Wildlife Conservation Society

A Global Social-Ecological Systems Monitoring Framework for Coastal Fisheries Management

A Practical Monitoring Handbook

Published by:
Wildlife Conservation Society
2300 Southern Blvd
Bronx, NY 10460 USA

Tel: +1 718 220 5193
www.wcs.org

Authors: Georgina G. Gurney[1] and Emily S. Darling[2]
[1] Australian Research Council Centre of Excellence for Coral Reef Studies
[2] Marine Program, Wildlife Conservation Society, Bronx NY, USA and University of Toronto, Toronto ON, Canada

Cover photo: A fisher works the surf in coastal Mozambique.
Photo: Emily Darling / WCS.

Suggested citation: Gurney, G.G. and E.S. Darling. 2017. A Global Social-Ecological Systems Monitoring Framework for Coastal Fisheries Management: A Practical Monitoring Handbook. Wildlife Conservation Society, New York, 63 pp.
ISBN-10: 0-9820263-3-1
ISBN-13: 978-0-9820263-3-5

Acknowledgements

We are grateful to Stacy Jupiter, Tim McClanahan and Caleb McClennen for developing the original concept for a global monitoring framework to inform the management of coastal fisheries. We thank WCS Marine programs in Kenya, Madagascar, Fiji, Indonesia and Belize for their invaluable input into this work, particularly in regards to identifying information needs, developing and refining indicators, and assessing the appropriateness of indicators: thank you Carol Abunge, Stuart Campbell, Stéphanie D'agata, Kim Fisher, Margaret Fox, Yudi Herdiana, Kate Holmes, Catherine Jadot, Stacy Jupiter, Tasrif Kartawijaya, Peni Lestari, Sangeeta Mangubhai, Elizabeth Matthews, Tim McClanahan, Efin Muttaqin, Nyawira Muthiga, Waisea Naisilisili, Prayekti Ningtias, Shinta Pardede, Volarina Ramahery, Bemahafaly Randriamanantsoa, Fakhrizal Setiawan, Sukmaraharja Tarigan, Alek Tewfik, Tantely Tianarisoa and Irfan Yulianto. We thank Josh Cinner for his continuing collaboration, and his leadership on socio-economic initiatives within many WCS Marine programs. We are also grateful to many experts, partners and stakeholders throughout the Western Indian Ocean, Melanesia, Indonesia and Caribbean, including but not limited to: Gabby Ahmadia, Jessica Blythe, Pip Cohen, Graham Epstein, Chris Filardi, Helen Fox, Louise Glew, Chris Golden, Nick Graham, Christina Hicks, Ando Raberisoa, Mike Mascia, Joe McCarter, Eleanor Sterling, Diogo Verrissimo, David Wilkie, and all participants who attended workshops in the Solomon Islands, Madagascar, Indonesia, the USA and Scotland. Funding for this work was generously provided by the John D. and Catherine T. MacArthur Foundation (Grant no. 13-105118-000-INP).

Contents

Background

What are the social, economic and ecological impacts of natural resource management?

How can natural resources be managed sustainably into the future?

What are the contextual conditions that facilitate positive or negative impacts of resource management?

These are critical questions for natural resource management, but to date, the evidence for addressing these questions across many forms of management, including protected areas, is weak (Miteva et al. 2012). This is particularly true in regards to the social impacts of natural resource management (Bottrill et al. 2014, Pullin et al. 2013). Despite the immense amount of resources allocated by the conservation practitioners to ecological and social monitoring, often the right things are not being monitored in the right way to robustly assess the *impact*[1] of conservation and management investments.

To assess the impacts of coastal conservation and management activities around the world, the Wildlife Conservation Society (WCS) has developed a global monitoring framework to identify and monitor a key set of social and ecological indicators. These indicators were defined to track progress towards two strategic goals over the next 10 years:

1. What are the social and ecological impacts of conservation and management actions?
2. What social, ecological and governance contexts create successful outcomes?

The overall goal is to monitor, evaluate and learn from successful conservation and management interventions, and to assess the social and ecological impacts of on-the-ground investments and develop a 'typology' of locally-defined successful interventions. As a first step to achieving this, we have worked with conservation programs and partners in the Western Indian Ocean, Melanesia, Indonesia and the Caribbean and leading academic researchers to develop a key set of social and ecological monitoring indicators. To do this, we have drawn on Elinor Ostrom's social-ecological systems framework (Ostrom 2007, 2009) to structure and guide our choice of indicators.

This manual is organised as follows: (1) we introduce the social-ecological systems framework (Ostrom 2007, 2009) that we use or organize our indicators; (2) we describe each of the social and ecological indicators in detail, including what they represent and how they are operationalized; (3) we provide further detail on the social science theory underpinning some of our indicators and how the indicators can be used to form composite indexes; and (4) we provide some information on impact evaluation in the context of global monitoring.

[1] Here, we define impact as the difference that a treatment (e.g. conservation intervention) makes relative to a control or counterfactual scenario (i.e. without a conservation intervention).

Local stakeholders monitor coral reefs in Indonesia.
Photo: Emily Darling / WCS.

Social-ecological systems

Social-ecological systems are complex and adaptive systems defined by feedbacks and interactions between nature and people. Here, we adopt Nobel Prize Winner Elinor Ostrom's social-ecological systems framework that that depicts the essential elements of social-ecological systems and was designed for analyzing outcomes in social-ecological systems (Figure 1; Ostrom 2007, 2009). Commons (i.e. 'common-pool resources') are a type of resource characterised by non-excludability and subtractability. Coastal fisheries are often defined as 'common-pool' resources because, (1) it is difficult to place spatial boundaries on fisheries and therefore costly to exclude other fishers (i.e. non-excludability); and (2) when one fisher extracts fish from the system there are less fish for other fishers to catch (i.e. subtractibility).

Ostrom's multi-tier social-ecological systems framework depicts elements operating at multiple scales that are thought to influence outcomes in situations involving common-pool resources (Ostrom 2007, 2009). It describes four core subsystems: actors (e.g., fishers or resource users), governance (e.g., decision-making process and formal and informal rules of resource use), resource system (e.g., coral reef ecosystem) and resource units (e.g., fish and invertebrate catches). Environmental governance can be defined as the 'set of regulatory processes, mechanisms, and organisations through which political actors influence environmental actions and outcomes' (Lemos and Agrawal 2006). Importantly, 'governance' is not the same as 'government', and encompasses actors such as NGOs (e.g. national and international NGOs), communities and community groups, and businesses, in addition to government organisations. Elements of the four core subsystems affect interactions within the social-ecological system, which can ultimately lead to outcomes. Each of the subsystems is composed of second-tier variables that may be drawn upon to assess specific social-ecological characteristics, outcomes, and behaviours. Second-tier variables for the actor subsystem, for example, include social attributes of actors and norms/social capital. The social-ecological system is embedded in the broader social, economic and political setting and may also affect and be affected by related ecosystems. Ultimately, engaging key social concepts is critical for sustainability (Hicks et al. 2016)

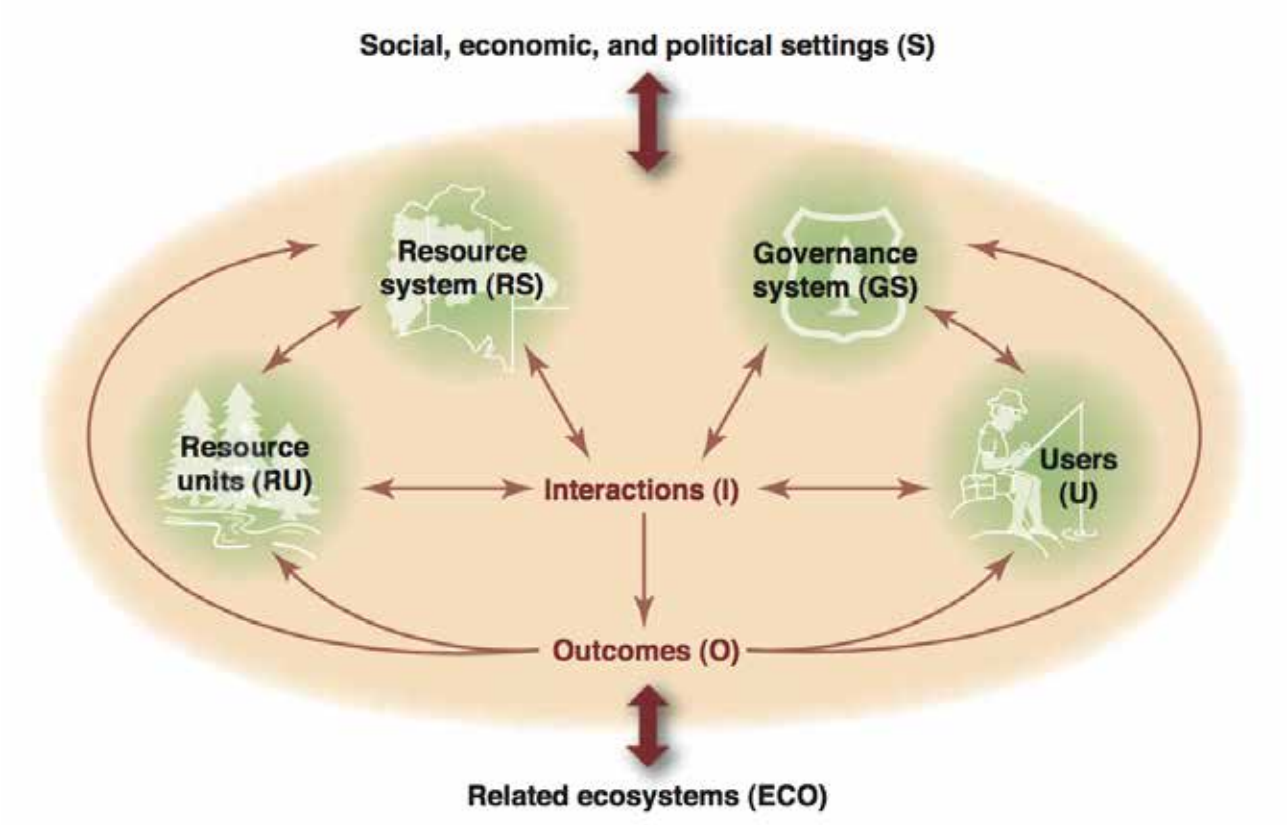


Figure 1. Elinor Ostrom's original social-ecological systems framework conceptualized using four core subsystems. Image from Ostrom (2009).

Global coastal fisheries monitoring framework

Here, we adapt and operationalize Ostrom's social-ecological systems framework to structure and guide our choice of indicators for a global coastal fisheries monitoring program, with a specific focus on small-scale coastal fisheries. Specifically, we populated each of the first-tier variables (including each of the four subsystems, interactions, outcomes, related ecosystems and social, economic and political setting) with indicators that we organized under the second-tier variables specified in the framework. Our approach to developing the set of indicators was to use the minimum number of indicators to adequately capture the key elements of the social-ecological system that are relevant in the context of assessing the impact of conservation and management interventions, and also feasible to operationalize and monitor over the long term. Standardising the indicators used across geographies will provide a global portfolio of comparable datasets, and is an important step in enabling resource managers and decision makers to assess the impact of their coral reef conservation and management interventions. At the same time, our approach allows for customization and flexibility of additional indicators that can be added to suit local contexts.

The social indicators were developed to facilitate assessment of the impact of conservation and management interventions, as well the describe various mechanisms and theories of change through which impacts occur and the conditions under which impacts are likely to be positive. Therefore, the set of indicators represent elements of the social system that are likely to be affected by interventions (e.g. participation in resource decision-making), and those that will not be affected (e.g. gender, ethnicity) but which are important moderators of impact. A moderator is a variable that is unaffected by the intervention and whose value affects the magnitude of an impact (Ferraro and Hanauer 2013)

In total, we describe 10 core indicators (Table 1) supported by a broader suite of social and ecological indicators (Table 2) to conceptualize a social-ecological systems framework.

Figure 2. The four subsystems of social-ecological systems conceptualized for coastal small-scale fisheries. Within each subsystem, the 10 core indicators are identified (see Tables 1, 2).

The social indicators can be implemented in a household survey and key informant survey, which are provided at the end of this manual. It is important to note that the household survey could also be conducted with individuals to understand individual-level variation by gender, age, ethnicity, etc. Household-scale surveys are typically employed in social monitoring, and involve surveying the head of the household. However, this approach does not allow examination of intra-household inequalities, and also hinders examination of gender inequalities.

To facilitate adoption of the social and ecological indicators by local managers and subsequent comparison of data across a global portfolio of coastal fisheries interventions, we attempted to adequately capture the key elements of the social-ecological system that are relevant in the context of assessing the impact of conservation and management interventions with the minimum number of indicators. To further facilitate comparison across geographies, many of the social indicators are operationalized with closed-ended questions (i.e. questions where the answer is limited to a set number of categories). Nevertheless, there are numerous questions in the survey that produce qualitative data, which will provide insights into elements of the social-ecological systems that are not amenable to quantification and will be critical to interpreting the quantitative data.

This framework is intended to be supplemented with intervention- and context-specific qualitative and quantitative data, including indicators based on local priorities (e.g., through a participatory development of indicators, see Woodhouse et al. 2015) or through a biocultural lens (see McCarter et al. in preparation). Further, the social indicators that could be derived from the data obtained with both types of surveys are not limited to the indicators detailed in the following section. Note that many of the social indicators described below were developed originally by Joshua Cinner (Australian Research Council Centre of Excellence for Coral Reef Studies, James Cook University) and have been successfully used by resource managers and decision makers field programs for many years; we strived to include as many of these previously-employed indicators to ensure comparable data through time.

Ultimately, this framework is intended to be practical and sustainable. Surveys can be repeated every three years, and supported by capacity building and cost-effective transitions from external expert monitoring to science practitioners and community monitoring (e.g., Fox et al. in press).

A small-scale fisher returns with his catch in Nosy Be, Madagascar. Photo: Emily Darling / WCS.

Social-ecological system indicators

Table 1. Social-ecological systems monitoring for coastal fisheries: 10 core indicators.

Construct	Indicator	Description
Resource System		
1 Productivity of the system	Hard coral cover	Essential habitat unlies the productivity of all coastal ecosystems. Using coral reefs as an example, the amount of living coral cover is the foundation of tropical reef ecosystems, and provides essential habitat and structural complexity for reef-associated organisms. Other indicators for mangroves and seagrass habitats can also be applied.
	Reef fish biomass	Fish biomass is a primary driver of coastal ecosystem services. For coral reefs, total reef fish biomass is used to evaluate reef status and set management targets (~500–1000 kg/ha) for sustainable coral reef fisheries (McClanahan et al. 2011, MacNeil et al. 2015, Graham et al. 2017). Biomass is also an indicator of fisheries exploitation and market drivers (Maire et al. 2016, Cinner et al. 2016).
Resource Units		
2 Number of resource units	Biomass of target reef fish	Fishable biomass represents the actual resource that users can extract from the broader resource system. This can be described as key fishery targets (e.g., groupers, snappers), or invertebrates (e.g., sea cucumbers, trochus shells, lobster).
	Density of target invertebrates	
Actors		
3 Knowledge of social-ecological system	Knowledge of human agency	Human agency assesses whether respondents recognize that humans are causal agents of change in marine systems (Cinner et al. 2012). Theory suggests that when actors share common knowledge of social-ecological systems, including how human actions affect the social-ecological system, they be more likely to engage in successful management outcomes (Ostrom 2009). There is reasonable consensus that it is desirable to increase human agency to reduce inequality, injustice and the imbalance of power (Hicks et al. 2016).
4 Importance of resource	Fisheries dependence	When people are highly dependent on marine resources for their livelihoods, they are more likely to attach a high value to the sustainability of the resource and engage in management of a common resource (Ostrom 2009). For example, high resource dependence is associated with 'bright spots' of fish biomass (Cinner et al. 2016).
	Number of livelihoods	The number of alternative livelihoods is an indicator of the pressure on natural resources, and the portfolio of household activities that can provide income and food security.
Governance System		
5 Operational rules	Rule description	Operational rules are those that directly guide behaviour concerning a resource (Ostrom 1990, Thomson and Freudenberger 1997). Operational rules define: (1) who can access the resource; (2) how much individuals can harvest, when and where they may exploit the resource, and what tools they are permitted to use; and (3) who has to contribute money, labour, or materials to protect and maintain resources in the community.
6 Collective-choice rules	Political efficacy	Collective choice rules specify who can make, modify or revoke rules about managing common resources. Theory suggests that if resource users are involved in making and modifying rules it is more likely the rules will be considered legitimate and fair.
	Fairness of decision making	

Construct	Indicator	Description
Interactions		
7 Harvesting	Catch per unit effort (CPUE)	The amount of resource extraction is critical to understanding social-ecological system dynamics (Ostrom 2009). Locations with different CPUEs will likely indicate different fisheries pressure and management outcomes. For example, fisheries that depend on low CPUE may suggest high effort and concerns of unsustainable exploitation. Areas with high CPUE may suggest more sustainable and profitable fisheries.
8 Conflict	Perceived conflict	Conflict can arise over a variety of issues including distribution of costs and benefits of management, different priorities for management (e.g., conservation vs. livelihoods), the distribution of authority, noncompliance, etc (e.g. Gurney et al. 2014). Understanding the frequency, severity, and reason for conflict is critical, given that conflict can jeopardize biological and social objectives.
Outcomes		
9 Social performance	Management effect on individual	We operationalize social outcomes with indicators focusing on local people's perceptions of the impacts of management. These indicators include perceivied: (1) management effect on the individual; (2) management effect on their community; and (3) fairness of management effects.
	Management effect on community	
	Fairness of management effects	
# Human wellbeing	Wealth (assets)	Material assets can be a useful indicator to identify the impacts of resource management on livelihoods and income generation. Further, improving community members' material wellbeing is often a key goal of many conservation and natural resource management activities.
	Change in subjective wellbeing	Wellbeing is multidimensional and consists of both objective and subjective elements. To capture subjective wellbeing, we ask the question, "All things considered, has your satisfaction with your life as a whole changed over the last three years? What were the three main causes of this change?". While not specific to resource management, this indicator provides insight into subjective wellbeing and whether the causes are related to natural resource use or management.

Ecological monitoring of coral reef resources in Fiji.
Photo: Emily Darling / WCS.

Table 2. *Full dashboard of social-ecological system indicators for small-scale coastal fisheries.*

Construct	Indicator	Method	Page
Social, economic, political settings, and related ecosystems			
S5. Market incentives	Market access	Global GIS layer	p. 37
	Market engagement (ice, middlemen)	Key informant #21-22	p. 38
ECO1. Climate patterns	Climate exposure to coral bleaching	Global GIS layer	p. 38
ECO2. Pollution patterns	Land-based pressures	Global/regional GIS layers	p. 38
Resource System			
RS5. Productivity of system	Hard coral cover	Underwater surveys	p. 31
	Coral genera richness	Underwater surveys	p. 31
	Structural complexity	Underwater surveys	p. 31
	Reef fish biomass	Underwater surveys	p. 31
	Reef fish species richness	Underwater surveys	p. 31
Resource Units			
RU5. Size	Fishable biomass	Underwater surveys	p. 32
	Density of target invertebrates	Underwater surveys	p. 32
Actors			
A1. Number of actors	Community population	Census information	p. 13
A2. Socioeconomic attributes of actors	Place of origin	Household #1	p. 13
	Residential period	Household #1	p. 13
	Age	Household #2	p. 13
	Formal education	Household #3	p. 13
	Clan or ethnicity	Household #4	p. 14
	Religion	Household #5	p. 14
	Marital Status	Household #6	p. 14
	Household status	Household #7	p. 14
	Gender	Household #8	p. 14
	Household size	Household #10	p. 14
	Wealth (assets)	Household #35-36	p. 15
	Community infrastructure	Key informant #22	p. 16
A5. Leadership	Trust in leadership	Household #20	p. 17
A6. Norms / Social capital	Participation in community organizations	Household #9	p. 17
	Community trust	Household #20	p. 17
A7. Knowledge of social-ecological system	Knowledge of human agency	Household #19	p. 18
	Change in resource abundance	Household #18	p. 18
	Resource decline response	Household #16	p. 18
A8. Importance of resource	Fisheries dependence	Household #11	p. 20
	Occupational multiplicity	Household #11	p. 20
	Fish consumption	Household #17	p. 20
	Catch use (eat)	Household #15	p. 20
	Catch use (sell)	Household #15	p. 20
	Catch use (give away)	Household #15	p. 20
	Fisheries occupational attachment	Household #12	p. 20
	Place attachment	Household #38	p. 20
	Traditional marine practices	Key informant #2	p. 21
A9. Technology used	Primary fishing gear	Household #13	p. 21
	Fishing gear diversity	Household #13	p. 21

Construct	Indicator	Method	Page
Governance System			
GS3. Network structure	Number of partners	Key informant #9	p. 22
	Partner activities	Key informant #9	p. 23
	Number of partner levels	Key informant #9	p. 23
	Partner contact frequency	Key informant #9	p. 23
	Partner benefits	Key informant #10	p. 23
	Partner costs	Key informant #11	p. 23
GS5. Operational rules	Knowledge of rules	Household #21 and Key informant #1	p. 25
	Rule origin	Household #21 and Key informant #1	p. 25
	Rule description	Key informant #1	p. 25
	History of rules	Key informant #1	p. 26
	Clearly defined management boundaries	Key informant #1	p. 26
GS6. Collective-choice rules	Participation in decision-making	Household #31	p. 26
	Political efficacy	Household #32	p. 26
	Fairness of decision-making	Household #33	p. 27
	Support for management	Household #30	p. 27
	Government support for prosecution	Key informant #17	p. 27
	Government support for rule changing	Key informant #18	p. 27
	Rights to participate	Key informant #13	p. 28
	Clearly defined membership	Key informant #4	p. 28
	Accountability	Key informant #5	p. 28
GS8. Monitoring and sanctions	Conflict resolution success	Key informant #19	p. 29
	Conflict resolution process	Key informant #20	p. 29
	Compliance monitoring	Key informant #14	p. 29
	Sanctions	Key informant #15	p. 29
	Graduated sanctions	Key informant #16	p. 29
	Monitoring frequency	Key informant #7	p. 30
	Congruence of rules	Key informant #8	p. 30
Interactions			
I1. Harvesting	Total catch	Household #14	p. 33
	Value of catch	Household #14	p. 33
	Catch per unit effort (CPUE)	Household #14	p. 33
	Level of poaching	Household #21 and Key informant #12-13	p. 33
I4. Conflict	Perceived conflict	Household #34	p. 34
	Conflict actors	Household #34 and Key informant #19	p. 34
	Conflict issue		p. 34
	Conflict intensity	Key informant #20	p. 34

Construct	Indicator	Method	Page
Outcomes			
O1. Social performance	Management effect on community	Household #22	p. 35
	Management effect on individual	Household #23	p. 35
	Fairness of management impacts	Household #26	p. 35
	Management effect on fish abundance	Household #27	p. 36
	Management effect on fishing effort	Household #28	p. 36
	Management effect on catch reliability	Household #29	p. 36
	Change in subjective wellbeing	Household #37	p. 36
	Management effect on traditional marine practices	Key informant #2	p. 37

A fish seller proudly displays a large snapper in the Maputo fish market, Mozambique. Photo: Emily Darling / WCS.

Description of indicators

This sections details the social and ecological indicators that can operationalize a socio-ecological systems approach for monitoring global coastal fisheries. These social indicators are operationalized using two methods: a **household survey** and a **key informant survey**.

Actors

A1 Number of actors

Common property theory suggests that while group size can affect the success of commons management, the effect depends on the context and type of management employed (Baland and Platteau 2000). For example, group size may have a negative effect on self-organisation by increasing transaction costs, i.e. the costs of getting actors together and agreeing on management actions. Conversely, if the tasks of managing a resource are costly, such as monitoring, group size may have a positive effect on management (Ostrom 2009). Recent revisions of the social-ecological systems framework have extended this component of the framework from number of users to number of actors, in part to make the framework less restrictive and to recognise that actors other than users may influence governance (McGinnis and Ostrom 2014).

Working use: We operationalise this component of the social-ecological systems framework through one indicator, community population.

Indicator: Community population

Method: Local census information

Notes: If possible, also extract number of fishers from census information. Further, depending on the context and how the social-ecological system is defined, actors to consider may also include users from more than one community, and/or other categories of users, such as tourism operators.

A2 Socioeconomic attributes of actors

Priorities for commons use and management, and capacities and powers to defend those priorities, are likely to differ according to social subgroups, defined by social and economic characteristics such as gender, age, ethnicity, religion and wealth (Hicks and Cinner 2014, Gurney et al. 2015).

Working use: We operationalise this component of the social-ecological systems framework through 12 indicators: (1) place of origin; (2) residential period; (3) age; (4) formal education;
(5) clan/ethnicity; (6) religion; (7) marital status;
(8) household status; (9) gender; (10) household size; (11) wealth (assets); and (12) community infrastructure.

Indicator: Place of origin

Question: Where are you from?
(Interviewer to circle only one option below based on above question. Choose the most specific)

- This village
- This district
- Coastal area other than this district
- This country (not coastal area)
- Other country

Method: Household survey, Q1a.

Indicator: Residential period

Question: How many years have you lived in this village?

Method: Household survey, Q1b.

Indicator: Age

Question: How old are you?
(Interviewer to record in years)

Method: Household survey, Q2.

Indicator: Formal education

Question: What was the highest level of formal education that you completed?

Method: Household survey, Q3.

Indicator: Clan/ethnicity

Question: What is your clan/ethnicity?

Method: Household survey, Q4.

Notes: Country-program to decide the most appropriate type and unit of social organisation for the context, e.g. clan or Mataqali is the most appropriate in Fiji, whereas in Indonesia ethnicity is more appropriate.

Indicator: Religion

Question: What is your religion?

Method: Household survey, Q5.

Indicator: Marital status

Question: Are you single, married etc?
☐ Single ☐ Married ☐ Widowed

Method: Household survey, Q6.

Indicator: Household status

Question: Are you head of the household?
☐ Yes ☐ No

Method: Household survey, Q7.

Indicator: Gender

Method: Household survey, Q8.

Indicator: Household size

Question: How many people are currently part of your household? *(Note that this includes the RESPONDENT. Who is counted as an adult or a child should be are decided by the respondent)*

Adult male
Adult female
Male children
Female children

Method: Household survey, Q10.

Calculation: Add up number of male and female adults and children.

Notes: The age definition of 'children' may differ with context. Therefore, context specific definitions will be used through allowing respondents to decide who is a child and who is an adult. Households are defined as people who jointly provide food and other essentials for living for themselves (UN 1980).

Fish traders sort through the morning catch in Indonesia. Photo: Georgina Gurney.

Indicator: Wealth (assets)

To calculate the assets component of wealth we use a multivariate index of Material Style of Life (MSL; Pollnac and Crawford 2001). MSL is a composite measure of wealth, based on the presence or absence of household possessions, and is used as an indicator of *relative* wealth (e.g. Gurney et al. 2014).

Question: Material Style of Life and owned assets. *(Please tick all the household items or facilities present in the household. Also record the number of each asset owned by the household.)*

Cooking pots Yes ☐ No How many:	Radios/cassette/CD ☐ Yes ☐ No How many:	DVD / VCD players ☐ Yes ☐ No How many:
Mattresses ☐ Yes ☐ No How many:	Mobile phone (not smartphone) ☐ Yes ☐ No How many:	Smartphones or tables ☐ Yes ☐ No How many:
Flushing toilet ☐ Yes ☐ No How many:	Electric fan ☐ Yes ☐ No How many:	Indoor piped water (tap) ☐ Yes ☐ No How many:
Washing machine ☐ Yes ☐ No	Computers ☐ Yes ☐ No How many:	Electric refrigerators or freezers ☐ Yes ☐ No How many:
Country-specific assets	Televisions ☐ Yes ☐ No How many:	Satellite dishes ☐ Yes ☐ No How many:
Country-specific assets	Country-specific assets	Country-specific assets

Roof Material ☐ Bamboo/ Thatch ☐ Wood ☐ Metal ☐ Tile ☐ Other:	Wall Material ☐ Bamboo/ Thatch ☐ Wood ☐ Metal ☐ Tile ☐ Other:	Floor Material ☐ Bamboo/ Thatch ☐ Wood ☐ Metal ☐ Tile ☐ Other:	Electricity ☐ Solar ☐ Generator ☐ Grid ☐ None ☐ Other:

Do you own a boat?
☐ No boat
☐ Boat without a motor (e.g., canoe)
☐ Boat with a motor (engine has _____ hp)
☐ Other (specify) _____

Method: Household survey, Q35, Q36.

Notes: The categories used for roof, wall and floor material can be changed to suit the relevant context, so long as there are four categories representing a gradient of economic value. Country programs should add additional assets where the presence or absence of which are important for defining monetary wealth in that context (i.e. don't choose a household item or facility that everybody has).

Calculation: Material Style of Life (MSL) is a *relative* measure of wealth. Therefore the first step in calculating MSL values is to define the bounds of the population for which you want to calculate wealth; do you want to measure relative wealth within one community, within a number of villages etc? For example, if relative wealth within a number villages is of interest, data from households in all villages needs to be analysed together. To get an MSL score per household ", we can use multivariate analyses (e.g., principal component analysis) or a Basic Necessities approach.

These are the basic steps for running a principal components analysis, PCA:

1. Run PCA, specifying extraction of one factor.
2. Examine the factor loadings for each household item and the total variance explained.
3. Remove one household items with the lowest factor loading.
4. Re-run PCA, and examine the total variance explained and factor loadings for each household item. Again remove one household item with the lowest factor loading.
5. Continue re-running PCA and removing household items until the total variance explained is greater than 0.4, and all retained household items have a factor loading of more than 0.4.
6. Extract the factor scores for each household. This is the MSL score, and a measure of relative wealth.

The information on assets can also inform a Basic Necessities Survey methodology, whereby local stakeholders define which assets are basic necessities, and can also add a suite of additional services (e.g., access to clean drinking water, medical services). By collecting information on how many assets are owned, this information can also be translated into other indicators of wealth (e.g., the total values of assets owned by a household, given local village prices of assets) (Wilkie et al. 2015). Other forms of indicators of wealth (assets) could be developed from the data in Q35, Q36,

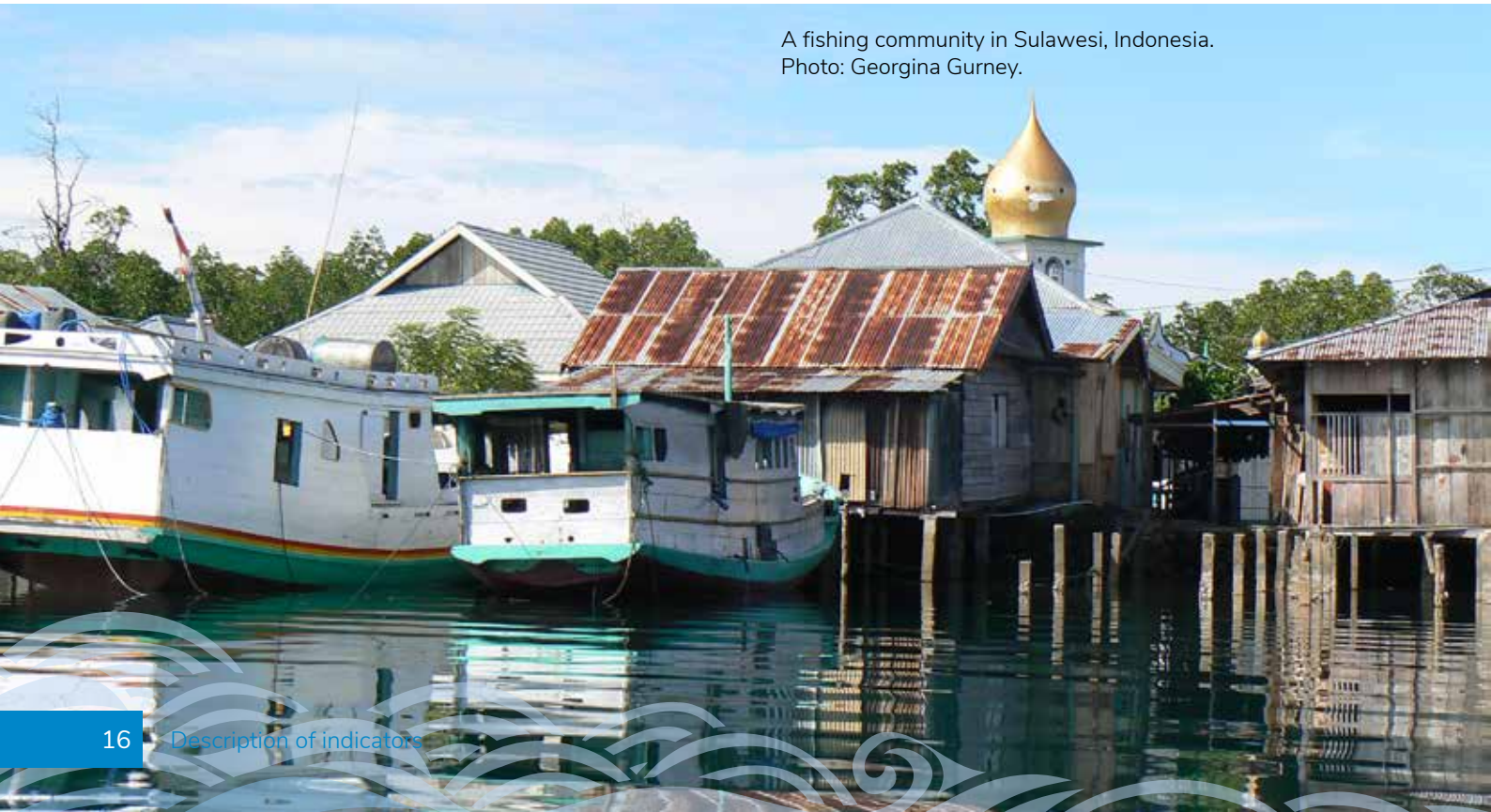
Indicator: Community infrastructure

Question: What types of infrastructure are available here in this community? (*Circle when an item is present in the community. Ask only ONCE per village.*)

	Item	present
1	Hard-top road	x
2	Phone service	x
3	Restaurant	x
4	Public market	x
5a	Clean water for drinking	x
5b	Piped water service	x
6	Public transportation	x
7	Fuel station	x
8	Electric freezers that fish is stored in	x
9	Hotel	
10	Dentist	x
11	Internet	x
12	Primary school	x
13	Secondary School	x
14	Electricity	x
15	Sewage treatment	x
16	Medical clinic	x
17	Doctor	x
18	Ice making facilities for storing fish	x
19	Police	

Method: Key informant survey, Q22.

Calculation: Add up the number of items that are present.



A fishing community in Sulawesi, Indonesia. Photo: Georgina Gurney.

A5 Leadership

Commons theory suggests that if actors trust and respect people in leadership positions in the relevant social context, collaborative management of natural resources is more likely (Baland and Platteau 2000, Ostrom 2009). However, when assessing the role of leadership in regards to natural resource management it is important to examine said leaders' attitudes and behaviour in regards to resource use and management.

Working use: We operationalise this component of the social-ecological systems framework with one indicator, trust in leadership.

Indicator: Trust in leadership

Trust in leadership is a composite score comprising in trust scores given to village leaders, marine resource management leaders, NGOs, and government.

Question: In general, how much do you trust the following people? *(Circle one option for each group)*

		Not at all	Distrust more people than trust	About half-half	Trust more people than distrust	Trust all
a.	People in your village	x	x	x	x	x
b.	Village leaders	x	x	x	x	x
c.	Marine resource management group	x	x	x	x	x
d.	NGOs	x	x	x	x	x
e.	Government	x	x	x	x	x

Method: Household survey, Q20, excluding (a).

Calculation: Add up the Likert-scale trust scores for village leaders, marine resource management leaders, NGOs, and government.

Notes: Rather than a composite indicator of trust in leadership described above, the trust scores to village leaders, marine resource management leaders, NGOs, and government could also be assessed separately.

A6 Norms/social capital

Social capital is a broad concept; the most commonly accepted definition is provided by Putnam (2000), namely, "connections among individuals – social networks, and the norms of reciprocity and trustworthiness that arise from them''. Social capital is suggested to be critical to the success of commons management (Pretty 2003), such as co-management of fisheries (Grafton 2005), because it lowers the transaction costs of working together, thus increasing the likelihood of engagement in management. Structural components (i.e. social networks) of social capital are suggested to facilitate the cognitive components (e.g. shared norms, trust, and reciprocity) through providing a venue for repeated interactions and reinforcement of norms (Uphoff 1993).

Working use: We operationalise this component of the social-ecological systems framework with two indicators; (1) participation in community organisations (an indicator of structural social capital); and (2) community trust (an indicator of cognitive social capital).

Indicator: Participation in community organisations

Question: How many community organisations are you involved in?

Method: Household survey, Q9.

Notes: Community organizations are defined as any group of people working together towards a common goal. All formal and informal organizations are included, including (but not limited to) those relating to natural resource management.

Indicator: Community trust

Question: See Indicator: Trust in leadership (above: A5 Leadership). Consider trust responses for a. People in your village.

Method: Household survey, Q20a.

A7 Knowledge of SES/mental models

Common property theory suggests that when actors share common knowledge of the characteristics and dynamics of social-ecological systems, including how human actions affect the social-ecological system and whether natural resource abundance is declining, they are more likely to engage in commons management (Ostrom 2009).

Working use: We operationalise this component of the social-ecological systems framework with three indicators: (1) knowledge of human agency; (2) change in resource abundance; and (3) resource decline response.

Indicator: Knowledge of human agency

This indicator assesses whether the respondent recognises that humans are causal agents of change in marine systems (Cinner et al. 2012).

Question: a. What can be done to increase the number of fish in the sea around here? (*Write down main key words and indicate if human management activities (e.g. reducing fishing, changing gears etc) were mentioned in part b.)*

b. Human management actions were mentioned?
☐ Yes ☐ No

Method: Household survey, Q19b.

Photo: Emily Darling / WCS.

Indicator: Change in resource abundance

Question: Over the past 5 years has the number of fish in the sea around here changed? *(If respondent says 'no', circle 'no change', if respondent says yes, ask* If so, how has it changed? *(Please circle one option)*

- Decreasing a lot
- Decreasing
- No change
- Increasing
- Increasing a lot
- Don't know

Notes: Be sure to consider the difference between mid-scale responses (ie 'no change') and a 'don't know' response. For example, the respondent may not be a fisher or have anything to do with fisheries or spend time in the ocean so they might not know (ie 'don't know' response) if the number of fish has changed. On the other hand, an experienced fisher who is very knowledgeable about fish populations might respond 'no change' because they think that fish populations are neither increasing nor decreasing.

Method: Household survey, Q18.

Indicator: Resource decline response

This indicator is used in the adaptive capacity index described in the last section of this module.

Question: If you were to get 50% less catch all year what would you do? *(Do not provide respondents with answers. Circle multiple boxes if necessary)*

- Keep fishing at same amount
- Fish more often
- Change fishing grounds
- Change fishing gears
- Fish less & switch to other livelihood
- Stop fishing entirely
- Other (specify):

Method: Household survey, Q16.

Calculation: The indicator takes the form of a binomial variable in the adaptive capacity index , such that '0' is given if the respondent answers 'Keep fishing at the same amount' and a '1' is given for all other answers (i.e. responses that show some ability to adapt to changing conditions).

A8 Importance of resource

Whether people engage in commons management is likely to be affected by whether actors "are either dependent on the resource system for a substantial portion of their livelihoods or attach high value to the sustainability of the resource" (Ostrom 2009). For example, a recent study of global coral reefs revealed that 'bright spots' of reef fish biomass were associated with high dependence on marine resources (Cinner et al. 2016).

Working use: We operationalise this component of the social-ecological systems framework with nine indicators: (1) fisheries dependence; (2) occupational multiplicity; (3) local fish consumption; (4) catch use (eat); (5) catch use (sell); (6) catch use (give away); (7) fisheries occupational attachment; (8) place attachment; and (9) traditional marine practices. The first two indicators relate to livelihood dependence on fisheries, the third indicator relates broadly to dietary dependence, the three 'catch use' indicators provide an indication of how catch is being used by the respondent (eating, selling or giving away) and therefore the nature of their fisheries dependence. The seventh and ninth indicators relate to cultural dependence. Although the 'place attachment' is not related specifically to marine resources, attachment to place may include attachment to local marine areas and could influence likelihood of involvement in commons management (Stedman 2002, Manzo and Perkins 2006).

Indicators: Fisheries dependence, occupational multiplicity

Question: a. What activities do you do that brings in food or money to your house? What do other people in your house do that brings in food or money to your house?

Livelihood activity	Tick livelihoods of RESPONDENT *(Circle their primary livelihood)*	# of people in HOUSEHOLD involved in activity		Rank importance for HOUSEHOLD
		Women	Men	
Fishing / gleaning				
Fish trading / selling				
Aquaculture / mariculture				
Hunting				
Farming – subsistence (e.g. household gardens, livestock)				
Farming – commercial / sell products				
Salaried employment (e.g. teacher, nurse)				
Tourism / handicrafts				
Small business				
Other				

b. Is fishing the *respondent's primary* livelihood? ☐ Yes ☐ No

Notes: The wording of the livelihoods can be adapted and additional livelihoods added to suit the local context (e.g., local sellers vs. *maryeueses* vs. *collecteurs* are defined as separate subgroups of fish traders in Madagascar).

Fisheries dependence

Fisheries dependence is defined as when fishing is stated as the primary livelihood.

Method: Household survey, Q11a, Q11b.

Calculation: Fisheries dependence can be measured at the individual (Q11b) or household scale (Q11a-5th column).

Occupational multiplicity

Occupational multiplicity is defined as the total number of different livelihood activities engaged in by a household or individual.

Method: Household survey, Q11a.

Calculation: Occupational multiplicity can be measured at the individual (Q11a-2nd column) or household scale (Q11a-5th column). For example, if 5 people fish and 5 people are involved in fish trading in the household, household-scale occupational multiplicity is 2.

Indicator: Catch use (eat)

Question: Typically, what percentage of your catch from fishing or gleaning do you eat, sell or giveaway?

a. _____% eat
b. _____% sell
c. _____% give away
☐ Don't know

Method: Household survey, Q15a.

Indicator: Catch use (sell)

Question: See above

Method: Household survey, Q15b.

Indicator: Catch use (give away)

Question: See above

Method: Household survey, Q15c.

Indicator: Local fish consumption

Question: In general, how often do you and your household eat locally caught fish or other seafood that was caught by you or someone in your community? *(Please circle one option)*

More than once per day
Once per day
More than once per week
Once per week
More than once per month

Method: Household survey, Q17.

Indicator: Fisheries occupational attachment

Question: *If respondent is a fisher ask them:* How much do you agree with this statement? *(Please circle one option):* "I could easily stop fishing, and make my living on land"

Strongly disagree
Somewhat disagree
Neither
Somewhat agree
Strongly agree

Method: Household survey, Q12.

Calculation: This indicator will need to be reverse-coded for many analyses, such that increasing numbers indicates more occupational attachment. To reverse-code this indicator, a response of 'strongly disagree' should be given a '5' rather than a '1', a response of 'somewhat disagree' should be given a '4' rather than a '2' etc.

Indicator: Place attachment

Question: Supposing that for some reason you were moving away from *[name of the village]*, how would you feel about leaving?

Very sad
Sad
Neither happy nor sad
Happy
Very happy

Method: Household survey, Q38.

Indicator: Traditional marine practices

Question: Are there any important cultural, traditional or spiritual practices associated with the sea here? Such as ceremonies, harvesting resources etc.

☐ Yes ☐ No
(If yes, write description)

If yes, do rules about managing fishing affect these practices? If yes, how?

No impact
Very bad
Bad
Neutral
Good
Very good

Description:

Method: Key informant survey, Q2a

Notes: Q2b provides data for the indicator 'Management effect on traditional marine practices' in the 'Outcomes' subsystem

A9 Technology used

Profiling the type and diversity of technology used by actors in relation to the ecological system is important for understanding social-ecological system dynamics (Ostrom 2009).

Working use: We operationalise this component of the social-ecological systems framework with two indicators: (1) primary fishing gear; and (2) fishing gear diversity.

A fisher returns from their morning trip in Indonesia. Photo: Georgina Gurney.

Indicators: Primary fishing gear, fishing gear diversity

Question: a. Which fishing gears does your HOUSEHOLD use? *(Circle the gears that the household uses. Circle multiple gears if necessary)*

Gear	Circle gear used
Handline (inshore / reef)	x
Handline (offshore / blue water)	x
Multiple hooks (more than 20)	x
Trolling line	x
Mesh gill net, above 5cm (2 inches)	x
Mesh gill net, below 5cm (2 inches)	x
Mosquito nets	x
Small/beach seine net (nets dragged along substrate)	x
Purse seine net	x
Hand spear	x
Spear gun	x
Fish trap	x
Explosives / Poison	x
Gleaning	x
Other (specify):	x
Other (specify):	x

b. Which of these fishing gears is the MOST IMPORTANT to your household?

Primary fishing gear

Method: Household survey, Q13b.

Fishing gear diversity

Fishing gear diversity is defined as the total number of separate gear types used by the household.

Method: Household survey, Q13a.

Calculation: Count total number of separate gear types used by household.

Governance system

GS3 Network structure

Natural resource management is not an isolated process; rather it interacts with other social and governance processes that may occur at multiple scales. Therefore, identifying the organisations involved in commons management, the interactions between these organisations and each organisation's particular role in commons governance (i.e. networks structure) is critical to understanding why commons management is successful or not. Common-property theory advocates the importance of cross-scale vertical linkages in particular; 'cross-scale vertical linkages' refers to links between organisations operating at lower scales (e.g. village) and organisations operating at higher scales (e.g. district government). Ostrom (1990) suggests that commons management is more successful if "governance activities are organised in multiple layers of nested enterprises". This recognises that the natural resources being managed by a particular community are usually part of a larger resource system, and that mechanisms to facilitate cooperation across spatial and governance scales are often needed (Berkes 2007).

Working use: We operationalise this component of the social-ecological systems framework with six indicators: (1) number of partners; (2) partner activities; (3) number of partner levels; (4) partner contact frequency; (5) partner benefits; and (6) partner costs.

Indicator: Number of management partners

Question: Currently, are there outside organizations that help with managing the marine resources here? (a) What is the name and type of this organization? (b) What do they do? (c) Where are they from? (d) In general, how often do you have contact with them?

Name and type of organization	What do they do? *(Please tick multiple boxes if necessary)*	Where are they from? *(Please tick one box)*	In general, how often do you interact? *(Please tick one box)*
☐ Community group ☐ NGO ☐ Government ☐ Other: ______	☐ Training / capacity building ☐ Help write management plans ☐ Hold meetings ☐ Conflict resolution ☐ Fundraising ☐ Education ☐ Other: ______	☐ This village ☐ Another village ☐ District ☐ Province ☐ National ☐ International	☐ Less than once a year ☐ 1–5 times/year ☐ 6–12 times/year ☐ >12 times/year
☐ Community group ☐ NGO ☐ Government ☐ Other: ______	☐ Training / capacity building ☐ Help write management plans ☐ Hold meetings ☐ Conflict resolution ☐ Fundraising ☐ Education ☐ Other: ______	☐ This village ☐ Another village ☐ District ☐ Province ☐ National ☐ International	☐ Less than once a year ☐ 1–5 times/year ☐ 6–12 times/year ☐ >12 times/year
☐ Community group ☐ NGO ☐ Government ☐ Other: ______	☐ Training / capacity building ☐ Help write management plans ☐ Hold meetings ☐ Conflict resolution ☐ Fundraising ☐ Education ☐ Other: ______	☐ This village ☐ Another village ☐ District ☐ Province ☐ National ☐ International	☐ Less than once a year ☐ 1–5 times/year ☐ 6–12 times/year ☐ >12 times/year
☐ Community group ☐ NGO ☐ Government ☐ Other: ______	☐ Training / capacity building ☐ Help write management plans ☐ Hold meetings ☐ Conflict resolution ☐ Fundraising ☐ Education ☐ Other: ______	☐ This village ☐ Another village ☐ District ☐ Province ☐ National ☐ International	☐ Less than once a year ☐ 1–5 times/year ☐ 6–12 times/year ☐ >12 times/year

Method: Key informant survey, Q9a.

Calculation: Add up the number of organisations involved in management.

Indicator: Partner activities

Question: see above

Method: Key informant survey, Q9b.

Indicator: Number of partner levels

Question: see above

Method: Key informant survey, Q9c.

Calculation: Add up the number of different hierarchical levels (i.e. this village, another village, district etc) of organisations involved in management.

Indicator: Partner contact frequency

Question: see above

Method: Key informant survey, Q9d.

Calculation: This indicator could be assessed for each partner organisation individually or to get one score per community, an average contact frequency score could be calculated.

Indicator: Partner benefits

Question: What are the benefits of relationships with these organizations for marine management and the community in general?

Method: Key informant survey, Q10.

Indicator: Partner costs

Question: What are the costs of relationships with these organizations for marine management and the community in general?

Method: Key informant survey, Q11.

Communities in Kubulau, Fiji discuss governance arrangements of natural resources.
Photo: Stacy Jupiter / WCS.

GS5 Operational rules

Operational rules are those that directly guide behaviour concerning a resource (Ostrom 1990, Thomson and Freudenberger 1997). Operational rules define: (1) who can access the resource; (2) how much individuals can harvest, when and where they may exploit the resource, and what tools they are permitted to use; and (3) who has to contribute money, labour, or materials to protect and maintain resources in the community.

Working use: We operationalise this component of the social-ecological systems framework with two individual-scale indicators: (1) knowledge of rules; and (2) rule origin, and three community-scale variables; (1) rule description; (2) history of rules; and (3) clearly defined management boundaries.

Indicators: Knowledge of rules, origin of rules

Question: I'm interested in learning about some of the rules and traditions about fishing here.
a. Are there places where people are not supposed to fish, not use certain gears, etc.? b. Who created the rules? c. Do people still fish there? If so, how many people?

Rule	Description of rules, e.g. what gears are not used etc.	Who created the rules? *(tick multiple boxes if necessary)*	Do people still fish there? If so, how many? *(tick one box)*
Places where people are not supposed to fish	☐ Not present	☐ Fishers/local users ☐ NGO ☐ Government ☐ Other: _____ ☐ Don't know	☐ No one ☐ A few ☐ About half ☐ Most ☐ Everyone ☐ Don't know
Certain **fishing gears** that people are not supposed to use	☐ Not present	☐ Fishers/local users ☐ NGO ☐ Government ☐ Other: _____ ☐ Don't know	☐ No one ☐ A few ☐ About half ☐ Most ☐ Everyone ☐ Don't know
Certain **times** that people are not supposed to fish	☐ Not present	☐ Fishers/local users ☐ NGO ☐ Government ☐ Other: _____ ☐ Don't know	☐ No one ☐ A few ☐ About half ☐ Most ☐ Everyone ☐ Don't know
Certain **species or types of fish** that people are not supposed to catch	☐ Not present	☐ Fishers/local users ☐ NGO ☐ Government ☐ Other: _____ ☐ Don't know	☐ No one ☐ A few ☐ About half ☐ Most ☐ Everyone ☐ Don't know
Other, please describe:	☐ Not present	☐ Fishers/local users ☐ NGO ☐ Government ☐ Other: _____ Don't know	☐ No one ☐ A few ☐ About half ☐ Most ☐ Everyone ☐ Don't know

Knowledge of rules

This indicator could be operationalised in a number of ways depending on the question of interest. For example, data from this question could be crossed checked with various other data sources (e.g. key informant interview, local government documents etc) to elucidate whether respondents are aware of designated rules. In the latter case, respondents' knowledge of rules could be turned into a binomial indicator for each type of rule.

Method: Household survey Q21a and Key informant Q1

Origin of rules

Method: Household survey Q21b and Key informant Q1

Indicator: Rule description

Question: I'm interested in learning about some of the rules and traditions about fishing here.
(a) Can you tell me what rules you have here? How did they start and why? What are the goals of these rules? (b) When did these rules start (specify year if possible)? (c) Who started or helped create these rules?

Rule	Description (including how and why, and goals)	When started	Who started this rule? *(Tick multiple boxes if necessary)*
Places where people are not supposed to fish			☐ People from here ☐ Outside NGO ☐ Government ☐ Other: _____
Certain **fishing gears** that people are not supposed to use			☐ People from here ☐ Outside NGO ☐ Government ☐ Other: _____
Certain **times** that people are not supposed to fish			☐ People from here ☐ Outside NGO ☐ Government ☐ Other: _____
Certain **species or types of fish** that people are not supposed to catch			☐ People from here ☐ Outside NGO ☐ Government ☐ Other: _____
Other, please describe:			☐ People from here ☐ Outside NGO ☐ Government ☐ Other: _____

Method: Key informant survey, Q1.

Notes: This questions provides qualitative data. The data could be reported in a table, figure or in the main text, and is essential to understanding the context and interpreting quantitative data.

Indicator: History of rules

Question: See above.

Method: Key informant survey Q1.

Calculation: Depending on the nature of the data provided, this indicator could be operationalised as continuous data (i.e. the number of years that the rule has been in place) or ordered categorical data (by creating a scale of duration, e.g. 'more than 100 years', '50–100 years', '20–50 years' etc).

Indicator: Clearly defined management boundaries

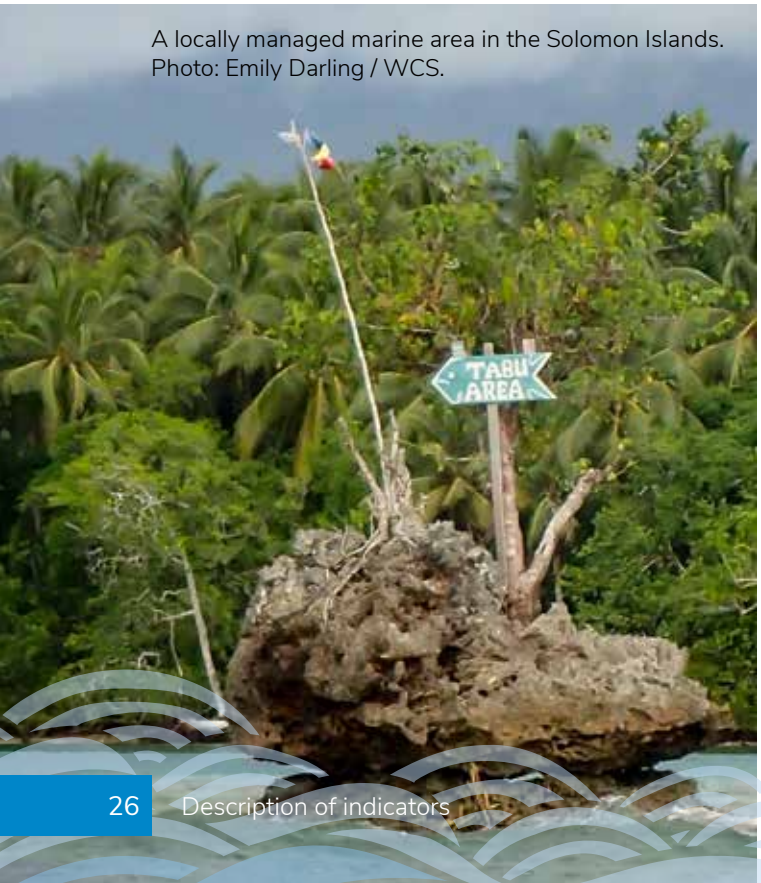
Question: a. How often is there confusion about boundaries of the area where management rules apply? *(Please circle one option)*

- Don't know
- Never
- Rarely
- Sometimes
- Often
- Always

b. Description:

Method: Key informant survey Q13a.

Notes: Part 'b' of this question provides important qualitative information that should be used in interpreting responses to part 'a'.



A locally managed marine area in the Solomon Islands. Photo: Emily Darling / WCS.

GS6 Collective-choice rules

Collective-choice rules are the rules dictating how the operational rules are established (Ostrom 1990, Thomson and Freudenberger 1997). Collective decision-making rules specify who can make, modify or revoke operational rules and under what conditions. Common property theory suggests that if resource users are involved in making and modifying operational rules, it is more likely that operational rules fit the local social-ecological context, and are considered legitimate and fair.

Working use: We operationalise this component of the social-ecological systems framework with four individual-scale indicators: (1) participation in decision-making; (2) political efficacy; (3) fairness of decision-making; (4) support for management, and five community-scale indicators: (1) government support for prosecution; (2) government support for rule changing; (3) right to participate; (4) clearly defined membership; and (5) accountability.

Indicator: Participation in decision-making

Question: Currently, are you involved in decisions about marine resource use or managing marine resources? For example, have you been to any meetings about marine resources? If yes, how? *(Please circle one option. Interviewer to decide level of participation, note that 'passive'=if attends meetings but does not talk; 'active' =if talks at meetings)*

- Not involved
- Passive
- Active
- Leadership role

Method: Household survey, Q31.

Indicator: Political efficacy

Question: How much do you agree or disagree with this statement: *(Please circle one option)*

"People like me have influence on management of marine resources."

- Strongly disagree
- Disagree
- Neither
- Agree
- Strongly agree

Method: Household survey, Q32.

Indicator: Fairness of decision-making

Question: a. In general, do you think THE WAY that decisions are made about marine resource use and management are fair? *(Please circle one option)*
b. Why?

- Very unfair
- Unfair
- Neither
- Fair
- Very fair
- Don't know

Method: Household survey, Q33.

Notes: Part 'b' of this question provides important qualitative information that should be used in interpreting responses to part 'a'.

Notes: Be sure to consider the difference between mid-scale responses (ie 'neither') and a 'don't know' response. A 'don't know' response would be appropriate if the respondent has no knowledge of how decisions are made, whereas a 'neither' response would be appropriate if the respondent was familiar with the way that decisions are made but didn't think the process was unfair or fair. The latter situation might arise if the respondent thinks that some aspects of the way in which decisions are made is fair, and other aspects are unfair.

Indicator: Support for management

Question: a. In general, do you support/agree with the management here? *(Please circle one option)*
b. Why?

- Very unsupportive
- Unsupportive
- Neutral
- Supportive
- Very supportive

Method: Household survey, Q30.

Notes: Part 'b' of this question provides important qualitative information that should be used in interpreting responses to part 'a'.

Indicator: Government support for prosecution

Question: a. When resource users want to prosecute and give out punishments to poachers, to what extent are they supported by government organizations? *(Please circle one option)*

- Don't know
- Strongly opposed
- Opposed
- Neither
- Supported
- Strongly supported

b. Description:

Method: Key informant #17.

Notes: Part 'b' of this question provides important qualitative information that should be used in interpreting responses to part 'a'. Be sure to consider the difference between mid-scale responses (ie 'neither') and a 'don't know' response (for a description of how the two responses are different please see explanation for 'Change in resource abundance' (p. 18) and 'Fairness of decision-making' (p. 27) indicators.

Indicator: Government support for rule changing

Question: a. If resource users make and change their own rules about resource use here, how supportive is the government? *(Please circle one option)*

- Don't know
- Strongly opposed
- Opposed
- Neither
- Supported
- Strongly supported

b. Description:

Method: Key informant #18.

Notes: Part 'b' of this question provides important qualitative information that should be used in interpreting responses to part 'a'. Be sure to consider the difference between mid-scale responses (ie 'neither') and a 'don't know' response (for a description of how the two responses are different please see explanation for 'Change in resource abundance' (p. 18) and 'Fairness of decision-making' (p. 27) indicators.

Indicator: Right to participate

Question: a. Who can participate in decision-making about marine resource use and management here? b. Who cannot participate in decision-making about marine resource use and management here?

Method: Key informant interview, Q3.

Indicator: Clearly defined membership

Question: a. How often is there confusion about who can participate in decision-making? *(Please circle one option)*

- Don't know
- Never
- Rarely
- Sometimes
- Often
- Always

b. Description:

Method: Key informant interview, Q4a.

Notes: This question also provides important qualitative information that should be used in interpreting responses to part 'a'. Be sure to consider the difference between mid-scale responses (ie 'neither') and a 'don't know' response.

Indicator: Accountability

Question: If resource users don't agree with the decisions made about natural resources, including decisions about punishments, what can they do about it?

Method: Key informant interview, Q5.

GS8 Monitoring and sanctions

Common-property scholars have repeatedly highlighted the importance of user group monitoring of resource conditions and the behaviour of actors in relation to resources (Cox et al. 2010). Information about changes in ecological and social conditions relevant to commons management can provide guidance for modifying and adapting operational rules to better fit the attributes of the problems they are meant to address. Monitoring of compliance with operational rules is also critical for generating incentives for actors to invest in the long-term management of resources (Ostrom 2009). Further, rule enforcement is suggested to be more effective if: (1) sanctions are graduated; and (2) mechanisms for conflict resolution are present (Ostrom 1990). Graduated sanctions progress incrementally based on either the severity or the frequency of rule violations, and thus, help to ensure proportionality between the severity of violations and sanctions. Conflict resolution processes are important for commons management given conflicts about compliance and enforcement (as well as a range of other issues) often occur. Studies have therefore shown repeatedly that the presence of mechanisms to resolve these conflicts rapidly and with little cost may improve the likelihood of successful management outcomes.

Working use: We operationalise this component of the social-ecological systems framework with seven indicators: (1) conflict resolution success; (2) conflict resolution process; (3) compliance monitoring; (4) sanctions; (5) graduated sanctions; (6) monitoring frequency; and (7) congruence of rules.

Women fish close to shore using mosquito nets in northwest Madagascar. Photo: Emily Darling / WCS.

Indicator: Conflict resolution success

Question: (a) Are there conflicts/problems about marine resources here?
☐ Yes ☐ No

If conflict happens, (b) Who is involved? (c) What is the conflict about? (d) What is the intensity? (e) How often does it happen? (f) Has this conflict been resolved?

Who is involved in this conflict?	**What issue is the conflict about?**	**Intensity of conflict** *(Please tick one box)*	**Frequency of conflict** *(Please tick one box)*	**Resolution success** *(Please tick one box)*
		☐ Mild / verbal ☐ Violent / destructive ☐ Don't know	☐ Don't know ☐ No conflict ☐ Less than once per year ☐ More than once per year ☐ Monthly ☐ Daily	☐ No resolution ☐ Partially resolved ☐ Fully resolved
		☐ Mild / verbal ☐ Violent / destructive ☐ Don't know	☐ Don't know ☐ No conflict ☐ Less than once per year ☐ More than once per year ☐ Monthly ☐ Daily	☐ No resolution ☐ Partially resolved ☐ Fully resolved

Method: Key informant survey, Q19.

Indicator: Conflict resolution process

Question: What types of processes (e.g. community meetings, laws, etc.) exist to help resolve this conflict?

Method: Key informant survey, Q20.

Indicator: Compliance monitoring

Question: Who monitors for people breaking rules?

Method: Key informant survey, Q14.

Indicator: Sanctions

Question: What are the penalties for breaking the rules here?

Method: Key informant survey, Q15.

Indicator: Graduated sanctions

Question: a. How often does the punishment or penalty increase if someone breaks the same rule twice, three times or more or with the severity of the offence? *(Please circle one option)*

Don't know
Never
Rarely
Sometimes
Often
Always

b. Description:

Method: Key informant survey, Q16.

Notes: Q16b provides important qualitative information that should be used in interpreting responses to part 'a'.

Indicator: Monitoring frequency

Question a. How often do people undertake monitoring (e.g. fisheries, ecological, social, etc.) for management around here? *(Please circle one option)*

- Don't know
- Never
- Rarely
- Sometimes
- Often
- Always

b. If yes, what do they monitor? c. If yes, who does the monitoring? d. If yes, what do they do with the information?

Method: Key informant survey, Q7a.

Notes: Q7b-d provides important qualitative information that should be used in interpreting responses to part 'a'.

Indicator: Congruence of rules

Question: a. In recent years, have rules about marine resource use changed in response to changes in environmental conditions? *(Please circle one option)*

- Don't know
- Never
- Rarely
- Sometimes
- Often
- Always

b. Please explain:

Method: Key informant interview, Q8.

Notes: Q8b provides important qualitative information that should be used in interpreting responses to part 'a'.

Note: Congruence of rules can be considered as separate questions about whether the rules have changed in response to environmental conditions or social conditions. If this is not stated in the question, this can be coded from the qualitative answers.

The day's catch is under consideration in Tofo, Mozambique. Photo: Emily Darling / WCS.

Resource system

RS5: Productivity of the system

Resource system is a key subsystem of the socio-ecological systems framework. Resource productivity can influence whether actors will see a need to manage the resource into the future; for example, resources that are already exhausted or, on the other hand, overabundant, are expected to have less community investment in resource management than resources that are perceived as scare by relevant actors (Ostrom et al. 2009).

Working use: For tropical coastal fisheries – typically coral reefs, or reef-associated habitats – we operationalize resources productivity using five typical indicators of nearshore coral reef health: (1) hard coral cover; (2) coral genera richness; (3) reef structural complexity; (4) reef fish biomass; and (5) reef fish species richness.

Hard coral cover, genera richness

Scleractinian corals are the foundation species of tropical reef ecosystems, and have long been recognized as providing essential habitat for reef-associated organisms.

Method: Underwater visual census data, ideally replicate line-intercept transects or point-intercept transects. Photo quadrats are also possible. Percent hard coral cover is an estimate of the percent of living, hard coral cover at a site, and based on standard analyses of Underwater Visual Census (UVC) methods. Observers also use UVC methods to record the number of hard coral genera observed at a site as an indicator of coral diversity. Possible methods include replicate line-intercept transect, point-intercept transects, although ideally, genera are estimated during a timed swim for diversity, or the roving observer bleaching methodology (which typically captures more diversity and rare taxa). Units for these indicators are number of genera per unit area, or can be compared using rarefaction methods (Gotelli and Colwell 2001).

Indicator: Reef structural complexity

Structural complexity, defined as the physical three-dimensional configuration of a reef, can shape the abundance and diversity of reef fish assemblages across large and small spatial scales (Darling et al. 2017).

Method: A visual 6-point observation of structural complexity based on replicate observations (e.g., every 5 m) along benthic or fish transects. See Appendix 3 for sample photos and description of the 6-point scale. Complexity scores are assigned to one of the following categories between 0 and 5: 0 no vertical relief, flat or rubbly areas; 1 low (<30 cm high) and sparse relief; 2 low but widespread relief; 3 widespread moderately complex (30–60cm high) relief; 4 widespread very complex (60–100 cm high) relief with numerous fissures and caves; 5 exceptionally complex (>1 m high) relief with numerous caves and overhangs. Numbers match photographs below. Along each transect, structural complexity can be estimated multiple times (e.g., every 5 m) to provide an average structural complexity score per transect. Averaged transect values can then be further averaged to provide a site-level estimate of structural complexity. Method adapted from Wilson et al. (2007).

Indicators: Reef fish biomass, species richness

Coral reef fish assemblages support fish productivity and diversity that drives important ecosystem patterns and processes for coral reefs. Attempts to rebuild reef fish abundances and associated functions require indicators of reef fish biomass and diversity, and can be used to set management targets for ecosystem function (e.g., 500–1000 kg/ha; McNeil et al. 2015, Graham et al. 2017, Darling and D'agata et al. 2015) and identify global 'bright spots' of successful local management (Cinner et al. 2016).

Method: UVC data, ideally belt transects or diver-observed videos. Fish are recorded to family, genus or species and evaluated to size, which can be converted to site-level biomass using standard length-width conversions. Reef fish are evaluated within standard reef fish families. The unit for this indicator is kg/ha. For species richness, the number of fish species are counted within standard reef fish families. Reef fish species richness is typically reported as the number of species / unit area (e.g., per 500 m^2).

A WCS scientist surveys reef fish using underwater visual census in Nosy Be, Madagascar. Photo: Emily Darling / WCS.

Resource units

RU5: Number of resource units

Resource units inhabit and interact within the broader resource system and represent the actual resource that users extract from the broader resource system.

Working use: We operationalise this component of the social-ecological systems framework with two indicators: (1) fish biomass and (2) density of target invertebrates.

Indicator: Fishable biomass

Method: The unit for this indicator is kg/ha. The indicator is a subset of total reef fish biomass from underwater visual census (UVC) survey data that describes biomass that is typically extracted by fisheries, specifically, the species of fish that can be caught by the gears that people use to fish. Fishable biomass is typically a subset of total reef fish biomass where species that are not targeted by the fishery are removed. In the Western Indian Ocean and Indonesia, all damselfish and fish <10 cm are not included in fishable biomass. In Melanesia, a list of target fishery species is used to evaluate fishable biomass.

Indicator: Density of target invertebrates

Method: UVC data, ideally based on replicate belt transects or diver-observed videos. Target invertebrates will differ by geography and should be clearly stated (e.g., bêche-de-mer and trochus shells in Western Pacific, sea cucumbers in Western Indian Ocean). The units for this indicator are the number of invertebrates per unit area (e.g., density per ha). Target individuals can be identified to suit the local context and management priorities

Reef fish catch during a traditional harvest on Koro Island, Fiji. Photo: Emily Darling / WCS.

Interactions

I1 Harvesting

Identifying the level of extraction of resource units is critical to understanding social-ecological system dynamics at multiple scales, including the system and individual scale (Ostrom 1990).

Working use: We operationalise this component of the social-ecological systems framework with four indicators: (1) total catch; (2) value of catch; (3) catch-per-unit-effort (CPUE); and (4) level of poaching.

Indicators: Total catch, value of catch, catch per unit effort (CPUE)

Question: I realize that some days you catch a lot of finfish, while other days you may not catch many finfish. a. On a normal day, how much do you catch? b. How many hours do you spend fishing? c) How much is that catch worth? d) Do you fish with a crew? If so, how many people do you fish with?

a. Catch	_____ ☐ bundles ☐ pieces ☐ kgs
b. # hours (fishing and travelling)	
c. Total value of catch (local currency)	
d. Number of people in crew:	☐ Don't fish with crew OR #crew members: _____

Total catch

Method: Household survey, Q14a.

Note: Countries can also specify additional context-specific units if fish are not measured in bundles, pieces or kgs.

Value of catch

Method: Household survey, Q14c. Record units in local currency, which can be converted to USD$ Purchasing Power Parity (PPP).

Catch-per-unit-effort (CPUE)

Calculate CPUE in kg/person/hour. First, if the fisher is part of a crew calculate how many kilos the individual fisher receives. Next divide the individual fisher's daily catch by effort.

Method: Household survey, Q14a, Q14b, Q14d.

Note: If units other than kgs are used in Q14a, please specify the approximate weight in kgs of units used or apply another standardization or comparison.

Indicator: Level of poaching

Question: See question for Knowledge of rules indicator.

Method: Household survey, Q21c:

Notes: This question is also asked in the key informant survey (Q12), with a related question on who typically breaks rules (Q13). The data from each type of survey may be used in different ways. The data from the household survey may be useful for analyses at the individual scale, for example, understanding individuals' perceptions of poaching may be important in understanding whether they support management or not. Whereas, the data from the key informant survey may provide the most accurate estimation of the level of poaching.

I4 Conflicts

Conflict in regards to commons management may arise over a variety of issues including distribution of costs and benefits of management, varying priorities for management, distribution of authority, noncompliance etc (e.g. Clarke and Jupiter 2010, Evans et al. 2011, Gurney et al. 2014). Understanding frequency, severity, and reason for conflict is critical given that it negatively affects human wellbeing and may jeopardise biological and social management objectives.

Working use: We operationalise this component of the social-ecological systems framework with one individual-scale indicator, perceived conflict, and three community-scale indicators: (1) conflict actors; (2) conflict issue; (3) conflict intensity.

Indicator: Perceived conflict

Question: Is there any conflict over marine resources here? If yes, how often does this conflict occur? *(Please circle one option)*

- No conflict
- Daily
- Weekly
- Monthly
- More than once per year
- Less than once per year

Method: Household survey, Q34.

Notes: The frequency of conflict is also asked in the key informant survey (Q26e) but in regards to different types of conflict individually.

Optional extension questions: What was the conflict about? What was the level of conflict?

Indicator: Conflict actors

Question: "Who is involved in this conflict?"

Method: Key informant Q19

Indicator: Conflict issue

Question: "What issue is the conflict about?"

Method: Key informant Q19

Indicator: Conflict intensity

Question: What is the intensity of conflict
☐ Mild / verbal
☐ Violent / destructive
☐ Don't know

Method: Key informant Q19

Outcomes

O1 Social performance

The social performance component of the outcomes subsystem outlines several evaluative criteria that may be used to determine whether management outcomes are deemed satisfactory (McGinnis 2011).

Working use: We operationalise this component of the social-ecological systems framework with eight indicators: (1) management effect on community; (2) management effect on individual; (3) fairness of management effects; (4) management effect on fish abundance; (5) management effect on fishing effort; (6) management effect on catch reliability; (7) change in subjective wellbeing; and (8) management effect on traditional marine practices. These indicators are all based on respondents' perceptions. For further reading on the value of subjective data (i.e. perception data) please see Bennett (2016) and Diedrich (2017). Note that while the 'change in subjective wellbeing' indicator is not specific to management, this indicator will provide insight into the key drivers of respondents' subjective wellbeing, in particular whether any of these drivers are related to natural resource use or management.

Coastal support important livelihoods, food security and culture for coastal communities around the world, including for mama karangas (female fish traders) in Kenya. Photo: Emily Darling / WCS.

Indicator: Management effect on community

The data for this indicator comes from part 'a' and part 'd' of this question, such that the response recorded for each respondent will either be 'no' (from part 'a') or 'very bad', 'bad', 'neutral' , 'good' or 'very good' (the latter 5 responses from part 'd'. Note that an answer of 'no' in part 'a' is different from an answer of 'neutral' in part 'd'; in the case of the latter response the respondent recognises that management effects them but thinks that the overall effect (i.e. balancing out the positive and negative impacts) is neutral, whereas in the case of the former, the respondent does not recognise any effect of management on them.

Question: a. In general, does management affect this COMMUNITY?
☐ Yes ☐ No

b. What are the positive impacts of management for this COMMUNITY?

c. What are the negative impacts of management on this COMMUNITY?

d. Considering these positive and negative impacts, what is the overall level of impact of management on this community? *(Circle appropriate level)*

- Very bad
- Bad
- Neutral
- Good
- Very good

Method: Household survey, Q22a, Q22d.

Notes: Parts 'b' and 'c' of this question provide important qualitative data on the nature of the perceived impacts of management and should be used to interpret results from analysis of the 'management effect on community' indicator. We ask first about management effects on the community and then about management effects on the individual because in more collective societies (e.g. Fiji) people often answer questions about themselves in terms of the community in which they are embedded.

Indicator: Management effect on individual

The data for this indicator comes from part 'a' and part 'd', as per the description for the 'Management effect on community' indicator (please see above).

Question: a. In general, does management affect YOU?
☐ Yes ☐ No

b. What are the positive impacts of management for YOU?

c. What are the negative impacts of management on YOU?

d. Considering these positive and negative impacts, what is the overall level of impact of management on you? *(Circle appropriate level)*

- Very bad
- Bad
- Neutral
- Good
- Very good

Method: Household survey, Q23a, Q23d.

Notes: Parts 'b' and 'c' of this question provide important qualitative data on the nature of the perceived impacts of management and should be used to interpret results from analysis of the 'management effect on individual' indicator.

Indicator: Fairness of management effects

Question: a. In general, do you think the distribution of the positive and negative impacts from the management here is fair? *(Please refer to the previous 2 questions and circle one option)*

- Very unfair
- Unfair
- Neither
- Fair
- Very fair
- Don't know

b.Why?

Method: Household survey, Q26a.

Notes: Q24, Q25 and 26b provide important qualitative data and should be used to interpret results from analysis of the 'fairness of management effects' indicator. Be sure to consider the difference between mid-scale responses (ie 'neither') and a 'don't know' response (for a description of how the two responses are different please see explanation for 'Change in resource abundance' (p. 18) and 'Fairness of decision-making' (p. 27) indicators.

Indicator: Management effect on fish abundance

Question: In general, do you think management has affected the number of fish?

If yes, how has the number of fish been affected? *(Please circle one option)*

- A lot less
- Somewhat less
- No change
- Somewhat more
- A lot more
- Don't know

Method: Household survey, Q27.

Optional: Extend question to perceived effects of management on fish size, type etc. Be sure to consider the difference between mid-scale responses (ie 'neither') and a 'don't know' response (for a description of how the two responses are different please see explanation for 'Change in resource abundance' (p. 18) and 'Fairness of decision-making' (p. 27) indicators.

Indicator: Management effect on fishing effort

Question: In general, do you think management has made it easier or harder to catch fish (in terms of time, effort, or travel distance)? *(Please circle one option)*

- Much harder
- Harder
- Neither
- Easier
- Much easier
- Don't know

Method: Household survey, Q28.

Notes: Be sure to consider the difference between mid-scale responses (ie 'neither') and a 'don't know' response (for a description of how the two responses are different please see explanation for 'Change in resource abundance' (p. 18) and 'Fairness of decision-making' (p. 27) indicators.

Indicator: Management effect on catch reliability

Question: In general, do you think management has affected the reliability of what you can catch?

- A lot less reliable
- Less reliable
- No change
- More reliable
- A lot more reliable
- Don't know

If yes, how has it changed the reliability? *(Please circle one option)*

Method: Household survey, Q29.

Notes: Be sure to consider the difference between mid-scale responses (ie 'neither') and a 'don't know' response (for a description of how the two responses are different please see explanation for 'Change in resource abundance' (p. 18) and 'Fairness of decision-making' (p. 27) indicators.

Indicator: Change in subjective wellbeing

Question: a. It would be great to know more about how you feel about your life here. All things considered, has your satisfaction with your life as a whole changed over the last three years?

- A lot worse
- Worse
- No change
- Better
- A lot better

b. *If there was a change*, what are the three main causes of this change?

Method: Household survey, Q37.

Understanding the outcomes of conservation and management on social outcomes, like human wellbeing, is a key focus of our monitoring approach. Photo: Emily Darling / WCS.

Indicator: Management effect on traditional marine practices

Question: b. If yes, do rules about managing fishing affect these practices? If yes, how?

- No impact
- Very bad
- Bad
- Neutral
- Good
- Very good

c. Description:

Method: Key informant survey, Q2b.

Notes: See page Key informant survey, Q2a for first part of this question. Part 'c' of this question provides important qualitative information that should be used in interpreting responses to part 'b'.

Social, economic and political settings

Understanding the dynamics of a defined social-ecological system, such as those associated with coral reefs, requires consideration of the larger-scale social, economic and political attributes of the setting in which such systems are embedded (Ostrom 2007). Consideration of the larger-scale context is particularly important when making comparisons across multiple geographies.

S5 Market incentives

The presence of markets to sell fish and other marine resources can influence actors' behaviour in regards to resource use and management. Aside from creating incentives for overexploitation, markets may also affect the likelihood that people will engage in collaborative resource management (Ostrom 1990).

Working use: We operationalise this component of the social-ecological systems framework with two indicators: (1) market access and (2) market engagement.

Indicator: Market access

Method: Maire et al. (2016) developed a global GIS layer that estimates the market accessibility of coral reefs using potential travel time to the nearest human settlement or market. This layer estimates the minimum cumulative cost in time between every coral reef in the world with (1) the nearest human settlement, and (2) the nearest major market (e.g., national capital, provincial capital, major population centre or landmark city).

Indicator: Market engagement

Question: In general, where do people in this community sell their fish? *(Please ask respondent to rank the answers they give. Note that if respondent does not mention one of the categories below, put an NA)*

Location	Rank
To other people in this village	
Fish trader/middleman who sells fish outside this village.	
If yes, where are they based?	
Local market outside this village.	
If yes, where?	
Other:	
Other:	

Method: Key informant survey, Q21.

The accessibility of coral reefs to people is an important context variable that can determine the interplay between humans and resources use and sustainability. The village of Munda, Solomon Islands is connected to national and international markets by ships travelling from the capital Honiara, Solomon Islands. Photo: Emily Darling / WCS.

Related ecosystems

ECO1 Climate patterns

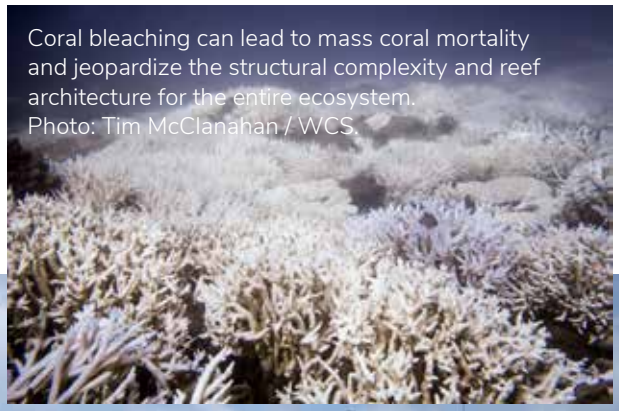
Indicator: Climate change

Method: WCS has developed a global GIS layer that predicts the exposure of global coral reef pixels to temperature-associated coral bleaching, and incorporates both acute (e.g., Degree Heating Months) and chronic (e.g., 100 years of temperature variability) into predictions of severe coral bleaching. Future indicators can also consider the effects of aragonite saturation and ocean acidification although here, we focus on the ongoing and near-term threats of ocean warming and coral bleaching.

ECO2 Pollution patterns

Indicator: Land-based pressures

Method: Regional GIS layers of sedimentation, pollution and ridge-to-reef processes can be used to evaluate land-based pressure on reefs. A global layer of land run-off for all global watersheds is under development.



Coral bleaching can lead to mass coral mortality and jeopardize the structural complexity and reef architecture for the entire ecosystem. Photo: Tim McClanahan / WCS.

Underpinning social science theory and composite social indicators

In this section we further describe the theoretical underpinnings of some of the indicators listed above, and outline a number of composite indicators that can be formed from combinations of the indicators. A composite indicator can be formed by compiling a number of individual indicators into a single index, and is intended to reflect the multi-dimensional nature of what is being measured. The main topics explored in this section are as follows:

1. Equality of resource management
2. Equity of resource management
3. Social adaptive capacity
4. Ostrom's institutional design principles

1. Equality of resource management

Equality is defined as the state of being equal. In the context of commons use and management, it is relevant to examine how people belonging to different social subgroups may differentially: (1) benefit from ecosystem services (e.g. Hicks and Cinner 2014); and (2) be impacted by commons management (e.g. Gurney et al. 2015). Social subgroups may be defined by characteristics such as gender, ethnicity, age, etc.

Working use: Equality in commons management can be assessed in regards to any of the indicators in the actor and governance subsystems that could be affected by management, and by differences in responses among relevant social subgroups that may be defined by characteristics such as age, religion, ethnicity, gender, migrant status etc.

Calculation: Equality can be assessed at a community scale by undertaking a disaggregated analysis according to the relevant social subgroup characteristic; namely, compare how changes in the actor or governance subsystem indicator differs according to the social subgroup characteristic (e.g. Gurney et al. 2015).

2. Equity of resource management

Equity is defined as the state of fairness. Although equity is often approached in terms of equality, equity refers to different groups in society receiving a 'fair share' not necessarily an equal share (Figure 3; McDermott et al. 2013). Given that social inequity can create conflict, and negatively affect human wellbeing, understanding social inequity in regards to commons use and management is critical to achieving both biological and social goals of management. In the context of commons management, two dimensions of equity are often recognised; 'procedural' and 'distributional' (e.g. McDermott et al. 2013). 'Procedural equity' refers to fairness in decision-making processes, while 'distributional equity' refers to fairness in the distribution of the social costs and benefits of management actions.

Working use: We operationalise procedural equity with the indicator Fairness of decision-making (p. 27) and distributional equity with the indicator Fairness of management effects (p. 35).

Calculation: Community-scale measures of procedural and distributional equity can be assessed by either: (1) calculating the average score within a community; or (2) calculating the proportion of people who responded each of the four outcome categories (i.e. 30% of people thought decision-making was very unfair, 10% thought decision-making was unfair etc).

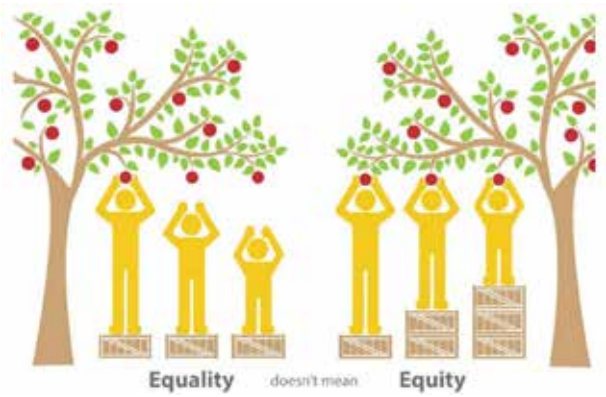


Figure 3. Equity vs. Equality (adapted from Tiny Trees 2015). Equality is giving people the same thing. Equity is fairness is every situation.

3. Social adaptive capacity

Social adaptive capacity is a latent characteristic (i.e. cannot be directly observed) that reflects people's ability to anticipate and respond to changes or perturbations to the social-ecological system, and to minimize, cope with, and recover from the consequences of those changes (Adger & Vincent 2005).

Working use: We operationalise social adaptive capacity in the context of fisheries; therefore we are examining the capacity of households and villages to anticipate and respond to changes in fisheries, and to minimise, cope with, and recover from the consequences (McClanahan et al. 2008). To assess social adaptive capacity we adopt a composite index developed by McClanahan et al. (2008) and Cinner et al. (2015), which is calculated at the household scale but which can be aggregated to provide a community-scale estimate. While this index was developed in the context of changes to fisheries associated with climate change, it can be applied to any situation in which there is a change to fisheries (e.g. with the establishment of an marine reserve).

The nine variables included in the index are: (1) Knowledge of human agency (p. 18); (2) Resource decline response (p. 18); (3) Occupational multiplicity (p. 20); (5) Wealth (assets) (p. 15); (6) Participation in community organisation (p. 17); (7) Fishing gear diversity (p. 21); (8) Community Infrastructure (p. 16); and (9) Community trust (p. 17).

Calculation: Create household-scale index by summing all of the seven indicators, after each indicator has been normalized between 0 and 1. Community-scale social adaptive capacity is the mean of the indexes of all households in the community.

4. Ostrom's institutional design principles

After years of studying collective management of small-scale commons, Ostrom developed a set of eight institutional design principles that typically characterise robust institutions to manage the commons (Table 3; Ostrom 1990). These design principles informed our choice of indicators populating the governance subsystem, and we operationalise them for MacMon using both open- and closed-ended questions. Note that these design principles are not intended to serve as a blueprint for effective commons governance; rather, they are a set of institutional characteristics that are often present in instances of robust commons management.

Ostom's design principles can inform the collective management of shared resources, like coral reef fisheries. Photo: Emily Darling/ WCS.

Table 3. Ostrom (1990)'s eight design principles operationalised in MacMon.

Design principle	Indicator(s)
Clearly defined boundaries Individuals or households who have rights to withdraw resource units from the common-pool resources must be clearly defined, as must the boundaries of the common-pool resources itself.	Clearly defined management boundaries (p. 26) Clearly defined membership (p. 28)
Congruence Appropriation rules restricting time, place, technology, and/or quantity of resource units are related to local conditions and to provision rules requiring labour, materials, and/or money.	Congruence of rules (p. 30)
Collective-choice arrangements Most individuals affected by operational rules can participate in modifying operational rules.	Participation in decision-making (p. 26) Political efficacy (p. 26) Fairness of decision-making (p. 27) Rights to participate (p. 28)
Monitoring Monitors, who actively audit common-pool resources conditions and participant behaviour, are accountable to the participants or are the participants.	Compliance monitoring (p. 29) Monitoring frequency (p. 30)
Graduated sanctions Participants who violate operational rules are likely to assessed graduated sanctions (depending on the seriousness and context of the offense) from other participants, by officials accountable to these participants, or by both.	Graduated sanctions (p. 29)
Conflict resolution Participants and their officials have rapid access to low-cost, local arenas to resolve conflict among participants or between participants and officials.	Conflict resolution success (p. 29) Conflict resolution process (p. 29)
Minimal recognition of rights to organise The rights of participants to devise their own institutions are not challenged by external governmental authorities.	Government support for rule changing (p. 27) Government support for prosecution (p. 27)
Nested enterprises Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises.	Number of partners (p. 22) Partner activities (p. 23) Number of partner levels (p. 23) Partner contact frequency (p. 23) Partner benefits (p. 23) Partner costs (p. 23)

Evaluating impact

The social and ecological indicators outlined in this manual are designed to be used in impact evaluation. Impact evaluation is one of the five approaches to conservation monitoring and evaluation identified by Mascia et al. (2014), and defined as "the systematic process of measuring the intended and unintended causal effects of conservation interventions, with emphasis upon long-term impacts on ecological and social conditions" (Mascia et al. 2014). In the context of this monitoring program, impact is the difference a conservation or management intervention makes to the social-ecological system relative to the scenario of no intervention (i.e. the counterfactual scenario), and recognizing that these impacts can be either positive or negative. Impact evaluation may also be used to identify characteristics of the context and intervention that may facilitate positive impacts (Miteva et al. 2012), and how impacts differ between different social subgroups (e.g. Gurney et al. 2015). Although impact evaluation is ideally undertaken using an experimental research design, involving random assignment of treatment and control groups, this approach is rarely feasible in conservation practice (Ferraro and Hanauer 2014). Alternative methods include quasi-experimental research designs, which involve using statistical methods to identify appropriate control groups, and before-after-control-impact (BACI) or difference-in-difference (DID) designs, which involve comparing changes in indicators over time between treatment and control groups (Gertler et al. 2011, Masica et al. 2014).

Employing an impact evaluation approach in the context of this global monitoring program means that any intended or unintended change in the core social or ecological indicators over time relative to the counterfactual indicates a positive or negative impact of conservation and management interventions. Specific research designs for impact evaluation will be developed in the future to further facilitate a standardized approach to monitoring and evaluation of conservation interventions. As this monitoring program develops a global portfolio of data in collaboration with many partners, impact can be further assessed by systematic review. This would involve assessing the state of the evidence and synthesizing findings on the impacts of conservation and management for coral reef fisheries.

Traditional fishers from Kolombangara Island, Solomon Islands. Photo: Emily Darling / WCS.

References

Adger, W. N., and K. Vincent. 2005. Uncertainty in adaptive capacity. Comptes Rendus Geoscience 337:399-410.

Agrawal, A. 2001. Common property institutions and sustainable governance of resources. World Development 29:1649-1672.

Baland, J., and J. Platteau.2000. Halting Degradation of Natural Resources. Oxford University Press, New York, USA.

Bennett, N. J. 2016. Using perceptions as evidence to improve conservation and environmental management. Conservation Biology 30:582-592.

Berkes, F. 2007. Community-based conservation in a globalized world. Proceedings of the National Academy of Sciences 104:15188-15193.

Bottrill, M., S. Cheng, R. Garside, S. Wongbusarakum, D. Roe, M. B. Holland, J. Edmond, and W. Turner. 2014. What are the impacts of nature conservation interventions on human well-being: a systematic map protocol. Environmental Evidence 3.

Cinner, J. E., C. Huchery, C. C. Hicks, T. M. Daw, N. Marshall, A. Wamukota, and E. H. Allison. 2015. Changes in adaptive capacity of Kenyan fishing communities. Nature Climate Change 5:872-876.

Cinner, J. E., C. Huchery, M. A. MacNeil, N. A. Graham, T. R. McClanahan, J. Maina, E. Maire, J. N. Kittinger, C. C. Hicks, and C. Mora et al. 2016. Bright spots among the world's coral reefs. Nature 535:416-419.

Cinner, J. E., T. R. McClanahan, M. A. MacNeil, N. A. Graham, T. M. Daw, A. Mukminin, D. A. Feary, A. L. Rabearisoa, A. Wamukota, and N. Jiddawi et al. 2012. Comanagement of coral reef social-ecological systems. Proceedings of the National Academy of Sciences 109:5219-5222.

Clarke, P., and S. D. Jupiter. 2010. Law, custom and comunity-based natural resource management in Kubulau District (Fiji). Environmental Conservation 37:98-106.

Coulthard, S. 2012. What does the debate around social wellbeing have to offer sustainable fisheries? Current Opinion in Environmental Sustainability 4:358-363.

Cox, M., G. Arnold, and S. V. Tomas. 2010. A review of design principles for community-based natural resource management. Ecology and Society 15:38.

Darling, E. S., and S. D'agata. 2017. Coral reefs: fishing for sustainability. Current Biology 27:R65-R68.

Darling, E. S., N. A. Graham, F. A. Januchowski-Hartley, K. L. Nash, M. S. Pratchett, and S. K. Wilson. 2017. Relationships between structural complexity, coral traits, and reef fish assemblages. Coral Reefs:1-15.

Diedrich, A., N. Stoeckl, G. G. Gurney, M. Esparon, and R. Pollnac. 2017. Social capital as a key determinant of perceived benefits of community-based marine protected areas. Conservation Biology 31:311-321.

Evans, L., N. Cherrett, and D. Pemsl. 2011. Assessing the impact of fisheries co-management interventions in developing countries: a meta-analysis. Journal of Environmental Management 92:1938-1949.

Ferraro, P. J., and M. M. Hanauer. 2014. Advances in measuring the environmental and social impacts of environmental programs. Annual Review of Environment and Resources 39:495-517.

Fox, H.E., Barnes, M.D., Ahmadia, G.A., Kaod, G., Glew, L., Haisfield, K., Ismu, N., Huffard, C.L., Katz, L., Mangubhai, S., Purwanto. Generating actionable data for evidence-based conservation: The global center of marine biodiversity as a case study. In press, Biological Conservation.

Gertler, P. J., S. Martinez, P. Premand, L. B. Rawlings, and C. M. Vermeersch. 2011. Impact evaluation in practice. World Bank Publications, Washington DC, USA.

Grafton, R. Q. 2005. Social capital and fisheries governance. Ocean & Coastal Management 48:753-766.

Graham, N. A., T. R. McClanahan, M. A. MacNeil, S. K. Wilson, J. E. Cinner, C. Huchery, and T. H. Holmes. 2017. Human disruption of coral reef trophic structure. Current Biology 27.

Gurney, G., J. Cinner, J. Sartin, R. Pressey, N. Ban, N. Marshall, and D. Prabuning. 2016. Participation in devolved commons management: Multiscale socioeconomic factors related to individuals' participation in community-based management of marine protected areas in Indonesia. Environmental Science & Policy 61:212-220.

Gurney, G. G., J. Cinner, N. C. Ban, R. L. Pressey, R. Pollnac, S. J. Campbell, S. Tasidjawa, and F. Setiawan. 2014. Poverty and protected areas: an evaluation of a marine integrated conservation and development project in Indonesia. Global Environmental Change 26:98-107.

Gurney, G. G., R. Pressey, J. Cinner, R. Pollnac, and S. Campbell. 2015. Integrated conservation and development: evaluating a community-based marine protected area for equality of socioeconomic impacts. Philosophical Transactions of the Royal Society B: Biological Sciences 370.

Hicks, C. C., Levine, A., Agrawal, A., Basurto, X., Breslow, S. J., Carothers, C. et al. (2016). Engage key social concepts for sustainability. Science, 352: 38-40.

Hicks, C. C., and J. E. Cinner. 2014. Social, institutional, and knowledge mechanisms mediate diverse ecosystem service benefits from coral reefs. Proceedings of the National Academy of Sciences 111:17791-17796.

Lemos, M. C., and A. Agrawal. 2006. Environmental governance. Annual Review of Environment and Resources 31:297-325.

MacNeil, M. A., N. A. Graham, J. E. Cinner, S. K. Wilson, I. D. Williams, J. Maina, S. Newman, A. M. Friedlander, S. Jupiter, and N. V. Polunin. 2015. Recovery potential of the world's coral reef fishes. Nature 520:341-344.

Maire, E., J. Cinner, L. Velez, C. Huchery, C. Mora, S. Dagata, L. Vigliola, L. Wantiez, M. Kulbicki, and D. Mouillot. 2016. How accessible are coral reefs to people? A global assessment based on travel time. Ecology Letters 19:351-360.

Manzo, L. C., and D. D. Perkins. 2006. Finding common ground: the importance of place attachment to community participation and planning. Journal of Planning Literature 20:335-350.

Mascia, M. B., S. Pailler, M. L. Thieme, A. Rowe, M. C. Bottrill, F. Danielsen, J. Geldmann, R. Naidoo, A. S. Pullin, and N. D. Burgess. 2014. Commonalities and complementarities among approaches to conservation monitoring and evaluation. Biological Conservation 169:258-267.

McClanahan, T. R., Graham, N. A., MacNeil, M. A., Muthiga, N. A., Cinner, J. E., Bruggemann, J. H., and Wilson, S. K. 2011. Critical thresholds and tangible targets for ecosystem-based management of coral reef fisheries. Proceedings of the National Academy of Sciences 108: 17230-17233.

McClanahan, T. R., J. E. Cinner, J. Maina, N. A. J. Graham, T. M. Daw, S. M. Stead, A. Wamukota, K. Brown, M. Ateweberhan, V. Venus, and N. V. C. Polunin. 2008. Conservation action in a changing climate. Conservation Letters 1:53-59.

McDermott, M., S. Mahanty, and K. Schreckenberg. 2013. Examining equity: a multidimensional framework for assessing equity in payments for ecosystem services. Environmental Science & Policy 33:416-427.

McGinnis, M. D. 2011. An Introduction to IAD and the Language of the Ostrom Workshop: A Simple Guide to a Complex Framework. Policy Studies Journal 39:169-183.

McGinnis, M. D., and E. Ostrom. 2014. Social-ecological system framework: initial changes and continuing challenges. Ecology and Society 19:30.

McGregor, J. A. 2008. Poverty and Conflict WeD Policy Briefing. (http://www.bath.ac.uk/econ-dev/wellbeing/research/bp/bp1-08.pdfS).

Miteva, D. A., S. K. Pattanayak, and P. J. Ferraro. 2012. Evaluation of biodiversity policy instruments: what works and what doesn't? Oxford Review of Economic Policy 28:69-92.

Ostrom, E. 1990. Governing the commons: the evolution of institutions for collective action. Cambridge University Press, Cambridge, UK.

Ostrom, E. 2007. A diagnostic approach of going beyond panaceas. Proceedings of the National Academy of Sciences 104:15181-15187.

Ostrom, E. 2009. A general framework for analyzing sustainability of social-ecological systems. Science 325:419-422.

Pollnac, R., and B. Crawford. 2000. Discovering Factors that Influence the Success of Community-Based Marine Protected Areas in the Visayas, Philippines. Coastal Management Report #2229. Coastal Resources Center, University of Rhode Island, Narragansett, RI, USA, and Philippine Council for Aquatic and Marine Research and Development, Los Banos, Laguna, Philippines.

Pretty, J. 2003. Social capital and the collective management of resources. Science 302:1912-1914.

Pullin, A., M. Bangpan, S. Dalyrymple, K. Dickson, N. Haddaway, H. J., H. Hauari, N. Hockley, J. Jones, T. Knight, C. Vigurs, and S. Oliver. 2013. Human well-being impacts of terrestrial protected areas. Environmental Evidence 2.

Putnam, R. D. 2000. Bowling Alone: the collapse and revival of American community. Simon & Schuster Paperbacks, New York, USA.

Sen, A. 1981. Poverty and Famines: An Essay on Entitlement and Deprivation. Oxford University Press, Oxford, UK.

Stedman, R. C. 2002. Toward a social psychology of place predicting behavior from place-based cognitions, attitude, and identity. Environment and Behavior 34:561-581.

Thompson, J., and K. Schoonmaker Freudenberger. 1997. Crafting institutional arrangements for community forestry. Food and Agriculture Organization of the United Nations, Rome, Italy.

Uphoff, N. 1993. Grassroots organizations and NGOs in rural development: opportunities with diminishing states and expanding markets. World Development 21:607-622.

White, S. C. 2010. Analysing wellbeing: a framework for development practice. Development in Practice 20:158-172.

Wilkie, D., Wieland, M. and Detoeuf, D. 2015. A guide to the modified Basic Necessities Survey:

Why and how to conduct BNS in conservation landscapes. Wildlife Conservation Society, New York, USA.

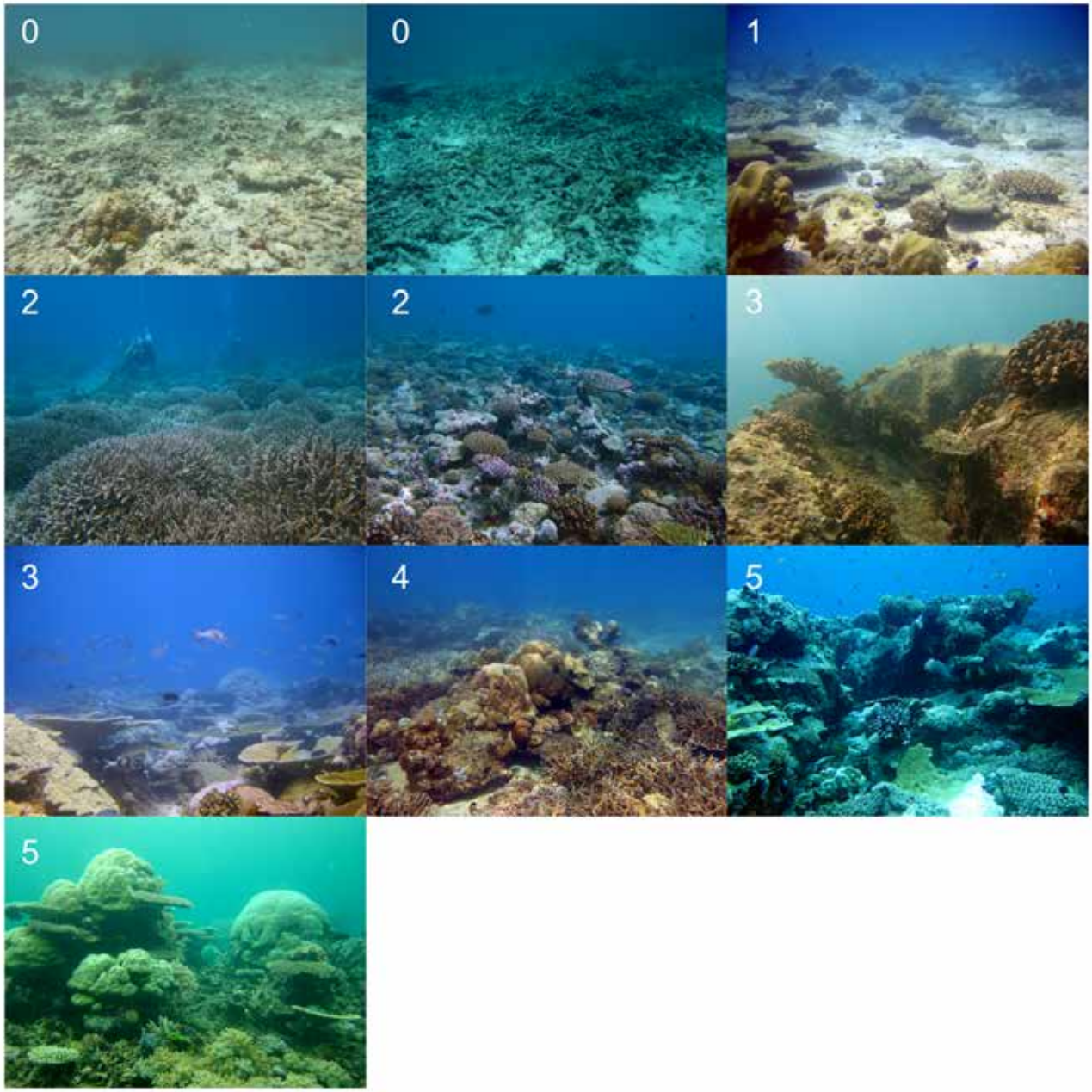
Wilson, S., N. Graham, and N. Polunin. 2007. Appraisal of visual assessments of habitat complexity and benthic composition on coral reefs. Marine Biology 151:1069-1076.

Woodhouse, E., K. M. Homewood, E. Beauchamp, T. Clements, J. T. McCabe, D. Wilkie, and E. Milner-Gulland. 2015. Guiding principles for evaluating the impacts of conservation interventions on human well-being. Philosophical Transactions of the Royal Society B: Biological Sciences 370:20150103.

Fishers in the Bird's Head Seascape, Indonesia.
Photo: Emily Darling / WCS,

Appendix 1: Underwater structural complexity

During underwater surveys, complexity scores are assigned to one of the following categories between 0 and 5: 0 no vertical relief, flat or rubbly areas; 1 low (<30 cm high) and sparse relief; 2 low but widespread relief; 3widespread moderately complex (30–60cm high) relief; 4 widespread very complex (60–100 cm high) relief with numerous fissures and caves; 5 exceptionally complex (>1 m high) relief with numerous caves and overhangs. Numbers match photographs below. Along each transect, structural complexity can be estimated multiple times (e.g., every 5 m) to provide an average structural complexity score per transect. Averaged transect values can then be further averaged to provide a site-level estimate of structural complexity. Method adapted from Wilson et al. (2007). Structural complexity can be recorded by benthic or fish observers.



Appendix 2: Global household survey

MACMON HOUSEHOLD SURVEY - GLOBAL

Date _____
Province / Seascape _____
District _____
Village _____
Respondent's name _____

Survey number:

Interviewer name:

Lat/Long:

Review informed consent before starting interview

DEMOGRAPHICS

1a. Where are you from?
(*Interviewer to circle **only one** option below based on above question. Choose the most specific)*

This village	This district	Coastal area other than this district	This country (not coastal area)	Other country

1b. How many years have you lived in this village?_____ **2.** Age _____

3. Education level_____ **4.** Clan_____

5. Religion _____ **6.** Marital status? ☐Single ☐Married ☐Widowed

7. Head of household? ☐YES ☐NO **8.** Gender ☐Male ☐Female ☐Trans*

9. How many community organisations are you involved in? _____

HOUSEHOLD AND LIVELIHOODS

10. How many people are currently in your household, including yourself?
(Please write down the number of people in each group. Note that this includes the RESPONDENT. Adults and children are decided by the respondent)

Adult male	Adult female	Male children	Female children

11a. What activities do you do that brings in food or money to your house? What do other people in your house do that brings in food or money to your house?

(***Rank*** *importance of activities that respondent does, then write the number of people who undertake different activities in the household, then rank the importance for household)*

Livelihood activity	Tick livelihoods of RESPONDENT	# of people in HOUSEHOLD involved in activity		Rank importance for HOUSEHOLD
		Women	Men	
Fishing and gleaning				
Fish trading / selling				
Aquaculture / Mariculture				
Hunting				
Farming (includes household gardens, livestock)				
Salaried employment (e.g. teacher, nurse)				
Tourism				
Small business				
Remittances				

11b. Is fishing the *respondent's* ***primary*** livelihood? ☐ Yes ☐ No

12. *If* ***respondent is a fisher*** *ask them:* How much do you agree with this statement? *(Please circle* ***one*** *option):*

"I could easily stop fishing, and make my living on land"

Strongly disagree	Somewhat disagree	Neither	Somewhat agree	Strongly agree

FISHING AND MARINE RESOURCE MANAGEMENT

*If household does NOT fish, please **skip to Q17.***

13a. Which fishing gears does your HOUSEHOLD use?
*(Circle the gears that the household uses. **Circle multiple gears** if necessary)*

Gear	Circle gear used	Gear	Circle gear used
Handline (inshore / reef)	X	Purse seine net	X
Handline (offshore / blue water)	X	Hand spear	X
Multiple hooks (more than 20)	X	Spear gun	X
Trolling line	X	Fish trap	X
Mesh gill net, above 5cm (2 inches)	X	Explosives / Poison	X
Mesh gill net, below 5cm (2 inches)	X	Gleaning	X
Mosquito nets	X	Other (specify):	X
Small/beach seine net (nets dragged along substrate)	X	Other (specify):	X

13b. Which of these fishing gears is the **MOST IMPORTANT** to your household?

Most important gear: _____

14. I realize that some days you catch a lot of **finfish**, while other days you may not catch many finfish. **On a normal day**, how much fish do you catch? How many hours do you spend fishing? How much is that catch worth?

Catch	☐**bundles** ☐**pieces** ☐**kgs**	Do you fish with a crew? If so, how many people do you fish with? # of people: _____
# hours (fishing and travelling)		
Total value of catch (local currency)		

15. Typically, what percentage of your catch from fishing or gleaning do you **eat, sell or giveaway**?

_____% eat _____% sell _____ % giveaway ☐Don't know

16. If you were to get 50% less catch **<u>all year</u>** what would you do?
(*Do **not provide** respondents with answers. Circle **multiple boxes** if necessary*)

Keep fishing at same amount	Fish more often	Change fishing grounds	Change fishing gears	Fish less & switch to other livelihood	Stop fishing entirely
Other (specify):					

17. In general, how often do you and your household eat locally caught fish or other seafood that was caught by you or someone in your community?
(*Please circle **one** option*)

More than once per day	Once per day	More than once per week	Once per week	More than once per month

18. Over the past 5 years has the number of fish in the sea around here changed?
(If respondent says 'no', circle 'no change', if respondent says yes, ask **If so, how has it changed**? *(Please circle* ***one*** *option)*

Decreasing a lot	Decreasing	No change	Increasing	Increasing a lot	Don't know

How?

19a. What can be done to increase the number of fish in the sea around here?
(Write down main key words and ***indicate if human management activity is mentioned****, e.g. reducing fishing, changing gears, etc.)*

19b. Human management actions were mentioned? YES ☐ NO ☐

20. In general, how much do you trust the following people? (*Circle* ***one*** *option for each group).*

	Not at all	Distrust more people than trust	About half-half	Trust more people that distrust	Trust all
People in your village	x	X	X	X	x
Village leaders	x	X	X	X	x
Marine resource management group	x	X	X	X	x
NGOs	x	X	X	X	x
Government	x	X	X	X	x

21. I'm interested in learning about some of the rules and traditions about fishing here. **(A)** Are there places where people are not supposed to fish, not use certain gears, etc.? **(B)** Who created the rules? (**C**) Do people still fish there? If so, how many people? *(Interviewer: please **fill out first row** before moving to next row, i.e. ask A-C for places where people are not supposed to fish followed by A-C for fishing gears that people are not supposed to use).*

Rule	**(A) Description of rules, e.g. what gears are not used etc.**	**(B) Who created the rules?** *(tick multiple boxes if necessary)*	**(C) Do people still fish there? If so, how many?** *(tick one box)*
Places where people are not supposed to fish		☐ Fishers/local users ☐ NGO ☐ Government ☐ Other:_____ ☐ Don't know	☐ No one ☐ A few ☐ About half ☐ Most ☐ Everyone ☐ Don't know
Certain **fishing gears** that people are not supposed to use		☐ Fishers/local users ☐ NGO ☐ Government ☐ Other:_____ ☐ Don't know	☐ No one ☐ A few ☐ About half ☐ Most ☐ Everyone ☐ Don't know
Certain **times** that people are not supposed to fish		☐ Fishers/local users ☐ NGO ☐ Government ☐ Other:_____ ☐ Don't know	☐ No one ☐ A few ☐ About half ☐ Most ☐ Everyone ☐ Don't know
Certain **species or types of fish** that people are not supposed to catch		☐ Fishers/local users ☐ NGO ☐ Government ☐ Other:_____ ☐ Don't know	☐ No one ☐ A few ☐ About half ☐ Most ☐ Everyone ☐ Don't know
Other, please describe:		☐ Fishers/local users ☐ NGO ☐ Government ☐ Other:_____ ☐ Don't know	☐ No one ☐ A few ☐ About half ☐ Most ☐ Everyone ☐ Don't know

22a. In general, does fisheries management affect this **COMMUNITY**? ☐ Yes ☐ No
(*If respondent answers no, prompt by saying '**so management has no positive or negative impacts on this community?**' If still no, **skip to question 22**. If respondent answers yes, continue.)*

22b. What are the positive impacts of fisheries management for this **COMMUNITY**?

22c. What are the negative impacts of fisheries management on this **COMMUNITY**?

22d. Considering these positive and negative impacts, what is the overall level of impact of fisheries management on this community? (*Circle appropriate level*)

Very bad	Bad	Neutral	Good	Very good

23a. In general, does fisheries management affect **YOU**? ☐ Yes ☐ No
(*If respondent answers no, prompt by saying '**so management has no positive or negative impacts on you?**' If still no, **skip to question 21**. If respondent answers yes, continue.)*

23b. What are the positive impacts of fisheries management for **YOU**?

23c. What are the negative impacts of fisheries management on **YOU**?

23d. Considering these positive and negative impacts, what is the overall level of impact of fisheries management on you? (*Circle appropriate level*)

Very bad	Bad	Neutral	Good	Very good

24. Who is most **positively** affected by fisheries management here and why?

25. Who is most **negatively** affected by fisheries management here and why?

26. In general, do you think the distribution of the positive and negative impacts from the management here is fair? *(Please refer to the previous 2 questions and circle **one** option)*

Very unfair	Unfair	Neither	Fair	Very fair	Don't know

Why?

27. In general, do you think management has affected the **NUMBER** of fish? If yes, how has the number of fish been affected?
*(Please circle **one** option)*

A lot less	Somewhat less	No change	Somewhat more	A lot more	Don't know

28. In general, do you think management has made it easier or harder to catch fish (in terms of time, effort, or travel distance)?
(*Please circle **one** option*)

Much harder	Harder	Neither	Easier	Much easier	Don't know

29. In general, do you think management has affected the reliability of what you can catch? If yes, how has it changed the reliability?
(*Please circle **one** option*)

A lot less reliable	Less reliable	No change	More reliable	A lot more reliable	Don't know

30. In general, do you support/agree with the management here?
(*Please circle **one** option*)

Very unsupportive	Unsupportive	Neutral	Supportive	Very supportive

Why?

31. Currently, are you involved in decisions about marine resource use or managing marine resources? For example, have you been to any meetings about marine resources? If yes, how?

*(Please circle **one** option. Interviewer to decide level of participation, note that 'passive'=if attends meetings but does not talk; 'active' =if talks at meetings)*

Not involved	Passive	Active	Leadership role

32. How much do you agree or disagree with this statement: *(Please circle **one** option)*

"People like me have influence on the management of marine resources."

Strongly disagree	Disagree	Neither	Agree	Strongly agree

33. In general, do you think **THE WAY** that decisions are made about marine resource use and management are fair? *(Please circle **one** option)*

Very unfair	Unfair	Neither	Fair	Very fair	Don't know

Why? _____

34. Is there any conflict over marine resources here? If yes, how often does this conflict occur?
*(Please circle **one** option)*

No conflict	Daily	Weekly	Monthly	More than once per year	Less than once per year	Don't know

WELLBEING

35. Material Style of Life and owned assets. *Please **tick all the household items or facilities** present in the household. Also **record the number of each asset** owned by the household.*

Cooking pots ☐ Yes ☐ No How many:	**Radios/cassette/CD** ☐ Yes ☐ No How many:	**DVD / VCD players** ☐ Yes ☐ No How many:	
Mattresses ☐ Yes ☐ No How many:	**Mobile phone** (not smartphone) ☐ Yes ☐ No How many:	**Smartphones or tables** ☐ Yes ☐ No How many:	
Flushing toilet ☐ Yes ☐ No How many:	**Electric fan** ☐ Yes ☐ No How many:	**Indoor piped water (tap)** ☐ Yes ☐ No How many:	
Washing machine ☐ Yes ☐ No	**Computers** ☐ Yes ☐ No How many:	**Electric refrigerators or freezers** ☐ Yes ☐ No How many:	
Cattle / Goats / Pigs / Sheep (livestock) ☐ Yes ☐ No How many:	**Televisions** ☐ Yes ☐ No How many:	**Satellite dishes** ☐ Yes ☐ No How many:	
Private toilet ☐ Yes ☐ No How many:	**Other 1** ☐ Yes ☐ No How many:	**Other 2** ☐ Yes ☐ No How many:	
Roof Material ☐ Bamboo/ Thatch ☐ Wood ☐ Metal ☐ Tile ☐ Other:_____	**Wall Material** ☐ Bamboo/ Thatch ☐ Wood ☐ Metal ☐ Cement ☐ Other:____	**Floor Material** ☐ Dirt / Soil ☐ Wood ☐ Concrete ☐ Tile ☐ Other:_____	**Electricity** ☐ Solar ☐ Generator ☐ Grid ☐ None ☐ Other:_____

36. Do you own a boat?

- ☐ No boat
- ☐ Boat without a motor (e.g., canoe)
- ☐ Boat with a motor (engine has _____ hp)
- ☐ Other (specify) _____

37a. It would be great to know more about how you feel about your life here. All things considered, has your satisfaction with your life as a whole changed over the last three years?
(If respondent says 'no', circle 'no change', if respondent says yes, ask **If so, how has it changed**?
*(Please circle **one** option)*

A lot worse	Worse	No change	Better	A lot better

37b. *If there was a change,* what are the three main causes of this change?

1. _____

2 .____

3. _____

38. Supposing that for some reason you were moving away from [*name of the village],* how would you feel about leaving?

Very sad	Sad	Neither happy nor sad	Happy	Very happy

Is there anything else you want to tell us?

Response: _____

_____

_____

_____

**** THANK YOU FOR YOUR TIME AND RESPONSES ****

MacMon Key Informant Survey

Survey number:
Interviewer name:

Date _____
Province _____
District (tikina) _____
Village _____
Respondent's name _____ ☐ Male ☐ Female
Position:_____ **Age**_____ **Religion** _____
Where are you from?
Village_____District_____Province_____

This village	This district	Coastal area other than this district	This country (not coastal area)	Other country

1. I'm interested in learning about some of the rules and traditions about fishing here. **(a)** Can you tell me what rules here? **(b)** When did these rules start (specify year if possible)? **(c)** Who started or help create these rules?

Rule	**(a) Description (including how and why, and goals)**	**(b) When started**	**(c) Who started this rule?** *(Tick multiple boxes if necessary)*
Places where people are not supposed to fish			☐ People from here ☐ Outside NGO ☐ Government ☐ Other: _____
Certain **fishing gears** that people are not supposed to use			☐ People from here ☐ Outside NGO ☐ Government ☐ Other: _____
Certain **times** that people are not supposed to fish			☐ People from here ☐ Outside NGO ☐ Government ☐ Other: _____
Certain **species or types of fish** that people are not supposed to catch			☐ People from here ☐ Outside NGO ☐ Government ☐ Other: _____
Other:			☐ People from here ☐ Outside NGO ☐ Government ☐ Other:

2a. Are there any important cultural, traditional or spiritual practices associated with the sea here? Such as ceremonies, harvesting resources etc.

NO ☐ YES ☐

(If yes, write description)

2b. If yes, do rules about managing fishing affect these practices? If yes, how?

No impact	Very bad	Bad	Neutral	Good	Very good

Description:

PARTICIPATION

3a. Who ***can*** participate in decision-making about marine resource use and management here?

3b. Who ***cannot*** participate in decision-making about marine resource use and management here?

4a. How often is there confusion about who can participate in decision-making? *(Please **circle** one option)*

Don't know	Never	Rarely	Sometimes	Often	Always

Please explain:

5. If resource users don't agree with the decisions made about natural resources, including decisions about punishments, what can they do about it?

6. How often is there confusion about boundaries of the area where management rules apply? *(Please **circle** one option)*

Don't know	Never	Rarely	Sometimes	Often	Always

Please explain:

MONITORING

7a. How often do people undertake monitoring (e.g. fisheries, ecological, social, etc.) for management around here? *(Please **circle** one option)*

Don't know	Never	Rarely	Sometimes	Often	Always

7b. If yes, what do they monitor?

7c. If yes, who does the monitoring?

7d. If yes, what do they do with the information?

8. In recent years, have rules about marine resource use changed in response to changes in **environmental conditions**? *(Please **circle** one option)*

Don't know	Never	Rarely	Sometimes	Often	Always

Please explain:

OUTSIDE ORGANIZATIONS

9. Currently, are there outside organizations that help with managing the marine resources here? **(a)** What is the name and type of this organization? **(b)** What do they do? **(c)** Where are they from? **(d)** In general, how often do you have contact with them?

(a) ***Name and type of organization***	**(b) What do they do?** *(Please tick multiple boxes if necessary)*	**(c) Where are they from?** *(Please tick one box)*	**(d) In general, how often do you interact?** *(Please tick one box)*
Name: ☐ Community group ☐ NGO ☐ Government ☐ Other:___________	☐ Training / capacity building ☐ Help write management plans ☐ Hold meetings ☐ Conflict resolution ☐ Fundraising ☐ Education ☐ Other:___________	☐ This village ☐ Another village ☐ District ☐ Province ☐ National ☐ International	☐ Less than once a year ☐ 1-5 times/year ☐ 6-12 times/year ☐ >12 times/year
Name: ☐ Community group ☐ NGO ☐ Government ☐ Other:___________	☐ Training / capacity building ☐ Help write management plans ☐ Hold meetings ☐ Conflict resolution ☐ Fundraising ☐ Education ☐ Other:___________	☐ This village ☐ Another village ☐ District ☐ Province ☐ National ☐ International	☐ Less than once a year ☐ 1-5 times/year ☐ 6-12 times/year ☐ >12 times/year
Name: ☐ Community group ☐ NGO ☐ Government ☐ Other:___________	☐ Training / capacity building ☐ Help write management plans ☐ Hold meetings ☐ Conflict resolution ☐ Fundraising ☐ Education ☐ Other:___________	☐ This village ☐ Another village ☐ District ☐ Province ☐ National ☐ International	☐ Less than once a year ☐ 1-5 times/year ☐ 6-12 times/year ☐ >12 times/year
Name: ☐ Community group ☐ NGO ☐ Government ☐ Other:___________	☐ Training / capacity building ☐ Help write management plans ☐ Hold meetings ☐ Conflict resolution ☐ Fundraising ☐ Education ☐ Other:___________	☐ This village ☐ Another village ☐ District ☐ Province ☐ National ☐ International	☐ Less than once a year ☐ 1-5 times/year ☐ 6-12 times/year ☐ >12 times/year

10. What are the benefits of relationships with these organizations for marine management and the community in general?

11. What is bad about these relationships for marine management and the community in general?

RULE BREAKING

12. We have talked about the rules for marine resources here. Do people break the rules?
(b) How many different people break the rules about marine resource use?

Rule	***(B) How many people break the rules?*** *(tick <u>one</u> box)*
Places *where people are not supposed to fish*	☐ No one ☐ A few ☐ About half ☐ Most ☐ Everyone ☐ Don't know
Certain ***fishing gears*** *that people are not supposed to use*	☐ No one ☐ A few ☐ About half ☐ Most ☐ Everyone ☐ Don't know
Certain ***times*** *that people are not supposed to fish*	☐ No one ☐ A few ☐ About half ☐ Most ☐ Everyone ☐ Don't know
Certain ***species or types of fish*** *that people are not supposed to catch*	☐ No one ☐ A few ☐ About half ☐ Most ☐ Everyone ☐ Don't know
Other, please describe:	☐ No one ☐ A few ☐ About half ☐ Most ☐ Everyone ☐ Don't know

13. Who typically breaks the rules here? *(Please tick* ***multiple boxes*** *if necessary)*

☐ Local users / people from this community
☐ Outsiders / people not from this community
☐ Other, please describe:

_____

14. Who monitors for people breaking the rules?

15. What are the penalties for breaking the rules here?
(Please either describe the penalty)

16. Does the punishment or penalty increase if someone breaks the same rule more than once, or with the severity of the offence?

Don't know	Never	Rarely	Sometimes	Often	Always

Please explain:

17. When resource users want to prosecute and give out punishments, are they supported by government?

Don't know	Strongly opposed	Somewhat opposed	Neither opposed nor supported	Somewhat supported	Strongly supported

Please explain:

18. If resource users make and change their own rules about resource use here, how supportive is the government? *(Please **circle** one option)*

Don't know	Strongly opposed	Somewhat opposed	Neither opposed nor supported	Somewhat supported	Strongly supported

Please explain:

CONFLICT AND RESOLUTION

19. (a) Are there conflicts/problems about marine resources here? ☐ Yes ☐ No

If yes, ask all components of Q19, if no, continue to Community Infrastructure section.
If conflict happens, **(b)** Who is involved? **(c)** What is the conflict about?
(d) What is the intensity? **(e)** What is the frequency? **(f)** How is this conflict resolved?

(b) Who is involved in this conflict?	**(c) What issue is the conflict about?**	**(d) Intensity of conflict** *(Please tick one box)*	**(e) Frequency of conflict** *(Please tick one box)*	**(f) Resolution** *(Please tick one box)*
		☐ Mild / verbal ☐ Violent / destructive ☐ Don't know	☐ Don't know ☐ Less than once per year ☐ More than once per year ☐ Monthly ☐ Daily	☐ No resolution ☐ Partially resolved ☐ Fully resolved
		☐ Mild / verbal ☐ Violent / destructive ☐ Don't know	☐ Don't know ☐ Less than once per year ☐ More than once per year ☐ Monthly ☐ Daily	☐ No resolution ☐ Partially resolved ☐ Fully resolved
		☐ Mild / verbal ☐ Violent / destructive ☐ Don't know	☐ Don't know ☐ Less than once per year ☐ More than once per year ☐ Monthly ☐ Daily	☐ No resolution ☐ Partially resolved ☐ Fully resolved
		☐ Mild / verbal ☐ Violent / destructive ☐ Don't know	☐ Don't know ☐ Less than once per year ☐ More than once per year ☐ Monthly ☐ Daily	☐ No resolution ☐ Partially resolved ☐ Fully resolved

20. What types of processes / mechanisms exist to help resolve this conflict? (e.g. community meetings, laws, etc.)

COMMUNITY INFRASTRUCTURE

21. In general, where do fishers in this community sell their fish?
*(Please ask respondent to **rank the answers** they give. Note that if respondent does not mention one of the categories below, put an NA)*

Location	**Rank**
To other people in this village	
Fish trader/middleman who sells fish outside this village. If yes, where are they based?	
Local market outside this village. If yes, where?	
Other	
Other	

22. What types of infrastructure are available here in this community?
Circle when an item is present in the community. Ask only ONCE per village.

	Item	**present**			**present**
1	Hard-top road	x	10	Dentist	x
2	Phone service	x	11	Internet	x
3	Restaurant	x	12	Primary school	x
4	Public market	x	13	Secondary School	x
5a	Clean water for drinking	x	14	Electricity	x
5b	Piped water service	x	15	Sewage treatment	x
6	Public transportation	x	16	Medical clinic	x
7	Fuel station	x	17	Doctor	x
8	Electric freezers that fish is stored in	x	18	Ice making facilities for storing fish	x
9	Hotel		19	Police	

Wildlife Conservation Society