Assesment of marine ecosystem health, Tanna Island, Vanuatu

Technical Report · March 2017

2 authors, including:

Tyson Martin
Department of Agriculture and Fisheries

Coastal habitat assessment: Tanna Island, Vanuatu, 2016

Local fisher operating dugout canoe to assist with marine surveys

Prepared for:

Ecological and Social Resilience Adaptation and Mapping project (ESRAM)

Prepared by:

Tyson S.H. Martin, Rod M. Connolly

Griffith University

Gold Coast, QLD, 4222

Background to this assessment

The coastline surrounding Tanna Island is comprised predominantly of coral reefs, but also features small patches of sandy beaches, seagrass beds and mangroves. These coastal habitats provide important resources for the local community. These resources include fish, shellfish and algae (seaweeds) for food, and sand and coral for building.

Due to the rapidly increasing local population, and global changes in climate and thus weather patterns, the coastal habitats surrounding Tanna may be threatened in the near future. Increasing fishing pressure, rising water temperatures and decreased water quality as a result of changing land-uses in catchments could adversely affect fish and corals of the island.

Resilience is the capacity of an ecosystem to resist or recover from a disturbance (Folke et al. 2004). Resilient habitats are likely to cope better with, and recover faster from, impacts such as overfishing, altered weather regimes and excess nutrient input (Nystrom et al. 2000). Resilience of coastal habitats can be increase by, for example, protecting herbivorous fish, which maintains rates of algal consumption on coral reefs. This grazing capacity enhances the resilience of reefs to increased nutrients and turbidity caused by logging, or bleaching of corals caused by increased water temperature (Hughes et al. 2007). Another example is planting or preserving coastal mangroves, which decreases wave action, protecting ecosystems and coastal infrastructure during storm surges (Guannel et al. 2016).

Adapting to these forecasted impacts on the coastal environment is critical for Tanna Island. Its population is largely self-sufficient and will continue to rely on the coastal environment for sustenance into the future. This project aims to assess the health of coastal habitats surrounding Tanna Island, and identifies methods for increasing their resilience, so that they continue to provide for the local community into the future.

This report outlines the current state of coral reef, mangrove and seagrass ecosystems on Tanna Island.

Methods

Coral reefs

We surveyed assemblages of coral reef fish in November of 2016 at three sites of varying levels of human disturbance around Tanna Island (Figure 1, Table 1). We conducted four replicate Underwater Visual Censuses (UVC) at each site to characterise fish communities (Hill & Wilkinson 2004). Each replicate consisted of a 50 m x 4 m belt transect with a minimum separation of 50 m between each transect. Transects were positioned at 3 m below the Lowest Astronomical Tide, and surveyed by the same diver (Martin et al. 2015). All fish >5 cm total length were recorded, identified to species, and their sizes estimated. We also performed qualitative visual inspections of deeper areas and recorded the presence of larger, more timid species not captured by the shallow censuses. Benthic coverage of the substrate at each site was quantified using four 30 m line intercept transects (LIT) (Hill & Wilkinson 2004). Transects were the same as those used to perform fish censuses. The type of substrate below the tape was recorded at 50 cm interval along transects. Substrate types recorded were: crustose coralline algae, turf algae, macroalgae, hard coral (growth form also recorded, i.e. foliose, branching, encrusting massive, tabulate), soft coral, recently killed coral, bleached coral, rubble, rock and sand. Both coral and fish transects were recorded using go-pro cameras to support field identifications of fish and corals.

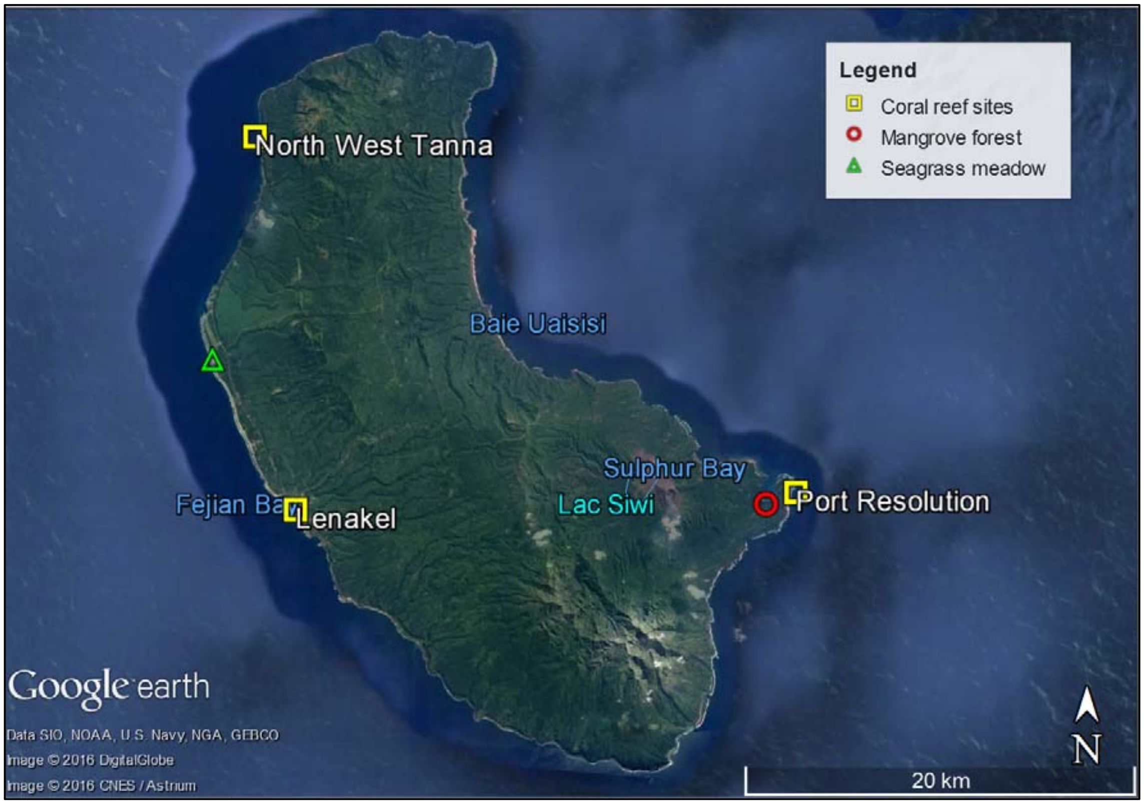

Figure 1: Site locations for marine surveys, Tanna Island.

Table 1: Summary descriptions of reef sites and levels of human impact. Note that the description of 'High' impact at Lenakel is in the context of overall relatively low impacts around the island.

Site	Description	Human disturbance
North West Tanna	Located on north-west side of Tanna near Whitegrass and Evergreen resorts. Relatively isolated from villages and access points. Steep reef edge dropping from 0.5 m down to approximately 10 m. Then patchy reef flat gradually lowering down to 25 m plus.	Low
Port Resolution	Easternmost point of Tanna Island. Located offshore from the Port Resolution bay and village which is home to a small local fishing population with beach access in calm weather. This site was located on the exposed ocean-side of the reef. Gentle reef slope ranging from 1 m deep on reef crest down to 15 m plus.	Medium
Lenakel	South-west side of Tanna adjacent to the main town (Lenakel) and harbour. Highest population of fishers on the island with beach access in most conditions. Similar reef configuration to North West Tanna with a steep reef edge ranging from 0.5 m down to 6 m with patchy reef flats and bommies in between.	High

Mangroves forest and seagrass beds

We visually checked for the presence of mangrove and seagrasses along the coastline near to the three reef sites, and within the constraints of access visually assessed their extent and health.

Fishing and market observations

We also visited local markets to assess the type of fish captured and methods used by local fisherman. Observations were recorded using photographs and notes.

Data analysis

We performed simple exploratory data analysis to characterise fish and benthic communities at each of the three sites.

Results

Coral Reefs

We recorded 69 species of fish across all three reef sites. Surveys revealed that fish were more abundant at North West Tanna compared to both Port Resolution and Lenakel (Figure 2). Diversity of fish species was also high at North West Tanna, with 36 species recorded compared to only 28 at Port Resolution and Lenakel (species list in Appendix S1). At both the North West Tanna and Port Resolution sites, large predators were recorded in the qualitative visual inspections performed on deeper sections of reefs. These larger bodies fish and predators were observed less frequently at Lenakel.

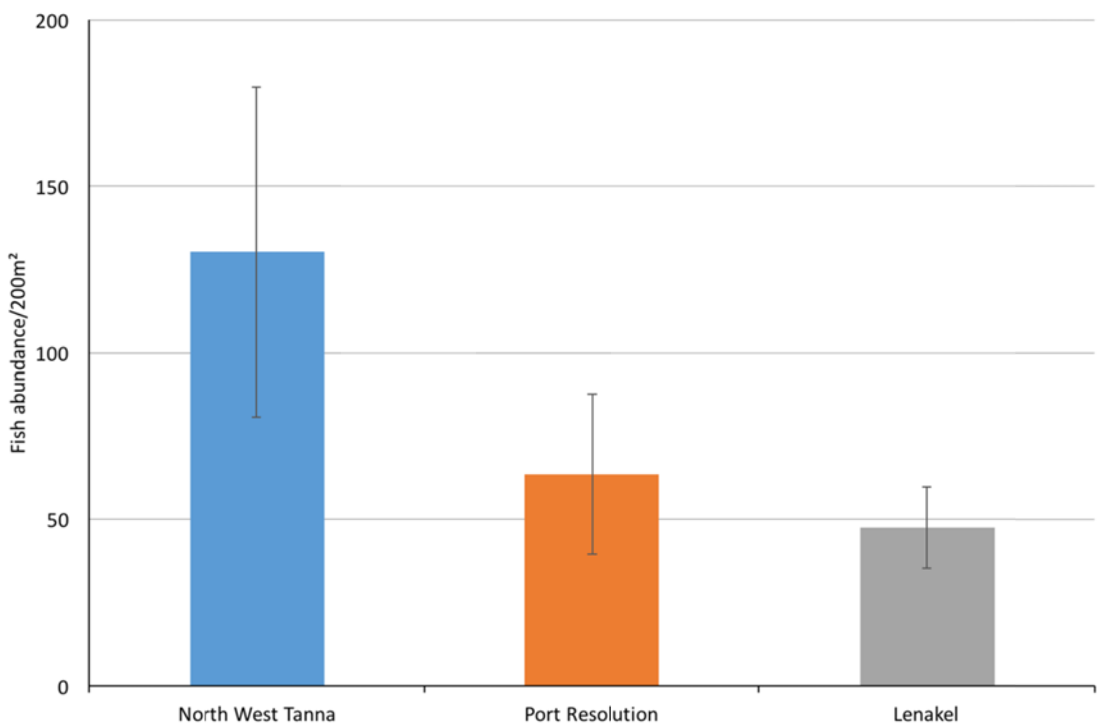

Figure 2: Fish abundance (mean, SE) at Tanna Island survey sites: North West Tanna (unimpacted); Port Resolution (medium impact); and Lenakel (high impact).

Coral cover was lowest at North West Tanna and highest at the impacted Lenakel site (Figure 3). Lenakel had the highest proportion of macroalgae and lowest coverage of crustose coralline algae (important in reef-building), opposite to North West Tanna. Port Resolution was intermediate in almost all categories.

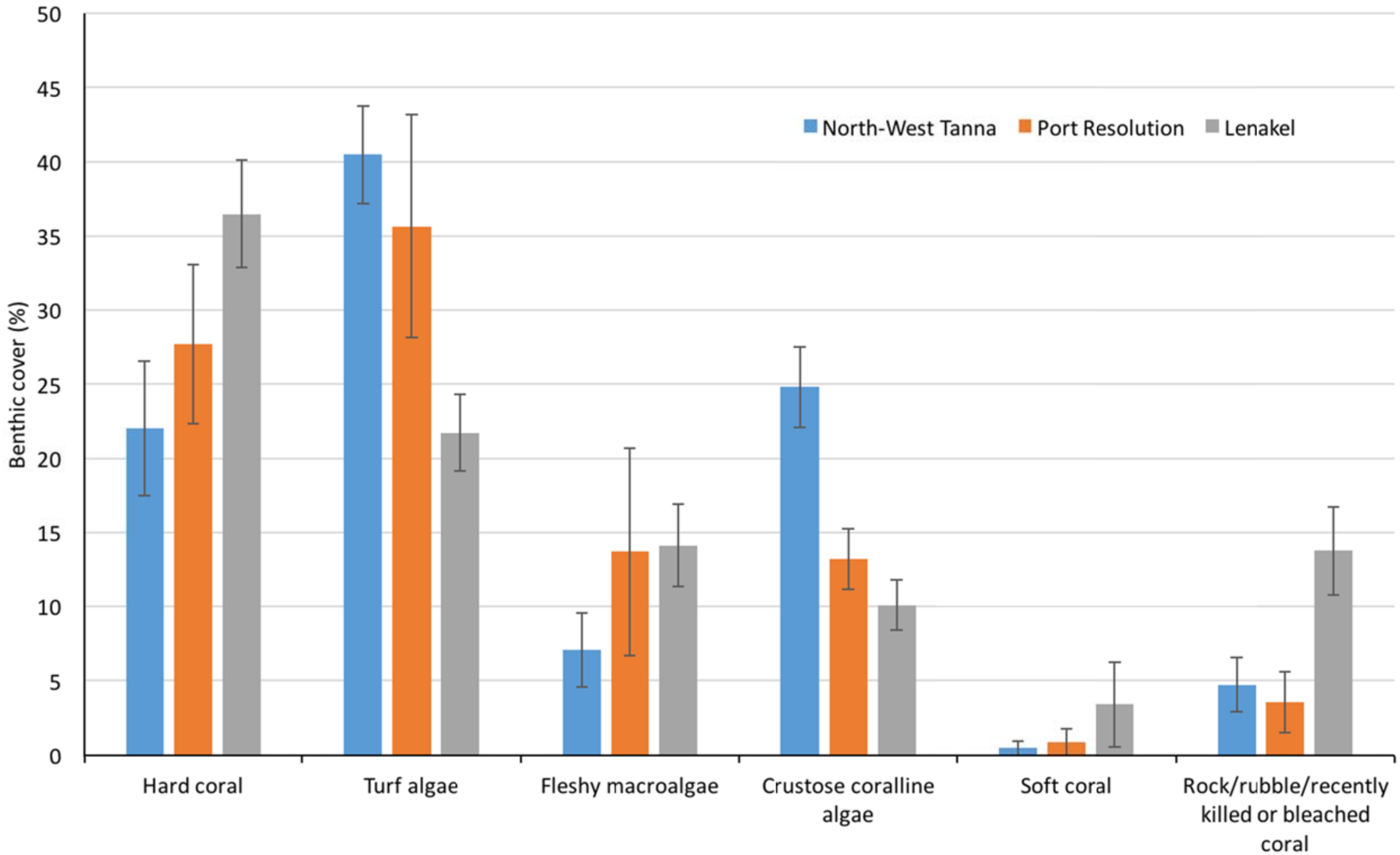

Figure 3: Benthic composition (mean, SE) at Tanna Island survey sites: North West Tanna (unimpacted); Port Resolution (medium impact); and Lenakel (high impact).

Mangrove forests and seagrass meadows

Mangrove forests and seagrass beds were found at one location each at the sites visited. Mangroves were found at Port Resolution, in the wetland backing the creek that flows into the southern side of the bay (Figure 4). The survey team could not gain direct access to the forest during this survey trip and have therefore not identified species or estimated areal cover. A seagrass meadow was recorded on the west coast near Imanaka village, located in a shallow reef pool with a sandy bottom. Seagrass grows here between small coral bommies (Figure 5). Areal extent was estimated at 3,000 m^2 and the meadow is composed entirely of the species *Thalassia hemprichii*.

Figure 4. Mangrove forest at Port Resolution - fringing stand on far side of wetland, which is backing the open coastal waters of the Port.

Figure 5: Seagrass (*Thalassia hemprichii*) growing between corals near Imanaka village.

Fishing and market observations

Locals fish around the Tanna coastline using dugout canoes (see cover image, title page). Gear used includes hook and line, synthetic nets and spearguns. At the local fish markets, fish of many species (and functional feeding groups) are traded, including both predatory and herbivorous species (Figure 6). This indicates that locals are not heavily targeting any one species or functional group in particular, and are instead capturing and selling whatever is easily captured at the time.

Figure 6: Fish for sale at local market in Lenakel. Note the variety of fish families present, including: parrotfish, surgeonfish, barracudas, trevallies and emperors.

Implications

Our preliminary findings indicate that the coral reefs of Tanna are generally in reasonable health. There is, however, a distinct gradient of fishing impacts across the three sites surveyed. Lenakel, the area of reef were the level of human disturbance was predicted to be highest, supported fewer species of fish, lower overall fish abundance, and low levels of crustose coralline algae which is essential for healthy reef building. North West Tanna had the highest fish abundance and most diverse fish assemblages, as well as high levels of crustose coralline algae, indicating this area of reef is relatively undisturbed. Port Resolution was intermediate in most categories, indicating moderate levels of human disturbance, across the rather narrow range of the impacts on Tanna Island. Given the population growth forecast for Tanna Island, it is important to conserve reefs and prevent any further degradation. One important consideration could be the strengthening of application of local customs that already include conservation measures such as avoiding harvesting seasonally (November to April) or in designated areas. The introduction of conventional fisheries restrictions such as size and bag limits is another possible conservation measure.

Coral cover was relatively high across all three sites. The low levels of crustose coralline algae at Lenakel mean that, despite its high coral cover, it is mostly likely the least resilient of the three sites. If the existing corals were to be damaged, the lack of crustose coralline algae means that the recolonization of corals may be low in this area. Herbivorous parrotfish increase the resilience of reefs via the consumption of algae that competes with corals for light and space (Hughes et al. 2007) (Figure 7). We noticed that on Tanna Island, important herbivores such as parrotfish are speared at night time while they are resting in caves and holes. This practise is highly effective at removing parrotfish from reefs and, as such, may result in decreased resilience of coral reefs (Lindfield et al. 2014). It will be important to control this particular type of fishing in future.

Figure 7: Parrotfish are important grazers, they consume algae and promote coral recruitment and growth. Night-time spearfishing for parrotfish on Tanna needs to be carefully managed. Photo by Maria Beger on Ailuk Atoll, Republic of the Marshall Islands.

Mangrove and seagrass habitats are present on Tanna. The areas documented so far are small, but in a local context are likely to provide critical ecosystem functions including nurseries and food for animals (Dorenbosch et al. 2005), shoreline stabilisation, and carbon storage (McLeod et al. 2011, Fourqurean et al. 2012). We consider the ongoing protection and maintenance of these habitats to be an important part of management of Tanna's coastal resources.

The initial findings support ongoing consultation with local communities to identify vulnerable sites amenable to ecosystem-based adaptation works.

References

Dorenbosch M, Grol MGG, Christianen MJA, Nagelkerken I, van der Velde G (2005) Indo-Pacific seagrass beds and mangroves contribute to fish density coral and diversity on adjacent reefs. Mar Ecol Prog Ser 302:63-76

Folke C, Carpenter S, Walker B, Scheffer M, Elmqvist T, Gunderson L, Holling CS (2004) Regime Shifts, Resilience, and Biodiversity in Ecosystem Management. Annu Rev Ecol Evol Syst 35:557-581

Fourqurean JW, Duarte CM, Kennedy H, Marba N, Holmer M, Mateo MA, Apostolaki ET, Kendrick GA, Krause-Jensen D, McGlathery KJ, Serrano O (2012) Seagrass ecosystems as a globally significant carbon stock. Nature Geosci 5:505-509

Guannel G, Arkema K, Ruggiero P, Verutes G (2016) The Power of Three: Coral Reefs, Seagrasses and Mangroves Protect Coastal Regions and Increase Their Resilience. PLoS ONE 11:e0158094

Hill J, Wilkinson C (2004) Methods for ecological monitoring of coral reefs. Book 1. Australian Institute of Marine Science, Townsville

Hughes TP, Rodrigues MJ, Bellwood DR, Ceccarelli D, Hoegh-Guldberg O, McCook L, Moltschaniwskyj N, Pratchett MS, Steneck RS, Willis B (2007) Phase shifts, herbivory, and the resilience of coral reefs to climate change. Curr Biol 17:360-365

Lindfield SJ, McIlwain JL, Harvey ES (2014) Depth Refuge and the Impacts of SCUBA Spearfishing on Coral Reef Fishes. PLoS ONE 9:e92628

Martin TSH, Olds AD, Pitt KA, Johnston AB, Butler IR, Maxwell PS, Connolly RM (2015) Effective protection of fish on inshore coral reefs depends on the scale of mangrove-reef connectivity. Mar Ecol Prog Ser 527:157-165

McLeod E, Chmura GL, Bouillon S, Salm R, Björk M, Duarte CM, Lovelock CE, Schlesinger WH, Silliman BR (2011) A blueprint for blue carbon: toward an improved understanding of the role of vegetated coastal habitats in sequestering CO2. Front Ecol Environ 9:552-560

Nystrom M, Folke C, Moberg F (2000) Coral reef disturbance and resilience in a human-dominated environment. Trends Ecol Evol 15:413-417

Appendix S1

Table S1: Complete list of fish species recorded on coral reefs during Tanna surveys.

Species
Abudeduf vaigiensis, Acanthurus achillies, Acanthurus grammoptilus, Acanthurus mata, Acanthurus nigrofuscus, Acanthurus olivaceus, Acanthurus triostegus, Amphiprion polymnus, Anampses neoguinaicus, Arothron mappa, Calotomus carolinus, Apogon sp., Centropyge loricula, Cetoscarus ocellatus, Chaetodon Auriga, Chaetodon lineolatus, Chaetodon plebeius, Chaetodon unimaculatus, Chaetodon vagabundus, Chlorurus bleekeri, Chlorurus microrhinos, Chlorurus ocellatus, Chlorurus sordidus, Cholorus Sordidus, Chromis acares, Chromis analis, Chromis iomelas, Chrysiptera biocellata, Chrysiptera taupou, Coriadon altivelis, Ctenochaetus binotatus, Ctenochaetus striatus, Dascyllus aruanus, Epinephelus merra, Halichoeres binotopsis, Halichoeres hortulanus, Halichoeres miniatus, Halichoeres richmondi, Heniochus acuminatus, Heniochus Monoceros, Hipposcarus longiceps, Kuhlia mugil, Kyphosus bigibbus, Labroides dimidiatus, Lethrinus olivaceus, Lutjanus bohar, Lutjanus rivulatus, Naso lopezi, Naso vlamingii, Neoglyphidodon melas, Neopomacentrus cyanomos, Neopomacentrus violascens, Parapercis clathrate, Parupeneus ciliates, Parupeneus crassilabris, Parupeneus cyclostomus, Plectroglyphidodon dickii, Pomacentrus nigromarginatus, Rhinecanthus rectangulus, Scarus rubroviolaceus, Scarus tricolor, Siganus spinus, Stagastes nigricans, Stegastes fasciolatus, Stegastes nigricans, Thalassoma jansenii, Thalassoma lunare, Thalassoma purpureum, Thalassoma trilobatum