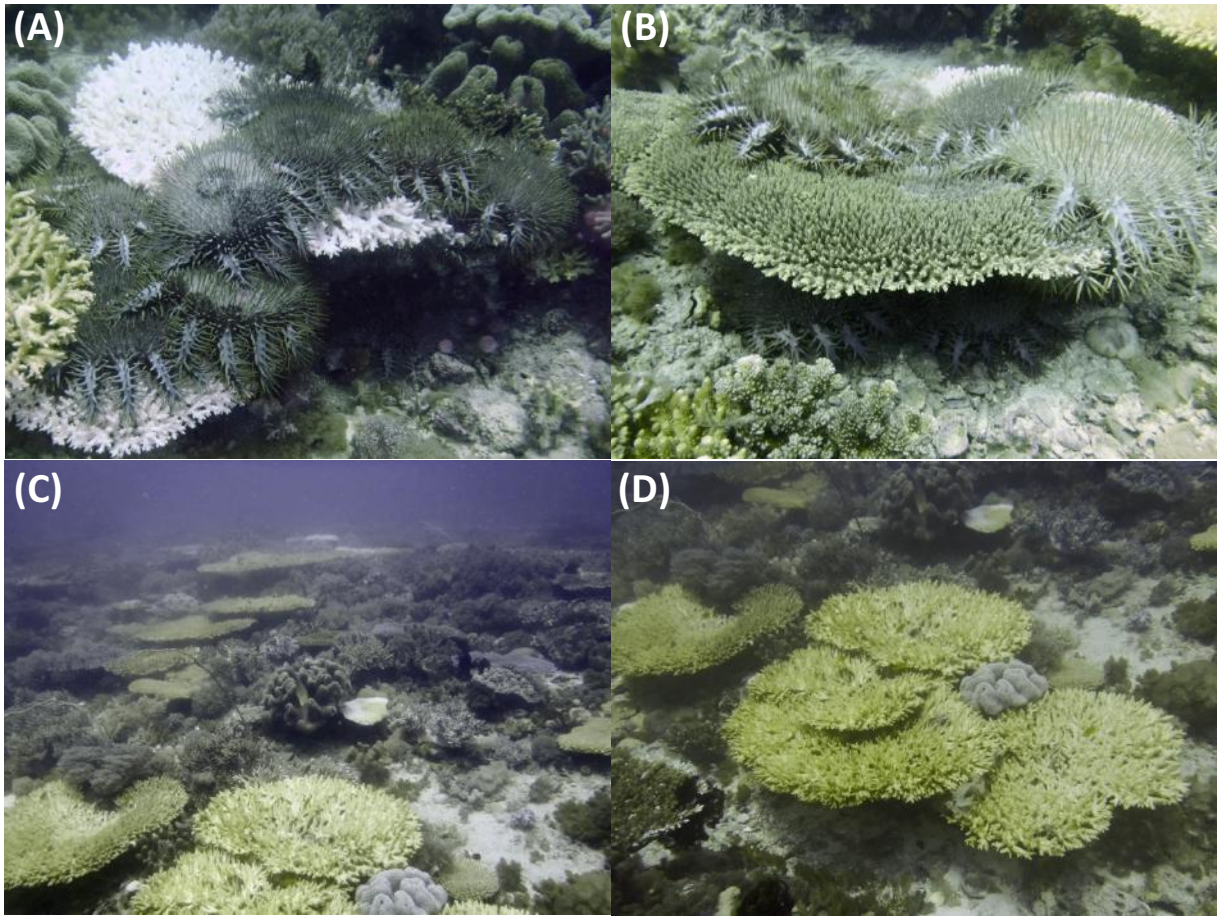


ALICIA DALONGEVILLE, PhD.
LEAD SCIENTIST, PEOPLE AND THE SEA

JUNE 2019

REPORT KEY-POINTS:

- Crown-of-Thorns are sea-stars feeding on corals. Their populations sometimes increase drastically into outbreaks that can **reduce live coral cover by more than 90%** in a period of just 2-3 years.
- Cebu PENR Office made a recommendation to declare COT outbreaks throughout the province of Cebu, and that **funds are being made available to LGUs** to help address the problem.
- **COTs spawn under stress,** thus carrying COTs underwater after manual extraction causes mass release of eggs and sperm, which will lead to further outbreaks.
- **Two techniques are recommended to control COT populations** while avoiding stress-spawning: free-diving removals or scuba-diving injections of household vinegar.
- Reef monitoring results show that **COT densities on the reefs of Malapascua are now SEVEN TIMES the threshold defining an outbreak** (more than 15 COTs per hectare).
- To respond to the important outbreak occurring in the site 'Coral Garden', People and the Sea has developed a **control program** over the past year and a half.
- **Free-diving removals of COTs were organized together with various local stakeholders** such as the Malapascua Tour Guide's Association, the Bantay Dagat of Malapascua, and local and foreign businesses and volunteers.
- Over the past year, the number of COTs collected during the removal sessions has constantly been above the outbreak threshold. Hence, we are committed to the continuation of **engagements that contribute to educated and coordinated efforts** to eradicate the COT problem.
- Since the beginning of June 2019, we have been conducting population assessments to observe COT densities around Malapascua. Out of the nine sites monitored, **only two showed COT populations below the outbreak threshold.**
- Our most recent observations show **alarming abundance of COTs** indicating an outbreak is occurring in the North of Malapascua, as attested by the following pictures (A, B, C, D)



Pictures taken on June 6th 2019 in Two Rocks, a dive site located in the North of Malapascua island, at a depth of about 10m. **(A)** and **(B)** show piles of large Crown-of-Thorns (diameter of 30 to 50cm) predating on table *Acropora spp.* corals. **(C)** and **(D)** show the damages inflicted by the COT outbreak to the reef. The large majority of hard coral colonies have been killed, and now appear white to greenish as their dead skeleton is colonized by algae.

1. Crown-of-Thorns (COTs) *Acanthaster planci*

COTs are found throughout the Indian and the Pacific Oceans, making them one of the most widely distributed of all reef species (De Vantier and Deacon, 1990). Despite only reproducing once a year, COTs have an enormous reproductive potential (Pratchett et al., 2014). A large female (>40 cm in diameter) can produce up to 65 million eggs while a smaller female (<30 cm) may produce up to 2.5 million eggs (Kettle and Lucas, 1987).

Adult COTs are specialist corallivores (De'ath and Moran, 1998), which means they prey on coral polyps and can consume 400cm² of coral per day (Carpenter, 1997). In low numbers, COTs can increase the biodiversity of a reef, preying on faster growing corals (e.g. Acropora spp.), giving way for slower growing corals (e.g. Porites spp.) to succeed. However, when numbers increase too quickly, large-scale predation of corals can lead to habitat destruction, as their feeding rate exceeds the average growth rate of the coral (Fabricius, 2013). This is known as an 'outbreak' (Bos et al., 2013). There are three stages of an outbreak: the build-up, which is when the numbers begin to increase; the outbreak, which is when the COTs density exceeds local resource availability; and the epidemic, which is when the COTs outbreak has spread to other reefs due to reef connectivity (Hock et al., 2014). A large outbreak can reduce live coral cover by more than 90 per cent in a period of just 2-3 years (Chesher, 1969; Buck et al., 2016).

Without intervention, COTs outbreaks will cause the disappearance of the corals in a region within only a few years. Although coral reefs may recover from outbreaks, this may take decades, with a range of anywhere between 5 and 100 years (Pratchett et al., 2017) before the corals were restored to a healthy reef, with most reefs estimated to take 10-25 years for full recovery (Fabricius et al., 2010). Highly impacted coral reefs may never be fully restored (Berumen and Pratchett, 2006).

This problem of COT outbreaks has gained attention in several parts of the Philippines recently. As reported in Sunstar (April 2019) the Cebu PENR Office made a recommendation to declare COT outbreaks throughout the province of Cebu, and that funds are being made available to LGUs to help address the problem.

2. Control programs

Once a COT outbreak has started, natural regulation of the starfish population by predation is not possible and active measures have to be taken to bring the number of COT back to a level that can be sustained by the ecosystem. COT control programs are typically used to regulate the population and limit coral damages that would threaten the health and resilience of the ecosystem (Boström-Einarsson & Rivera-Posada, 2016). The DENR technical Bulletin 2017-13 (Guidelines on the implementation of Environmental standards for diving and snorkeling) encourages locally declared and managed MPAs to adopt the "Green Fins Crown of Thorns Cleanup Guidelines" as part of the prescribed Code of Conduct of the Green Fins

Approach. These guidelines would ensure that COT control initiatives are conducted with ecological interest at the forefront.

As stated above, COTs have extremely high fecundity (reproductive capacity). As many species of sea stars, they also spawn under stress, as a method of ensuring the continued survival of the species. Hence, carrying COTs underwater after manual extraction causes mass release of eggs and sperm, which could lead to further outbreaks within a couple of years (Great Barrier Reef Marine Park Authority, 2017).

Two main techniques are commonly used to actively control COT populations: free-diving removals for shallow sites, and scuba-diving injections of household vinegar for sites where freediving is not possible. Both methods have to be carried out in accordance to strict guidelines in order to avoid COTs stress spawning and prevent injury of the participants.

- *Manual removals procedure*: free-divers collect the COTs using tongs to avoid injuries. COTs should be immediately brought to the surface and placed in buckets to avoid stress spawning. Water from these buckets should be buried on land and never thrown back into the ocean, as it contains eggs and sperm of the collected sea stars.

- *Household vinegar injections procedure*: scuba-divers inject a 20mL dose of a solution of household vinegar at a concentration of about 4% at the base of the starfish arm using a veterinary needle. For the control program to be efficient, all the starfish in the area have to be injected, which usually requires several visits to the site within 15 days (Great Barrier Reef Marine Park Authority, 2017).

3. Results of the reef monitoring

People and the Sea has been monitoring the coral reefs around Malapascua since the beginning of their activities on the island in early 2015. Part of that monitoring includes recording the abundance of coral predators such as COTs. Hence, People and Sea has three years of data showing the evolution of COTs on ten survey sites around Malapascua (Figure 1).

Results of the monitoring show that the mean density of COTs in Malapascua has increased by 440% since 2016, and now reaches 0.015 (± 0.005) individuals/m^2 (105 individuals/ha). The COT control guidelines, published by the Great Barrier Reef Marine Park Authority, state that a site is experiencing an outbreak if their density exceed 15 individuals/ha. COT densities on the reefs of Malapascua are now 7 times that threshold.

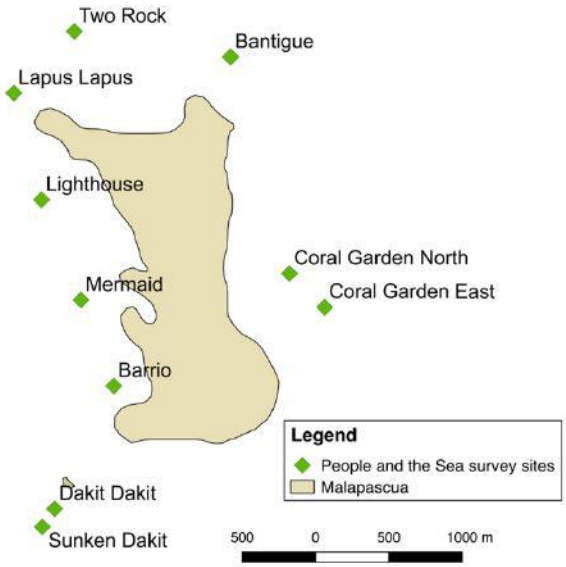


Figure 1.

Map of People and the Sea survey sites in Malapascua.

Figure 2 shows the COT density for each survey site in 2016, 2017 and 2018. The abundance of Crown-of-Thorns has increased in eight out of the ten sites. The two sites where no COT has been observed (Lapus Lapus and Two Rocks) are the two sites dominated by soft coral, which are of poor interest for the starfish since it mainly feeds on hard coral. Four sites have COT densities significantly higher than the outbreak threshold of 15 individuals/ha, and four are right on the limit (average of 16.7 COT/ha in Dakit Dakit, Lighthouse, Barrio and Sunken Dakit; Figure 2). Two sites located in Coral Garden, on the East coast of Malapascua, have shown COT densities above the outbreak threshold since the beginning of our monitoring activities in 2016.

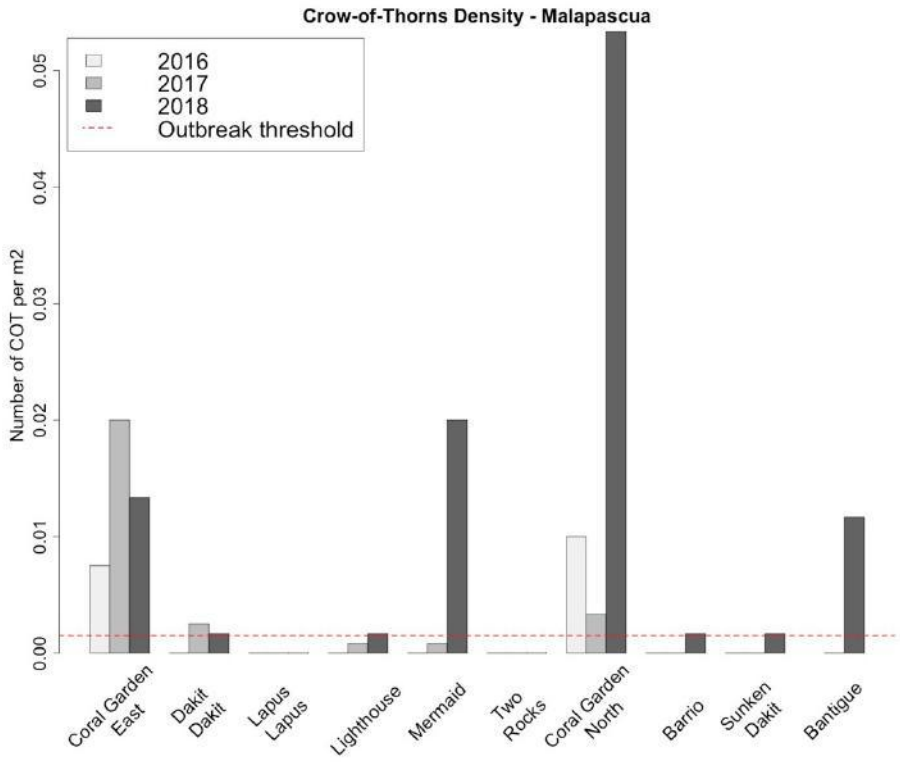


Figure 2.

Results of People and the Sea reef monitoring of Malapascua. Density of COT in the ten survey sites in 2016, 2017 and 2018

4. People and the Sea COT removals

To respond to the important outbreak occurring in the site 'Coral Garden', on the East side of Malapascua, People and the Sea has developed a control program over the past year and a half. We have been organizing regular free-diving removals on the impacted site since January 2018. As part of this effort we have teamed up with various local stakeholders such as the Malapascua Tour Guide's Association, the Bantay Dagat of Malapascua, and local and foreign business and volunteers.

The scheme we implemented is low cost and easy to repeat; buckets are floated on the surface and swimmers dive down using tongs to collect the COT, where they are immediately brought to the surface and placed in buckets to avoid stress spawning. In order to monitor the evolution of COT outbreaks, we also collected biometric data of removed starfish. The total number of starfish collected was recorded, and each individual was weighed and measured. In addition, one in every ten COTs was also sexed and its symmetry assessed by counting the number of missing and/or short arms. The size and weight of a COT is proportional to its age and the number of eggs produced (Kettle & Lucas, 1987). Symmetry is an indicator of the predation/competition affecting COT population. Hence, the biometrics can inform us on the age structure, sex-ratio and potential fecundity of COT population, allowing to measure the efficiency of the control programs.

An important part of People and the Sea work is to spread awareness of the best methods of COT removal recommended by the guidelines. For each removal session, a presentation was provided beforehand to describe the safest and best way to remove COT from the environment, along with giving some basic information on their biology and the reasons behind doing removals.

In addition, People and the Sea hosted a COT workshop in September 2018 with representatives of the local businesses and dive centres to inform them about the issues related to COT, best practices in control activities, as well as to share the results of our collection activities. We are committed to the continuation of engagements that contribute to educated and coordinated efforts to eradicate the COT problem.

From February 2018 to February 2019, People and the Sea organized a total of thirteen (13) removals of one hour in the area shown in red in Figure 3. During these sessions, a total of more than 3300 COTs have been removed.

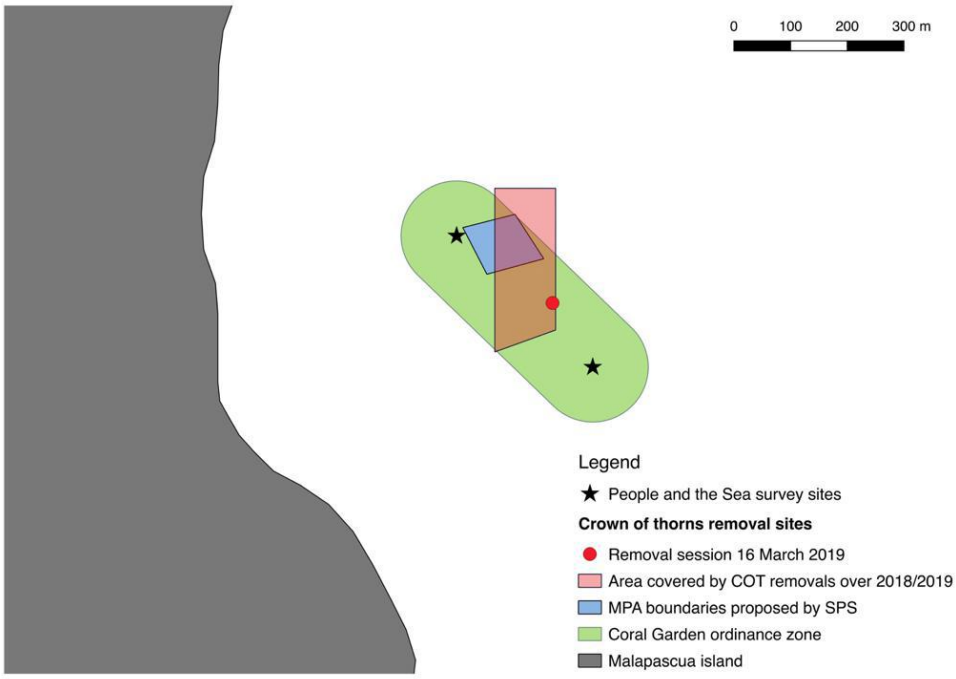


Figure 3.

Map of Coral Garden where the COT removal sessions have been conducted from Feb 2018 to Feb 2019.

Figure 4 shows the total number of COT collected per one-hour removal sessions. The number of participants per session varied from 6 to 14 (average 10.6). To account for the differences in the number of participants, we calculated the Catch per Unit Effort (CPUE) as the total number of COT removed during the one-hour session divided by the number of participant buddy teams, and divided by 60 to have the number collected per minute.

For management purposes, the Great Barrier Reef Marine Park Authority (GBRMPA) currently considers a CPUE of 0.1 as an active outbreak when coral cover is above 40% (as it is in Coral Garden according to our monitoring data). Figure 5 shows the CPUE calculated from our removal data. From February 2018 to February 2019, the CPUE calculated from our removal data vary from 0.1 to 1.48, which is constantly above the outbreak threshold. However, it started to decrease over the last three months, which may indicate that the outbreak is slowing down thanks to the collective effort.

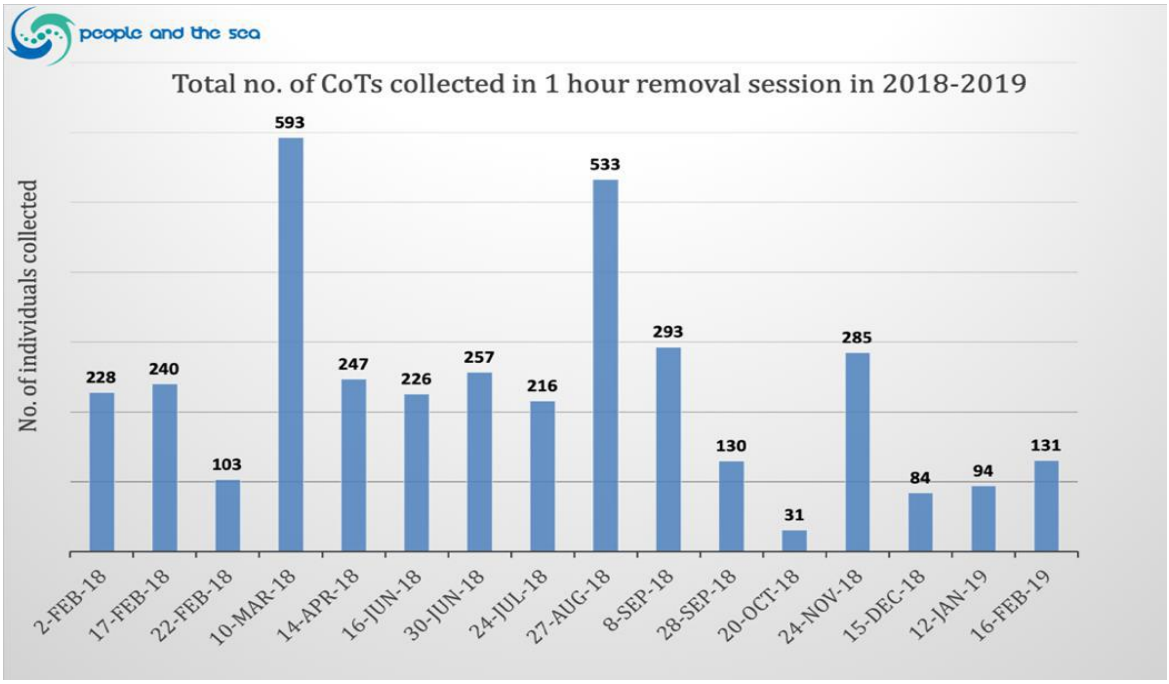


Figure 4.
Number of COT collected per removal session in Coral Garden from February 2018 to February 2019.

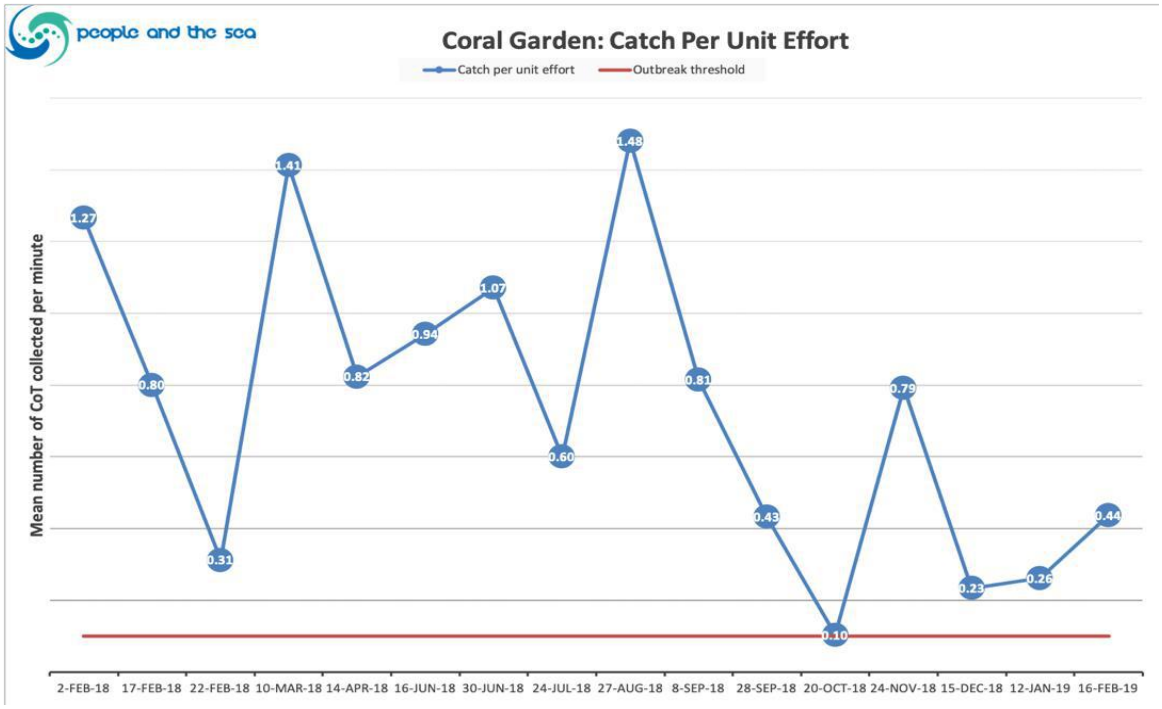


Figure 5.
Catch Per Unit Effort (CPUE) calculated from COT removals: number of COT removed per participant buddy team per minute. The red line indicates the threshold of active outbreak (0.1 COTS removed/min).

Figure 6 shows the average diameter and average weight of COT collected during each removal session. Average diameter ranged from 17 to 21.5cm (mean 19.2cm). Average weight seems well correlated to diameter, and varied between 129.5 and 320g (mean 221.1g). Both diameter and weight remained relatively constant over the year, which indicates that COT population is maintaining a constant presence of reproductive adults.

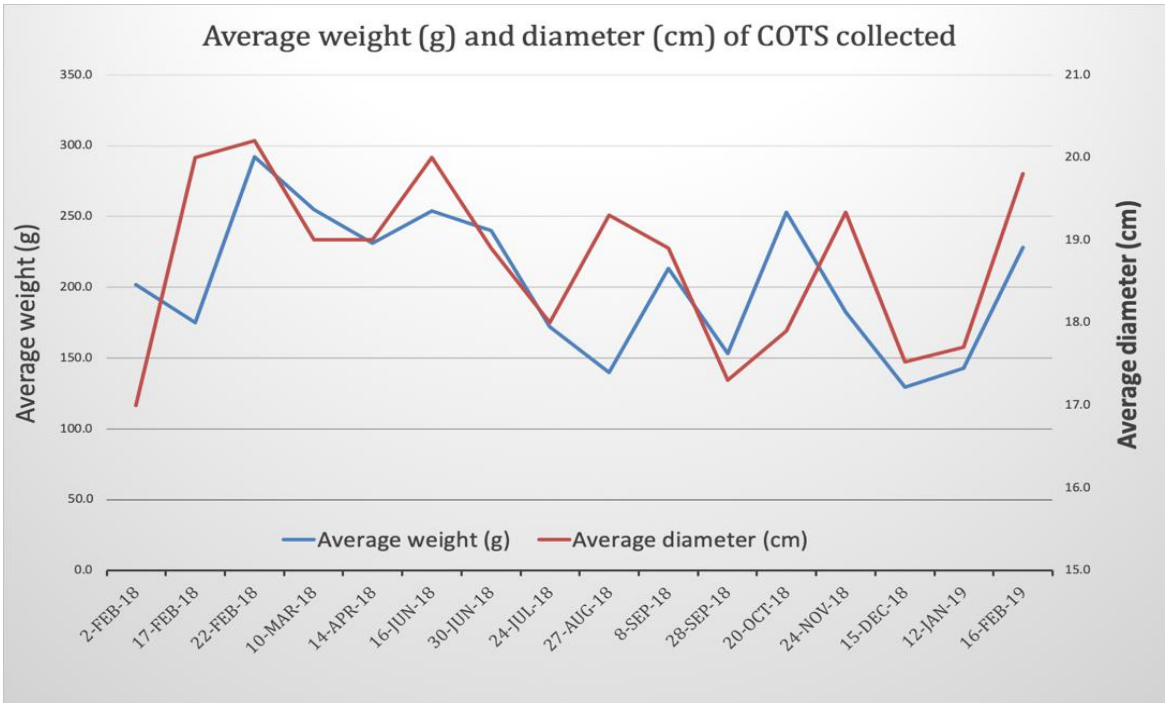


Figure 6.
Average weight and diameter of COTs collected during each removal session.

5. Population assessment

Recently, People and the Sea has started a population assessment of COTs. The observational technique we employed is known as 'SCUBA searching', a method that provides a quantitative measure of abundance (Endean, 1974). For each site, 2-3 divers spend up to an hour searching for COTs. When a COT is observed, its diameter across the longest arms is measured. After that the area around the COT is observed for preyed on corals (within a 2m radius). The corals form and genus are recorded to help understand the feeding preferences of the COTs. Figure 7 shows the location of the nine sites that have been assessed so far. Their GPS coordinates, dive time and number of observed COTs are given in Table 1.

As mentioned previously, the COT control guidelines (published by the Great Barrier Reef Marine Park Authority) state that a site is experiencing an outbreak if the COT population exceeds 15 individuals per hectare, which correspond to more than one COT spotted per 20-

minute swim. Hence, sites are considered to be experiencing a COT outbreak if more than 3 COTs were observed during a one-hour dive. The number of COTs spotted per hour was calculated from our population assessment observations as follows: the number of COTs was divided by the dive time to get the number of COTs observed per minute. And that number was multiplied by 60 to have the number of COT per hour.

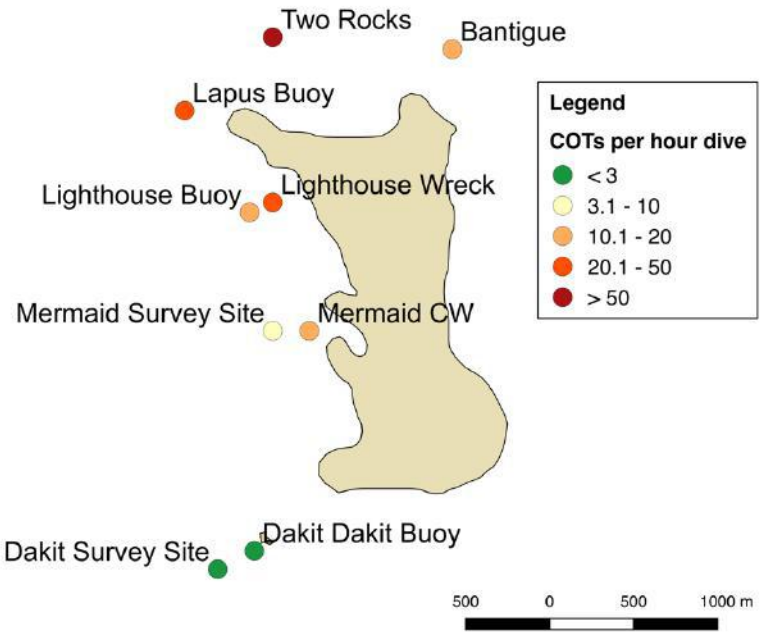


Figure 7.

Map showing the number of COTs observed in one-hour dive for each site monitored during the population assessment conducted in June 2019.

Out of the nine sites monitored, only two showed COT populations below the outbreak threshold (< 3 COTs/hour). These sites are located by the Dakit islet on the southwestern side of Malapascua (Figure 7). As shown in Figure 7, the abundance of COTs seems particularly high on the North-East of the island. Two Rocks is the site the most affected, with 127 COTS recorded in just 52 minutes and a high proportion of dead coral, as shown in the pictures at the beginning of this document. This outbreak is located at a short distance from our reef monitoring survey site, in an area richer in large table *Acropora spp.* corals on which COTs feed preferentially (Bos, Gumanao, Mueller, & Saceda-Cardoza, 2013).

Hence, our observations show alarming abundance of COTs indicating an outbreak is occurring in the North of Malapascua. This outbreak has already strongly affected the corals, as evidenced by the pictures taken in Two Rocks on June 6th 2019 (page 3). In addition, several dive centers have reported similar outbreaks in surrounding areas including Monad shoal (which is a protected area) and Kalaggaman island. Both these sites are protected areas, and the health of these reefs is crucial for tourism and local economy as they are the most visited by divers.

Table 1. The total number of COTs observed at each site during the population assessment.

Date	Dive Site	GPS Coordinates		Total Dive Time (mins)	Total COTs Number
		Latitude	Longitude		
04/06/19	Mermaid Survey Site	11.335	124.109	55	5
05/06/19	Mermaid CW	11.335	124.111	45	13
05/06/19	Lighthouse Buoy	11.342	124.107	57	13
06/06/19	Lapus Buoy	11.347	124.104	54	20
06/06/19	Two Rocks	11.351	124.109	52	127
07/06/19	Dakit Survey Site	11.322	124.106	50	0
10/06/19	Dakit Dakit Buoy	11.323	124.108	53	1
10/06/19	Lighthouse Wreck	11.342	124.109	55	20
11/06/19	Bantigue	11.350	124.119	40	13

Hence, our observations show alarming abundance of COTs indicating an outbreak is occurring in the North of Malapascua. This outbreak has already strongly affected the corals, as evidenced by the pictures taken in Two Rocks on June 6th 2019 (page 3). In addition, several dive centers have reported similar outbreaks in surrounding areas including Monad shoal (which is a protected area) and Kalaggaman island. Both these sites are protected areas, and the health of these reefs is crucial for tourism and local economy as they are the most visited by divers.

References

Berumen, M. L. and Pratchett, M. S. (2006). Recovery without resilience: Persistent disturbance and long-term shifts in the structure of fish and coral communities at Tiahura Reef, Moorea. *Coral Reefs*, 25, 647-653.

Bos, A. R., Guamanao, G. S., Mueller, B., Saceda-Cardoza, M. M. E. (2013). Management of crown-of-thorns sea star (*Acanthaster planci* L.) outbreaks: Removal success depends on reef topography and timing within the reproduction cycle. *Ocean and Coastal Management*, 71, 116-122.

Boström-Einarsson, L., & Rivera-Posada, J. (2016). Controlling outbreaks of the coral-eating crown-of-thorns starfish using a single injection of common household vinegar. *Coral Reefs*, *35*(1), 223–228. https://doi.org/10.1007/s00338-015-1351-6

Buck, A. C. E., Gardiner, N. M. and Boström-Einarsson, L. (2016). Citric Acid Injections: An Accessible and Efficient Method for Controlling Outbreaks of the Crown-of-Thorns Starfish *Acanthaster* cf. *solars*. *Diversity*, 8,28.

Carpenter, R. C. (1997). Invertebrate predators and grazers. In *Life and death of coral reefs* (pp. 198–229). New York: Chapman and Hall.

Chesher, R. H. (1969) *Acanthaster planci: impact on Pacific coral reefs*. Final report to U.S. Dept. of the Interior, Pittsburgh, Penn: Westinghouse Electric Corporation Research Laboratories.

De Vantier, L. M. and Deacon, G. (1990). Distribution of *Acanthaster planci* at Lord Howe Island, the southern-most Indo-Pacific reef. *Coral Reefs*, 9, 145-148.

De'ath, G. and Moran, P. J. (1998). Factors affecting the behaviour of Crown-of-thorns starfish (*Acanthaster planci* L.) on the Great Barrier Reef: 2: Feeding Preferences. *Journal of Experimental Marine Biology and Ecology*, 220, 107-126.

Endean, R. (1974). Acanthaster planci on the Great Barrier Reef. Proceedings of the Second International Symposium on Coral Reefs, 1973, Brisbane: Great Barrier Reef Committee.

Fabricius, K. (2013). '*Acanthaster planci*'. In: Lawrence, J. M. *Starfish: Biology and ecology of the Asteroidea*, p 132-141.

Fabricius, K. E., Okaji, K. and De'ath, G. (2010). Three lines of evidence to link outbreaks of the crown-of-thorns seastar *Acanthaster planci* to the release of larval food limitation. *Coral Reefs*, 29, 593-605.

Great Barrier Reef Marine Park Authority. (2017). *Crown-of-thorns starfish control guidelines: second edition* [Report]. Retrieved from Great Barrier Reef Marine Park Authority website: http://elibrary.gbrmpa.gov.au/jspui/handle/11017/3162.

Greenfins. (2019). *Crown-of-Thorns Clean-up Guidelines*. Retrieved from http://greenfins.net/en/Guides on 2019/03/22.

Hock, K., Wolff, N. H., Condie, S. A., Anthony, K. R. N. and Mumby, P. J. (2014). Connectivity networks reveal the risks of Crown of Thorns starfish outbreaks on the Great Barrier Reef. *Journal of Applied Ecology*, 51 (5), 1188-1196.

Kettle, B.T. and Lucas, J.S. (1987). Biometric relationships between organ indices, fecundity, oxygen consumption and body size in *Acanthaster planci* (Echinodermata; Asteroidea), *Bulletin of Marine Science* 41:541–551

Pratchett, M. S., Caballes, C. F., Rivera-Posada, J. A. and Sweatman, H. P. A. (2014). Limits to understanding and managing outbreaks of Crown-of-thorns starfish (*Acanthaster* spp.). *Oceanography and Marine Biology: An Annual Review*, 52, 133-200.

Pratchett, M. S., Caballes, C. F., Wilmes, J. C., Matthews, S., Mellin, C., Sweatman, H. P. A., Nadler, L. E., Brodie, J., Thompson, C. A., Hoey, J., Bos, A. R., Byrne, M., Messmer, V., Fortnato, S. A. V., Chen, C. C. M., Buck, A. C. E., Babcock, R. C. and Uthicke, S. (2017). Thirty Years of Research on Crown-of-Thorns Starfish (1986-2016): Scientific Advances and Emerging Opportunities. *Diversity,* 9, 41.