VANUATU CROWN-OF-THORNS STARFISH CONTROL PROJECT REPORT

January – July 2020

Grant period: 1 February – 30 June 2020

SAILAWAY CRUISES

Big Blue

Pacific C2O
Coasts | Climate | Oceans

WATERSPORTS NAUTILUS VANUATU

Tranquility Island Resort
Eco-Tourism, Scuba Diving & Turtle Sanctuary

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This report covering activities and achievements of the Vanuatu COTS Control project for the period 1 January 2020– 31 July 2020 has been collaboratively produced by C_2O Pacific (Johanna Johnson and David Welch) and the Vanuatu Scuba Operators Association (Christina Shaw and Peter Whitelaw) for the New Zealand Ministry of Foreign Affairs. The project team acknowledges the New Zealand Ministry of Foreign Affairs for providing funding for the project from 1 February 2020 – 30 June 2020 under their community grants scheme.

Executive Summary

Controlling crown-of-thorns starfish (COTS) outbreaks in Vanuatu has historically been a voluntary activity, however, in 2020, the New Zealand Ministry of Foreign Affairs provided funding to the Vanuatu Scuba Operators Association for this short-term control project. The project aimed to protect coral on high-value tourist reefs in Vanuatu, particularly around Efate Island, from coral damage caused by COTS predation. The project was in collaboration with the Vanuatu Department of Tourism and community networks and volunteers.

This report summarises delivery of the COTS Control project by the Vanuatu Scuba Operators Association (VSOA) during the period 1 January 2020 – 31 July 2020, including the grant funding period of 1 February – 30 June (with a one-month no-cost extension for June), and in-kind activities by operators in January and July.

During the reporting period, five VSOA groups were involved in COTS control activities – Big Blue Scuba, Nautilus Watersports, Sailaway Cruises, Tranquillity Eco-Resort, Hideaway Island Resort – mainly focused on culling or removal on target reefs around Efate Island.

The operators with their crews and volunteers conducted 62 voyages or day-trips during this reporting period. These voyages represent a total of 62 days of COTS control activities around Efate and surrounding islands and a total of 102 dives (or 85 hours of diving) conducting culling, removal and some surveillance. A total of 5,626 COTS (4,305 COTS during the grant period) were culled or removed from 18 reef sites, mostly located on the southwest coast of Efate.

The latest available surveillance and culling information from all project activities indicate that COTS densities remain highest in the southwest of Efate Island, and that outbreak numbers have reduced on the west and northwest coasts, particularly in Havannah Harbour and around Lelepa and Moso islands. However, movement of COTS from Mele Bay to the northwest around Pangona Point has been observed in previous outbreaks and may threaten the UNESCO World Heritage listed reefs around Artoka Island (also known as Eretoka or Hat) in Chief Roi Mata's Domain. Ongoing surveillance is therefore needed as an early warning, and COTS control activities should continue on the southwest coast of Efate, particularly in Mele Bay and Pango Peninsula, to reduce the COTS population prior to spawning season in October/November 2020.

A more strategic and coordinated approach to COTS control and surveillance would greatly benefit protection of high-value tourism reefs, including the UNESCO listed World Heritage site, and coastal reefs important for community fishing and subsistence. It is recommended that funding is sourced to develop such a strategic approach in collaboration with the Vanuatu Department of Tourism.

Introduction

COTS are a marine starfish species that are naturally occurring on coral reefs and adults feed on hard coral tissue. Their ecological role on reefs is to control fast-growing corals (such as branching Acropora) so slower growing corals (like massive Porites) can compete for space. However, when their populations explode as seen in the current outbreak, they eat too much coral and can damage large areas of reef. Most of what is known about COTS comes from research on Australia's Great Barrier Reef (GBR) where outbreaks are known to have occurred as early as the 1930's, however evidence shows that outbreaks are now occurring more frequently. On the GBR, outbreaks are thought to originate in the northern section when favourable environmental conditions allow very high survival and recruitment of larval and juvenile COTS. This is thought to be correlated to very high phytoplankton (food for larvae) blooms at the time of spawning brought on by land-based runoff of nutrients during high rain periods and/or upwelling from the deep ocean. Other theories of why outbreaks occur are that natural predators of COTS (e.g. trumpet triton, wrasse and triggerfish) have been depleted, or that it is natural for animals like COTS (high fecundity, fast regeneration times) to have highly variable population sizes (Brodie et al. 2005, Fabricius 2010). It is likely that all three theories play a role in outbreaks, depending on the time and place (Pratchett et al. 2017).

Once an outbreak occurs, very high numbers of adults can then produce thousands of larvae and juveniles (recruits) in each annual spawning, thereby perpetuating the outbreak. Ocean currents then spread the larvae, and the outbreak, across open ocean areas to nearby reefs, as well as anecdotal evidence that adults can move large distances in deep water (up to 300 m) between reefs. Because they feed on corals, large numbers of COTS can have a devastating impact on coral reefs by damaging large areas of hard coral (Osborne et al. 2011). This can have significant impacts on reef-based tourim and fishing for reef resources due to the degradation of popular dive sites and reductions in reef species that rely on live coral for habitat (e.g. Jones et al. 2004, Paddack et al. 2009). Research and monitoring over the past 35 years on the Great Barrier Reef suggests that the impact of COTS on coral reefs is greater than coral bleaching or cyclones (De'ath et al. 2012). Collectively, these stressors can greatly reduce the resilience of reefs to resist pressures or recover from other impacts. Recovery from a COTS outbreak can take 10-20 years, however if other impacts, such as thermal bleaching or cyclones also occur, this would take longer.

In Vanuatu, documented reports of COTS observations were as early as 1989-90 (Done and Navin 1990), with outbreak densities (commonly recognised as >15 COTS per hectare; Pratchett et al. 2014) reported in 2004 (Espiritu Santo), 2006–2009 (Efate and surrounding islands of Moso, Emao, Nguna and Pele) with peak densities recorded in 2008 (e.g. 4,000/ha on Emao Island), and in 2012–2014 (Efate and surrounding islands of Moso, Emao, Nguna and Pele). Patterns of coral cover in north Efate indicates previous COTS impacts from the 2006–2009 and 2012–2014 outbreaks, with highly impacted reefs continuing to have low coral cover (5-12%) and slow recovery (e.g. near Emua and Siviri; Johnson et al. 2016, Johnson et al. in prep). Reefs that weren't impacted by COTS had high coral cover (e.g. Lelepa Island 30-70%; Johnson et al. 2018), which is above the Pacific regional average of 25-29% (Moritz et al. 2018).

COTS outbreaks have continued to be observed on different islands throughout the Vanuatu archipelago, including Espiritu Santo, Aore, Malekula and Aniwa (Figure 1).

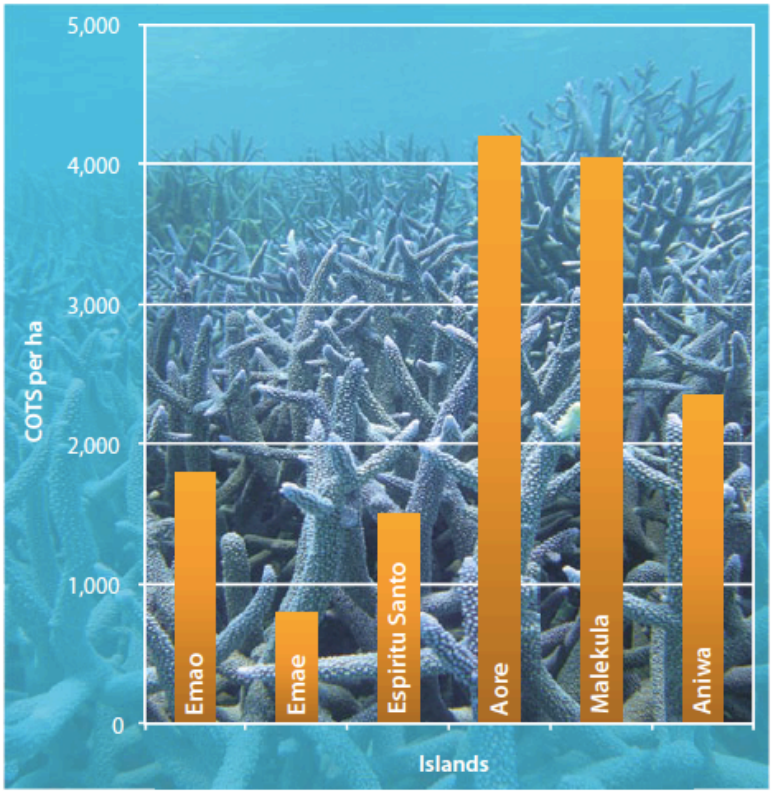

Figure 1. *Peak densities of COTS recorded by underwater surveys in 2014 (N.B.>15/ha is considered an outbreak population, Pratchett et al. 2014) (Source: Dumas et al. 2015).*

Around Efate Island, there was only four years between outbreaks of COTS, and the current outbreak appears to have started in Vila Harbour in 2017 and moved northeast to Havannah Harbour in North Efate in 2018 and 2019. Over the past 2–3 years, the Vanuatu Scuba Operators Association (VSOA) with the support of C_2O Pacific and community volunteers have been actively locating and culling COTS (local name *posen sta*) at important tourism sites around Efate and surrounding islands of Moso, Lelepa, Emao, Nguna and Pele.

COTS spawn when water temperatures reach around 28 ºC. Around Efate Island, that is during October/November each year. Therefore, the critical months for control are in June to September to reduce the population size before spawning. This will limit the next wave of recruits from the spawning event.

COTS control strategy in Vanuatu

The issue of COTS outbreaks is therefore not new to Vanuatu, and from 2003–2011 the Vanuatu Fisheries Department with the French Research Institute Development (IRD) conducted a COTS awareness campaign with communities and the general public. This was part of their initiative to use the community to detect and report early signs of COTS outbreaks, and in some cases, conduct removal activities (Dumas et al. 2014, 2020). Under

this initiative, 3.7 tonnes of COTS were removed from just one fringing reef by local snorkelers during a nine-day community activity on Santo in 2013.

In addition, trials were conducted on the efficacy of different types of injection methods using different liquids. It was determined that lime juice (10 ml) is lethal in 89% COTS after 34 hours, white vinegar (10 ml) is lethal in 97% COTS after 29 hours, and double shots (20 ml) of either is 100% lethal after 24 hrs (Dumas et al. 2015). Bile salts (10 ml; extracted from ox livers) is 100% lethal almost immediately after injecting. As a result, white vinegar is mostly commonly used at 2 x 10 ml, with extra shots for large COTS.

At the same time, a 'citizen science' App and online form was developed for communities to report COTS sightings or control activities, which was particularly important in remote and regional locations where centralised coordination isn't possible. Three-levels of classification were developed to discriminate risk areas and propose targeting management responses (low – no response, medium – confirmed outbreak, high – control starts).

While these initiatives are a step in the right direction, in practice, COTS sightings are rarely reported, and the data are not analysed or used to inform control activities. For example, during the current outbreak, culling to control the outbreak has been mostly by local residents and community members, in partnership with VSOA, on a voluntary basis without any access to the early warning data, and few of these control activities have been reported.

This considerable effort by VSOA members and dedicated locals to cull COTS around Efate Island and to a lesser degree Santo Island, managed to remove or inject 30,357 starfish in 2018 and 2019, mostly in Havannah Harbour and offshore Pango Peninsula.

Therefore, the current control strategy relies on the dedication and considerable effort by VSOA members and local volunteers to cull or remove COTS without any guidance on where the COTS aggregations are located and the most effective sites to target. As a consequence, despite these efforts, large numbers of COTS remained in late 2019 as they moved along reefs and between deep and shallow zones. In late 2019, hundreds were found offshore Lelepa Island with many stacked on top of each other. Efforts to reduce their numbers have resulted in thousands being removed however more remain and a more strategic and coordinated effort is needed.

Project objectives and method

Historically, COTS control in Vanuatu has been fully voluntary, however, this project represents recent support from the New Zealand Ministry of Foreign Affairs (MFAT) who funded control activities from February to June 2020 supplemented by in-kind activities from VSOA members in January and July.

The primary objective of the project was for VSOA members with local volunteers ***to conduct coordinated COTS control activities to target high density COTS aggregations and protect coral on high-value tourist reefs around Efate Island***.

During the current outbreak, culling to control the outbreak has been by bagging and removal and/or injection with lemon juice or vinegar, or ox bile when available (Figure 2). Many locals in the area have also been actively culling or removing COTS, mostly local residents and community members, in partnership with VSOA.

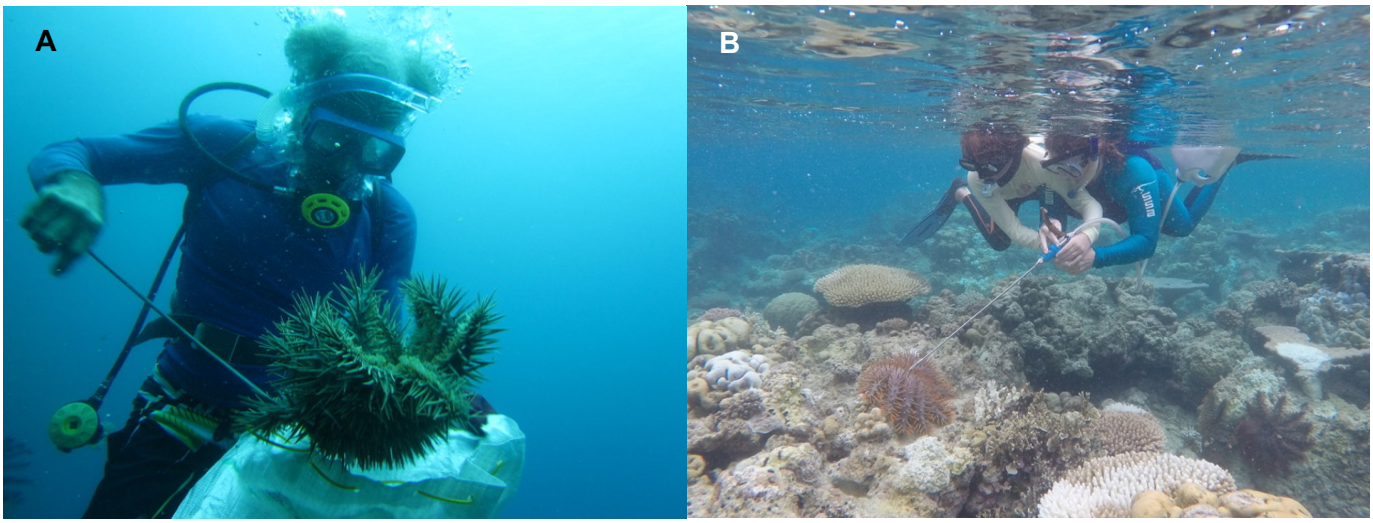

Figure 2. *Control methods used in Vanuatu to control COTS include: (A) bag and removal, and (B) injection with vinegar or bile salt. Photo credits Peter Whitelaw (A), David Welch (B).*

The project was jointly implemented by the VSOA, C_2O Pacific and local volunteers with the support of the Vanuatu Department of Tourism. An initial stakeholder meeting reviewed the current state of knowledge regarding the COTS outbreak, mapped control efforts in 2018-2019 to determine the key areas for control activities in 2020, and agreed on the control techniques, in particular, injection and bag and removal, depending on the circumstances.

Culling used application kits with a reservoir where 20 ml of either vinegar or lime juice is injected between the arms of each starfish. While the most efficient culling method is the 10 ml single-shot bile salts, it is costly and difficult to import, so was only used where available and feasible. An alternative method, which is the least efficient but most practical for Vanuatu communities, is manual removal by hand. The starfish are bagged and dried out before disposal, and communities either bury them or have tried using them as garden fertiliser.

Project results

The project period coincided with the global COVID-19 pandemic, which severely impacted the tourism industry in Vanuatu and therefore limited the capacity of the local dive industry. Despite this, five VSOA members – Big Blue Scuba, Sailaway Cruises, Nautilus Watersports, Tranquillity Eco-Resort, Hideaway Island Resort – were involved in culling COTS and conducting some surveillance activities. COTS control activities mainly focused on culling or removal at target reefs on the west and south coasts of Efate Island between Havannah Harbour to the northwest and Iriwiti Lep Island on the southern coast (Figure 3).

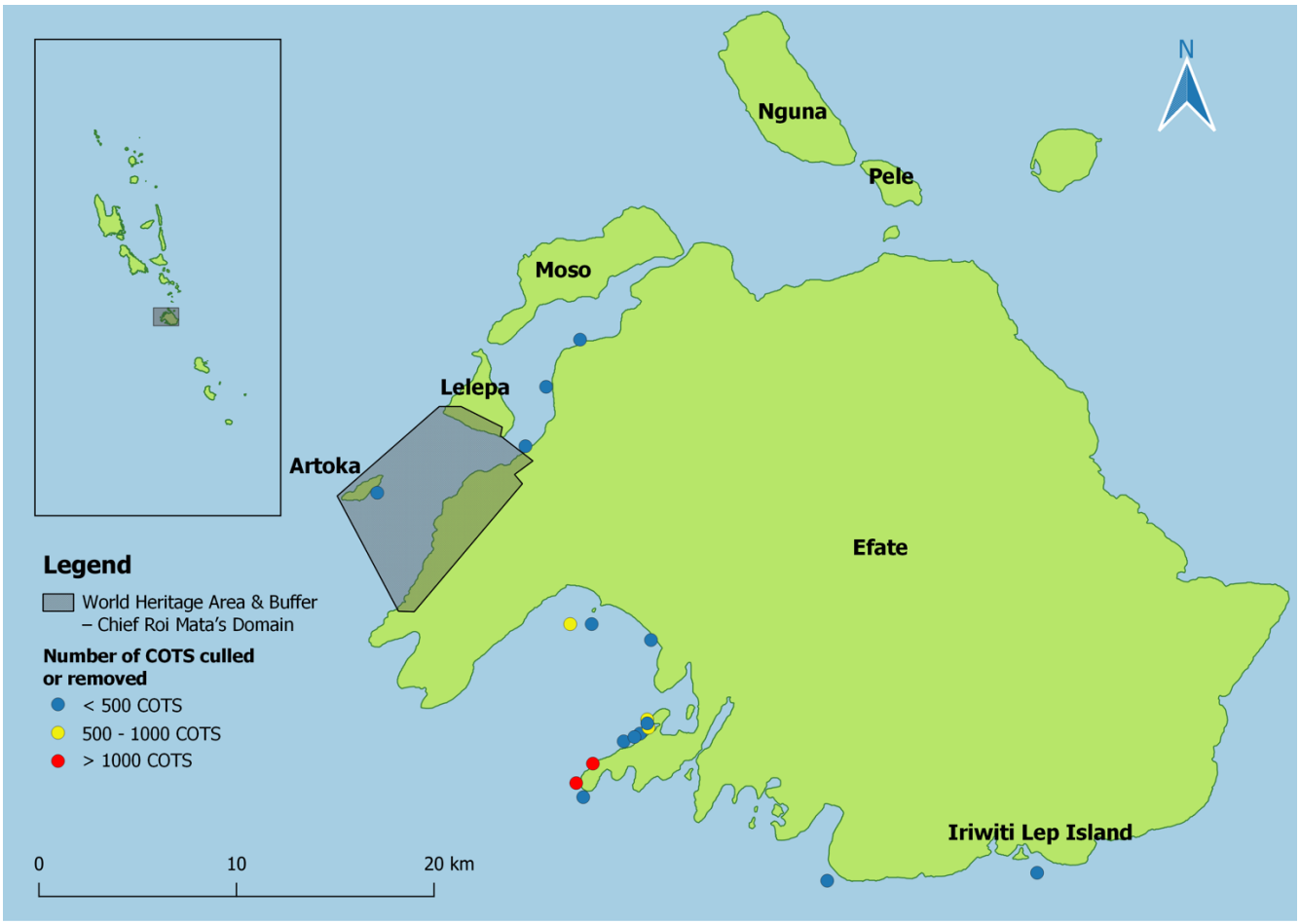

Figure 3. *Map of COTS control activities from January–July 2020 around Efate, including summary numbers of COTS culled or removed (Data source: VSOA and C_2O Pacific).*

Most control activities in 2020 were undertaken by three operators with their crews and volunteers – Big Blue Scuba, Nautilus Watersports and Sailaway Cruises – who conducted 62 voyages or day-trips between January and July 2020. With borders closed and the absence of tourists, one dive operator, Big Blue Scuba, was able to increase control activities from April to June, and accounted for 70% of all voyages and 87% of all COTS culled or removed.

All voyages around Efate and surrounding islands totalled 102 dives (85 dive hours) conducting culling, removal and some surveillance. A total of 5,626 COTS were culled or removed from 18 reef sites, mostly located on the southwest coast of Efate Island (Figure 3). The grant funding covered the period from 1 February to 30 June 2020 when 4,305 COTS were culled, with activities in January and July being in-kind. Control activities were hampered by the pandemic restrictions from March to April 2020, as the monthly breakdown demonstrates (Table 1). When restrictions were lifted in late April, and with limited tourists visiting Vanuatu, control activities increased from May. A no-cost extension allowed for further control voyages in June. Notably, funding substantially increased the number of COTS culled, with February, May and June recorded the highest numbers, while January and July were lower (March and April not considered due to pandemic restrictions).

Table 1. *Summary of COTS control activities for current outbreak, 2017–2020 (N.B. table only includes reported data and not all community-based activities).*

	2020						
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**
Number of COTS culled	777	1,331	316	629	996	1,033	544
Number of sites visited	7	9	4	5	9	7	4
Number of days	10	11	6	6	10	13	6

As a result of the continued COTS control efforts of the VSOA and local volunteers, surveillance is no longer recording large numbers of COTS in Havannah Harbour in north Efate. While surveillance indicates there are still some individuals within Havannah Harbour, COTS are no longer found in large numbers moving southward from Nguna and Pele islands as was observed in previous outbreaks.

Larger COTS have appeared on Lelepa Island, adjacent to the mainland and more recently at Artoka Island, however, it is likely that they are a different generation from the ones which were culled inside Havannah Harbour in 2018–2019. Although thousands of COTS have been culled over the past 3 years, a large aggregation is still moving towards Mangaliliu on the mainland, where healthy corals are present. Ongoing surveillance is needed to specifically locate this moving aggregation of COTS, that are likely seeking healthy coral reefs using chemical cues.

Surveillance has also observed a new cohort of small COTS on the reefs in Mele Bay, including reefs around Hideaway Island and at tourism dive sites further offshore. Previous healthy reefs have large numbers of small COTS, which arrived at the beginning of 2020. In particular, large numbers of small COTS recruits have been observed on reefs around Hideaway Island as well as on reefs further offshore, particularly Westside and Eastside reefs, which have high coral cover. This is of significant concern as these smaller COTS are starting to impact on corals at these sites, which are healthy and important tourism sites.

Surveillance divers have observed COTS-scarring on corals in Mele Bay and noted that COTS from the Hideaway Island area have moved northwest past Devils Point in the last couple of months, *en route* to Pangona and Tukutuku Point. This northeast movement was also observed in previous outbreaks. Surveillance at Tukutuku Point indicates that they had not arrived there as of June 2020, but it is expected that they will arrive later in the year, perhaps for spawning season.

The Mangaliliu– Artoka Island area of the UNESCO World Heritage site (within Chief Roi Mata's Domain) could shortly be the centre of COTS movement from Mele Bay (moving northeast past Tukutuku) and from Lelepa/ Havannah Harbour (moving southwest). Therefore, continued surveillance around Artoka Island is essential to detect increasing COTS numbers early and respond with active culling to avoid significant coral damage in this World Heritage site, as occurred in the 2012–2014 outbreak.

Budget expenditure

The grant received from New Zealand MFAT for the project was 800,000 vatu, to cover operational expenses of COTS control and surveillance between 1 February and 31 May (extended to 30 June) 2020. The project budget was supplemented by a further 800,000 vatu in-kind contribution by VSOA members and C_2O Pacific team that covered the period from January – July 2020.

Conclusions

The Vanuatu Scuba Operators Association (VSOA) in partnership with C_2O Pacific and local volunteers conducted intense COTS culling activities from January to July 2020 through on-water voyages and land-based activities on Efate Island. The availability of funding from MFAT increased the effectiveness of control, with substantially more COTS culled or removed during the grant period. This is the third year that the current COTS outbreak has been present, and represents the most coordinated and focused effort to date. The VSOA and partners are strongly supportive of efforts to ensure that the COTS culling continues and is as efficient and effective as possible, targeting high-value sites with high densities of COTS. The project team has worked steadily to improve surveillance, data recording and management, communication between operators, and on-water procedures. This project also represents a new era of COTS detection and data reporting, which should continue.

The area of COTS control activities in 2020 focused on the western and southern coasts of Efate Island, and associated nearby islands, with greatest COTS numbers observed on the southwestern coast, around Pango Peninsula. The density of COTS has shifted from northwest Efate, and demonstrates that COTS are highly mobile. More recently, significant numbers of COTS are appearing in Mele Bay and the Hideaway Island area that will require further surveillance and control. Previous experience indicates that aggregations will continue to move, and may threaten high-value coral reefs around the UNESCO World Heritage site at Artoka Island, as well as other important tourism sites. Considering the significant damage that COTS aggregations can cause on coral reefs, and the fact that numbers need to be further reduced before the October/November spawning season, continued culling efforts are essential.

The Efate marine tourism industry is valuable from an economic and livelihoods perspective, and COTS predation of coral reefs is one of the greatest pressures on reefs, along with thermally-driven coral bleaching and cyclone damage. While tropical cyclone Pam damaged reefs in 2015, and a minor bleaching event occurred around Efate Island in 2016, recovery has steadily improved, and there have not been any subsequent significant disturbances since and surviving corals appear generally healthy. This means that COTS outbreaks have been the likely major threat to coral reefs around Efate (and potentially other islands in Vanuatu) during this reporting period, and represents the greatest current threat.

Of the 18 reef sites visited during this reporting period, many remain in a relatively healthy condition, with moderate to high hard coral cover. However, in areas where the COTS outbreak has been the most severe over the past two years, such as Havannah Harbour and the Pango Peninsula, coral cover has been severely impacted at some sites. More recently, areas of Mele Bay are experiencing similar increases in COTS and notable impacts to live

coral cover. For example, reefs at Black Sands Cave had healthy live hard coral in early 2019 however this had significantly declined to almost no live hard coral when visited in May 2020. The impacts on reef habitat in just one year have had flow-on effects to fish populations, with parrotfish and butterflyfish also absent (C. Shaw pers comm).

While the current outbreak continues, and its duration remains uncertain, further surveillance and culling is critical, particularly at key sites with high densities of COTS. Some specific recommendations for future COTS control in Vanuatu are outlined below.

Future recommendations

1. Continue COTS culling:

While the MFAT-funded project has been a success, control efforts will need to continue for at least another year to minimise the extent of coral damage from this current outbreak. This will be particularly important on reefs with international values, such as the UNESCO World Heritage site around Artoka (Hat) Island, and reefs that support the tourism industry in Mele Bay and Pango Peninsula. Continued culling efforts over the next 6-months is also important to reduce COTS populations before the next spawning season in October/November 2020. Efate has historically had healthy reefs with surveys by C_2O Pacific and NOAA coral expert Doug Fenner in Havannah Harbour showing some of the highest live hard coral cover in the Pacific (Johnson et al. 2018), and many reefs have been identified as national special and/or unique marine areas (Ceccarelli et al. 2018). Already, the impacts of COTS are evident with large areas of dead coral at Emua, Siviri, Pango Peninsula and Black Sands Caves. These dead reefs are being overgrown by macroalgae (seaweed), which, unless controlled by herbivore species (fish and shellfish), will further limit space for new coral recruits and slow the recovery of reefs.

2. Continue COTS surveillance:

Removing all COTS is not possible and as they are a natural part of the ecosystem, not advisable. However, as continued cycles of COTS outbreaks are expected in the future, it is important to maintain surveillance and early warning systems, and respond quickly with culling and removal activities as soon as numbers increase, so that the population and breeding rate remain under critical thresholds. Importantly, strategic surveillance can provide an early warning of COTS outbreaks and moving aggregations before they significantly damage healthy coral reefs at important tourism sites and in the World Heritage area.

3. Develop a Strategic Response Plan:

While continued control efforts over the next year will be critical, coordination of culling efforts to have a meaningful impact on COTS numbers at the highest density sites is the challenge. The Vanuatu Fisheries Department online system to report COTS in Vanuatu[1] is an existing mechanism that can help to mobilise efforts to control COTS numbers in the areas with the highest density. This is dependent on the timely sharing and reporting of these data. With increased public awareness of the COTS issue and the reporting system, these data can be extremely powerful if used in conjunction with a coordinated and strategic

[1] https://www.nab.vu/sites/default/files/nab/cots_monitoring_flyer_0.pdf, https://fisheries.gov.vu/index.php/crowns-of-thorns.

response plan. Currently this is lacking, and a future strategy to report COTS outbreaks and mobilise coordinated effort should be developed in partnership with the Vanuatu Department of Tourism, the Vanuatu Fisheries Department, the VSOA and other relevant community networks, such as the VanuaTai Resource Network. Similar to recent efforts to control the Coconut Rhinoceros beetle, such a strategic approach brings industry and government together to coordinate control activities, track outbreak movements and target culling activities at sites that have the highest density of COTS and are valuable in terms of international recognition, tourism livelihoods and/or community subsistence.

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