NOAA GENERAL CORAL GRANT AWARD: NA10NMF4630067

FINAL REPORT

Title: Improved resource monitoring to support community-based marine protected area planning on Yap, Federated States of Micronesia.

Applicant Organization: Pacific Marine Resources Institute, Inc. (PMRI)
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Relevant Program Priorities:

(1) Fishing Impacts: Biological monitoring to evaluate management effectiveness, assess MPA effectiveness, and outreach to increase community support for regulations.

(2) Climate Change: Ecological assessments of coral community changes relative to climate change and the response of reef organisms to stressors.

Geographic Location: Yap State, Federated States of Micronesia, Western Pacific
Grant funds requested: $37,380
Matching funds and source: $37,570, Pacific Marine Resources Institute (PMRI) and Yap Community Action Program (Yap CAP)
Project start date: October 1, 2010
Project end date: Septermber 30, 2011

Summary of the project completed:

Common challenges for coral-reef conservation across Micronesia include understanding the spatial distribution of marine resources so that areas of significance can be identified; as well as translating complex ecological knowledge into rational insight. Community ownership and management of marine resources in Yap State, Federated States of Micronesia, underpins this need, which was collaboratively approached by PMRI and Yap Community Action Program.

Major coral-reef habitat types were initially examined as surrogates of species abundance and diversity patterns. While inner, channel, and outer reefs clearly held distinct assemblages, contrasting patterns were found. For corals, inner and channel reefs were most similar based upon the presence of large massive and branching species. On outer reefs, mean colony size and percent coverage decreased, however, diversity and evenness increased. In contrast, outer and channel fish assemblages had tight affinities, while inner assemblages were unique. These trends were due to declining abundances of all major fish, rather than any habitat-specific shifting of occurrences.

We used the initial characterization of Yap's reefs that was gained to assess the 'condition' of each site investigated, while accounting for inherent differences that are an artifact of environmental regimes (i.e., isolation upon the variance of interest, local stressors). This study defined 'condition' by integrating several ecological metrics that are known to be sensitive to human influence, while being sufficiently independent for their integration (*described in detail within the attached manuscript*). The results highlighted: 1) channel reefs that were under successful community-driven management, 2) outer reefs that had high resiliency from disturbance, and 3) inner reefs that were key habitats for juvenile humphead wrasse populations. Thus, condition indices were robust indicators of several themes of coral-reef conservation, beneficial to Yap and beyond. The results documented the current condition of coral reef assemblages across Yap, a framework for the placement of future MPA's, and the high-potential associated with community-based MPA success, in a manner that is digestible for traditional and modern management.

The specific outcomes for our project included robust ecological datasets pertaining to Yap's long-term coral monitoring efforts, capacity building for Yap CAP and community-based monitoring staff, preparation of a summary powerpoint highlighting key findings for ongoing community presentations, and the preparation of a peer-reviewed manuscript that is currently in review.

Introduction:

The numerous small island nations throughout Micronesia hold the most diverse and extensive coral-reef ecosystems that reside under the US flag. Despite their global significance, many jurisdictions lack adequate resources needed to monitor their marine resources, despite placing a high dependence upon them for subsistence and livelihood. In the case of Yap State, Federated States of Micronesia, a sound traditional knowledge of their marine resources has provided guidance for many community-based management programs; however, traditional knowledge and insight does not account for changes related to a warming climate and the effects of continued technological advances for resource exploitation. It therefore becomes desirable to augment traditional conservation practice with contemporary science that aims to effectively quantify the status and trends of marine resources under changing environmental conditions and management practices. These concepts formed the basis for our collaborative project between the Pacific Marine Resources Institute (PMRI) and Yap Community Action Program (Yap CAP).

Because Yap is a member of the freely associated states (FAS), little financial support is available to them from non-competitive, NOAA coral monitoring awards that are earmarked for US-affiliated jurisdictions (~$25K per year). While local governmental funding for environmental protection augments this award, insufficient funding exists to hire full-time technical staff to conduct monitoring, and even less for collaborative, trained scientific oversight of data analyses and reporting. Using this competitive award, our goals were not only to build upon the science surrounding Yap's coral-reef ecosystems, but also to build local capacity for the maintenance of sound long-term monitoring datasets. Our project specifically builds a spatial examination of Yap's coral-reef ecosystems, during which local capacity was built, monitoring program databases established, scientific insight gained, and knowledge was rationally digested for management interpretation and current use.

Work Completed:

Work completed under this project falls under four categories: 1) scientific insight and application, 2) capacity built, 3) products developed, and 4) outreach performed.

Scientific insight and application. We collected spatially robust datasets across Yap in conjunction with local monitoring teams (Figure 1). These datasets afford deeper insight into the habitat preferences of coral and fish populations (Figures 2 and 3). Subsequently, this project defined a measure of 'condition' using several ecological attributes of the coral and fish assemblages (Table 1, Figure 4, *see attached manuscript for full scientific details*). Condition was assessed spatially across each reef type, and a regression model was built to examine the degree to which human and natural drivers successfully predicted condition. We provide evidence that three contemporary themes of coral reef management were inherently encompassed within our criterion. Condition rankings highlighted reefs that were under successful community-based MPA management (Nimpal Area), that had high resiliency from disturbance, and that were key habitats for fish species of special concern (humphead wrasse and bumphead parrotfish),

without any prior assumptions or knowledge. It follows that condition was reciprocally predicted by an interactive term that included two measures related to human activity, fishing and MPA status, and one artifact of natural history, habitat size. Both the sensitivity to human influences and predictability of key ecological attributed suggest our defined condition can serve as a benchmark, against which current status and future trends can be evaluated.

In addition to the overall ecosystem assessment for prioritizing Yap's coral reef monitoring and conservation activities into the future, our project produced direct insight and outreach regarding the current status of MPA's. Specifically, our project addressed three items: 1) current status of Nimpal MPA that has been established since 2007-8, 2) recommend boundaries of Reey MPA based upon knowledge gained, and 3) recommend an approach for building a resilient network of MPA's.

Nimpal MPA was traditionally established through a series of community meetings and collaboration with Yap CAP, and in 2008, an official declaration was signed by all village chiefs (Site 12, Figure 1). Shortly after, a community-driven management planning process was held, which led to the recent completion of their official management plan in 2011. Through this project we conducted collaborative investigations of all existing datasets for Nimpal MPA, and provided a framework for the continued analyses of new data that continues to emerge. This work represented direct efforts from the awarded project, as well as a matching project identified in our proposal to produce a data analysis and interpretation guidebook. This guidebook developed a step-by-step process to assist local monitoring programs efficiently and accurately understand and interpret their data, and through this project we highlighted Nimpal MPA datasets as an independent exercise to help the entire region learn (Exercise 7, http://www.pacmares.com/Data_Workshop.html). These collaborative analyses highlighted excellent, initial success of the MPA in meeting the goals of enhancing fish biomass, analyzed for univariate and multivariate considerations both (Figure 5, also see guidebook available from the link above). In addition, the present analyses furthered that enhanced fish biomass translated to high ecosystem 'condition', as described above, higher than many other monitoring locations despite having much smaller habitat sizes and greater proximity to watershed discharge.

Reey MPA remains in the final stages of formally declaring their MPA and boundaries. Our investigations were centered upon both inner and outer reef (Sites 14 and 15, Figure 1). Our results indicated relatively low overall condition currently exists in both instances with respect to what currently exists around Yap (Figure 4), which was a probable consequence of unfavorable habitat availability (i.e., a lack of a channel connecting inshore and outer reef waters, coupled with a lack of deeper lagoon water). Given the conditions revealed, it was jointly recommended with YapCAP to create MPA boundaries that encompass all major habitat types, as connectivity between them was relatively limited by natural features. Currently, MPA boundaries have been established in accordance with these recommendations, and management planning activities are underway.

Finally, overall MPA network designs benefitted from the big-picture understanding generated by this project. Our approach was to first define where high integrity ecosystems naturally exist on Yap (Figure 4), and identify key ecological criteria for promoting a MPA network structure into future planning. Stated above, we identified sites where resiliency from disturbances was high as a probable consequence of favorable natural conditions (*see attach manuscript*), and sites that held unique abundances of species of special concern (i.e., Napoleon wrasse) as indicators for future MPA placement. Our results indicate that all three major habitat types should be considered into an eventual integrated network to achieve optimal success, however remained focused upon specific locations of ecological integrity, without integrating concepts of geographic connectivity at the present time because of limited knowledge of surface currents and retention times. Finally, we used our results to translate site specific findings to each community to enhance their perspective on their resources, and their overall importance to Yap (Figure 6).

Capacity built. Capacity was built pertaining to all aspects of scientific monitoring, including the generation of sound field data, building efficient databases, processing and analyzing data, and translating findings into rational insight. Field data was collaboratively collected by experienced scientific experts in the field alongside local monitoring teams. Data were entered into databases each night and feedback was provided on a daily basis to local team members pertaining to taxonomy and scientific methods where needed. Yap already has a very strong foundation for robust scientific monitoring, and field training was mainly focused upon taxonomy and technical aspects of methods employed. Database finalization was conducted shortly after fieldwork was completed. All local team members collaboratively entered and examined datasets with Dr. Peter Houk, prior to formal scientific analyses. Initial examinations were focused upon quality assessment of the datasets and initial findings. Figure 7 shows an example of the databases generated for Yap. Subsequently, analyses were conducted pertaining to the attached manuscript that was developed in conjunction with the head of Yap's coral monitoring program (Vanessa Fread).

Notably, through a matching grant awarded to PMRI, a data management workshop was held for all Micronesia coral-reef monitoring programs, referenced above. Data from numerous sources, including the present project, were utilized to advance the local capacity for database design, data interpretation, and formal analyses. While much has been gained, future trainings are still needed to improve upon and reinforce these skills.

Products and Outreach. A list of all products developed and outreach performed associated with this project is provided.

- Sound ecological datasets pertaining to fish, coral and macroinvertebrate assemblages around Yap
- Manuscript summarizing our scientific findings that will benefit coral-reef management on Yap and beyond
- Re-formatting of a major existing database pertaining to fisheries dependent datasets collected in FY 09, used for local interpretation and publication

(*separate study than the present, but database design was improved from the present project*)

- Graphic summaries of pertinent findings pertaining to MPA efficacy, future MPA designs, and the spatial distribution of current coral-reef ecosystem condition around Yap
- An analysis framework for the local monitoring program to assess MPA efficacy
- Community presentations (powerpoints) that have, and continue to be conducted across Yap to share findings and recommend management adaptation
- Knowledge-base that is currently being used in many Community Action Planning groups across Yap, as well as for continued coral reef monitoring

Conclusions:

This project concludes that a simple, thoughtful approach, combining several robust measures coral and fish populations provided a useful assessment of Yap's coral reefs, upon which management, monitoring, and specifically MPA design and effectiveness continues to build. In summary, we conclude that establishing an objective, repeatable index of coral ecosystem condition across Yap, and eventually across Micronesia, greatly enhances our ability to define conservation targets and progress towards meeting them.

Figure 1. A map of monitoring sites established and re-visited on Yap.

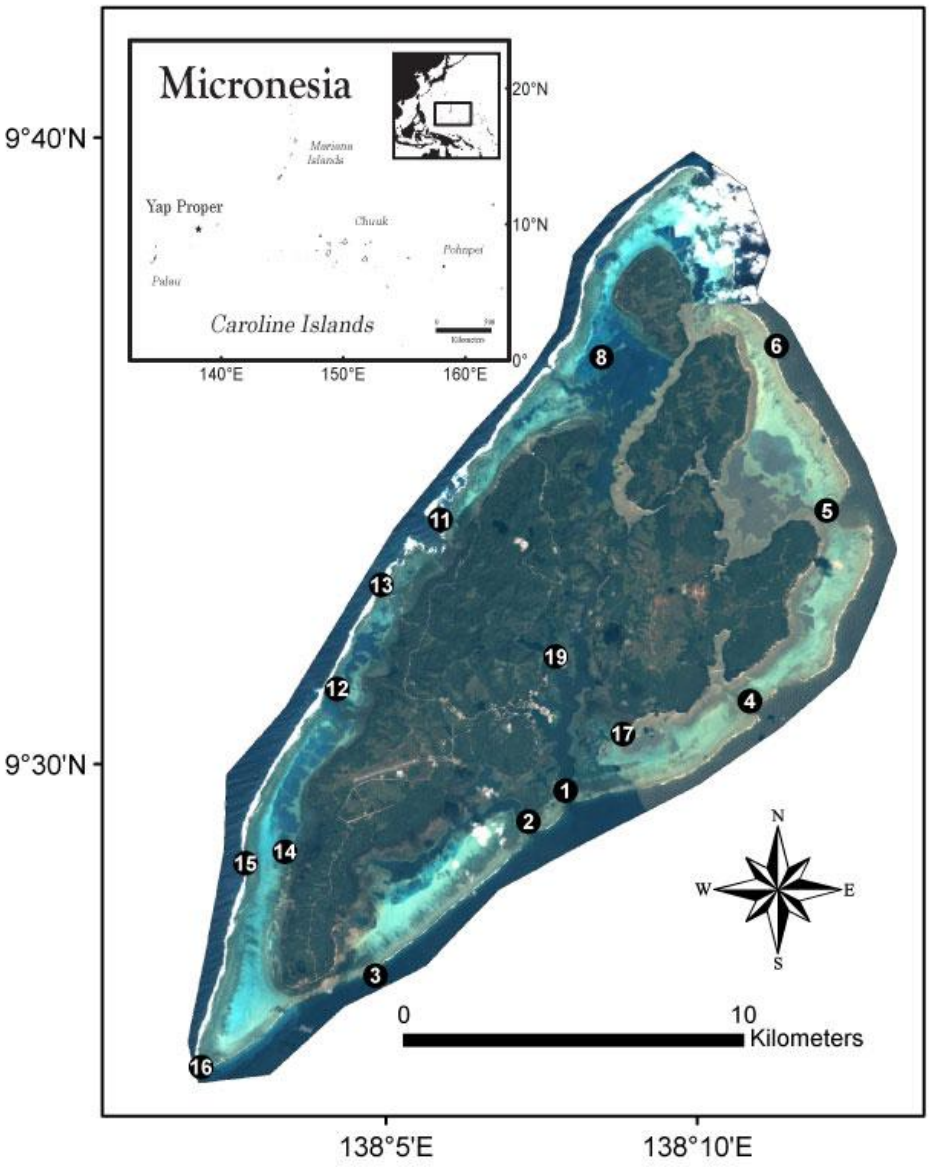

Figure 2. Distribution of dominant corals on Yap by reeftype.

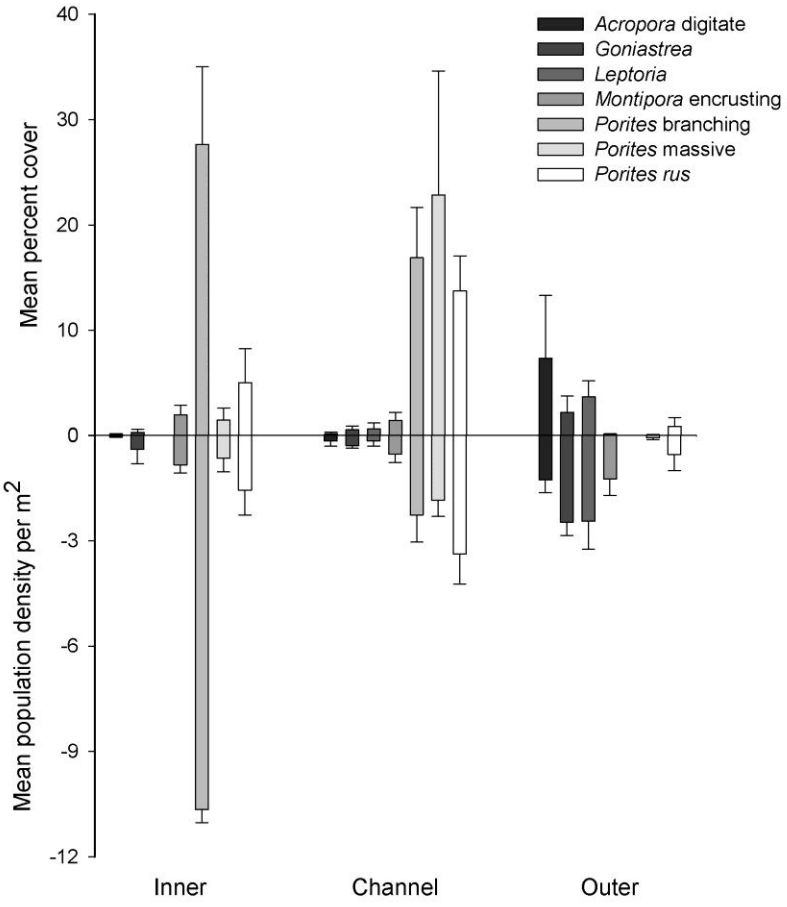

Figure 3. Distribution of dominant fish resources on Yap by reeftype.

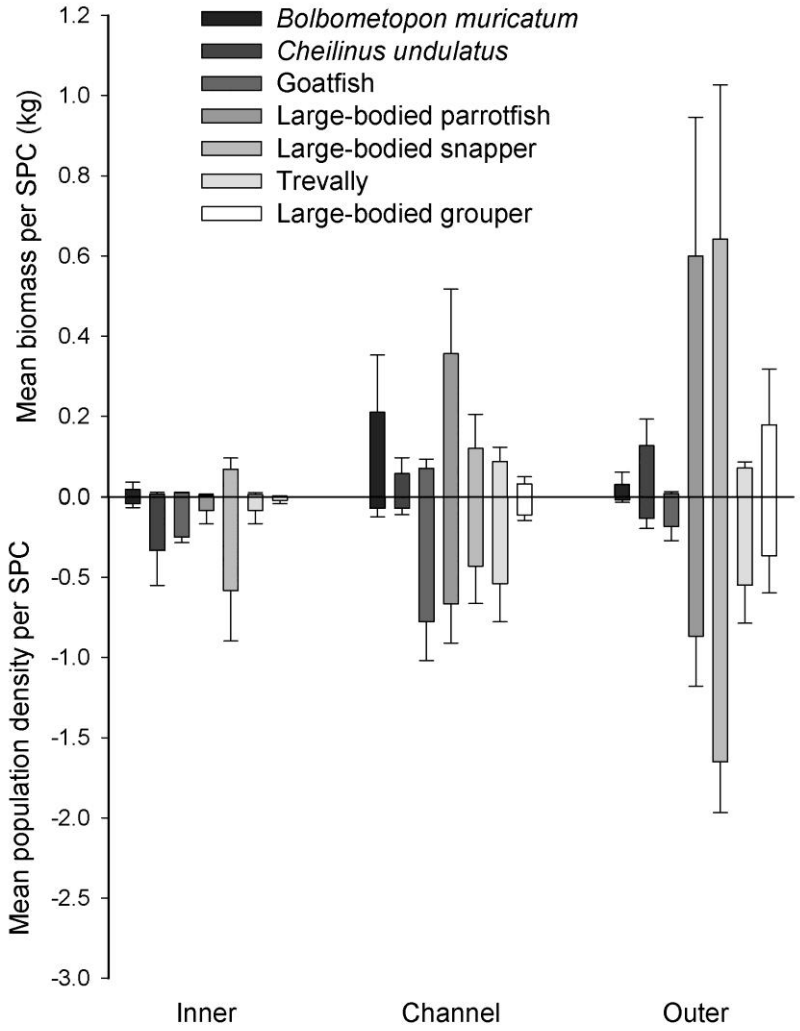

Table 1. Raw values of the ecological measures used to evaluate coral-reef condition. Metrics were standardized to provide equal weighting, a constant value was added to make all numbers positive integers, and the overall mean is reported under "standardized scores" (*see attached manuscript for full details*).

	Site	*Coral species richness*	*Multivariate dissimilarity*	*Percent Cover*	*Skewness and kurtosis*	*Fish biomass*	*Fish evenness*	*Standardized scores*
Inner reefs	**8**	*6.5*	*38.7*	*54.8*	*(5) (31)*	*0.7*	*1.0*	**2.36**
	14	*3.9*	*39.9*	*50.2*	*(4.4) (24.5)*	*0.3*	*0.9*	**2.25**
	17	*2.1*	*53.0*	*43.0*	*(2.5) (6.4)*	*0.5*	*1.1*	**2.71**
	19	*4.1*	*37.0*	*54.6*	*(3.8) (16.5)*	*0.3*	*0.5*	**2.14**
Channel reefs	**1**	*2.6*	*33.3*	*65.1*	*(4.1) (18)*	*1.1*	*1.1*	**2.63**
	2	*4.4*	*72.2*	*45.1*	*(3.3) (12.7)*	*3.6*	*1.3*	**3.26**
	4	*5.3*	*51.0*	*61.0*	*(3.5) (14.2)*	*0.8*	*1.0*	**2.86**
	5	*7.3*	*81.8*	*74.2*	*(4.5) (24.4)*	*1.6*	*1.2*	**3.32**
	12	*5.8*	*104.5*	*78.2*	*(3.6) (18.5)*	*1.5*	*1.2*	**3.58**
	13	*3.9*	*102.3*	*79.6*	*(4.3) (22.7)*	*3.1*	*1.0*	**3.35**
Outer reefs	**3**	*9.6*	*12.4*	*65.9*	*(3.6) (15.9)*	*5.3*	*1.1*	**3.44**
	6	*9.5*	*16.8*	*69.1*	*(4.5) (30.3)*	*1.4*	*0.9*	**2.7**
	11	*8.1*	*54.6*	*66.8*	*(4) (19.8)*	*2.0*	*1.2*	**3.31**
	15	*10.6*	*14.7*	*66.4*	*(3.9) (23.3)*	*1.7*	*1.0*	**3.02**
	16	*9.1*	*26.9*	*75.2*	*(3.4) (16)*	*8.4*	*1.4*	**4.06**

Figure 4. A map of Yap with coral-reef condition overlaid. Condition estimates were calculated within each major habitat type (inner, channel, and outer reefs) to account for as much inherent variation as possible and isolated upon human influence.

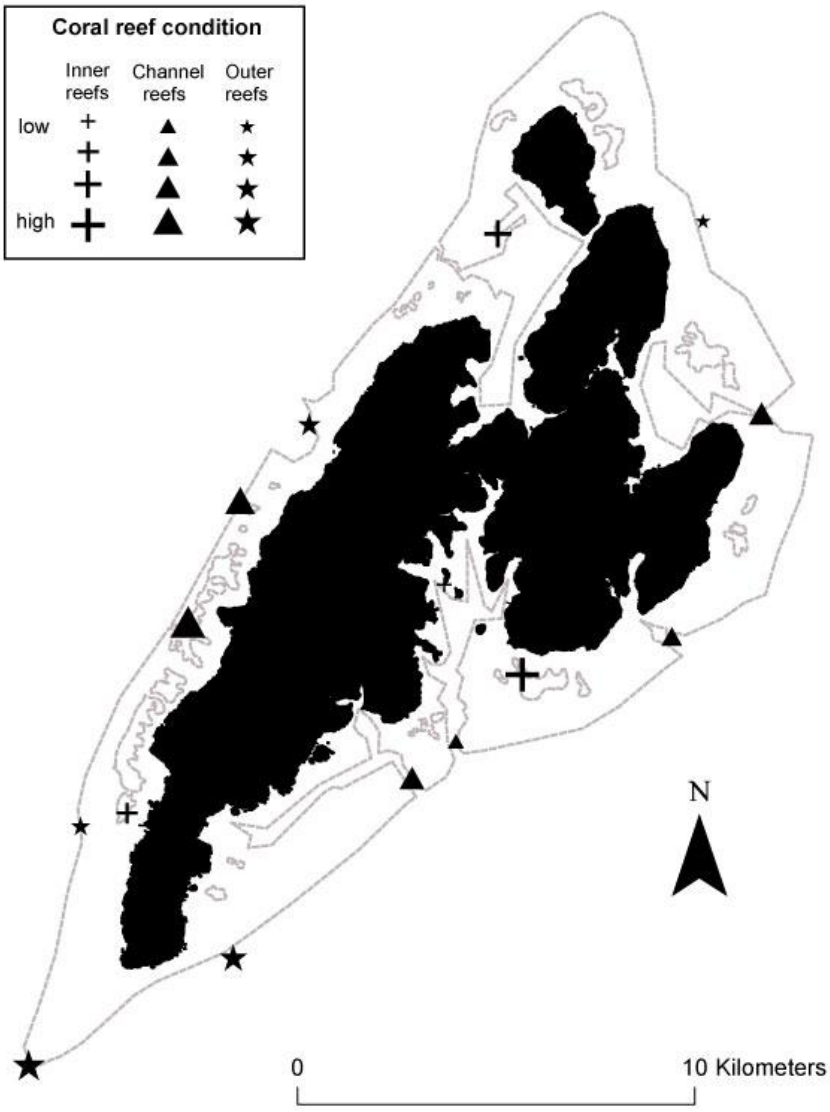

Figure 5. Multivariate summary showing enhanced biomass of foodfish in Nimpal MPA, as compared with Gachuug the reference site, over the course of two years. This was one of many summaries provided in the referenced guidebook that was produced to teach local programs how to efficiently and accurately understand their monitoring data (Exercise 7, http://www.pacmares.com/Data_Workshop.html).

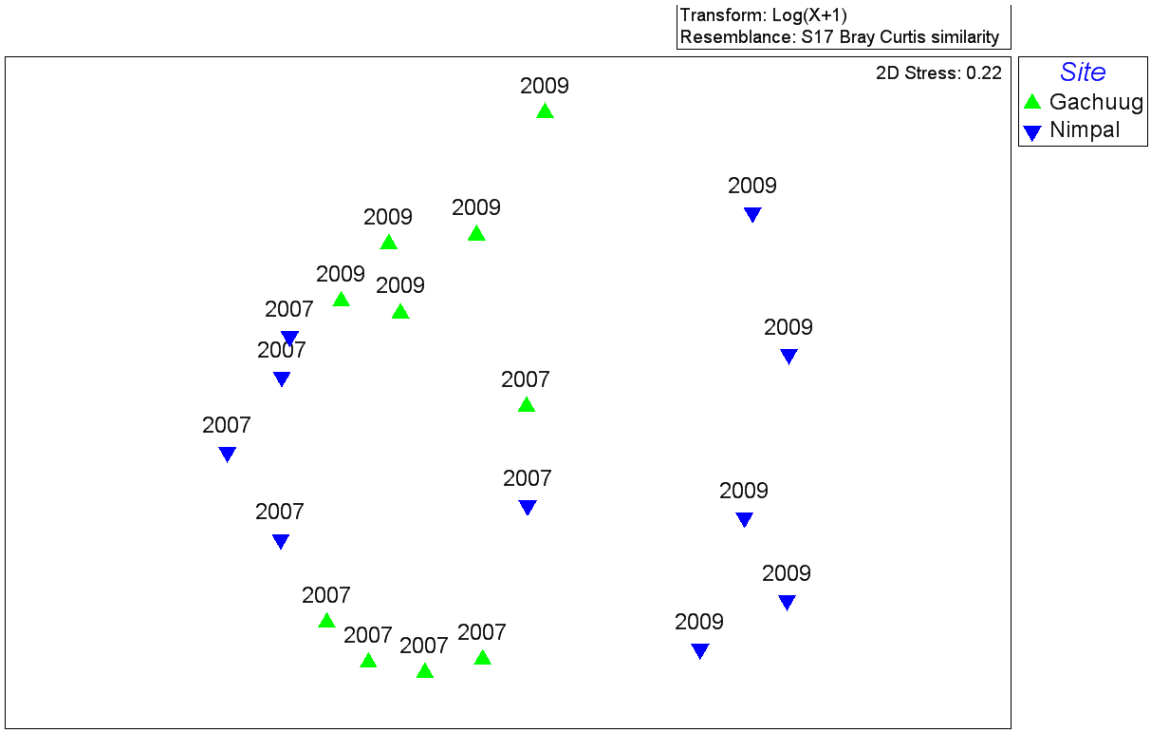

Figure 6. An example of a powerpoint slide that was presented to Tomil community regarding the substantial presence of juvenile Napoleon wrasse in their lagoonal waters.

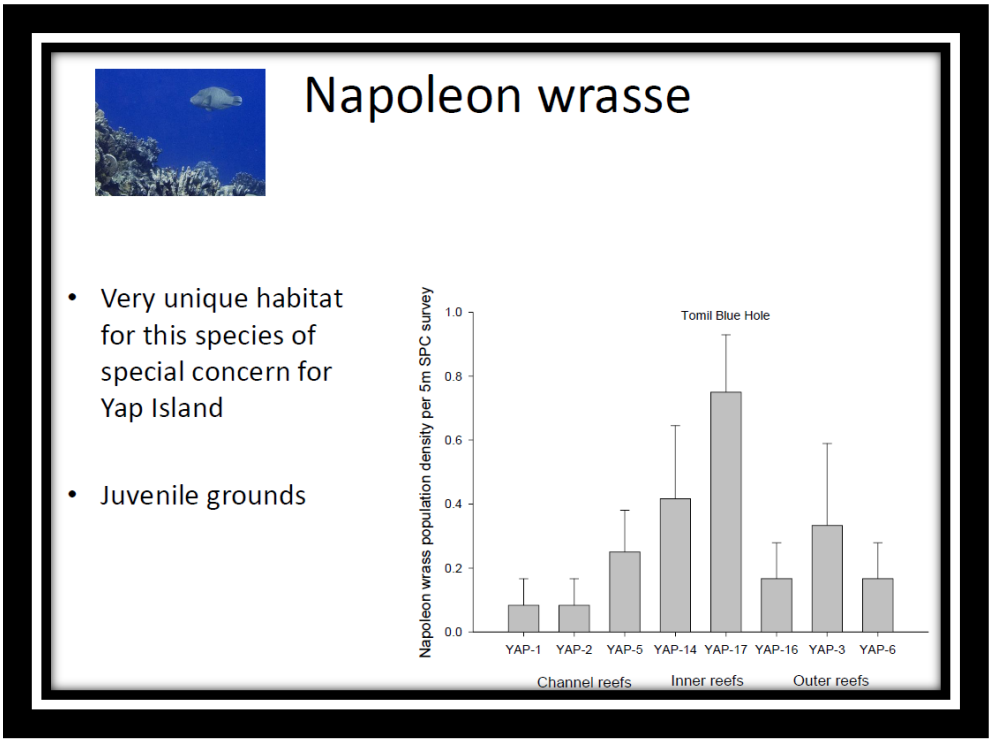

Figure 7. A snapshot of the newly created coral colony size database created through this project. Others follow a similar format.