Scaling up marine protected areas in Sogod Bay, Philippines into an ecologically-linked network using the decision-support tool, Marxan with Zones

Final Report

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Prepared by

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Introduction

The Coral Triangle (CT), which includes the marine waters of Indonesia, Timor-Leste, Solomon Islands, Malaysia, Papua New Guinea, and Philippines, is a global conservation priority. It is an epicenter of marine biodiversity and supports millions of people who rely on marine resources for food and income (Allen 2008; Foale *et al.* 2012).

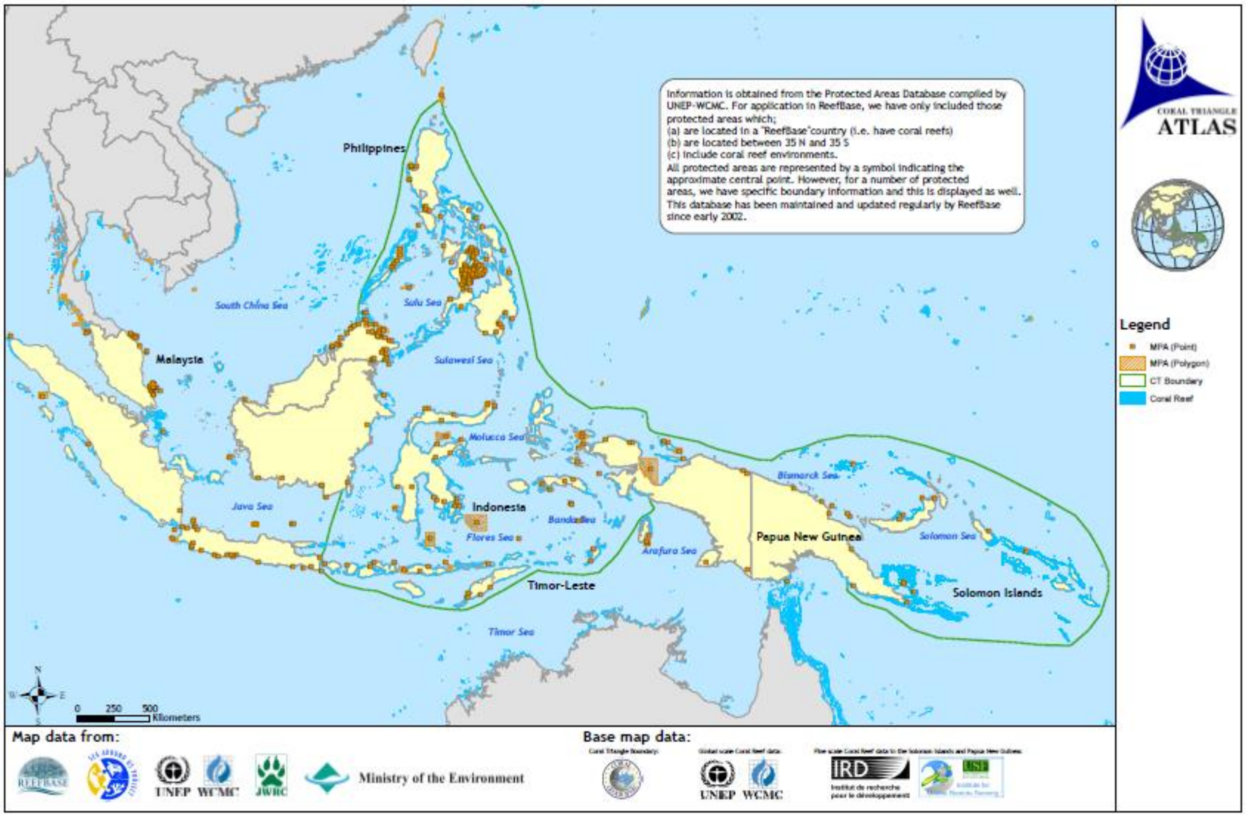

Figure 1. MPAs in the Coral Triangle Initiative (CTI-CFF 2009a)

Marine protected areas (MPAs) are the primary conservation tool employed in the CT to protect marine biodiversity and maintain fisheries (IUCN-WCPA 2008). Despite the successful establishment of more than a thousand MPAs (Figure 1 shows the location of some MPA sites in the CT), the current distribution and coverage is insufficient to account for the array of threats including destructive fishing practices, overharvesting, coastal development, pollution, and climate change (Burke *et al.* 2012). Scaling up individual MPAs into networks is increasingly advocated to address these threats. A MPA network is defined as "a collection of individual MPAs operating cooperatively and synergistically, at various spatial scales, and with a range of protection levels that are designed to meet objectives that a single [MPA] cannot achieve" (IUCN-WCPA 2008 p. 12).

In 2007, all six CT countries endorsed the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF). A key goal of the CTI-CFF is to scale up existing MPAs into well-planned, coordinated, and functional MPA networks (CTI-CFF 2009a; Lowry, White & Christie 2009; Walton *et al.* 2014). This involves identifying existing functional MPAs, selecting priority sites for new MPAs, and eventually linking these together to form networks

(Walton *et al.* 2014). Scientific guidelines on best practices for designing MPA networks (e.g., size, shape, and spacing) is still evolving, but it is widely acknowledged that MPA planners should prioritize protecting critical coastal habitats (e.g., coral reefs, mangrove, and seagrass beds) (see review by Green *et al.* 2014). MPAs that include critical habitats can enhance ecological and fisheries benefits through protecting a full range of species and life stages, and through maintaining ecological processes and ecosystem functions across bioregions (Green *et al.* 2014; Walton *et al.* 2014).

Designing MPA networks requires careful planning. It requires decisions on which biodiversity features to consider, how much of each feature to conserve, and how to address data gaps and current limitations. Human dimensions, such as spatial use patterns of different marine resource users, also need to be considered. This is because inadequate consideration and inclusion of stakeholders can lead to poor compliance to MPA rules and inequitable distribution of costs among stakeholders (Christie 2004). The stakeholder group most often at risk of adverse impacts of MPAs are small-scale fishers. While MPAs are often promoted for their fishery benefits (e.g., spillover effect and recovery of overfished fish stocks), their initial establishment may require loss of access to important fishing grounds. This can have negative impacts to fishers. These impacts can be particularly harmful for fishers in the CT, who often live in poverty and rely heavily on access to limited marine resources for food and income (Brody 2003; Christie 2004).

Systematic conservation planning (hereafter "systematic planning") can help balance the conflicting needs of conservation and fisheries. It is a science-driven practice of locating, configuring, and designing protected areas to achieve explicit conservation objectives with limited costs to stakeholders (Margules & Pressey 2000). This process is often supported through spatial prioritization tools, such as the most widely utilised tool, Marxan (Ball, Possingham & Watts 2009). Marxan (along with Marxan relatives such as Marxan with Zones) uses an algorithm to produce multiple MPA network configurations to meet set conservation targets (e.g., include at least 20% of each coastal habitat type in the MPA network) at a minimal cost (e.g., minimises overlap with areas important to a stakeholder group). The tool can help planners (1) evaluate how well different MPA network plans meet conservation and socio-economic objectives, (2) highlight areas that occur in multiple network options, and (3) identify set priorities for future conservation initiatives. Using these tools provides objective, transparent, and repeatable results that can then be fine-tuned to consider political, socio-economic and practical factors important in MPA management and implementation (Ball, Possingham & Watts 2009; Grantham et al. 2013).

Advancements in systematic planning research and spatial prioritization software have supported large-scale conservation initiatives, such as the rezoning of the Great Barrier Reef (Fernandes et al. 2005). Yet, it has rarely led to conservation action in the CT (Weeks *et al.* 2014; White *et al.* 2014). One reason for this "research-implementation" gap (Knight *et al.* 2008) is the geographic origin of systematic planning. Most of the research in this field originates from developed countries (e.g., America and Australia) with very different social, economic, and political factors in comparison to those in the CT (Ban *et al.* 2011). There are also limited guidelines on how to explicitly incorporate human factors into the spatial planning of MPA networks (Weeks *et al.* 2010a; Gurney *et al.* 2015). Instead, the vast majority of studies to date have either (1) assumed that socioeconomic costs are uniform, (2) only considered costs to one or a few groups of stakeholders, or (3) used untested surrogates in the absence of available data (Ban *et al.* 2011). In reality, however, stakeholders vary in their spatial and temporal resource use patterns and needs. For instance, fishers in the Philippines will vary greatly in their fishing use patterns based on gear type and social factors such as age, class, and gender (Garcia *et al.* 2008; Fabinyi, Knudsen & Segi 2010). Insufficient consideration of these types of variations may result in MPA network plans that disproportionately impact some stakeholders more than others. This in turn can lead to social or political conflicts, noncompliance, and failed attempts to implement plans (Gurney *et al.* 2015).

While the importance of stakeholders is increasingly recognized, there are limited guidelines on how to explicitly collect, measure, and incorporate stakeholder data in systematic planning processes. In the context of the CT, this requires addressing key challenges relating to the lack of fine-scale ecological and socioeconomic data, limited governance capacity, and community-based governance systems of most CT nations (Mills *et al.* 2010; Weeks *et al.* 2014). In recognition that the CT is a global conservation priority, emerging research should focus on developing, testing, and evaluating approaches that consider the ecological, socioeconomic, and governance realities of the developing nations.

This Master's research study focuses on Sogod Bay in Southern Leyte, Philippines to investigate alternative approaches for incorporating data derived from small-scale fishers in the design of equitable and ecologically-representative MPA networks. This study began in 2015 and is still in progress. It involves the collection of both ecological and socioeconomic data to develop and evaluate alternative MPA network plans. All plans aim to design an MPA network in Sogod Bay that will protect at least 20% of coral, mangrove, and seagrass habitats, while simultaneously minimizing costs to small-scale fisher groups. The plans reflect varying degrees of socioeconomic and governance considerations. The next phase of the study will use the decision-support tool, Marxan with Zones, to develop different scenarios with increasing levels of complexity, where additional information on marine tenure boundaries and spatial use patterns of small-scale fishers will be added.

The study is being conducted by Alessia Kockel (akockel@uvic.ca) from the Department of Geography at the University of Victoria (British Columbia, Canada) in partnership with Coral Cay Conservation (CCC), the Large Marine Vertebrates Project Philippines (LAMAVE), Ocean Action Research Centre (ORC), and local government units (LGUs) of Southern Leyte.

Study Site

The study site includes the southern portion of Sogod Bay (10°12’N, 125°12’E). The bay is located in the Eastern Visayan province of Southern Leyte in the Philippines (Figure 2). It has a narrow coastal shelf and a deep central channel (maximum depth of ~1,400 m). The coastal habitats include fringing coral reefs, seagrass beds, mangrove areas, intertidal areas, and beaches. Approximately 60% of the population (c. 110,608) in the bay live in coastal barangays (analogous to village) and rely heavily on marine resources for income and food (Calumpong *et al.* 1994; Araujo *et al.* 2014).

The bay includes eleven municipalities. These municipalities are part of an alliance, known as the Sogod Bay Sustainable Marine Management Alliance (SBSMMA). Members of the alliance meet monthly to collaborate on shared management activities and issues. Under the Local Government Code (LGC) of 1991 (Republic Act No. 7160) and Fisheries Code of 1998 (RA 8550), each municipality has the authority to govern marine resources within their municipal waters (marine tenure extends 15km offshore from the shoreline). While barangays often play a key role in resource management, municipal LGUs have jurisdiction over the allocation of MPAs, revenue and licencing permits for fishing, and enforcement of all fishery laws and regulations (White, Courtney & Salamanca 2002; White *et al.* 2014). The MPAs in the bay were all implemented and managed by barangays in partnership with municipal governments.

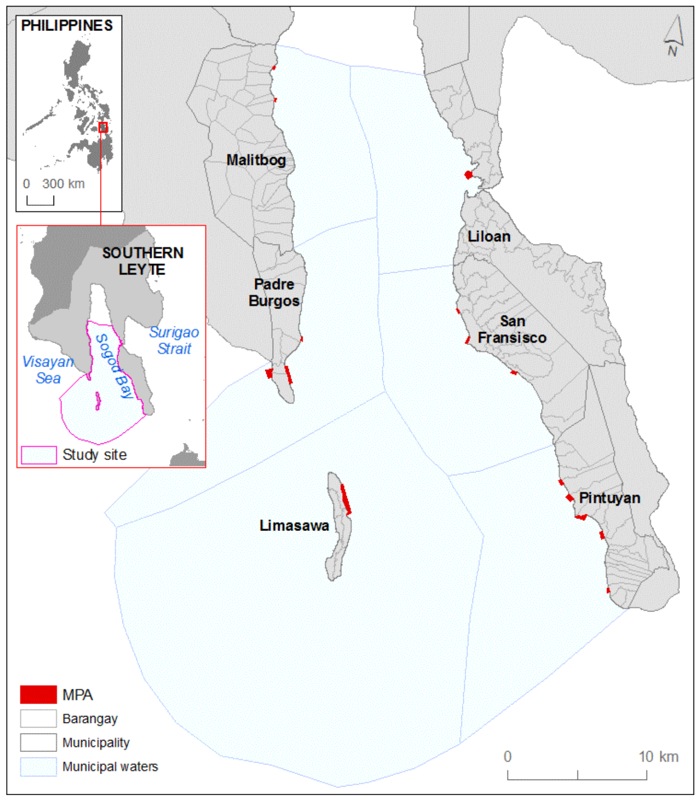

Figure 2. Map of study area in Sogod Bay, Southern Leyte, Philippines

A total of 94 coastal barangays (CB) were included in this study. These were in the municipality of Liloan (23 CB, 1 MPA), San Francisco (13 CB, 3 MPAs), Pintuyan (20 CB, 5 MPAs), Malitbog (21 CB, 2 MPAs), Padre Burgos (11 CB, 4 MPAs), or Limasawa (6 CB, 1 MPA).

Methods, Data, and Analysis

Ecological, socioeconomic, and administrative spatial data were required to develop and evaluate MPA planning scenarios. Data was collected through secondary data sources, remote sensing, and participatory mapping methods (Figure 3).

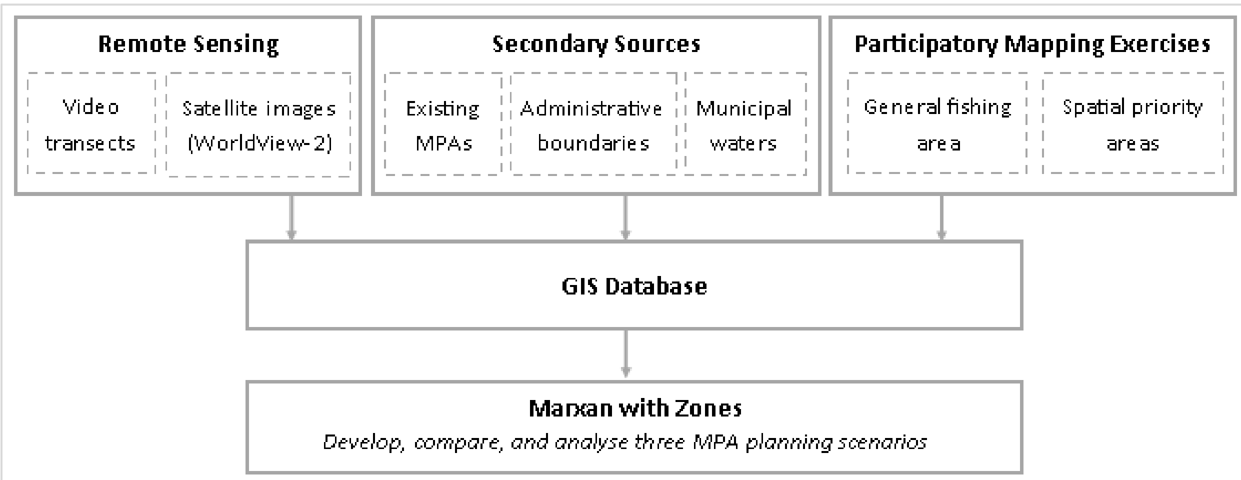

Figure 2. Summary of methods and data used to develop MPA planning scenarios

The study consisted of three field seasons. Data for Liloan, San Francisco, and Pintuyan was collected from June to December 2015. Data for Malitbog, Padre Burgos, and Limasawa was collected from January to April 2016. The third field season from October to December 2016 did not involve data collection. Instead, it was used to disseminate results to stakeholders, and to assist LGUs in establishing new MPAs in Sogod Bay.

The last phase of this study is currently underway. It will apply the decision-support tool, Marxan with Zones to develop and examine different scenarios with increasing levels of complexity, where additional information on marine tenure boundaries and spatial use patterns of small-scale fishers will be added.

Remote Sensing

Remote sensing is a widely-accepted approach for mapping coastal habitats suitable for MPA network planning (Green et al. 2000; Yamano 2013). It provided a practical solution for large-scale habitat mapping in our study area, since existing ecological data was sparse. WorldView-2 satellite images were used to produce a benthic habitat classification map for Sogod Bay. Three images were granted by the Digital Globe Foundation and are described on Table 1. Field data required for the analysis of remote sensing imagery was collected *in situ* using underwater video transects. Spatial data from the final habitat map will be incorporated into Marxan with Zones as biodiversity features. Biodiversity features for coral reefs, mangroves, and seagrass will be targeted for inclusion in MPAs. Figures 4 shows a subsection of the benthic cover class maps overlaid on the true colour WorldView-2 image.

Table 1. WorldView-2 imagery information

Image code name	Digital Globe Catalog ID	Location	Acquisition Date	Acquisition Time	Imaging Bands	Spatial resolution	Area Max Off Nadir Angle	Total Cloud Cover %	Tide
P008	103001000EAF3900	West side of bay	2011-10-21	10:30	Pan_MS1_MS2	0.5m	27	19%	low (0.2-0.3m)
P006	103001000D9E1E00	East side of bay	2011-10-21	10:30	Pan_MS1_MS2	0.5m	24	17%	low (0.2-0.3m)
P004	1030010009C51300	Bottom of Panoan	2011-02-09	10:30	Pan_MS1_MS2	0.5m	27	2%	mid (0.5m)

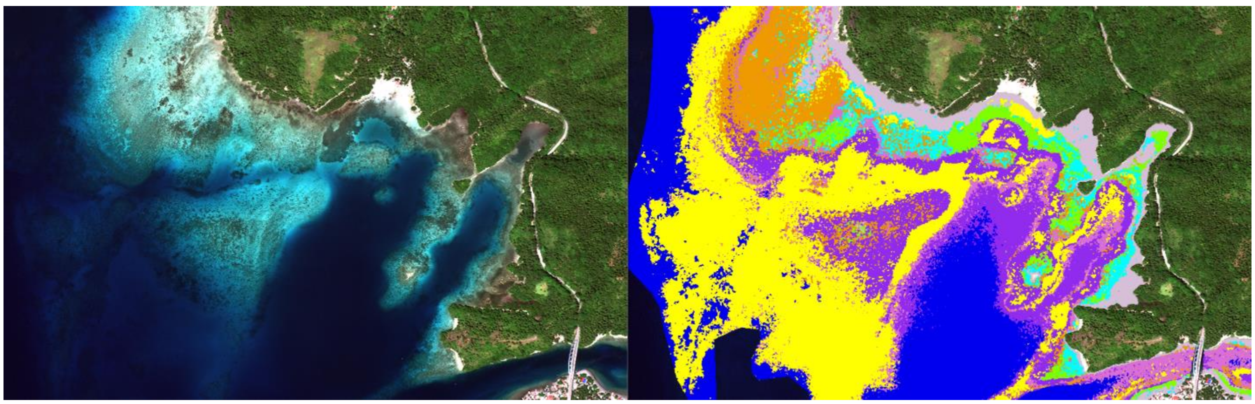

Figure 4. Liloan subset of the WorldView-2 true colour image [left] and overlay of the final benthic classification map [right]. Purple= hard coral (high coverage); pink= hard coral (low coverage) and bedrock; orange= bedrock; green= seagrass; cyan= macroalgae; yellow= sand; grey= boulder; and blue= optically deep water (sensor cannot detect bottom).

Secondary Sources

Administrative, municipal waters, and MPA boundaries were collected through various secondary sources (Table 2) and digitized in ArcGIS 10.2. Municipal, and barangay administrative land boundaries were available as maps or spatial data files through municipal government offices. MPA information (locations, delineations, size, level of protection, and relevant legislation) were compiled from the MPA Philippines Database (Philippines MPA Database 2014), and from examining the Comprehensive Municipal Fisheries Ordinance (CMFO) report of each municipality. CMFO were also examined for information pertaining to municipal water delineations (marine tenure) and marine use legislations and policies. The research team worked closely with LGUs to validate available data or address data gaps. GPS devices were used *in situ* to validate barangay boundaries and delineate existing MPAs.

Table 2. Secondary data source

Data	Description	Source
Administrative boundaries	Provincial, municipal, and barangay administration boundaries	Municipal government offices
Municipal waters	Municipal marine tenure delineations	Municipal ordinance documents
Marine protected areas	MPA locations, delineations, size, level of protection, and relevant legislation	Municipal ordinance documents and Philippine MPA database http://www.mpa.msi.upd.edu.ph/

Participatory mapping with small-scale fishers

Participatory mapping exercises with small-scale fishers from coastal barangays were conducted in 94 barangays to map the spatial use patterns of different fishing methods. This information was digitized and will be incorporated into Marxan with Zones as “opportunity costs” to minimize and distribute costs equitably to small-scale fishers.

The procedures and protocols of the participatory mapping exercise were adapted from NOAA (2014), Close and Hall (2006), and Yates and Schoeman (2013) and approved by the Human Research Ethics Board at the University of Victoria. The interviews were facilitated by the lead researcher and a local assistant in the Filipino dialect of Visayan. A GIS technician was also present to digitize maps using Google Earth Pro. The mapping exercises generally took between three to four hours per barangay. Each exercise consisted of focus groups of six to twelve fishers. This research study defines a small-scale fisher as any man or woman who directly engages in the taking of fishery and other coastal resources in municipal waters (within 15km from the shore). It includes fishers who do not use vessels or use vessels of 3 gross tons or less. Under the LGC of 1991 (R.A. No. 7160), small-scale fishers are permitted to fish anywhere within their designated municipal waters, except for in MPAs. They may utilize various types of fishing methods that may or may not involve the use of gear (e.g., gleaning, diving).

Both men and women participants over the age of 18 were included in this study. Participants were identified through purposeful sampling. Barangay captain or barangay council members were asked to nominate individuals who have extensive knowledge on the fishing practices in their barangay. The experience and type of fishers (based on the primary fishing method used by fishers) were also considered for recruitment. Participation was completely voluntary and identities were kept confidential (i.e., no names recorded). Verbal consent was obtained prior to commencing the mapping exercise.

During the mapping exercise, fishers were given paper maps and access to a digital map of Google Earth Pro displayed on a 20-inch touch-screen tablet. Paper maps displaying Google Earth Pro images (scale of 1:20,000 with a grid reference overlay) were laminated to allow fishers to draw directly on the maps with markers. The tablet acted as a mapping tool to assist fishers to measure distances from shore and describe fishing sites with greater accuracy (e.g., zoom in and out to show fishing area extent). To minimize map bias and facilitate mapping (many fishers had a limited understanding of maps), the facilitator began all exercises by explaining the scale, direction, and features (e.g., landmarks, shoreline, and islands) of the paper and digital map. The comprehension of participants was tested by asking participants to locate certain map features.

Figure 5. Fishers mapping fishing areas on paper maps during a participatory mapping exercises

Each fishing method was mapped separately. These were categorized based on gear type and generalized spatial use patterns (Appendix A). The fishing method categories were developed and tested prior to the field season in collaboration with volunteer fishers, local academics, and fisheries technicians working in various LGUs.

Before mapping the fishing grounds of a fishing method, participants were read a definition of the fishing method (e.g., what it includes and excludes) and asked whether it had been used by any members of their barangay within the last 12 months. If the method was used, the group was asked to provide general information on the seasonality, main catch, mode of transport, distances from shore, depth, and number of fishers who engage in the fishing method. Participants were then asked to work in groups of 2 or 3 to map the general fishing areas on a paper map (Figure 5). The general fishing area includes any area (closed polygon) within municipal waters where the fishing method is known to be used by fishers from the barangay, within the past 12 months, regardless of its frequency or intensity. It does not include areas used exclusively for transit. Drawn maps were compared and discussed in a group to produce one final map. The final map was digitized on site by a GIS technician.

Figure 6. Fishers assigning different levels of importance to fishing areas

Once consensus was reached, participants were asked to assign different levels of importance to fishing areas using a scale of high, medium, low, or no distinction (Figure 6). Fishers were told that they could base their choice on various reasons (e.g., presence of target species, regulations, fisher's experience, accessibility/proximity to barangay, proximity to a marine protected area) and were asked to explain their reasons with the research team. This method, adapted from Yates and Schoeman (2013), was chosen based on its ability to actively engage fishers, document rather than infer stakeholder information (i.e., use of surrogates in the absence of data), and its potential to produce fisheries data that can be incorporated into Marxan with Zones.

Each participatory mapping exercise concluded with an open forum. This gave participants the option to share any additional information pertaining to conservation and/or fisheries. Topics discussed included challenges facing MPAs and fisheries (e.g., corruption, conflicts between divers and fishers, illegal fishing practices, illegal commercial fishing within municipal waters), prospective new MPA sites, and potential solutions to enhance MPA effectiveness (e.g., salary for MPA guards, greater police enforcement, and community consultation).

Marxan with Zones

The next phase of this study will use the spatial prioritization software 'Marxan with zones' (Watts *et al.* 2009) to develop and compare alternative MPA planning scenarios that achieve biodiversity conservation targets at minimal and equitable costs to small-scale fishers. This study chose Marxan with Zones over other iterative and optimizing algorithms due to its ability to account for multiple objectives and management zones. The costs and contributions of each zone can be specified to meet alternative objectives (Ball, Possingham & Watts 2009; Watts *et al.* 2009). This functionality will be used to explicitly incorporate marine tenure boundaries and set zone-specific targets in selected scenarios (Weeks *et al.* 2010b).

In accordance with the CTI-CFF Philippines National Plan of Action (CTI-CFF 2009b), all scenarios will have a biodiversity target to protect a minimum of 20% of each major habitat type (mangroves, seagrass, coral reefs) within MPAs. The spatial use patterns of different small-scale fisher groups act as opportunity cost. Scenarios will therefore aim to identify locations for MPAs that achieve biodiversity targets at minimal and equitable costs to small-scale fishers (i.e., spatial restrictions to fishing areas). Existing MPAs will be included as part of the biodiversity target. The planning unit size will be selected based on a scale relevant to the management, which will reflect the size of the smallest existing MPA. Each scenario will generate 100 different iterations.

Different MPA network planning scenarios will be developed and evaluated to identify the implication of alternative methods for (1) delineating planning extents (entire bay extent or by municipal water) and (2) defining small-scale fisher groups. Scenarios that differ in the planning extent will evaluate the ecological and socioeconomic implications of planning MPAs at a bioregional extent (entire study area) versus a marine tenure (defined by municipal water delineations). While the former reflects general practices in systematic planning, the latter recognizes the governance system of the Philippines and may facilitate implementation of MPA plans.

Scenarios will be run to reflect different approaches for defining small-scale fisher groups. These scenarios will have the same biodiversity targets, but will differ in how fishers are defined and grouped. For example, one scenario will group all fishers in the study area by fishing method. It will not consider the spatial variability between different communities, so fishing areas of different communities will be compiled into a single layer. Another scenario will consider the spatial variability between different communities. Each fisheries feature will therefore account for a separate fishing method and community. The results of each scenario will be compared to determine how including or excluding information on variations between communities are likely to distribute costs to different fisher stakeholder groups.

The single 'best solution' of each scenario (which meets targets at the least cost to fishers) will be used to compare scenarios. The scenarios will be analysed using spatial statistical methods to determine: (1) whether biodiversity targets are met, (2) the total area and boundary length of protected areas, (3) the total areas of fishing area lost to each fisher group by fishing method, and (4) the proportion of fishing area lost in each municipality and barangay.

Hence, the results of each scenario will be compared to identify trade-offs between meeting biodiversity targets, minimizing impacts to small-scale fishers, and maintaining equitable division of opportunity costs between stakeholder groups.

Community engagement and collaboration

This study would not have been possible without the participation of small-scale fishers. All municipalities and coastal barangays in the study area participated in this study. Many fishers were very willing to participate in the research without any compensation. They were often eager to share their local knowledge and opinions on fishing practices and MPAs. At times, this even included sensitive topics such as illegal fishing and corruption. It was common for participants to express their gratitude for participating in the research, particularly in regards to being able to share their concerns on environment and fisheries issues. Many explained that they often feel ignored in the decision-making processes that impact their livelihood. On several occasions, the research team was invited to meals, barangay council meetings, and community events to discuss topics relating to the research in greater detail. At times, the team was asked to provide recommendations and further information. For instance, a dozen barangays requested to view underwater videos taken near their barangays. Through viewing these videos with researchers, local people could learn how to identify signs of habitat degradation and recognize important habitats for biodiversity and fisheries. For many people, this was the first time they had ever seen the state of underwater habitats surrounding their barangay.

In addition to small-scale fishers, this study received the support and guidance of various government, academic, NGO, and community members. LGU officials at all levels of government assisted the research team to compile and validate existing data, and address data gaps. They helped coordinate interviews, and disseminate results as well as other logistic aspects such as transportation, accommodation, and community outreach events. The team held several meetings with government members, and attended monthly SBSMMA meetings. The alliance meetings focused on marine management activities and issues in Sogod Bay, but also provided an opportunity to identify and address knowledge gaps and training needs. In partnership with the SBSMMA, the research team conducted Google Earth Pro workshops (Figure 7), GPS training workshops, beach clean-ups, and information, education, and communication (IEC) campaigns. Training workshops in Google Earth and GPS devices were particularly helpful in building governance capacity. These workshops focused on MPA managers and enforcers to build basic GIS skills to facilitate MPA management and enforcement. They also taught participants how to access and use spatial data derived from this study.

Local NGOs, particularly LAMAVE, CCC, and ORC, were invaluable in assisting our team in project logistics, networking, and adapting participatory mapping techniques appropriate for small-scale fishers in the Philippines. Local academics and students from SLSU also volunteered their time to assist the research team in developing and testing field protocols, along with translation services. Fishers from KASAKA (a people's organization in Son-Ok, Pintuyan) were instrumental in developing a complete list of fishing methods and in piloting the participatory mapping exercises.

All spatial data on habitat classifications, MPAs, and administrative boundaries were provided to NGO, academics, and LGU members during the third field season of this study. The data is also available on an online database upon request. A major focus of the third field season was to assist the provincial government with the Protected Area Management Enhancement (PAME) project commissioned by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB). The objective of PAME for Sogod Bay is to establish up to 15 new MPAs in Sogod Bay by the end of 2017. The results of this study are being used in the PAME project as baseline data to help plan and implement new MPAs.

The research was disseminated to the public, along with small-scale fishers, via a short documentary film. The film was developed to facilitate access and utilization of knowledge to stakeholders, organizations, and institutions outside of academia. It summarizes the goals, research process, methodology, and key research findings. The film included interviews with fishers, researchers, and MPA managers, along with animations to describe what MPAs are and how they work. The documentary was part of an undergraduate directed study course, and is available in English and Visayan. Film nights were held in several barangays in Sogod Bay and open to the public. The film was always followed by an open forum, which allowed the public to provide feedback and ask questions to researchers. The film showing at municipal halls were often attended by government members (including mayors and other elected officials), NGO members, academics, and small-scale fishers. This provided a rare opportunity for decision-makers, support institutes, and stakeholders to openly discuss topics related to fisheries and MPAs. Common topics discussed included threats to local fisheries, strengths and weaknesses of MPAs, MPA management and enforcement practices, and future conservation initiatives.

The English version of the film can be viewed at https://www.youtube.com/watch?v=f1PuFml0OgQ or at http://www.alessiakockel.com/masters-project.html.

Figure 7. Google Earth Pro training workshops with LGUs and police

Challenges

The research team faced several challenges in the field despite the support of various LGUs, NGOs, academic institutes, and small-scale fishers. A major challenge involved coordinating and scheduling mapping exercises. While small-scale fishers were often willing to participate, the team often struggled to schedule exercises that did not interfere with fishing, community events, and other projects. Meetings were often cancelled due to bad weather or other unexpected circumstances. The same was true for meetings with LGU officials, NGO members, and academics. On some occasions, the research staff had to reschedule meetings due to health issues and difficulties in accessing remote communities (e.g., road closures, turbulent seas).

There were also several issues with existing datasets. One local institution was unwilling to share bathymetry data that would have enhanced the accuracy of remote sensing results. Data that was available from NGOs and LGUs was often inaccurate or insufficient for systematic planning purposes. While the research team planned to collect ecological and fisheries data for MPA planning, they did not anticipate validating administrative boundaries, municipal waters, and MPA delineations. Validating these datasets required a substantial investment of time and energy from both international and local volunteers. One positive outcome of this was the development of a comprehensive and up-to-date spatial database. This dataset can serve as baseline information for future research and conservation initiatives.

Government officials in provincial and municipal LGUs generally spoke English. However, the clear majority of fishers from rural communities only spoke the local dialect of Visayan. This dialect is one of hundreds of dialects spoken in the Philippines. It was difficult to find qualified local staff that spoke Visayan, in addition to having previous work experience in fisheries and community engagement. Fortunately, CCC and ORC provided temporary staff to coordinate and facilitate participatory mapping exercises.

Opportunities for future research and community-partner collaboration

It is anticipated that the results of this study will be shared with others through a thesis paper, defense presentation, municipal reports, public community and partner presentations, academic and media presentations, and published scholarly articles. The results will contribute to the scientific literature to provide guidelines for systematic planning approaches in developing nations in the CT. As stated above, the spatial database will serve as important baseline data for future research and conservation initiatives, such as the PAME project. It has also shared data with researchers from LAMAVE and academic institutes in the United Kingdom and Australia who are in the process of conducting research in the bay. The research team continues to work in collaboration with local officials and NGOs to develop and implement best practices for involving stakeholders in the design of MPA networks.

Research Expenses Summary

Table 3 summarizes the research expenses for the first field season of this study, which was funded by the Robin Rigby Trust (RRT). The predicted budget is based on the desired budget (not minimum budget) requested in the RRT application submitted in October 2014.

Table 3. Research expenses (CAN$) from June-December 2015, funded by RRT

Equipment (Preparation for field)	Predicted Budget*	Actual Costs
Research assistants	$2,000	$2,238
Equipment (including tablet for mapping tool, dry containers, hard drives, voice recorders, GPS device, and office supplies)	$2,050	$2,966
Field costs of participatory mapping exercises (including snacks for fishers, materials and supplies, and print & copy)	$2,250	$1,701
International travel	$1,500	$0**
Local transportation (including land and boat transport)	$4,000	$573
Accommodation and bills	$750	$1,408
Subsistence	$1,250	$1,762
Internet and phone	$150	$502
Total	**$13,950**	**$11,150**

*Predicted budget based on desired budget and excludes estimated overhead costs.
**International travel costs provided through CAPI Fellowship Award

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APPENDIX A

Fishing Methods in Sogod Bay

Code	English name	Visayan name	Description
GL	Gleaning	*Panginhas, Pantama, Panglapas* (Abalone) *Panuyom* (Sea Urchin) *Pangswaki* (Sea Urchin)	Gleaning is done by walking in intertidal areas and colleting marine animals by hand or with the assistance of hand tools (e.g., knife, machete, rod, or spear). Includes collection of abalone and octopus in intertidal areas (low or high tide) with or without the use of a mask.
DI	Hand collection while diving	*Panawom Panuyom, Panawom Panginhas, Panglawom* (deep diving)	Fishers dive to collect prey by hand or with the assistance of hand-held accessory tools (e.g. knife, gaff hook).
SF	Spear fishing	*Pana*	Firing device used to shoot and propel a spear.
OJ	Octopus fishing	*Pangugita*	Fishing methods used to target octopus while diving. Can use accessories to attract (e.g., octopus lure) and catch octopus (e.g., spear).
PT	*Pot trap*	*Bubo (square) Pangaw (round) Panggal (round, Bantak (cylindrical)*	Stationary trap designed to passively trap target prey (e.g., fish, crab, lobster, squid, and shrimp) and prevent escape.
FC	Fish corral	*Bungsod, Tower*	Fixed nets used to corral and trap prey.
BN	Barrier net	*Pukot pahubas*	Fixed net used to corral and trap prey as the tide goes out (low tide).
FY	Fyke net	*Sangab*	Fixed side nets funnel prey into bag at the centre of the net. Normally fixed by anchors, stakes or ballast in shallow water.
FN	Filter net	*Saluran*	Fixed nets that use the current to catch and trap prey. Net opening positioned against the current and held open by stakes or a boat.
Q1	Squid fishing 1	*Pamoko bukoay*	Line with jig designed to catch small pencil squid (*Loliginidae*). The jig is moved by hand in a jerking action to attract squid. Typically done at sunset and sunrise. Squid caught are used as bait for other gears.
Q2	Squid fishing 2	*Pangnokus, Sarangat. Kawil pangnokus. Kabir (Barawan/ Nokus sa lawod/ Bulingit)*	Line with jig designed to catch Flying Squids (*Ommastrephidae)*. The gear is typically used at night in offshore areas.
Q3	Squid fishing 3	*Subid-subid (Nokus sa piliw)*	Line with jig designed to catch Bigfin Reef Squid (*Sepioteuthis lessoniana*). Typically done in shallow areas at sunset, sunrise or during the full moon
Q4	Squid fishing 4	*Pang koli-papa (Koli-papa)*	Baited jig attached to a line coiled around a buoy. Designed to catch large Flying Squid species (*Ommastrephidae) (greater than 5kg)*. The gear is typically used during the morning and found far offshore.

Code	English name	Visayan name	Description
SH	Simple handline (from shore)	*Labyog*	Consists of a line with one hook operated by hand from the shore. Can include accessories, such as a weight, spool, or rode.
SB	Simple handline (from boat)	*Pauro* *Pamasol* *Mingwit*	Consists of a line with one hook operated by hand on a boat. It does not include methods where the line is dragged behind a boat. Can include accessories, such as a weight, spool, or rode.
MH	Multiple handline	*Ontog,* *Bira-bira,* *Undak*	Handline that uses multiple hooks suspended to a mainline. Can include accessories, such as a weight, spool, or rode.
HF	Hook and line with float	*Palotaw,* *Pataw-pataw,* *Tawa- tawa*	Line with one or more hooks attached to a float and left to drift with the current.
TL	Troll line	*Lambo (1 boat),* *Tapsay*	Multiple hook and line towed behind one boat (lambo) or two boats (tapsay) to catch fish.
RX	Rentex (silk thread)	*Rentex,* *Pambawo,* *Spirikitik*	Synthetic fiber (called Rentex) tied to line and towed behind a boat. Effective at catching needlefish and even sailfish. Line can consists of no hooks, or can be fitted with hooks to catch other types of fish such as tuna and mackerel.
BL	Bottom-set longline	*Palangre (panlahoy)*	Longline anchored and set vertically in shallow bottom areas to catch fish. The mainline has multiple branch lines with hooks.
SL	Surface-set longline	*Palangre (palotaw)*	Longline mainly used to catch large pelagic species. The mainline is set near the surface with floats and has multiple branch lines with hooks: either anchored or adrift.
SG	Surface-set gill net	*Lamba* (6-8 mesh) *Pamasayan* (14-20 mesh) *Bungkol, Kayagkag, Pangisaw, Patulay*	Gill net set in shallow areas to catch schools of fish. The top of the net is set at the surface with floats while the net is held to the bottom with weights. It may be used with "plungers", stones, or even swimmers to scare fish into the net.
BG	Bottom-set gill net	*Sedewe* *Pantaan* (6-8 mesh) *Palubog* (6-8 mesh) *Patugkad* *Palunod,*	Gill net set on or near sea floor to catch bottom-dwelling fish.
DG	Drift gill net	*Paanod,* *Palaran*	Type of surface gillnet designed to drift with the current or attached to a boat over a period of time. The top of the net is set at the surface with floats.
IG	Drive-in gill net	*Bahan,* *Sagiwsiw,* *Tapsay*	Type of surface gill net that uses scare lines to drive the school of fish towards the net. The top of the net is set at the surface with floats.
EG	Encircling gill net	*Likos,* *Panglihos, Kayagkag, Lambat* *Likom* (commercial*)*	Gill net used to surround and capture a shoal of pelagic fish within a 'wall' of netting. It is often operated by two boats. Does not include commercial fishing gear.
FG	Fixed gill net	*Pahubas*	Gill net stretched between two or more stakes that are fixed into the bottom. Set in inter-tidal areas where catch is collected during low tide.

Code	English name	Visayan name	Description
BE	Beach seine	*Baling*	A long net used to catch fish in shallow water near the shore. One end is held on the shore while the other end is circled around a school of fish, and then hauled back onto land to enclose them.
DS	Danish seine	*Liba-liba* *Hulbot-hulbot*	Seine consists of a conical net with two long wings. One end is held by a boat or anchor, while a boat encircles the net around fish. Alternately, the net can be dragged by two boats.
CN	Cast net	*Laya*	Circular or conical weighted net thrown by hand over target prey and hauled in to collect prey.
LN	Lift net	*Skylab*	A net that is submerged, then hauled upwards out of the water to collect prey. Can be operated by hand or with boats, pulleys, and/or levers.
PN	Push net	*Sud sud*	Gear consisting of a net and one or two poles to keep the net open. It is either pushed forward in shallow water by one or two fishers, or in deeper water by a boat.
SC	Scoop net	*Sikpaw, Sibot, Kandos (tool)* *Mamolinao, Pangbolinao, Pangtognos (method)*	Small to medium sized meshed net used to scoop prey from the water. Excludes cases where gear is used as a fishing accessory only (e.g., used to remove fish from nets).
MT	Municipal Trawl	*Likop*	An iron or net basket that is dragged along the bottom of the sea to collect bottom-dwelling species (e.g., mussels, clams, scallops, crabs, and sea cucumber). Only includes municipal fishing methods (boats of 3 gt (gross tons) or less).
BE	Beach seine	*Baling*	A long net used to catch fish in shallow water near the shore. One end is held on the shore while the other end is circled around a school of fish, and then hauled back onto land to enclose them.