KINGDOM OF TONGA

Special Management Area Report 2020
Primary Authors:
Patrick Smallhorn-West\textsuperscript{1,2,*} and Jason Sheehan\textsuperscript{3}

Contributing authors:
Alma Paola Rodriguez-Troncoso\textsuperscript{4}, Siola’a Malimali\textsuperscript{3}, Tuikolongahau Halafihi\textsuperscript{3}, Latu Aisea\textsuperscript{3}, Sione Mailau\textsuperscript{3}, Amanda Le’ota\textsuperscript{3}, Daniela Ceccarelli\textsuperscript{2}, Karen Stone\textsuperscript{3}, Bob Pressley\textsuperscript{2,}, Geoffrey Jones\textsuperscript{1,2}

Compiled 2016-2020

\textsuperscript{1}Marine Biology and Aquaculture, College of Science and Engineering, James Cook University, Townsville, QLD, 4811, Australia
\textsuperscript{2}Australian Research Council Centre of Excellence for Coral Reef Studies, James Cook University, Townsville, QLD, 4811, Australia
\textsuperscript{3}Ministry of Fisheries, Nuku’alofoa, Tongatapu, Tonga.
\textsuperscript{4}Centro Universitario de la Costa, Universidad de Guadalajara, JAL 48280, Mexico
\textsuperscript{5}Vava’u Environmental Protection Agency, Neiafu, Tonga

*Corresponding author:
Patrick Smallhorn-West
Email: patricksmalhornwest@my.jcu.edu.au
Permanent address: 1 James Cook dr, Townsville, QLD, Australia

Suggested Citation:

Funding and support provided by:

Additional funding of this project or projects with data contribution provided by:
National geographic Society (CP-137ER-17), Asian Development Bank and the WAITT Institute
Acknowledgements

At the outset we would like to thank both the town officers and residents of the 49 SMA communities that allowed us to conduct ecological surveys of their reefs in partnership with the Tongan Ministry of Fisheries. In addition, we also acknowledge the ecological surveys conducted on the reefs adjacent to all non-SMA communities.

The authors are also grateful to the Tongan government and Prime Minister’s Office for supporting this work. We are also indebted to the entire staff of the Ministry of Fisheries in Tongatapu, Ha’apai and Vava’u, in particular the communities teams, for their patience and ongoing support.

This study benefited from the advice of Dr. Robert Gillett and Dr. Hugh Govan. We also thank the academic supervisors of Patrick Smallhorn-West’s PhD dissertation at James Cook University who are not contributors to this report: Dr. Tom Bridge and Dr. Georgina Gurney. We are also indebted to McIntyre Adventure and the Halaevalu Mata’aho Marine Discovery Centre.

Additional support either in the field or during the analysis stage was provided by:

Jesse Clarke, Stefano Freddi, Sophie Gordon, Tevita Havaea, Dr. Chancey MacDonald, Don and Jane McIntyre, David and Tristin Sheen, James Smallhorn-West, Tevila Vea’ila and Dr. Mathew Wyatt.

We hope that this work will be beneficial to Tonga in the years to come.

Preface

In 2016 a partnership was developed between the Tongan Ministry of Fisheries and James Cook University in Townsville, Australia. Its aim was to implement the first stage of a Tongan national coral reef monitoring project, and to provide an overview of the current status of Tonga’s Special Management Area (SMA) program. Since 2002 the Ministry of Fisheries has been heavily focused on expanding the SMA program, and communities throughout Tonga have been enthusiastic about introducing local marine management. As a result of this momentum, the Ministry has focused primarily on implementation. However, this came at the cost of monitoring, and until now there was very little information available on whether the SMA program was achieving its target objectives. Until this information was available, it has not been possible to fully demonstrate the efficacy of Tonga’s SMA program.

This document provides the missing details on the current ecological status and impacts of Tonga’s SMA program. It provides a broad overview of the program on a national scale, including detailed reports on each SMA community and impact assessments of the oldest SMA communities.

The Ministry of Fisheries is happy to share the results of this work with the hope of improving the future conditions of coastal resources in the Kingdom of Tonga.

Dr. Tuikolongahau Halafihi
CEO
Ministry of Fisheries
Nuku’alofa, Tonga

The research vessel S.V. Chaveta with Patrick Smallhorn-West, James Smallhorn-West and Stefano Freddi conducting surveys in Vava’u. Sketch by Dominique Serafini, former comic artist for Equipe Cousteau.
Map of the Kingdom of Tonga outlining the current extent of both the Special Management Area program and the ecological surveys used for this study. Yellow outlines are Special Management Areas, where only registered members of the community can fish. Red outlines are Fish Habitat Reserves, which are permanent no-fishing zones. Black circles represent survey sites, green represents land and black outlines on land villages.
This document is divided into nine sections:

Section 1. Overview of the Special Management Area program. This includes i) What is an SMA?, ii) History of the SMA program and ii) Monitoring Tonga's coral reefs and SMAs.

Section 2. Overview of the management of Tonga's coral reefs. Current status of Tonga's coral reefs across Tongatapu, Ha'apai and Vava'u and the main trends and challenges identified.

Section 3. Ecosystem health scores for all 49 SMAs. Overall scores, from one to five, calculated for each SMA included in the report. This score provides a summary of the detailed findings outlined for each SMA in sections five and six.

Section 4. Impact of Tonga's eight oldest SMAs. Overview of the methods and results of the impact assessment conducted for the eight oldest SMAs.

Section 5. Tonga's eight oldest SMAs. Detailed description of the marine ecosystem within the eight older SMAs in Tonga.

Section 6. Tonga's new SMAs. Detailed baseline data on the newest 41 SMA communities, or proposed SMA communities in Tonga at the time of writing. The descriptions of these communities marine life does not include an impact assessment, as at the time the surveys were conducted these SMA's were still too young for effective results. 

Section 7. Key questions, limitations and recommendations. This section summarizes the main findings of the report and addresses key questions about the results. It then lists limitations of the assessment program and recommendations for improving marine management in Tonga.

Section 8. Conclusion remarks.

Section 9. Appendices.
Community-based management can be defined as natural resource or biodiversity protection by, for and with the local community. This means that communities are given the responsibility of proper management and use of resources within their environment. This is a social response as the government needs help from people who have a deep connection with their local environment. Community-based management can be a useful tool because local groups may know the area being managed better than anyone, and also are the ones most affected by change.

Special Management Areas are a management tool where specific and committed communities are given exclusive access to an area of the ocean that they are responsible for looking after not only for themselves, but also for future generations. Within each area, called a Special Management Area, or SMA, there must be a Fish Habitat Reserve, or FHR. The FHR is permanently closed to all fishing and is there in order to keep part of the ecosystem healthy, and allow the fish to recover. Under this scenario, resources may continue to be used by local communities, but at the same time maintained for future generations.

Coastal community management committees (CCMCs) and coastal community management plans (CCMPs) are developed to assist communities in their management role.

Box 1. Objectives of the SMA program

The objectives of the SMA program in Tonga are to:

1. Control fishing activities
2. Restore fish stocks and habitat in no-fishing areas (FHRs)
3. Raise community awareness and involvement on fisheries conservation and management
4. Promote sustainable fishing practices
5. Improve the living standards in the community

This can all be summarized in the long-term vision of the Special Management Area program, which is to “revive the health and status of coastal fisheries resources in Tonga for current and future generations.”


*A Tongan translation available in Appendix C

Coastal Community Management Committee for the Ha'ano Special Management Area

Rules of an SMA:

- No persons shall access or undertake fishing of any nature within the SMA
- NTS may not be harvested or restocked within the SMA

Rules of an FHR:

- NTS may not be harvested or restocked
- No persons shall access or undertake fishing

The Committee may allow for any stated activities they agree upon.

Fisheries management in Tonga has been historically open access, meaning anyone can fish anywhere. While this might have worked well in the past, in modern times it has resulted in overfishing. In the early 2000s, growing support for letting local communities manage their own resources resulted in the Fisheries Management Act 2002. The first SMA, O’ua in the Ha’apai group, was designated in November 2006. While the program has since received funding from many domestic and international sources, it has largely been the Tongan Ministry of Fisheries that has driven its expansion. Tongans are therefore justifiably proud in the fact that the successful implementation of this “home grown” program has largely been by their own efforts.

The SMA program has become so popular with Tongan communities that one consultant noted that it is “bursting at the seams”. In the first decade the program grew slowly, but the gradual increase in awareness of the program lead to 31 new SMAs being established from 2016-2019, resulting in roughly half of all coastal communities in Tonga having an SMA. As of September 2019, an additional 46 SMA communities have either been confirmed, submitted to cabinet for approval, written a letter of interest, or been proposed, with the aim of including all coastal communities in the program by 2025.

So far, it is clear that the implementation of the SMA program in Tonga has been very successful, and should be seen as a good example of how local action can rapidly grow into change on a regional scale.

However, does the rapid growth of the SMA program actually tell us if the program is achieving its objectives?

Community consultations are a very important part of implementing any new SMA. First, communities must submit a letter of interest. This is followed by meeting with the Ministry of Fisheries to decide on the Coastal Community Management Committee (CCMC) and the boundaries of the SMA and FHR. Additional consultations are then performed with both the SMA community and other nearby communities, as well as key stakeholders. Finally, the SMA is gazetted through parliament and the boundary markers added.
Section 1. Background

Why is Monitoring important?

As discussed previously, so far it is clear that the implementation and expansion of the program has been very successful. The Ministry of Fisheries and the SMA communities have done a remarkable job at creating new SMAs.

But what does this actually tell us about whether the SMAs are “reviving the health and status of coastal fisheries resources for current and future generations”? In other words, even if many SMAs are put in, unless the fish come back, the job isn’t finished. Implementation is only the first step towards a better future.

So how do we know if the SMA program is working?

This is the role of the marine monitoring program.

What is Monitoring?

Monitoring involves going out and collecting data on the health and status of coral reefs and coastal fisheries resources in Tonga. It also involves testing whether the ecosystem has changed because of management. Unless efforts are committed to examine the state of the ecosystem in Tonga, both inside and outside the SMAs and FHRs, then it is not possible to say whether the SMA program is achieving its main objectives. While some of the stated goals of the SMA program were not explicitly about improving fish stocks and ecosystem health, if these objectives are not achieved then interest in the program may erode. Unless proper monitoring occurs, accurate conclusions cannot be made about the success of the SMA program.

Monitoring SMAs involves carefully quantifying and evaluating the coral reefs and reef fish fisheries both inside and outside the SMAs and FHRs using a very strict survey design. This involves divers with a strong knowledge of local species and coral reef ecosystems quantifying the health of coral reef ecosystems at sites all around the country. This is done by counting many different fish species and their sizes, as well as the proportion of the reef that is covered by different organisms. Importantly, the same methods must be used at every site, which allows comparisons to be made between sites.

Monitoring Tonga’s coral reefs and SMAs

From 2016 – 2019 the Ministry of Fisheries, in partnership with James Cook University and the Australian Research Council Centre for Excellence in Coral Reef Studies, implemented a national coral reef monitoring program to examine the status of coral reefs in Tongatapu, Ha’apai and Vava’u. This initiative was funded by the National Geographic Society with the aim of mapping the entire countries coral reef ecosystem for the first time. This work has been combined with three other survey trips that took place from 2016 – 2019, using the same methodology, in order to provide the data for this report.

At each site, four to six 30 m belt transects were conducted between 2 to 12 m depth. Along each transect the size (cm) and number of all fish species was recorded. The proportion of reef that was covered by living coral or other types of substrate (e.g. algae, sponges etc.) was also recorded as percent cover. For full details of the survey methods see the references at the bottom of this page.

Surveys were conducted inside the FHRs and SMAs of 49 communities throughout Tonga. As of 2019 this represented every SMA in Tonga with the exception of those inside the Fanga’uta lagoon in Tongatapu and those in Eua. Importantly, surveys were also conducted around non-SMA communities and in other areas open to fishing in order to compare between FHR or SMA areas and areas that were still open to fishing. This allows conclusions to be made about whether the fisheries and coral reefs inside the FHRs or SMAs are improving because of management.

During these surveys a total of 1686 transects at 383 sites were completed across Tonga’s coral reefs and the size and identity of over 280,000 individual fish recorded as one of 510 separate species. While some areas are still incomplete (e.g. the Niua’s and Eua), this is the largest dataset in existence on Tonga’s nearshore marine environment.

A diver swims along a transect and records the size, number and species of coral reef fish.
Section 2. Tonga’s Coral Reefs

Historically Tonga’s coral reefs have been largely understudied, with little information on their overall health. Data from 2016-2019 shows:

The coral reefs of Vava’u were in the poorest condition in the country. Mean live coral cover was <10%, and there was widespread evidence of large-scale damage from cyclones, coral bleaching, overfishing and poor water quality. Urchin barrens and entirely dead reef (0% coral cover) were observed over large areas near the mouth of the estuarine lagoons. Similar conditions were observed in Tongatapu near the mouth of the Fanga’uta lagoon.

Average coral cover in Ha’apai was 21%, and 25% in Tongatapu. Within Ha’apai, the northern islands (Muitoa to Uiha) had evidence of recent large-scale bleaching along the sheltered, western sides of the islands. The exposed southern islands of Ha’apai (Nomuka, Mango and Fono) had very high coral cover and can be considered some of the healthiest reefs in the country. Coral cover in the Tongatapu bay adjacent to the capital was high, although these areas were heavily overfished.

These surveys found two broad and consistent patterns in the health of Tonga’s coral reefs. First, large coral bleaching events have likely occurred in areas with low exposure to flushing by cool, oceanic waters (e.g. sheltered areas of Vava’u and Ha’apai). This may be exacerbated in Vava’u and minimized Tongatapu by a 2°C temperature difference which has protected the reefs of Tongatapu. Secondly, poor water quality flowing from the lagoons of Vava’u and Tongatapu (e.g. Fanga’uta) appear to have resulted in widespread decimation of reefs, often with 0% live coral cover, and possibly related outbreaks of Diadema sp. sea urchins.

The SMA program is an important first step towards improving the health of Tonga’s coral ecosystem by reducing overfishing. However, it is important to note that they are not a panacea. Coral bleaching and cyclones are both made worse by climate change and therefore it is imperative to work on changes at both the local and international level.

For additional details see:


*While the Crown-of-Thorns starfish has been observed in Tonga, none of the surveys recorded them in large numbers.

Overall status of Tonga’s coral reefs and reef fishery. Because of it’s large latitudinal gradient, Ha’apai is split into south, central and north. Letters denote statistical groupings.

Healthy reefs around Mango island (left) and Nomuka Island (right). The reefs surveyed in southern Ha’apai were the healthiest in the country.
Section 2. Tonga’s Coral Reefs

Live coral cover

Abundance of adult (< 20 cm) target reef fish

Target species density (# fish/km²)
- 0 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 +

Vava’u
Northern Ha’apai
Central Ha’apai
Southern Ha’apai
Tongatapu
Section 3. Reef ecosystem health rating

Reef ecosystem health ratings for 49 Special Management Areas

An overall reef ecosystem health rating was calculated for all 49 SMAs included in this report. This rating is based on six variables of ecosystem health that were measured for all SMAs and FHRs, including the new ones for which only baseline data was available. Each community was given a rating out of 5 for each variable, and the total rating calculated as the average between all variables and rounded up to the nearest 0.5.

For all SMAs the following six variables were used to calculate the reef ecosystem health rating:
1. Adult food fish abundance inside the FHR
2. Reef fish diversity inside the FHR
3. Total live coral cover inside the FHR
4. Adult food fish abundance inside the SMA
5. Reef fish diversity inside the SMA
6. Total live coral cover inside the SMA

Considerations of rating

It is important to understand that many external factors beyond the control of each community will ultimately affect the condition of their coral reefs and fishery, and therefore this rating. National problems like water quality, and international problems like coral bleaching and cyclones will all affect a communities coral reefs. Therefore this score does not exclusively reflect the actions of each community, but also of the country and region as a whole and beyond.

For the 41 new SMA communities, as well as the older SMA communities for which there was no evidence of recovery, this score represents the current baseline status of their coral reefs, but does NOT indicate any change to these conditions since the establishment of the SMA.
Section 4. Impact of Tonga’s oldest SMAs

We examined the estimated recovery inside the oldest SMA and FHR areas in Tonga. At the time the surveys were completed (2016-2018) there were eight SMAs in the country that were old enough to expect the ecosystem to be starting to recover. Typical recovery times of coral reef fish can take at least two to three years for early signs of recovery and over 20 years for full recovery. Therefore only the eight SMA communities established prior to 2013/14 were examined for estimated ecosystem recovery. The 41 additional SMAs that were established after this date cannot be accounted for recovery, and were treated only at baseline data.

Recovery was estimated by comparing surveys inside the SMAs and FHRs to specific areas open to fishing by everyone. The open areas used for comparison were carefully selected according to 11 socio-environmental variables, and statistically matched between open and managed areas to ensure only similar areas were compared. For example, a shallow fringing reef could only be compared to other shallow fringing reefs. Likewise, remote and exposed reefs were also only compared to other remote and exposed reefs.


This report includes the impacts of the older SMAs on two variables: the overall abundance of adult food fish and the species richness of reef fish.

Overall there was a strong impact of the FHRs on the diversity of reef fish and a moderate effect on the abundance of adult fish food, with more species of reef fish and higher abundances of adult fish overall inside the FHRs. This is the first evidence that demonstrates positive impacts for Tonga’s SMA program.

While there has been strong recovery inside some FHRs, where fishing is not allowed, there is little evidence of recovery inside SMA areas, where the community is still allowed to fish. There was no evidence of any increase in adult food fish, and only marginal evidence for an increase in fish diversity inside the SMA areas themselves. However, these places are also important for community livelihoods and their sense of relationship with the ocean, and therefore even if the ecosystem has not recovered, managing these places is still important.

Overall, the best two performing FHRs in the country were for the communities of Atata and Nomuka, which both had recovery of adult food fish and reef fish diversity inside the FHRs.

In contrast, the Eueiki, Ha’afeva and O’ua FHRs were the poorest performing of all the other FHRs, with little evidence of any recovery.

### Table. The variables used to match managed and open transects

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
<td>Depth (m), collected in-situ</td>
</tr>
<tr>
<td>Distance to land</td>
<td>Distance (m) from the nearest land source (Smallhorn-West et al., In review).</td>
</tr>
<tr>
<td>Distance to village</td>
<td>Distance (m) from the closest village (Smallhorn-West et al. In review).</td>
</tr>
<tr>
<td>Fishing pressure</td>
<td>Normalized (0-100) abundance of commercial and subsistence fishers (adjusted for catch) extrapolated across the coral reefs of Tonga. It constitutes a unit-less value of relative long-term fishing effort throughout the region (Smallhorn-West et al., In review).</td>
</tr>
<tr>
<td>Habitat</td>
<td>Exposed, semi-exposed or fringing, collected in-situ.</td>
</tr>
<tr>
<td>Island group</td>
<td>Ha’apai, Tongatapu or Vava’u.</td>
</tr>
<tr>
<td>Total live coral cover (%)</td>
<td>Collected either by the point intercept method or from photo quadrats.</td>
</tr>
<tr>
<td>Habitat rugosity</td>
<td>Estimate habitat complexity collected on-in-situ on a five point scale from low and sparse relief (score = 1) to exceptionally complex with numerous caves and overhangs (score = 5)</td>
</tr>
<tr>
<td>Slope</td>
<td>Estimate of reef slope collected in-situ on a five point scale from &lt; 10° (score = 1) to 90° (score = 5).</td>
</tr>
<tr>
<td>Surveyor</td>
<td>Dr. Daniela Ceccarelli, Heather Kramp, Patrick Smallhorn-West or Karen Stone.</td>
</tr>
<tr>
<td>Wave energy</td>
<td>Average daily wave energy (joules per m²) (Smallhorn-West et al. In review).</td>
</tr>
</tbody>
</table>

### Recovery ratings for Tonga’s eight oldest Special Management Areas

To provide an overview of the overall change to fish stocks, a recovery rating was calculated for each of the eight older SMAs in Tonga. This rating is based on the two main recovery variables that were measured for each FHR and SMA. Each FHR and SMA was rated out of five for each variable, and the total score calculated as the average between both variables and rounded up to the nearest 0.5. If there was no effect then they were given a score of 1.0. Anything above 1.0 indicates that there was evidence of at least some recovery inside the FHR or SMA.

For the purpose of this report, recovery is defined as the difference between inside the FHR/ SMA and matched areas open to fishing. This is different than baseline abundance, which is the raw value measured within the FHR/SMA.

It is important to note that no recovery score was calculated for the 41 new SMAs as at the time the surveys were conducted these had been implemented too recently to record evidence of recovery.

Right: Example of one of the variables used for matching SMA/FHR transects and areas open to fishing for the Ha’apai island group. This wave energy model (joules per m²), along with 16 other socio-environmental layers, were made for all of Tonga’s coral reef ecosystem as part of this project. Downloadable rater files are freely available at https://doi.pangaea.de/10.154/PANGAEA.994805. For more information see: Smallhorn-West, P. F., Gordon, S., Dempsey, A., Purnis, S., Matimali, S., Halathir, T., Southgate, P. T., Bridge, T. C. L., Pressey, R. L., & Jones, G. P. (In review). Tonga socio-environmental layers for marine ecosystem management.
Section 5. Tonga’s eight oldest SMAs

What is included in each report?

In the pages that follow we provide details of the ecosystem state within the eight oldest Special Management Areas in Tonga. This includes not only estimated recovery due to management, but also overall ecosystem health. Following this we provide a baseline report for 41 new SMAs that only provides information on the current ecosystem state. Each older SMA is provided with a two page layout that can also be printed as a stand-alone leaflet or poster.

For each of the eight older SMAs in Tonga we provide:

A) A detailed map outlining the boundaries of the Special Management Area (yellow), where only registered members of each community are allowed to fish, and the Fish Habitat Reserve (red), which is permanently closed to all fishing activities. This map also includes the sites where the ecological surveys were completed. Circles are from the 2017/18 National monitoring program, squares from the 2017 Vava’u Ocean Expedition, diamonds from the Asian Development Bank 2016 Vava’u SMA baseline surveys and triangles from the 2017-2019 VEPAsurveys.

B) Details of each SMA and its community including SMA area, FHR area, proportion of the SMA that is FHR, proportion of the SMA/FHR that is reef habitat and village population.

C) A short description of the main findings for each SMA

D) Figures that detail the abundance of adult food fish and diversity of fish inside the FHR and SMA, as well as the matched control sites. If there is strong evidence for a difference between the FHR or SMA and its matched control sites (in blue), then this shows that the FHR or SMA is having an effect (indicated by a star). Since multiple transects were completed at each site and inside each FHR or SMA, the column represents the average and the error bars around each column represent the variation between transects.

E) An image of the reefs inside the SMA or FHR.

F) Benthic cover – this is the amount (in total %) of different categories of reef substrate that was found on the transects inside the FHR and SMA*. The categories are:

- Branching coral
- Encrusting coral
- Foliose coral
- Massive coral
- Soft coral
- Sponges
- Other invertebrates – sea urchins, sea stars, sea cucumbers etc.
- Crustose Coralline Algae (CCA) – This is a very important encrusting pink algae that helps reefs recover
- Macro algae
- Turf algae

*Sand and rubble categories were removed so the data only represents what was found on areas suitable for reef growth. This is because reef areas were the targets of the surveys and sandy areas were generally surveyed only when reef habitat was not available. If sand and rubble were included it would not accurately represent coverage of these habitat types. Benthic cover values therefore represent the percent cover of total reef habitat, which is available in the table, not percent cover of total area within the SMAs/FHR.

From left to right: Examples from the benthic surveys of branching, encrusting, foliose, massive and soft corals respectively.
The Atata FHR is the best performing FHR in the country, with a very large difference in adult fish abundance and reef fish diversity between FHR and control sites. There was no evidence of a difference between SMA and control sites for either fish abundance or diversity. Three sites were surveyed inside both the SMA and FHR.

Adult food fish abundance was greatest at FHR site 3 (431.7 fish/km²) and lowest at SMA site 1 (89.2 fish/km²). Fish diversity was greatest at FHR site 1 (46.5 species) and lowest at SMA site 1 (35 species). Coral cover was lowest at the FHR site 1 (15.1%) and greatest at SMA site 3 (44.2%).

Overall the coral communities inside the FHR appeared less healthy than the SMA. This is a trend throughout Tonga depending on whether the reefs are sheltered from or facing prevailing weather conditions, with healthier reefs on the exposed, eastern sides.

The reefs along the eastern side of the ‘Atata SMA have very high cover of branching corals.

Abundance of food fish

<table>
<thead>
<tr>
<th>Koe lahi 'o e meʻatokoni 'a e ʻika</th>
<th>Number of adult food fish</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHR Sites</td>
<td>SMA Sites</td>
</tr>
<tr>
<td>500</td>
<td>375</td>
</tr>
<tr>
<td>250</td>
<td>125</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Benthic habitat coverage

<table>
<thead>
<tr>
<th>Turf algae</th>
<th>Branching Coral</th>
<th>Encrusting Coral</th>
<th>Sponge</th>
<th>Massive Coral</th>
<th>Soft Coral</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21°03'15.00'' S 175°15'17.59'' W</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There was greater fish abundance and diversity inside the Atata FHR than matched control sites. There was no difference in fish abundance or diversity inside the Atata SMA than matched control sites.

Naʻe tokolahi anga mo kalasi kehekehe 'o e ika naʻia maʻu 1 he savea 1 ioto 1 he Feltuʻu Puleʻi Makehe 'o e Nofoʻanga 'a e Ika 1 hono fakahao ki he ngaahi 'əia makehe naʻia kau hono savea. Naʻe 'iako ki 'aia haʻu kehekehe 1 he tokoiai pe kalasi kehekehe ‘o e ika 1 ioto 1 he Feltuʻu Puleʻi Makehe ‘o ‘Atata 1 hono fakahao ki he ngaahi 'əia makehe naʻia kau hono savea.

The reefs along the eastern side of the ‘Atata SMA have very high cover of branching corals.

Ko e hakau ‘i he tafaʻai faakahake ‘o e Feltuʻu Puleʻi Makehe ‘o ‘Atata ʻoku lahi ai ‘a e feo vaʻavaʻa a e Nofoʻanga ‘a e Ika.
The coral reefs at all six sites surveyed around Eueiki are in clear oceanic waters exposed to high wave energy. These sites had consistently some of the greatest abundance of adult reef fish anywhere in the Kingdom. However, there was no evidence of either the FHR or SMA at 'Eueiki having more adult food fish or fish diversity than nearby matched control sites, which also had many fish.

Adult food fish abundance was greatest at SMA site 1 (628.3 fish/km²) and lowest at SMA site 2 (203.3 fish/km²). Fish diversity was greatest at SMA site 1 (48.3 species) and lowest at FHR site 3 (34.5 species). Coral cover was lowest at the FHR site 3 (13.2%) and greatest at SMA site 1 (37.2%).

The clear and cool oceanic waters around 'Eueiki are the likely reason why these reefs are in good condition, as this was also the case for nearby areas outside the FHR and SMA.

---

**Table:**

<table>
<thead>
<tr>
<th>Population</th>
<th>Area of SMA</th>
<th>% Reef of SMA</th>
<th>Area of FHR</th>
<th>% Reef of FHR</th>
<th>FHR as % of SMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>76</td>
<td>3.75 km²</td>
<td>27.2%</td>
<td>0.87 km²</td>
<td>80.4%</td>
<td>23.2%</td>
</tr>
</tbody>
</table>

---

The healthy reefs around 'Eueiki are likely because of cool and clean oceanic water.
The reefs around Fafa island are generally in poor to medium condition, with evidence of cyclone damage, coral bleaching and overfishing across all four sites surveyed. While there was no evidence of more food fish inside the FHR, there was a greater diversity of reef fish inside the FHR than matched control sites.

The greatest fish diversity was along the southern side, with an average of 42.5 species recorded at the southern sites and 31.8 species at the northern sites. The southern sites also had many more adult food fish than the northern sites (190 fish/km$^2$ vs. 5.8 fish/km$^2$).

Coral cover was low at the south-western site (12.5%), but moderately high at all other sites (31–37%). Given its proximity to Nuku'alofa, poaching may be a problem affecting the recovery of reef fish abundance inside the FHR. Discussion with staff members at the resort appeared to confirm this.

### Abundance of food fish

Koe lahi 'o e me'atokoni 'a e 'ika

<table>
<thead>
<tr>
<th></th>
<th>HBR Sites</th>
<th>Matched Control Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of adult food fish per km$^2$</td>
<td>200</td>
<td>10</td>
</tr>
<tr>
<td>Abundance of food fish</td>
<td>200</td>
<td>10</td>
</tr>
</tbody>
</table>

There was no difference in fish abundance inside the Fafa FHR than matched control sites. However, there was significantly greater diversity of reef fish within the FHR than matched control sites.

### Diversity of reef fish

Kehekehe 'o e ngaahi 'ika mei he hakau

There was no difference in fish abundance inside the Fafa FHR than matched control sites. However, there was significantly greater diversity of reef fish within the FHR than matched control sites.
The coral growth on the Felemea bommie inside the FHR was exceptional, with lots of branching corals and many adult food fish. The fringing reef inside the Felemea SMA and FHR was in poor condition, likely due to coral bleaching and cyclones. There was greater adult fish abundance inside the FHR than in matched control sites. There was no difference between the SMA and matched control sites or for reef fish abundance. The southern FHR was in less than shallow depth.

The fringing reefs around Felemea were generally in poor condition, with low coral cover and poor water quality. However, from the 6 sites surveyed across the SMA and FHR, it was clear that the FHR was having an important effect. Fish abundance was much greater inside the FHR than matched control sites, although no difference was observed for the SMA or for fish biodiversity from the FHR or SMA.

Adult food fish abundance was greatest at FHR site 1 (135 fish/km²) and lowest at SMA site 2 (6.7 fish/km²). Coral cover was lowest at the FHR site 2 (6.7%) and greatest at SMA site 1 (38.4%).

There was greater adult fish abundance inside the FHR than in matched control sites. There was no difference between the SMA and matched control sites or for reef fish biodiversity. The fringing reef inside the Felemea SMA and FHR was in poor condition, likely due to coral bleaching and cyclones.
Fifteen sites were surveyed inside Ha'afeva's SMA and FHR by the 2017/18 national monitoring program and the 2017 Vava'u Ocean Initiative Marine Expedition. The seven sites surveyed along the outside edge of Ha'afeva's SMA were in good condition, although there was no evidence that the SMA or FHR were having an effect for fish abundance or diversity.

Adult food fish abundance was greatest at FHR site 1 (163.3 fish/km²) and lowest at SMA site 4 (6.6 fish/km²). Fish diversity was greatest at SMA site 1 (51 species) and lowest at FHR site 6 (17.2 species). Coral cover was lowest at the FHR site 5 (4.1%) and greatest at SMA site 8 (33.4%).

The overall condition of these reefs is more likely because of their exposure to clean and clear oceanic conditions. In addition, when visiting the village it appeared that the sign depicting the area of the FHR and SMA was in poor condition.*

*For additional details on this SMA please read the 2017 Vava'u Ocean Initiative Marine Expedition Interim Report.
The Nomuka FHR is one of the best performing in the country, and 23 sites have been surveyed around Nomuka and Nomuka Iki by the 2017/18 national monitoring program and the 2017 Vava'u Ocean Initiative Marine Expedition. The reefs inside both the FHR and SMA are in very good condition, with some of the highest coral cover in the country and the most diverse assemblages of reef fish anywhere in the Kingdom. In addition, there was evidence of a strong effect of the FHR, with many more adult food fish, and greater fish diversity, inside the FHR than matched control sites. There was no evidence of an effect of the SMA areas, where the community can still fish.

Adult food fish abundance and coral cover were greatest at FHR site 1 (393.3 fish/km$^2$; 50.2%). Fish diversity was greatest at FHR site 4 (60 species). The lowest values for fish abundance, diversity and coral cover were in front of the village (79.7 fish/km$^2$, 15 species and 13.2%).

The strong effect of Nomuka's FHR is due to very good enforcement and strict monitoring by the community. In addition, the overall environmental conditions in southern Ha'apai are the best in the country for reef health. *For additional details on this SMA please read the 2017 Vava'u Ocean Initiative Marine Expedition Interim Report.

**Table 1:**

<table>
<thead>
<tr>
<th>POPULATION</th>
<th>AREA OF SMA</th>
<th>% Reef of SMA</th>
<th>AREA OF FHR</th>
<th>% Reef of FHR</th>
<th>FHR as % of SMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>362</td>
<td>68.2 km$^2$</td>
<td>16.6%</td>
<td>0.53 km$^2$</td>
<td>65.2%</td>
<td>0.8%</td>
</tr>
</tbody>
</table>

The coral reefs inside the Nomuka FHR are very healthy, with high coral cover, lots of adult food fish and high reef fish diversity.

There was greater fish abundance and diversity inside the Nomuka FHR than matched control sites. There was no difference in fish abundance or diversity inside the Nomuka SMA than matched control sites.
The coral reefs at the 6 outer slope sites of the O’ua SMA and FHR are in very good condition, with many adult food fish. However, there was no evidence of any difference between these areas and other areas open to fishing. The good condition of these reefs is likely the result of environmental conditions. The inner sites at O‘ua were in very poor condition, with high turbidity and algal cover.

Adult food fish abundance was greatest at FHR site 4 (370 fish/km²) and lowest at SMA site 1 (0 fish/km²). Fish diversity was greatest at SMA site 5 (47.5 species) and lowest at SMA site 3 (16.8 species). Coral cover was lowest at the FHR site 3 (2.9%) and greatest at SMA site 5 (21.8%).

The O’ua SMA is the oldest in the country, established in 2006. Because it is in such a remote location, fishing pressure may be very low, which may also be why there was no difference between the FHR and areas open to fishing.

There was no difference in fish abundance or diversity inside the O’ua FHR than matched control sites. There was significantly lower fish abundance and diversity inside the SMA than matched control sites.

The coral reefs around O’ua are very healthy, with lots of food fish. The coral reefs at the 6 outer slope sites of the O’ua SMA and FHR are in very good condition, with many adult food fish. However, there was no evidence of any difference between these areas and other areas open to fishing. The good condition of these reefs is likely the result of environmental conditions. The inner sites at O’ua were in very poor condition, with high turbidity and algal cover.

Adult food fish abundance was greatest at FHR site 4 (370 fish/km²) and lowest at SMA site 1 (0 fish/km²). Fish diversity was greatest at SMA site 5 (47.5 species) and lowest at SMA site 3 (16.8 species). Coral cover was lowest at the FHR site 3 (2.9%) and greatest at SMA site 5 (21.8%).

The O’ua SMA is the oldest in the country, established in 2006. Because it is in such a remote location, fishing pressure may be very low, which may also be why there was no difference between the FHR and areas open to fishing.

There was no difference in fish abundance or diversity inside the O’ua FHR than matched control sites. There was significantly lower fish abundance and diversity inside the SMA than matched control sites.

The coral reefs around O’ua are very healthy, with lots of food fish. The coral reefs at the 6 outer slope sites of the O’ua SMA and FHR are in very good condition, with many adult food fish. However, there was no evidence of any difference between these areas and other areas open to fishing. The good condition of these reefs is likely the result of environmental conditions. The inner sites at O’ua were in very poor condition, with high turbidity and algal cover.

Adult food fish abundance was greatest at FHR site 4 (370 fish/km²) and lowest at SMA site 1 (0 fish/km²). Fish diversity was greatest at SMA site 5 (47.5 species) and lowest at SMA site 3 (16.8 species). Coral cover was lowest at the FHR site 3 (2.9%) and greatest at SMA site 5 (21.8%).

The O’ua SMA is the oldest in the country, established in 2006. Because it is in such a remote location, fishing pressure may be very low, which may also be why there was no difference between the FHR and areas open to fishing.

There was no difference in fish abundance or diversity inside the O’ua FHR than matched control sites. There was significantly lower fish abundance and diversity inside the SMA than matched control sites.

The coral reefs around O’ua are very healthy, with lots of food fish. The coral reefs at the 6 outer slope sites of the O’ua SMA and FHR are in very good condition, with many adult food fish. However, there was no evidence of any difference between these areas and other areas open to fishing. The good condition of these reefs is likely the result of environmental conditions. The inner sites at O’ua were in very poor condition, with high turbidity and algal cover.

Adult food fish abundance was greatest at FHR site 4 (370 fish/km²) and lowest at SMA site 1 (0 fish/km²). Fish diversity was greatest at SMA site 5 (47.5 species) and lowest at SMA site 3 (16.8 species). Coral cover was lowest at the FHR site 3 (2.9%) and greatest at SMA site 5 (21.8%).

The O’ua SMA is the oldest in the country, established in 2006. Because it is in such a remote location, fishing pressure may be very low, which may also be why there was no difference between the FHR and areas open to fishing.

There was no difference in fish abundance or diversity inside the O’ua FHR than matched control sites. There was significantly lower fish abundance and diversity inside the SMA than matched control sites.

The coral reefs around O’ua are very healthy, with lots of food fish. The coral reefs at the 6 outer slope sites of the O’ua SMA and FHR are in very good condition, with many adult food fish. However, there was no evidence of any difference between these areas and other areas open to fishing. The good condition of these reefs is likely the result of environmental conditions. The inner sites at O’ua were in very poor condition, with high turbidity and algal cover.

Adult food fish abundance was greatest at FHR site 4 (370 fish/km²) and lowest at SMA site 1 (0 fish/km²). Fish diversity was greatest at SMA site 5 (47.5 species) and lowest at SMA site 3 (16.8 species). Coral cover was lowest at the FHR site 3 (2.9%) and greatest at SMA site 5 (21.8%).

The O’ua SMA is the oldest in the country, established in 2006. Because it is in such a remote location, fishing pressure may be very low, which may also be why there was no difference between the FHR and areas open to fishing.

There was no difference in fish abundance or diversity inside the O’ua FHR than matched control sites. There was significantly lower fish abundance and diversity inside the SMA than matched control sites.

The coral reefs around O’ua are very healthy, with lots of food fish. The coral reefs at the 6 outer slope sites of the O’ua SMA and FHR are in very good condition, with many adult food fish. However, there was no evidence of any difference between these areas and other areas open to fishing. The good condition of these reefs is likely the result of environmental conditions. The inner sites at O’ua were in very poor condition, with high turbidity and algal cover.

Adult food fish abundance was greatest at FHR site 4 (370 fish/km²) and lowest at SMA site 1 (0 fish/km²). Fish diversity was greatest at SMA site 5 (47.5 species) and lowest at SMA site 3 (16.8 species). Coral cover was lowest at the FHR site 3 (2.9%) and greatest at SMA site 5 (21.8%).

The O’ua SMA is the oldest in the country, established in 2006. Because it is in such a remote location, fishing pressure may be very low, which may also be why there was no difference between the FHR and areas open to fishing.

There was no difference in fish abundance or diversity inside the O’ua FHR than matched control sites. There was significantly lower fish abundance and diversity inside the SMA than matched control sites.

The coral reefs around O’ua are very healthy, with lots of food fish. The coral reefs at the 6 outer slope sites of the O’ua SMA and FHR are in very good condition, with many adult food fish. However, there was no evidence of any difference between these areas and other areas open to fishing. The good condition of these reefs is likely the result of environmental conditions. The inner sites at O’ua were in very poor condition, with high turbidity and algal cover.

Adult food fish abundance was greatest at FHR site 4 (370 fish/km²) and lowest at SMA site 1 (0 fish/km²). Fish diversity was greatest at SMA site 5 (47.5 species) and lowest at SMA site 3 (16.8 species). Coral cover was lowest at the FHR site 3 (2.9%) and greatest at SMA site 5 (21.8%).

The O’ua SMA is the oldest in the country, established in 2006. Because it is in such a remote location, fishing pressure may be very low, which may also be why there was no difference between the FHR and areas open to fishing.

There was no difference in fish abundance or diversity inside the O’ua FHR than matched control sites. There was significantly lower fish abundance and diversity inside the SMA than matched control sites.

The coral reefs around O’ua are very healthy, with lots of food fish.
The Ovaka SMA is the oldest SMA in Vava'u and has been surveyed by the 2017/18 national monitoring program and the 2017 Vava'u Ocean Initiative Marine Expedition in collaboration with VEPA. While several sites had very high abundances of reef fish, others had very few and overall there was no evidence of an effect of the FHR or SMA on adult fish abundance. There was however a strong effect of the FHR on reef fish diversity, with many more species inside the FHR than in areas open to fishing.

Adult food fish abundance was greatest at FHR site 4 (370 fish/km²) and lowest at SMA site 1 (0 fish/km²).

Fish diversity was greatest at SMA site 5 (47.5 species) and lowest at SMA site 3 (16.8 species). Coral cover was lowest at the FHR site 3 (2.9%) and greatest at SMA site 5 (21.8%).

There was greater reef fish diversity inside the FHR than in matched control sites. There was no difference between the SMA or FHR and matched control sites or for reef fish abundance.

The outer slopes of the Ovaka SMA have a high abundance of parrotfish and surgeonfish.

**For additional details on this SMA please read the 2017 Vava'u Ocean Initiative Marine Expedition Interim Report.**
Section 6. Tonga’s 41 new SMAs

What is included in each report?

In the pages that follow we provide details of the ecosystem state within the 41 new Special Management Areas in Tonga, established after 2013/14. It is important to note that this report does not include any information on estimated recovery within these areas as at the time of surveying they were all too young to be having an effect. Typical recovery times of coral reef fish can take at least three years for early signs of recovery and over 20 years for full recovery. Each SMA is provided with a one page layout that can also be printed as a stand-alone leaflet or poster.

We therefore provide only a baseline assessment of the current ecological state within these areas, which can be used in the future to examine changes due to management.

For each of the 41 new SMAs in Tonga we provide:

A) A detailed map outlining the boundaries of the Special Management Area (yellow), where only registered members of each community are allowed to fish, and the Fish Habitat Reserve (red), which is permanently closed to all fishing activities. This map also includes the sites where the ecological surveys were completed. Circles are from the 2017/18 national monitoring program, squares from the 2017 Vava'u Ocean Expedition, diamonds from the Asian Development Bank 2016 Vava'u SMA baseline surveys and triangles from the 2017-2019 VEPAs surveys.

B) Details of each SMA and its community including SMA area, FHR area, proportion of the SMA that is FHR, proportion of the SMA/FHR that is reef habitat and village population.

C) A short description of the main findings for each SMA

D) Figures that detail the baseline abundance of adult food fish and diversity of fish inside the FHR and SMA. Since multiple transects were completed at each site and inside each FHR or SMA, the column represents the average and the error bars around each column represent the variation between transects.

E) An image of the reefs inside the SMA or FHR.

F) Benthic cover – this is the amount (in total %) of different categories of reef substrate that was found on the transects inside the FHR and SMA*. The categories are:

- Branching coral
- Encrusting coral
- Foliose coral
- Massive coral
- Soft coral
- Sponges
- Other invertebrates – sea urchins, sea stars, sea cucumbers etc.
- Crustose Coralline Algae (CCA) – This is a very important encrusting pink algae that helps reefs recover
- Macro algae
- Turf algae

*Sand and rubble categories were removed so the data only represents substrata suitable for reef growth. This is because reef areas were the targets of the surveys and sandy areas were generally surveyed only when reef habitat was not available. If sand and rubble were included it would not accurately represent coverage of these habitat types. Benthic cover values therefore represent the percent cover of total reef habitat, which is available in the table, not percent cover of total area within the SMA/FHR.

From left to right: Examples from the benthic surveys of branching, encrusting, foliose, massive and soft corals respectively.
The Eueiki FHR is one of the outermost management areas in Vava’u, and two sites were surveyed along its western side. The abundance of adult food fish was high (155 fish/km²), with many large adult snapper. However, species richness was low (28.5 species). Coral cover was generally low at most sites.

The Vava’u Environmental Protection Agency (VEPA) has been monitoring one site at Eueiki since 2014. They have reported on a large coral bleaching event along the north-west side of the island in 2015.

The Fakakakai SMA in northern Ha’apai had high fish abundance inside both the new SMA (118.5 fish/km²) and FHR (155 fish/km²). However, the coral reefs appeared to have been recently damaged by cyclones and coral bleaching, with very low coral cover (4.8%) at the two sites surveyed. This pattern was observed all along the western sides of the northern Ha’apai islands. Many large table corals littered the sandy areas near the reefs, which appear to have been broken off in a cyclone at some point in the past several years.

The reefs around Fakakakai appear to have been recently damaged from a cyclone, with many dead and broken table corals littering the ground.

A large thicket of Porites cylindrical coral that has recovered since the 2015 bleaching event at the VEPA site.

The Fakakakai SMA has high fish abundance and coral cover, with many large adult snapper and many large table corals littering the ground.
Five sites were surveyed within the Faleloa SMA, both close to the village and near the two resorts on the islands northern end. Fish abundance was greatest at the village SMA site (29.2 species), the greatest coral cover was also at the shallow bommie in front of village SMA sites (29.2 species). The greatest coral was greatest at the shallow bommie in front of Matafonua resort (36.5 species) and lowest at the sandy beach resort (8.3 fish/km²). Fish abundance was greatest at the south also were in very poor condition, with many signs of damage from anchoring yachts. However, the bommies around Nuku island towards Kapa (0 fish/km²), 35.5 species, 16.7%) and lowest at the bommie past Anchorage had many signs of damage from anchoring yachts. However, the bommies around Nuku island to the south also were in very poor condition, with evidence of damage from cyclones.

Adult food fish density, total reef fish diversity and live coral cover were all greatest at A’aisland (78.3 fish/km²), 14.8 species, 4.1%).

Eight sites were surveyed within the Falevai SMA and FHR as part of both the 2017/18 national monitoring program as well as the Asian Development Bank Vava’u baseline SMA surveys. Overall the reefs within the Falevai SMA are in poor condition, with many signs of reef stress. The surveys around Port Maurelle anchorage had many signs of damage from anchoring yachts. However, the bommies around Nuku island to the south also were in very poor condition, with evidence of damage from cyclones.

Adult food fish density, total reef fish diversity and live coral cover were all greatest at A’aisland (78.3 fish/km²), 14.8 species, 4.1%).

For additional details on this SMA please read the Asian Development Bank Vava’u SMA baseline survey report.

The coral reefs within the Falevai SMA were in poor condition, with very low coral cover throughout.

For additional details on this SMA please read the Asian Development Bank Vava’u SMA baseline survey report.
Seven sites were surveyed within the Fonoi SMA by the 2017/18 national monitoring program and the 2017 Vava'u Ocean Initiative Marine Expedition, and these represent some of the healthiest coral reefs in Tonga. Southern Ha'apai has a combination of clean and clear oceanic currents and limited fishing pressure, both of which protect the reefs from degradation.

Within the Fonoi SMA, adult food fish abundance was greatest in the SMA area out front of the village (245 ika/km²). Reef fish diversity was greatest at the farthest site within the FHR (43.8 species), but comparable at 38.8%.

In general, the reefs along the western side of the northern Ha'apai islands are shallow and fringing, changing between 5m and 12m and in a sandy bottom with sharp overhangs. The sheltered condition of these reefs from open ocean swell and current may limit flushing by cooler water and exacerbate coral bleaching, driving the observed conditions.

The coral reefs around Fonoi island in southern Ha'apai are some of the healthiest in the country, with clear water, low fishing pressure and high coral cover.

The coral reefs around Fonoi island in southern Ha'apai are some of the healthiest in the country, with clear water, low fishing pressure and high coral cover.

**Abundance of food fish**

<table>
<thead>
<tr>
<th></th>
<th>SMA</th>
<th>FHR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of adult food fish per km²</td>
<td>160</td>
<td>40</td>
</tr>
</tbody>
</table>

**Diversity of reef fish**

<table>
<thead>
<tr>
<th></th>
<th>SMA</th>
<th>FHR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of reef fish species</td>
<td>37.5</td>
<td>30</td>
</tr>
</tbody>
</table>

**Benthic habitat coverage**

<table>
<thead>
<tr>
<th></th>
<th>SMA</th>
<th>FHR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turf algae</td>
<td>36%</td>
<td>7.3%</td>
</tr>
<tr>
<td>Branching Coral</td>
<td>36%</td>
<td>7.3%</td>
</tr>
<tr>
<td>Other Invertebrates</td>
<td>8.6%</td>
<td>36%</td>
</tr>
<tr>
<td>Massive Coral</td>
<td>10%</td>
<td>7.3%</td>
</tr>
<tr>
<td>Encrusting Coral</td>
<td>7.3%</td>
<td>36%</td>
</tr>
<tr>
<td>Foliose Coral</td>
<td>10%</td>
<td>7.3%</td>
</tr>
<tr>
<td>Turf algae</td>
<td>36%</td>
<td>7.3%</td>
</tr>
<tr>
<td>Branching Coral</td>
<td>36%</td>
<td>7.3%</td>
</tr>
<tr>
<td>Other Invertebrates</td>
<td>8.6%</td>
<td>36%</td>
</tr>
<tr>
<td>Massive Coral</td>
<td>10%</td>
<td>7.3%</td>
</tr>
<tr>
<td>Encrusting Coral</td>
<td>7.3%</td>
<td>36%</td>
</tr>
<tr>
<td>Foliose Coral</td>
<td>10%</td>
<td>7.3%</td>
</tr>
</tbody>
</table>

**SCORE**

<table>
<thead>
<tr>
<th></th>
<th>SMA</th>
<th>FHR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Branching and massive corals inside the Ha'ano SMA.</td>
<td>10%</td>
<td>7.3%</td>
</tr>
</tbody>
</table>
The exposed Ha’atafu FHR was changed to its present location in November 2019. The exposed Ha’atafu FHR was characterized by very turbid conditions, likely from run off are likely a significant threat at this site. Pollution and excess nutrients from run off are likely a significant threat at this site. The exposed side of Ha’atafu had the healthiest reef habitats are important to protect for different species.

The exposed Ha’atafu FHR was changed to its present location in November 2019. The exposed Ha’atafu FHR was characterized by very turbid conditions, likely from run off are likely a significant threat at this site. Pollution and excess nutrients from run off are likely a significant threat at this site. The exposed side of Ha’atafu had the healthiest reef habitats are important to protect for different species.

The exposed Ha’atafu FHR was changed to its present location in November 2019. The exposed Ha’atafu FHR was characterized by very turbid conditions, likely from run off are likely a significant threat at this site. Pollution and excess nutrients from run off are likely a significant threat at this site. The exposed side of Ha’atafu had the healthiest reef habitats are important to protect for different species.

The exposed Ha’atafu FHR was changed to its present location in November 2019. The exposed Ha’atafu FHR was characterized by very turbid conditions, likely from run off are likely a significant threat at this site. Pollution and excess nutrients from run off are likely a significant threat at this site. The exposed side of Ha’atafu had the healthiest reef habitats are important to protect for different species.
The Holopeka SMA is divided into two sections: the sheltered western section and the exposed eastern section. The sheltered western section has a large expanse of very shallow (>4 m) sandy habitat. One site along the shallow fringing reef of the SMA was surveyed as part of the 2017/18 national monitoring program.

Coral cover at this site was moderate and primarily thin branching corals (23.8%). While reef fish species richness was high (40.5 species), the abundance of adult food fish was very low (11.6 fish/km²).

Benthic habitat coverage: Ko e nofo’anga ‘o e ‘ika
- Turf algae
- Branching Coral
- Palauan Coral
- Massive Coral
- Brooding Coral
- Soft Coral
- Sponge
- CCA
- Other Invertebrates

Abundance of food fish: Ko e lahi ‘o e me’atokoni ‘o e ‘ika
- Number of adult food fish
- Koi e lahi ‘o e me’atokoni ‘o e ‘ika
- Number of reef fish
- Koi e nofo’anga ‘o e ‘ika
- Number of reef fish

Populations: POPULATION
- Number of adult food fish
- Number of reef fish

The Holopeka SMA had high cover of branching corals.

Ko e nofo’anga ‘o e ‘ika
- Turf algae
- Branching Coral
- Palauan Coral
- Massive Coral
- Brooding Coral
- Soft Coral
- Sponge
- CCA
- Other Invertebrates

Abundance of food fish: Ko e lahi ‘o e me’atokoni ‘o e ‘ika
- Number of adult food fish
- Koi e lahi ‘o e me’atokoni ‘o e ‘ika
- Number of reef fish
- Koi e nofo’anga ‘o e ‘ika
- Number of reef fish

Populations: POPULATION
- Number of adult food fish
- Number of reef fish

Hunga is the largest SMA in Vava’u and has two FHRs, one within the lagoon near the village and the second near the blue lagoon, along the southern section of the SMA. Combined, the two FHRs make Hunga have the second largest FHR area in the country, after Kotu in Ha’apai. Eight sites were surveyed in the Hunga SMA as part of the 2017/18 national monitoring program and the Asian Development Bank Vava’u SMA baseline surveys.

Live hard coral cover was greatest inside the lagoon (28.3%), where there were large stands of Porites rus and Porites cylinndrica corals that grow well in sheltered conditions. Coral cover was lowest along the south western part of the SMA, particularly SMA site 2 (3.8%), where there were large stands of Porites cylindrica and Porites rus. Reef fish diversity was greatest at SMA site 2 (38.25 species) and lowest inside the Hunga lagoon (22.7 species).*

Abundance of food fish: Ko e lahi ‘o e me’atokoni ‘o e ‘ika
- Number of adult food fish
- Koi e lahi ‘o e me’atokoni ‘o e ‘ika
- Number of reef fish
- Koi e nofo’anga ‘o e ‘ika
- Number of reef fish

Populations: POPULATION
- Number of adult food fish
- Number of reef fish

The Asian Development Bank Vava’u SMA baseline survey report.

*For additional details on this SMA please read the Asian Development Bank 2018 Vava’u SMA baseline survey report.
The Kapa SMA is the most remote management area in the Kingdom. While Kelefesia has a semi-permanent fishing camp, responsibility for management of this area lies with the Nomuka community to the north. The coral reef system inside the Kelefesia SMA is extensive, and overall in fairly healthy condition. It has likely been protected from bleaching events by cooler oceanic waters driven from the east by prevailing wind and wave conditions.

Adult food fish abundance was high throughout, and greatest at SMA site 1 (296.7 fish/km²). Likewise, coral cover and reef fish diversity were moderate to high throughout, and greatest at SMA site 2 (31.1% and 36.3 species).

Three sites were surveyed within the Kapa SMA and FHR as part of the 2017 Vava’u Ocean Initiative Marine Expedition in partnership with VEEPA. Coral cover was very low (0.1%) across all sites within the Kapa SMA and FHR, with dead coral observed as the dominant substrate. High numbers of Diadema sp. sea urchins were also observed at very high densities, a sign of poor water quality. Adult food fish density was moderate throughout, and greatest at SMA site 2 (31.1% and 36.3 species).

For additional details on this SMA please read the 2017 Vava’u Ocean Initiative Marine Expedition Interim Report.
Four sites were surveyed inside the Koloa SMA by the Vava‘u Environmental Protection Agency (VEPA) in 2018. However, two of these sites were very shallow tidal areas not suitable for data collection. The inner area of the Koloa SMA is dominated by sand, macroalgae and cyanobacterial mats.

At both sites adult food fish abundance and reef fish diversity was low (inner site 30 fish/km² and 13 species). Coral cover at the lagoon FHR site was high and dominated by massive and branching corals which do well in turbid conditions. Although the water was clearer along the exposed site, no macroalgae or cyanobacterial mats were observed. The high coral cover of these reefs, despite overfishing, may be because of environmental conditions. The cooler waters in Tongatapu protect the reefs from coral bleaching, while the sheltered bay may protect them from cyclone damage.

The proposed Kolomotu’a SMA is the closest SMA to the capital of Tonga, Nuku‘alofa. There are two proposed FHRs, one near the Ministry of Fisheries in Tongatapu, and the other in front of the royal Palace.

The reefs in front of Kolomotu’a had surprisingly high coral cover, likely protected from coral bleaching due to the cooler waters in Tongatapu and from cyclones by sheltered bay.

The proposed Kolomotu’a SMA is the closest SMA to the capital of Tonga, Nuku‘alofa. There are two proposed FHRs, one near the Ministry of Fisheries in Tongatapu, and the other in front of the royal Palace.
The coral reefs around Kolonga have been heavily damaged, likely from nutrient run-off from Fanga'uta lagoon and large numbers of Diadema sp. sea urchins which have destroyed the reef.

Ko e halau takai 'o Kolonga 'oku 'i he tu'unga faka-Tonga (5.1%) pea lahi mo e 'i he tu'unga 'o e 'i he tafa 'i he vahefonua (33.7%).

Abundance of adult food fish

<table>
<thead>
<tr>
<th>Area</th>
<th>Number of adult food fish per km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHR 1</td>
<td>120</td>
</tr>
<tr>
<td>SMA</td>
<td>90</td>
</tr>
</tbody>
</table>

Abundance of reef fish

<table>
<thead>
<tr>
<th>Area</th>
<th>Number of reef fish per km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHR 1</td>
<td>20</td>
</tr>
<tr>
<td>SMA</td>
<td>10</td>
</tr>
</tbody>
</table>

The two Kolonga FHRs were changed to the present FHR in November 2019.

The outer edge of the FHR and SMA have a thriving coral reef community.

Ko e 'elia le 6 na'a saveasi 'i 1 i lahi mai he Feltu's Pule'i Makehe 'o Koloto ihe 2079/18 (kolonga 'a hono mua) fakakulufa 'o e polotaka ma pei mo e Vava'u Ocean Initiative Marine Expedition 2017. Ko e Feltu's Pule'i Makehe 'o Koloto 'ihe 2079/18 a e 'elia tapa 'ihe halai ihe 'o e 'elia ta'ika 'ihe hakau 'ihe Vava'u Ocean Initiative Marine Expedition Interim Report.

Abundance of food fish

<table>
<thead>
<tr>
<th>Area</th>
<th>Number of adult food fish</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHR 1</td>
<td>120</td>
</tr>
<tr>
<td>SMA</td>
<td>90</td>
</tr>
</tbody>
</table>

Diversity of reef fish

<table>
<thead>
<tr>
<th>Area</th>
<th>Number of reef fish species</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHR 1</td>
<td>20</td>
</tr>
<tr>
<td>SMA</td>
<td>10</td>
</tr>
</tbody>
</table>

The two Kolonga FHRs were changed to the present FHR in November 2019.

The SMA is the westernmost SMA in the Ha'apai island group and has the largest FHR in the country.

Ko e 'elia le 6 na'a saveasi 'i 1 i lahi mai he Feltu's Pule'i Makehe 'o Koloto ihe 2079/18 (kolonga 'a hono mua) fakakulufa 'o e polotaka ma pei mo e Vava'u Ocean Initiative Marine Expedition 2017. Ko e Feltu's Pule'i Makehe 'o Koloto 'ihe 2079/18 a e 'elia tapa 'ihe halai ihe 'o e 'elia ta'ika 'ihe hakau 'ihe Vava'u Ocean Initiative Marine Expedition Interim Report.

Abundance of food fish

<table>
<thead>
<tr>
<th>Area</th>
<th>Number of adult food fish per km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHR 1</td>
<td>120</td>
</tr>
<tr>
<td>SMA</td>
<td>90</td>
</tr>
</tbody>
</table>

Diversity of reef fish

<table>
<thead>
<tr>
<th>Area</th>
<th>Number of reef fish per km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHR 1</td>
<td>20</td>
</tr>
<tr>
<td>SMA</td>
<td>10</td>
</tr>
</tbody>
</table>

The coral reefs around Kolonga have been heavily damaged, likely from nutrient run-off from Fanga'uta lagoon and large numbers of Diadema sp. sea urchins which have destroyed the reef.

Ko e halau takai 'o Kolonga 'oku 'i he tu'unga faka-Tonga (5.1%) pea lahi mo e 'i he tu'unga 'o e 'i he tafa 'i he vahefonua (33.7%).

Abundance of adult food fish

<table>
<thead>
<tr>
<th>Area</th>
<th>Number of adult food fish per km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHR 1</td>
<td>120</td>
</tr>
<tr>
<td>SMA</td>
<td>90</td>
</tr>
</tbody>
</table>

Diversity of reef fish

<table>
<thead>
<tr>
<th>Area</th>
<th>Number of reef fish per km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHR 1</td>
<td>20</td>
</tr>
<tr>
<td>SMA</td>
<td>10</td>
</tr>
</tbody>
</table>

The two Kolonga FHRs were changed to the present FHR in November 2019.

The SMA is the westernmost SMA in the Ha'apai island group and has the largest FHR in the country.

Ko e 'elia le 6 na'a saveasi 'i 1 i lahi mai he Feltu's Pule'i Makehe 'o Koloto ihe 2079/18 (kolonga 'a hono mua) fakakulufa 'o e polotaka ma pei mo e Vava'u Ocean Initiative Marine Expedition 2017. Ko e Feltu's Pule'i Makehe 'o Koloto 'ihe 2079/18 a e 'elia tapa 'ihe halai ihe 'o e 'elia ta'ika 'ihe hakau 'ihe Vava'u Ocean Initiative Marine Expedition Interim Report.

Abundance of food fish

<table>
<thead>
<tr>
<th>Area</th>
<th>Number of adult food fish per km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHR 1</td>
<td>120</td>
</tr>
<tr>
<td>SMA</td>
<td>90</td>
</tr>
</tbody>
</table>

Diversity of reef fish

<table>
<thead>
<tr>
<th>Area</th>
<th>Number of reef fish per km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHR 1</td>
<td>20</td>
</tr>
<tr>
<td>SMA</td>
<td>10</td>
</tr>
</tbody>
</table>

The coral reefs around Kolonga have been heavily damaged, likely from nutrient run-off from Fanga'uta lagoon and large numbers of Diadema sp. sea urchins which have destroyed the reef.

Ko e halau takai 'o Kolonga 'oku 'i he tu'unga faka-Tonga (5.1%) pea lahi mo e 'i he tu'unga 'o e 'i he tafa 'i he vahefonua (33.7%).

Abundance of adult food fish

<table>
<thead>
<tr>
<th>Area</th>
<th>Number of adult food fish per km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHR 1</td>
<td>120</td>
</tr>
<tr>
<td>SMA</td>
<td>90</td>
</tr>
</tbody>
</table>

Diversity of reef fish

<table>
<thead>
<tr>
<th>Area</th>
<th>Number of reef fish per km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHR 1</td>
<td>20</td>
</tr>
<tr>
<td>SMA</td>
<td>10</td>
</tr>
</tbody>
</table>

The two Kolonga FHRs were changed to the present FHR in November 2019.

The outer edge of the FHR and SMA have a thriving coral reef community.

Ko e 'elia le 6 na'a saveasi 'i 1 i lahi mai he Feltu's Pule'i Makehe 'o Koloto ihe 2079/18 (kolonga 'a hono mua) fakakulufa 'o e polotaka ma pei mo e Vava'u Ocean Initiative Marine Expedition 2017. Ko e Feltu's Pule'i Makehe 'o Koloto 'ihe 2079/18 a e 'elia tapa 'ihe halai ihe 'o e 'elia ta'ika 'ihe hakau 'ihe Vava'u Ocean Initiative Marine Expedition Interim Report.
The Koulo SMA is at the top of Lifuka island and has a channel where water flows from the exposed eastern edge to the sheltered western side of the island. Famously, in 1806 the Port-au-prince ship was discovered. The landing strip for the Ha'apai airport also goes very close to these reefs and airplanes routinely fly low over the SMA.

One site along the fringing reef of the SMA was surveyed as part of the 2017/18 national monitoring program. Coral cover at this site was very low (3.03%).

The fringing reef along the western edge of the Koulo SMA drops steeply into a sandy habitat at 10 to 15 m, near where the Port-au-prince shipwreck was discovered in 2012.

Four sites were surveyed inside the Lape SMA as part of the 2017/18 national monitoring program and the 2016 Asian Development Bank baseline SMA surveys. However, no surveys were conducted inside the Lape FHR, which remains unsurveyed. Overall the area inside the Lape SMA is mostly sandy slope with very little habitat for coral growth. There was shallow fringing reef habitat along the southern edge of the island, although there was strong evidence of recent cyclone damage, with lots of coral rubble.

Coral cover was 0.5%. Adult food fish abundance was very low, ranging from 8.8 to 58.9 fish/km². Reef fish species richness was also very low, between 7.5 and 29.3 species.

The exposed southern side of the Lape FHR may be in better condition but it is data deficient.

*For additional details on this SMA please read the Asian Development Bank 2016 Vava'u SMA baseline survey report.

Ko e nofo'anga 'o e 'ika
Ko e me'atokoni 'a e 'ika
Ko e lahi 'o e 'elia tapu
Ko e lahi 'o e 'iaka
Ko e 'elia fakahihifo 'o e 'elia tapu 'o Ha'atafu fakataha mo hono feo moe lahi ma mo masai 'oku mahu 'unga ke tauhi mo tokanga'i koe halafonionga ki he tauhi mo fakahoko.
The Lofanga SMA contains two FHRs, one on the peninsula, where live coral cover was 1.6%.

Adult food fish abundance inside the Lofangai FHR was 491.7 fish/km², one of the highest sites measured anywhere in the Kingdom. Reef fish diversity at this site was 49.8 species, also one of the highest recorded in the Kingdom. The gentle slope of the Lofangai FHR has some of the highest abundance and diversity of fish measured anywhere in the Kingdom.

Adult food fish abundance was very low (5.3 to 40 ika/km²) in the Makave SMA, as was reef fish diversity everywhere except near the old harbour (5.4 to 27.5 species).

The shallow fringing reef near the old harbour in Neiafu has high coral cover of Porites rus and Porites cylindrica, which both do well in turbid shallow environments.

Five sites were surveyed in the new Makave SMA as part of the 2017/18 national monitoring program and the 2017 Vava'u Ocean Initiative Marine Expedition. The reefs inside the Makave SMA are generally in very poor condition. There were many signs of Diadema sp. unichn outbreaks, likely from poor water quality from both the old harbour and the lagoon. These eat away at the reef matrix and destroy most of the corals. This was particularly severe at the southern edge of the peninsula, where live coral cover was 1.6%.

However, near the old harbour there were large stands of Porites rus and Porites cylindrica, which are both corals that do well in shallow and turbid water. Coral cover here was 21.5% and reef fish diversity was 36.5 species. Adult food fish abundance was very low (5.3 to 40 fish/km²), as was reef fish diversity everywhere except near the old harbour (5.4 to 27.5 species).

The shallow fringing reef near the old harbour in Neiafu has high coral cover of Porites rus and Porites cylindrica, which both do well in turbid shallow environments.

The Lofanga SMA contains two FHRs, one on the peninsula, where live coral cover was 1.6%. Coral cover ranged from very poor in the Lofangai FHR to 49.8 species, also one of the highest recorded in the Kingdom. Reef fish diversity at this site was 491.7 fish/km², one of the highest sites measured anywhere in the Kingdom. Reef fish diversity at this site was 491.7 fish/km², one of the highest sites measured anywhere in the Kingdom.

There were many signs of Diadema sp. outbreaks, likely from poor water quality from both the old harbour and the lagoon. These eat away at the reef matrix and destroy most of the corals. This was particularly severe at the southern edge of the peninsula, where live coral cover was 1.6%.

However, near the old harbour there were large stands of Porites rus and Porites cylindrica, which are both corals that do well in shallow and turbid water. Coral cover here was 21.5% and reef fish diversity was 36.5 species. Adult food fish abundance was very low (5.3 to 40 fish/km²), as was reef fish diversity everywhere except near the old harbour (5.4 to 27.5 species).

The shallow fringing reef near the old harbour in Neiafu has high coral cover of Porites rus and Porites cylindrica, which both do well in turbid shallow environments.

The shallow fringing reef near the old harbour in Neiafu has high coral cover of Porites rus and Porites cylindrica, which both do well in turbid shallow environments.

The shallow fringing reef near the old harbour in Neiafu has high coral cover of Porites rus and Porites cylindrica, which both do well in turbid shallow environments.

The shallow fringing reef near the old harbour in Neiafu has high coral cover of Porites rus and Porites cylindrica, which both do well in turbid shallow environments.

The shallow fringing reef near the old harbour in Neiafu has high coral cover of Porites rus and Porites cylindrica, which both do well in turbid shallow environments.

The shallow fringing reef near the old harbour in Neiafu has high coral cover of Porites rus and Porites cylindrica, which both do well in turbid shallow environments.

The shallow fringing reef near the old harbour in Neiafu has high coral cover of Porites rus and Porites cylindrica, which both do well in turbid shallow environments.

The shallow fringing reef near the old harbour in Neiafu has high coral cover of Porites rus and Porites cylindrica, which both do well in turbid shallow environments.

The shallow fringing reef near the old harbour in Neiafu has high coral cover of Porites rus and Porites cylindrica, which both do well in turbid shallow environments.

The shallow fringing reef near the old harbour in Neiafu has high coral cover of Porites rus and Porites cylindrica, which both do well in turbid shallow environments.
The Mango FHR has very healthy coral reefs, with the most adult food fish anywhere in the Kingdom and very high coral cover and reef fish diversity.

The coral reefs inside the Manuka SMA have been heavily damaged, likely from nutrient run of from Fanga’uta lagoon and large numbers of Diadema species which have destroyed the reefs.

For additional details on the SMA please read the 2017 Vava’u Ocean Initiative Marine Expedition interim report.
The coral reefs inside the Matuku SMA and FHR were consistently in the very good condition. Coral cover was high at both of the two sites surveyed (43.7 and 49.5%). Likewise, reef fish diversity was also very high at both sites (47.3 and 49.5 species). Adult food fish abundance was moderate (93.3 to 127.5 fish/km²). The overall good health of the reefs inside the Matuku SMA are likely due to environmental conditions. Clean oceanic currents will reduce the effects of coral bleaching and there was no immediate evidence of cyclone damage.

The reefs inside the Matuku SMA have both high coral cover and reef fish diversity.
The Muitoa SMA is very exposed and stretches as a fringing reef before dropping steeply into deep water.

The coral reefs around Muitoa‘one and Ofolanga island are in very good condition, with extensive reef habitat and clear oceanic water.

The Muitoa SMA is the northern most SMA in the Ha‘apai ribbon islands. Two sites were surveyed along the inner edge of the reef. The outer edge of all the Ha‘apai ribbon islands was too exposed for divers to survey.

Adult food fish abundance was moderate inside the FHR (136.7 fish/km²) but very high inside the SMA (208.3 fish/km²). Reef fish diversity was also high inside the SMA (42.25 species), but low inside the FHR (28 species). Coral cover was high at both sites inside the SMA and FHR (39.8 and 41.3%).

The coral reefs around Muitoa‘one and Ofolanga island are in very good condition, with extensive reef habitat and clear oceanic water.

There are two FHRs inside the Muitoa‘one SMA, which also covers Ofolanga Island. The reefs around both islands are in very good condition and have extensive reef habitat. This environment is characterized by high wave energy and clear and clean water. The extensive fringing reefs drop rapidly into deep water.

Adult food fish abundance was very high, particularly around Ofalanga (21.9 to 38.7%). Reef cover was low around Muitoa‘one (9 to 12%) and diversity was also very high (38 to 49.8 species). Coral around Ofalanga (552.5 to 651.7 fish/km²) tu‘unga fakafiemalie. Ko e tu‘unga faka‘atakai ‘o e hakau takai ‘i he ongo motu ni ‘oku ‘i he Ha‘apai ribbon islands was too exposed for divers to survey.

Adult food fish abundance was moderate inside the FHR (136.7 fish/km²) but very high inside the SMA (208.3 fish/km²). Reef fish diversity was also high inside the SMA (42.25 species), but low inside the FHR (28 species). Coral cover was high at both sites inside the SMA and FHR (39.8 and 41.3%).

The coral reefs around Muitoa‘one and Ofolanga island are in very good condition, with extensive reef habitat and clear oceanic water.

Ko e tu‘unga mo‘uilelei ‘o e feo ‘i he hakau takai ‘i he Tu‘u ki he tafa‘aki faka-Tokelau ‘o e ‘otumotu Ha‘apai. Ko e ‘elia ‘e 2 na‘e savea! 1 loto i he tata‘ota aki hakau, ‘o ‘ikau kau ai ngaahi tafa‘aki ki tu‘a he ‘oku fu‘u hanga ia ki tu‘a ki he malu mo e hao ‘o e kau uku na‘a nau hango‘ako e savea.

Ko e tafa‘aki hakau, ‘o ‘ikai kau ai ngaahi tafa‘aki ki tu‘a he ‘oku fu‘u hanga ia ki tu‘a ki he malu mo e hao ‘o e kau uku na‘a nau hango‘ako e savea.
Initiative Marine Expedition Interim Report.

Species). Coral cover inside the lagoon was low to moderate (27.7 to 175.5 fish/km²), although still low. Reef fish species richness was very low within the lagoon (21.3 to 26.6 species) and greater on the outer reefs (95.5 to 165.5 fish/km²). Adult food fish abundance was low inside the lagoon (2.2 to 40 fish/km²), although still low. Reef fish species richness was high at FHR (20.3 to 45.5 species), but low at the inner sites (23.6 to 25.8 species).¹

ADULT FISH

Abundance of food fish

Number of adult food fish
per km²

FHR
SMA

95
5.84 km²
8.64%
0.92 km²
11.1%
15.8%

FHR Sites
SMA Sites

POPULATION
AREA OF SMA
% Reef of SMA
AREA OF FHRs
% Reef of FHR
FHRs as % of SMA

SMASites
FHR Sites

Five sites were surveyed in the Ofu SMA as part of the 2017/18 national monitoring program and the Asian Development Bank 2016 baseline SMA surveys. The reefs in the Ofu SMA were in very poor condition, with large outbreaks of the Diadema sp. sea urchin. Coral cover was less than 1%, with very few live corals observed anywhere. The poor condition of the reefs here is likely because of runoff from lagoon, which has made many sea urchins grow. These destroy the reef and kill any newly settled corals. This is a pattern that is also present near the Fangataufa lagoon in Tongatapu. It is very important for water quality to be improved at these locations.

Abundance of food fish

Number of adult food fish
per km²

FHR
SMA

117
5.35 km²
10.8%
0.29 & 0.38 km²
20.3%
13.6%

FHR Sites
SMA Sites

POPULATION
AREA OF SMA
% Reef of SMA
AREA OF FHRs
% Reef of FHR
FHRs as % of SMA

SMASites
FHR Sites

Six sites were surveyed in the proposed Nuapapu SMA as part of the Asian Development Bank 2016 baseline SMA surveys, the 2017 Vava'u Ocean Initiative Marine Expedition and the 2017/18 national monitoring program. The inner reef areas are sheltered and lagoon-like, with scattered reefs. The outer reef is a shallow, narrow platform that drops off into deep water.

Benthic habitat coverage

Ko e nofo'anga 'o e 'ika

Ko e lahi 'o e me'atokoni 'a e 'ika

Ko e laka mamaha 1 he 1 lahi 'o e hakau 'o Nuapapu.

Ko e 'elia mamaha 1 he 1 lahi 'o e hakau 'o Ofu.

Ko e 'elia mamaha 1 he 1 lahi 'o e hakau 'o Vava'u ofi 'i Fanga'uta Tongatapu. 'Oku fu'u mahu'inga pea fakatupunga ai mo e ngaahi feitu'u ofi 'i Fanga'uta Tongatapu. 'Oku fu'u mahu'inga pea 'a e ma'a 'o e tahi 'i he ngasa'i feiti'u ni.
Adult food fish abundance was very low (4.4 to 80 fish/km²) at all sites surveyed inside the Olo’ua SMA. This became deep walls and past Swallows Cave (95-110 fish/km²) also observed here. Eight sites were surveyed inside the proposed Otea SMA as part of the 2017/18 national monitoring program and the Asian Development Bank 2016 SMA baseline survey. Shallow fringing reef habitat dominated this area in front of the village. This became deep walls towards the end of the point and around past Swallows Cave. The shallow area to the southeast, known as Japanese Gardens, was dominated by sandy habitat and many coral boulders. Crown of thorns starfish were also observed here.

Adult food fish abundance was low in front of the village (161.7 fish/km²), but higher at the end of the point and past Swallows Cave (95-110 fish/km²). Reef fish diversity was low, to moderate throughout the SMA (22 to 37.5 species). Coral cover was very low at all sites surveyed (3.3 to 13.7%).

Benthic habitat coverage

<table>
<thead>
<tr>
<th>SMA</th>
<th>% Reef of SMA</th>
<th>AREA OF SMA</th>
<th>% Reef of FHR</th>
<th>AREA OF FHR</th>
<th>FHR as % of SMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olo’ua</td>
<td>4.3%</td>
<td>2.88 km²</td>
<td>1.0%</td>
<td>0.42 km²</td>
<td>14.6%</td>
</tr>
<tr>
<td>Otea</td>
<td>4.2%</td>
<td>2.77 km²</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

For additional details on the SMA, please read the Asian Development Bank 2016 Vava’u SMA baseline survey report.
One site was surveyed along the outer edge of the Pangaimotu FHR, near the shipping channel. A minimum of four replicates are surveyed at each site. While the area closer to the Pangaimotu resort is mainly sandy bottom, the outer edge of the reef is a steep drop into deeper water with high current flow. This is also a busy shipping channel. Adult food fish abundance was very high (368.3 fish/km²), as was reef fish diversity (41.5 species) and live coral cover (34.5%).

Abundance of food fish
Ko e lahi 'o e me'atokoni 'a e 'ika

Number of adult food fish

<table>
<thead>
<tr>
<th>Number of adult food fish</th>
<th>FHR Sites</th>
<th>SMA Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>375</td>
<td>375</td>
<td>375</td>
</tr>
<tr>
<td>350</td>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>325</td>
<td>325</td>
<td>325</td>
</tr>
<tr>
<td>300</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>275</td>
<td>275</td>
<td>275</td>
</tr>
<tr>
<td>250</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>225</td>
<td>225</td>
<td>225</td>
</tr>
<tr>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>175</td>
<td>175</td>
<td>175</td>
</tr>
<tr>
<td>150</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>125</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>75</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

Diversity of reef fish
Ko e ngapi 'i he ika ʻia ma he hakau

The coral reef along the northern edge of the Pangaimotu FHR slopes steeply down into deeper water along the edge of the shipping channel.

Ko e hakau feso 'i he tataki faka-Tokelau 'o Pangaimotu, 'oku hifo hangataonou ki lalo ki he tahi floketo 'o e 'alu 'anga vaka.
The sheltered condition of these reefs from open ocean swell and current may limit flushing by cooler water and exacerbate coral bleaching, driving the observed trends.

The abundance of adult food fish was moderate (155 fish/km²), as was reef fish diversity (32.3 species). Coral cover is a pattern that is present along the whole length of the Fanga'uta lagoon. Coral cover was 12.1% and dominated by Porites bommies. Low coral cover is a pattern that is present along the whole length of the Fanga'uta lagoon. Coral cover was 12.1% and dominated by Porites bommies.

One site was surveyed along the outer edge of the proposed Talafo'ou SMA. The reefs inside the proposed Talafo'ou SMA were in poor condition and very turbid due to runoff from the Fanga'uta lagoon. Coral cover was 12.1% and dominated by Porites bommies. Low coral cover is a pattern that is present along the whole length of the Fanga'uta lagoon. Coral cover was 12.1% and dominated by Porites bommies.

The reefs inside the proposed Talafo'ou SMA were very turbid from the lagoon and dominated by large Porites bommies.
Four sites were surveyed within the Talihau SMA as part of the 2017/18 national monitoring program and the Asian Development Bank 2016 SMA baseline surveys. The village is surrounded by sandy slopes with little coral cover and large rubble fields. At all sites adult food fish abundance was very low (0 to 23.3 fish/km$^2$), as was reef fish species richness (7.3 to 23.8 species).*

*For additional details on this SMA please read the Asian Development Bank 2016 Vava’u SMA baseline survey report.

Two sites were surveyed around the proposed Taoa SMA as part of the 2019 VEPA baseline SMA monitoring. The abundance of adult food fish was extremely low (0.1 fish/km$^2$), and reef fish diversity was low (17.5 species). Coral cover was low to moderate, with occasional patches of *Porites rus* and *Porites cylindrica*, which both do well in turbid environments.

As a school of juvenile parrotfish swim along a shallow slope within the proposed Taoa SMA.

The Talihau SMA is mostly comprised of sand and small boulders with little live coral cover.

Ko e ‘elia ‘e 4 na’e savea’i ‘i he Feitu’u Pule’i Makehe (SMA) ‘o Talihau ‘i he 2017/18 lolotonga hono muimui fakalukufua ‘o e polokalama pea mo e 2016 ‘e he poloseki ‘a e Pangike Fakalakalaka ‘o ‘Esia. Ko e SMA ko eni ‘oku lahi takatakai’i ‘e he ‘one’one pea mo e haonga a’i pe ‘o e hakau pea mo e ngaahi maka/punga lalahi.

Ko e ‘elia ‘e 2 na’e savea’i ‘i he Feitu’u Pule’i Makehe (SMA) fakaangaanga ‘o Taoa ‘i he 2019 e he VEPA. Ko e tokolahi ‘e e ika na’e holo ‘apito (6.1 fish/km$^2$) kae pehe ki he tanae o leali ki he taka ki he fakafemi, pea ‘asi mo e kalasi ‘o e feo ‘oku. Vai’a ko e Pontes rus mo e Pontes cylindrical, ko e ono ki he kalasi ni ‘oku na tava matu’uaki ‘a e ‘ata’ata ‘oku ‘uili e tahii.
Nine sites were surveyed within the Taunga SMA and FHR as part of the 2017/18 national monitoring program and the 2017 Vava'u Ocean Initiative Marine Expedition. The area in front of the village and along the western side was dominated by rubble flats and sandy areas. There was evidence of widespread cyclone damage in the recent past, and very low live coral cover.

Adult food fish abundance was very high along the outside of the lagoon is dominated by shallow sandy habitat with lots of rubble and very little live coral.

The water inside the Tefisi lagoon was turbid, but with occasional bommies of Porites rus were present, which do well in turbid conditions.

Adult food fish abundance was low in both the SMA and FHR areas (16.6 to 35.8 fish/km²), as was reef fish diversity (11.92 to 15.7 species).*

**For additional details on this SMA please read the 2017 Vava'u Ocean Initiative Marine Expedition Interim Report.**

---

**TAUNGA SMA 2013 VAV**

**TEFISI SMA 2020 VAV**

---

*For additional details on this SMA please read the 2017 Vava'u Ocean Initiative Marine Expedition Interim Report.*
The Uiha SMA has two FHRs, one in front of the village and a second along the small island to the north. This SMA is characterized by shallow fringing reefs and a sandy bottom, with large coral bommies further from shore.

Adult food fish abundance was very low (1.7 to 43.3 fish/km²), and much lower than the well-established Felemea FHRs to the south, which are having a large effect. Reef fish diversity was moderate (32.3 to 34), pea ko e tupulaki 'o e feo na'e mei he 'I he kalasi kehekehe 'o e ika, na'e holo 'aupito (26.7 - 44.4 ika/km²). Reef fish species richness was also very low (15 to 31 species). Coral cover was moderate to high (20.1 to 47%).

The shallow fringing reefs around Uiha were characterized by high coral cover and a shallow sandy bottom.

The Utulei SMA has many bommies of the coral Porites rus, which thrives in more turbid conditions.
Four sites were surveyed inside the Utungake SMA as part of the 2017/18 national monitoring program and the Asian Development Bank 2016 SMA baseline surveys. No sites were surveyed inside the current FHR. Habitat along the coastline was dominated by sandy bottom and occasional patches of coral reef with moderate coral cover (25.9%).

Adult food fish abundance was low (21.7 to 95.5 fish/km²), as was reef fish species richness (21 to 26.8).

*For additional details on this SMA please read the Asian Development Bank 2016 Vava'u SMA baseline survey report.*
Section 7. Key questions, limitations and recommendations

Overall, both the Ministry of Fisheries and Tongan communities should be proud of the positive results of the SMA program. It has been no small task for the ministry or the communities to grow a program such as this from the first SMA in 2006 to over 50 a decade later. Furthermore, the information provided in this report now demonstrates for the first time that fish stocks are improving. Clearly, in many ways the program has been a success story for community-based marine management and should be seen as such both in Tonga and abroad.

However, these results should also be considered with caution. Ultimately the most fundamental component of the SMA program is more fish. This is made clear by the primary objectives of most SMA management plans: improve fish catch, improve livelihoods, increase fish abundance and decrease environmental degradation. Likewise, the perceived benefits of SMAs by community members are also largely based on ecological trends: secure access to more fish, increase fishing catches, spend less time fishing and sustain marine resources. The extensive surveys and analysis included in this report demonstrate that while this has occurred, it is to a large extent that people may realize. While fish stocks have improved inside some FHRs, there is very little evidence for any improvements inside the SMAs, where fishing is still allowed.

A serious consideration therefore is that if improvements inside the SMA areas (non-FHR) are not eventually demonstrated, support for the program may erode. However, it may be that current levels of fishing pressure inside the SMAs are preventing recovery in these areas. Therefore it is essential to continue improving marine management in Tonga, either as part of, or in addition to the SMA program. Likewise any backwards steps, such as temporarily opening the FHRs to harvesting, or dewetting any SMAs or FHRs should be viewed with extreme caution.

In the sections that follow we summarize the main findings of these surveys, address key questions likely to arise from the results, discuss limitations of the SMA program and provide recommendations for future action.

Box 2. Focusing on long-term goals and the importance of monitoring

It is important to recognize that the long-term goal of the SMA program rests on having a healthy ecosystem and a healthy community, not just more SMAs. SMAs are only one tool that is being used to reach the desired objectives of the Tongan communities and Ministry of Fisheries. SMAs can be expensive, and donors may spend lots of money in implementation. But ultimately no matter how many SMAs are implemented, the only way to demonstrate the success of the program is through the difference it makes to its intended or unintended outcomes. This is why monitoring is essential.

Ultimately, unless changes to the ecosystem are observed, many other benefits and objectives of SMAs (e.g. community empowerment and ownership, food security) may erode. This can be further exacerbated by broken promises to communities if they are given unrealistic expectations of what the outcomes will be. Therefore ongoing monitoring is a very necessary part of the program, both to demonstrate to donors that their efforts have been worthwhile, and to show communities what is actually happening from their efforts. If we only focus on implementing and not on if and how they are achieving the changes that they are meant to, we risk confusing the means with the end.

Question 1: Why are fish recovering inside some FHRs and not others?

The surveys clearly show that fish stocks are recovering in the FHRs of some communities and not others. There are three primary reasons why this might be the case:

1. Poor enforcement/regulation

Fish stocks only begin to recover when fishing pressure changes. This means there has to be sufficient change in the behavior of people within and beyond the SMA communities. If fishermen continue to fish inside the FHR then it is unlikely that any recovery will occur.

For example, in discussions with the Fafa island FHR, it became clear that fishermen from Nuku’alofa were often still entering the FHR in order to fish. This is therefore a likely reason why there is no evidence of recovery of fish abundance inside the Fafa island FHR. In addition, the boundaries of the FHRs need to be clear to members of the community. The Nomuka and Alatua FHR have very visible boundaries in front of the village that are strictly enforced and monitored. It is easy to see if someone is fishing where they should not be. In contrast, from the village it is not clear where the Ha’afeva FHR is. During the surveys we visited the Ha’afeva village and found that the SMA sign was also no longer visible and when asked people were unsure about the location of the FHR. Unless people are aware of the FHR location it is unlikely that fishing will cease and fish will be able to recover.

2. Small size of the FHR

Many studies have shown that larger no-fishing areas have greater recovery than smaller ones. This is because the larger the area, the greater the number of fish can grow to maturity inside its boundaries and the greater the availability of space for species to reproduce. Many FHRs in Tonga are extremely small, and too small to contain the home ranges of target fish species. However, despite this consideration fish abundance did recover in some very small FHRs (e.g. Felemea). While this may be the case broadly, it was not clear if the larger FHRs in Tonga were having a greater effect.

3. Poor quality habitat inside the FHR

Fish Habitat Reserves will only work if there is enough good quality habitat within the area for fish stocks to recover. For example, if the FHR is placed over large areas of sand, where there wouldn’t be many fish even if no one was fishing there, then it would be unlikely to show any recovery. Care should therefore be taken to configure FHRs on high quality habitat where there will be the greatest recovery of fish stocks only occurs when fishing pressure is reduced. In addition, the greatest and most rapid changes will occur where there is the greatest change to fishing pressure. Therefore it would be expected that fish stocks would begin to show greater signs of recovery faster inside the FHRs over the SMAs, where fishing is still allowed. Furthermore, it may be that fishing pressure inside the SMA areas has remained the same, just who is doing the fishing has changed. Restricting outside access to a reef may not change the total amount harvested, just who harvests it (Polunin, 1984). Whether or not this is considered negative depends on the objectives of the community. If the goal is to foster a sense of ownership over local reefs then it may be acceptable that fish stocks are not recovering inside the SMAs. However if the objective is to also increase fish stocks in these areas, then additional management actions may also be required, or it may take much longer for smaller changes to be observed. These could include gear restrictions or limiting certain destructive fishing activities, such as night time spearfishing.


Question 2: Why has recovery only occurred primarily inside the FHRs and not the SMAs?

Recovery of fish stocks only occurs when fishing pressure is reduced. In addition, the greatest and most rapid changes will occur where there is the greatest change to fishing pressure. Therefore it would be expected that fish stocks would begin to show greater signs of recovery faster inside the FHRs over the SMAs, where fishing is still allowed. Furthermore, it may be that fishing pressure inside the SMA areas has remained the same, just who is doing the fishing has changed. Restricting outside access to a reef may not change the total amount harvested, just who harvests it (Polunin, 1984). Whether or not this is considered negative depends on the objectives of the community. If the goal is to foster a sense of ownership over local reefs then it may be acceptable that fish stocks are not recovering inside the SMAs. However if the objective is to also increase fish stocks in these areas, then additional management actions may also be required, or it may take much longer for smaller changes to be observed. These could include gear restrictions or limiting certain destructive fishing activities, such as night time spearfishing.


Box 3. Summary of main findings:

SMA Recovery

1. Fish stocks are improving in roughly half of the older FHRs in the country.
2. The diversity of reef fish is also improving in roughly half of the older FHRs in the country.
3. There is limited evidence of any recovery inside the SMA areas (outside the FHRs), where fishing is still allowed by the community.

Ecosystem health

1. The coral reefs and reef fish fishery in Vava’u is in noticeably worse condition than elsewhere in the country.
2. There is extensive evidence of damage to reefs from coral bleaching in Vava’u and northern Ha’apai.
3. There is extensive evidence of cyclone damage in southern Vava’u and northern Ha’apai.
4. Poor water quality appears to have damaged many of the reefs around lagoonal areas in both Vava’u and Tongatapu.
Section 7. Key questions, limitations and recommendations

Limitations of the Special Management Area program

While this report has clearly demonstrated many merits of the SMA program, it is important to note that it is not a panacea for marine conservation and management. Below we list ten limitations of the SMA program. In addition, a review by Dr. Bob Gillett on the SMA program in 2017 provides specific details on some of the overarching issues with costs, implementation and streamlining of the program.

1. Anticipated changes are not occurring in some older SMA communities. As detailed above, some FHRs and almost all SMAs are not having an effect. This is likely due to community issues with enforcement and management. Recovery is a slow process, and in order for changes to occur communities must consistently follow the rules of their management areas. Otherwise these risk becoming ‘paper parks’, which only contribute to national targets without realizing any change on the ground.

2. Some threats cannot be addressed solely by SMAs. Climate change is an issue that requires large-scale changes in international behavior. As such, SMAs and FHRs are unlikely to protect reefs from climate change related threats such as cyclones or coral bleaching. SMAs act by changing fishing pressure, and while this may boost the resilience of a reef to climate change related impacts, it cannot prevent them. Likewise, the openness of the marine environment means that at a local level SMAs will not limit the amount of pollution from land based runoff that is affecting reefs.

3. SMAs are only one tool among many. Many additional methods also exist to achieve the desired objectives of the SMA program, and it is important not to rely too heavily on only one. Jupiter et al. (2014) outlined six strategies that could be used to achieve eight different objectives from locally managed marine areas. These were: permanent closures (e.g. FHRs), periodically-harvested closures, species restrictions, gear restrictions, access restrictions (e.g. SMAs) and alternative livelihood strategies. Different combinations of these can be used to achieve the objectives of: increasing long-term sustainable yield, increase efficiency of harvests for short-term yield, maintain biodiversity and ecosystem function, maintain biomass and breeding populations, enhance economy and livelihoods, maintain or reinforce customs, assert access rights and increase community organization, cohesiveness and empowerment.

4. Many FHRs are very small. Currently there is no minimum size, nor minimum percent area of the SMA, that is required for the FHRs. Consequently some FHRs may be too small to realistically expect changes to occur. For example, three FHRs in Vava’u (Koloa and two FHRs at Matamaka) are each less than .1 km². While some small SMAs in Tonga have an effect (e.g. Felitama, 0.44 km²), where the lower limit is on the minimum size that will still be effective in unclear. At this stage, there should be a push for FHRs to be as large as possible.

5. Discussion over periodic harvesting inside FHRs. FHRs are the cornerstone of the SMA program. Without them it is unclear whether any ecological recovery, and hence its ability to hinder down socioeconomic impacts, will occur. Some discussion has occurred over the possibility of opening up the FHRs to periodic harvesting. This is strongly discouraged. Recovery inside no-fishing areas can take many years and very little harvesting effort is needed to undo years of progress. Most studies on periodically harvested areas in the South Pacific show that as soon as any harvesting occurs, stocks revert to pre-protection levels. Harvesting the FHRs will also minimize the long-term benefits to the SMA communities, as once these areas reach carrying capacity they will act as a source of fish to the SMA areas through spill-over. Ultimately, great care should be taken to minimize any harvesting inside the FHRs.

6. Clarification over specific rules. Issues have been raised in Tonga over specific rules of what can and cannot be done inside SMAs and FHRs. Some FHRs have been placed around islands that tourist operators frequent, and are now being told they cannot enter these areas. Likewise many yachts in Vava’u frequently anchor inside SMAs, and occasionally FHRs, which has also created tension between SMA communities and transiting vessels. Clarification on the specific rules should be made available to all concerned. In general it is the view of the authors that preference be given to solutions that are likely to maximize the health of the ecosystem for the communities benefit.

7. Displacing fishers from larger towns and inland communities. This issue was also raised by Gillett (2017), who noted that landlocked communities (and those from larger towns with no SMAs) will have less access to coastal fishing areas as more SMAs are implemented. Several recommendations to mitigate this issue were: i) to ensure adequate communication occurs between coastal and landlocked communities, ii) implement district level SMAs, which include multiple (both coastal and landlocked) communities and iii) maintain certain areas (e.g. land adjacent to King’s land and urban areas) as open access.

8. SMAs will not help ecosystems away from communities. It is important to note many SMAs are only based around communities. Therefore they are unable to provide support for areas further from human populations. Additional management, such as marine protected areas, may be necessary for this.

9. FHRs may disproportionately affect different groups. In Tonga women primarily undertake reef gleaning for invertebrates. Many FHRs are situated close to villages and in intertidal areas, and this may disproportionately affect gleaning activities.

10. Costs. A review of the SMA program by Gillett (2017) estimated the cost per SMA of implementation as US$ 28,191 for Vava’u, US$ 21,731 for Ha’apai and US$ 8,118 for Tongatapu. This estimate made SMAs some of the most expensive community managed areas in the South Pacific


From top to bottom: i) The volcanic island of Kao in Ha’apai. There is no village on this island therefore other management apart from SMAs will be necessary. ii and iii) A fish fence and gill net. In addition to SMAs, regulations regarding size and gear restrictions will be important for improving fish stocks. iv) Coral colonies such as this large Porites bommie can be hundreds of years old. However, coral bleaching from climate change is damaging Tonga’s coral reefs both within and beyond the SMA boundaries.
Section 7. Key questions, limitations and recommendations

Recommendations

Based on the results of this report, below are nine recommendations for marine management in Tonga:

1. FHRs should be larger, both in absolute terms and relative to the size of the SMA (for example 30%).

2. FHRs should be configured over the best quality habitat within each SMA. This will ensure that the FHR has the greatest possible recovery and the greatest chance to export these benefits to the SMA areas.

3. Fish Habitat Reserves should remain closed permanently to all extractive or damaging activities. It can take many years for recovery to build up and spill over to occur, and only days to reduce this recovery to its pre-existing state.

4. Additional management strategies should be implemented in conjunction with the SMA program. These include other methods by which to reduce fishing effort inside the SMAs, such as gear restrictions or minimizing damaging fishing practices such as night-time spear fishing.

5. Management should be improved beyond the SMAs. Additional management strategies should be implemented beyond the borders of the SMAs. While marine protected areas may be an option, in Tonga these have failed in the past due to the limited ability of a centralized government to enforce them. Therefore other management strategies may be better suited for Tonga. These could include banning or limiting certain gear types (e.g. gill nets of a specific size) or activities (e.g. night-time spear fishing).

6. Degazzeting SMAs should be prevented. It has taken many years for the SMA program to develop into what it is today. Unfortunately, this progress could be undone relatively quickly if enthusiasm for the program wains. If a single SMA is degazzeted then this may open a pandora’s box, whereby confidence in the program is reduced and a precedent is set for going back to the previous, open access state.

7. Water quality around the lagoons and estuarine areas of Vava’u and Tongatapu should be seriously addressed. Based on the surveys it appears that poor water quality around the lagoonal areas of Tonga may be affecting the health of the marine ecosystem. While only correlative, many dead reefs with large urchin outbreaks of the Diadema sea urchin were only recently discovered near the mouths of lagoons in both Vava’u and Tongatapu. Large outbreaks of the Diadema sea urchin were only found in these areas and they may prevent the settlement of new coral recruits through their grazing. While these results are still tentative, and we are unsure of the mechanisms involved, it nonetheless warrants serious consideration.

8. An ongoing national monitoring program should be implemented. Many funders are putting money towards expanding the SMA program, but few resources are available for ongoing monitoring. Monitoring is the only way to clearly demonstrate if the objectives of the program are being achieved. An emphasis should be placed on good quality data, as poor data may not only provide ambiguous results, but also preclude good quality data from being collected or result in double handling, thereby increasing costs. While trained individuals should therefore be used for data collection, there may be ways of minimizing the costs. A dedicated team of three individuals, with support from fisheries and a small vessel, could complete detailed surveys and reporting of one island group per year, in addition to other tasks. This would result in a national monitoring program that covers the whole country on a rolling three-year basis.

9. Socioeconomic monitoring could be integrated into the national census. Socioeconomic monitoring is important for understanding whether the livelihoods and health of communities are changing as a result of the SMA program. However, with the expansion of the program this will become an expensive and labor intensive procedure. One alternative, suggested in the 2017 review by Dr. Bob Gillett, would be to integrate the socioeconomic monitoring into the national census. There are three reasons for this. Firstly, many questions are similar in nature and this will minimize double handling and improve efficiency. Second, additional questions not currently in the census could potentially be implemented with minimal difficulty into section H (Agriculture and Fishing). Lastly, demonstrating change from management requires sampling both SMA and non-SMA communities, which can be difficult to do when the focus is primarily on the SMAs. The national scale of the census minimizes this issue and potentially allows for proper counterfactual estimations. Further investigation should occur into the feasibility of integrating these two programs.

Ultimately, these recommendations are made with the intent of benefiting the communities and ecosystems of Tonga. They are suggestions for how to strike a balance between Tongans today and future generations.
Section 8. Concluding remarks

In 2017 a review of the SMA program concluded that while most SMA communities were very enthusiastic about the benefits of the program, at the time it was not possible to substantiate these claims with quantitative data (Gillett 2017). These surveys now demonstrate that this program is on the way to achieving its objectives.

It has been no small feat for Tonga to change from a completely open access fisheries system to a national network of locally managed marine areas and over 50 no-fishing zones. This transformation is suggested to be the biggest change in Tonga’s fisheries sector since the Royal Proclamation of 1887 and will likely to affect many more Tongan lives than any other fisheries event in the country (Gillett 2017).

However, change also takes time. It is very likely that in the next five years the Ministry of Fisheries will achieve its objective of establishing an SMA in close to 100% of coastal communities. This will mark the completion of the first step. From there the responsibility will lie with making sure that these tools are actually achieving the objectives they were designed for. It can take many years for ecosystems to recover from generations of overexploitation. Therefore we ask for patience when considering the changes required to sustain Tonga’s future generations. We are on our way...


Section 9. Appendices

Appendix A: Recommendations on how to use this resource for community consultations

This report is intended as a multi-use document for managers, stakeholders, communities and anyone with a broad interest in the SMA program. Therefore while certain challenges have arisen from trying to display this information clearly to various groups, we hope that it will nonetheless be useful to all involved.

If presenting this report to SMA communities then we feel that the most important sections to show are:
1. What is an SMA and FHR? (Page 1, Tongan Appendix C)
2. Objectives of the SMA program (Page 1, Tongan Appendix C)
3. Rules of the SMA program (Page 2, Tongan Appendix C)
4. How does an SMA and FHR work? (Page 3, Tongan Appendix C)
5. Overall map of the Tonga’s SMA network and the surveys completed (Page iv)
6. Individual SMA report (Two pages for older SMAs, one page for the newer SMAs)

The individual SMA reports have also been designed so they can also be printed as stand-alone leaflets or posters. However, copies of the entire report should also be made available to each SMA community for their use.

Appendix B: Articles for further reading

The aim of this section is not to exhaustively list all additional resources that could be read regarding the SMA program and community-based marine management in the South Pacific. Rather, it provides a concise set of articles that may provide useful additional information for those interested, particularly in Tonga. A comprehensive reference list is available at the end of many of these articles.


Govan, H. et al. (2009). Status and Potential of Locally-Managed Marine Areas in the South Pacific: meeting nature conservation and sustainable livelihoods through widespread implementation of LMMAs. SPREP/ WWF/WorldFish-Reefbase.


Malimali, S. (2013). Socioeconomic and Ecological Implications of Special Management Areas (SMAs) Regime in the Kingdom of Tonga. A thesis presented to the Bangor University for the degree of Doctor of Philosophy, School of Ocean Sciences, Bangor University. 235 pages.


Puha 1. Ngaahi Taumu'a mo e Tu‘utu‘uni ‘a e Polokalama Feitu‘u Pule‘i Makehe

Ko e ngaahi taumu’a ‘a e Polokalama Feitu‘u Pule‘i Makehe i Tonga:

1. Pule‘i ngaahi founga toutai
2. Fakatupulekina ‘a e me‘amo‘ui mo e ngaahi nofo‘anga ika ‘i loto ‘i he Feitu‘u Pule‘i Makehe ‘i Tonga, mo e ngaahi nofo‘anga ika ‘i loto ‘i he Feitu‘u Mamaha ‘i Tonga.

Ko e ngaahi Taumu’a mo e Tu‘utu‘uni ‘a e Polokalama Feitu‘u Pule‘i Makehe i Tonga:

Puha 3. Ngaahi teñifo ola ma‘ai i he tekum na ngaahi teñifo ‘i he ngaahi taumu'a ike ‘o e Polokalama Feitu‘u Pule‘i Makehe (SMA)

Ko e ngaahi Taumu’a ike ‘o e Polokalama Feitu‘u Pule‘i Makehe (SMA):

1. Tu‘unga ‘a e kalasi ‘o e ika ‘i he fekumi ‘a e ngaahi Taumu’a ike ‘o e Polokalama Feitu‘u Pule‘i Makehe, mo ngaahi Taumu’a ike ‘o e Polokalama Feitu‘u Pule‘i Makehe ‘i Tonga.

Taumu'a 'o e SMA & FHR ('Elia Tapu)?