Food and Agriculture Organization of the United Nations

FIPI/R1136 (En)

FAO Fisheries and Aquaculture Report

ISSN 2070-6987

Report of the

FAO WORKSHOP ON IMPACTS OF MARINE PROTECTED AREAS ON FISHERIES YIELD, FISHING COMMUNITIES AND ECOSYSTEMS

Rome, Italy, 16–18 June 2015

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ROME, 2016

ISBN 978-92-5-109066-4

PREPARATION OF THIS DOCUMENT

This document provides a summary of the presentations, discussions and conclusions and recommendations of the *Workshop on impacts of marine protected areas on fisheries yield, fishing communities and ecosystems* held in FAO, Rome – Italy, on 16–18 June 2015. The report was prepared by Mary-Elizabeth Miller, Jessica Sanders and Lena Westlund with important contributions by workshop presenters and participants. The document also takes into account work that was carried out immediately after the workshop by participants and that contributed to further development of concepts and ideas that had been discussed in the meeting.

The workshop was organized by FAO in close collaboration with the Ray Hilborn, School of Aquatic and Fisheries Sciences, University of Washington, USA and Jake Kritzer, Director, Environmental Defence Fund (EDF), USA. Financial support from the Government of Japan and the Environmental Defence Fund is gratefully acknowledged.

FAO. 2016**.**
Report of the "Workshop on impacts of marine protected areas on fisheries yield, fishing communities and ecosystems". FAO, Rome. 16–18 June 2015.
FAO Fisheries and Aquaculture Report. No 1136. Rome, Italy.

Abstract

Marine protected areas (MPAs), especially no-take closures, are usually referred to in the context of biodiversity conservation but have increasingly also been promoted as a fisheries management tool as a response to concerns regarding the poor state of many coastal and fishery resources. While specific area-based protections including full closures have historically been common fisheries management measures, the specific notion or use of the term MPAs has been mostly restricted to those implemented by environmental stakeholders – rather than fisheries managers and fishers. Moreover, the areas termed MPAs are often not integrated within an overall fisheries management framework.

FAO has engaged in work on MPAs in relation to fisheries, including through the publication in 2011 of technical guidelines on MPAs and fisheries (www.fao.org/docrep/015/i2090e/i2090e00.htm) and the organisation of several regional workshops bringing together a broad range of MPA and fisheries stakeholders. However, while MPAs are increasingly being implemented, there is still an apparent lack of knowledge on how MPAs and fisheries interact. Specifically, what is the relationship between fishing pressure and areas closed to fishing (total area and average size of closures) and the impacts on food security, total abundance and diversity of ecosystem components, fishing communities and incomes?

In order to address this lack of knowledge, a workshop was convened to bring together experts from different disciplines and parts of the world for an initial discussion that would lay the foundation for one or more future working groups that would examine how MPAs affect fisheries and fish and fishing communities, and provide guidance on how to optimise biodiversity, fisheries and livelihoods benefits.

The workshop agreed on some tentative elements that could form the basis for further global and regional analyses including fisheries, environmental, social, economic, and governance dimensions. The workshop outcomes provide a basis for further collaboration through multidisciplinary including experts from around the world.

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APPENDICES

ABBREVIATIONS AND ACRONYMS

ACP	African Caribbean and Pacific
ADG	Assistant Director General
BACI	Before After Control Impact
BIOPAMA	Biodiversity and Protected Areas Management Programme
CBD	Convention on Biodiversity
COFI	FAO Committee on Fisheries
Coope Tárcoles R.L.	Tárcoles Fisherfolk's Cooperative
CoopeSoliDar R.L.	Professional Service Cooperative for Social Solidarity
CTI-CFF	Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security
EC	European Commission
EAF	Ecosystem Approach to Fisheries
EDF	Environmental Defense Fund
EEZ	Exclusive Economic Zone
STECF	EU's Scientific, Technical and Economic Committee for Fisheries
FAO	Food and Agriculture Organization of the United Nations
GBR	Great Barrier Reef
GIZ	Gesellschaft für Internationale Zusammenarbeit
INCOPESCA	National Fishing and Aquaculture Institute
IPCC	Intergovernmental Panel on Climate Change
IUCN WPC	International Union for Conservation of Nature World Parks Congress
IUCN-CEM	International Union for Conservation of Nature Commission on Ecosystem Management
MPA	Marine Protected Area
MSY	Maximum Sustainable Yield
NGO	Non-Governmental Organization
NTZ	No Take Zone
RFMO	Regional Fishery Management Organization
RIS	Reference Information System
RRIS	Regional Reference Information System
SESYNC	National Socio-Environmental Synthesis Center
TAC	Total Allowable Catch

INTRODUCTION

Background

The term marine protected areas (MPAs) is usually referred to in the context of biodiversity conservation but has increasingly also been promoted as a fisheries management tool as a response to concerns regarding the poor state of many coastal and fishery resources. While specific area-based protections including full closures have historically been common fisheries management measures, the specific notion or use of the term MPAs has been mostly restricted to those implemented by environmental stakeholders – rather than fisheries managers and fishers. Moreover, the areas termed MPAs are often not integrated within an overall fisheries management framework.

Many States have signed up to international commitments to increase the area covered by MPAs in their waters (e.g. the CBD Aichi targets) and MPAs are continuing to receive significant attention and support. However, in spite of the increasing numbers of MPAs around the world, there is still limited understanding of when MPAs are useful as a fisheries management tool and what their impacts are more specifically in the context of fisheries.

There is substantial demand within fisheries dependent communities and their governments, including fisheries and environmental agencies, for a better understanding of and information about the likely effects of MPAs in the context of their fisheries and livelihoods. While there has been considerable analysis of impacts of fishing pressure on fish abundance and yields (i.e. not in the context of MPAs) and of the impact of MPAs on the abundance of species within protected areas, there has been no major synthesis of the data on how these two approaches interact. Specifically, what is the relationship between fishing pressure and areas closed to fishing (total area and average size of closures) and the impacts on total abundance and diversity of ecosystem components, as well as fishing communities, food security, and incomes?

In order to address this lack of knowledge, a workshop was convened with a view to tease out what analyses are needed and what information is available and necessary to advance the understanding of MPAs and their effects in fisheries and livelihoods. The aim of this workshop was to bring together experts from different disciplines and parts of the world for an initial discussion that would lay the foundation for one or more future working groups that would examine how MPAs affect fisheries and fish and fishing communities, and provide guidance on how to optimise biodiversity, fisheries and livelihoods benefits. These working groups would focus on undertaking meta-analyses using data sets from around the world.

It should be noted that the workshop considered MPAs in a broader sense, i.e., spatial management measures in the marine environment that are established for fisheries and/or biodiversity conservation. It was noted though that there are many types of protected areas and spatial management tools and that there is no agreed definition or terminology. It is hence important to specify what type of measure is meant in each situation.

The workshop

The workshop, which was organized by FAO was prepared in close collaboration with the Ray Hilborn from the University of Washington and Jake Kritzer from the Environmental Defence Fund (EDF), took place in FAO, Rome, on 16–18 June 2015. In addition to FAO staff and consultants, 26 researchers and MPA practitioners from Africa, Australia, the Caribbean, Europe, Latin and North America, and South Asia participated in a mix of plenary presentations, working-group discussions and feedback with plenary-based syntheses and future directions.

The workshop concept note and agenda are included in APPENDIX A and APPENDIX B, respectively, and list of participants is found in Appendix C. The welcome address made by the FAO Fisheries and Aquaculture Department Assistant Director General (ADG), Mr Árni Mathiesen, is in APPENDIX D.

The financial support from the Government of Japan to the workshop through the project "Fisheries Management and Marine Conservation within a Changing Ecosystem Context" (GCP/INT/228/JPN) and the Environmental Defence Fund is gratefully acknowledged.

INITIAL PLENARY PRESENTATIONS

The three workshop background presentations addressed three different perspectives of MPA management and impacts: governance, socioeconomics and fisheries yield (biology). There were also a number of case studies presented and a breath of experiences and examples of various aspects of MPA management were shared. In addition to more detailed information, two related axes of 'tensions' or differences in perspectives were evidenced in these presentations.

- There are differences between conservation objectives and fisheries objectives and the perspectives of MPAs differ between those (governments agencies and others) coming from an environment angle and those with a fisheries interest. Risks and allocations of benefits between nature and people are often viewed differently and these differences currently hinder a more effective integration of both conservation and fisheries management objectives (and results) in MPAs.

- MPAs with both types of objectives (biodiversity conservation or fisheries management) require input/involvement from natural and social sciences with clear incorporation of the human dimension. This requires that different disciplines are integrated into a comprehensive analysis but, in practice, natural and social sciences, for example, tend to work separately and along different pathways.

These perspectives were revisited throughout the workshop discussion and the workshop recognised the need for enhanced integration along both axes. A challenge for the post-workshop working groups will be how this integration can be achieved at the same time as keeping the scope of specific analyses focused enough to generate useful and evidence-based results.

Summaries of the presentations made during the workshop are included in APPENDIX E[1].

BREAK-OUT GROUP DISCUSSIONS

For some of the discussions, participants were divided into smaller the groups. These break-out groups discussed a sequence of interlinked topics:

- Session 1: Groups were asked to identify a priority set of components or issues ('variables') that are considered important when determining the potential effects of MPAs on fishing and related communities. The groups were asked to list the type of 'variables' for (i) fisheries; (ii) community (human) well-being; (iii) governance; and (iv) ecosystems.

- Session 2: Focusing on a consolidated list of 18 variables or components that had been identified during Session 1, each group was asked to define a specific context (fishery and country or region) and to discuss what the conditions determining the outcomes for each of the variables were likely to be. This could be in the context of either responding to proposals for the creation of an MPA by other groups or where MPAs are being considered as an appropriate fishery management tool for the selected context. The different contexts chosen were:

    - Group 1: Small-pelagic fisheries
    - Group 2: Commercial fisheries in temperate waters

[1] Only those presentations of which summaries were prepared by the presenters are included.

- Group 3: Tropical trawl fisheries
- Group 4: Tropical coral fisheries

- Session 3: Groups were asked to consider potential pathways for further analysis, e.g.:
  - What needs to be done?
  - How should it be done?
  - How to ensure that all disciplines are included and integrated: what are the analytical frameworks, methods and types of information needed?

OUTCOMES OF DISCUSSIONS

The results of each of the break-out group discussions were presented and discussed in plenary. Further work and refinements were also carried out after the workshop by smaller groups of participants communicating by email and the outcomes reported on here include also this further work.

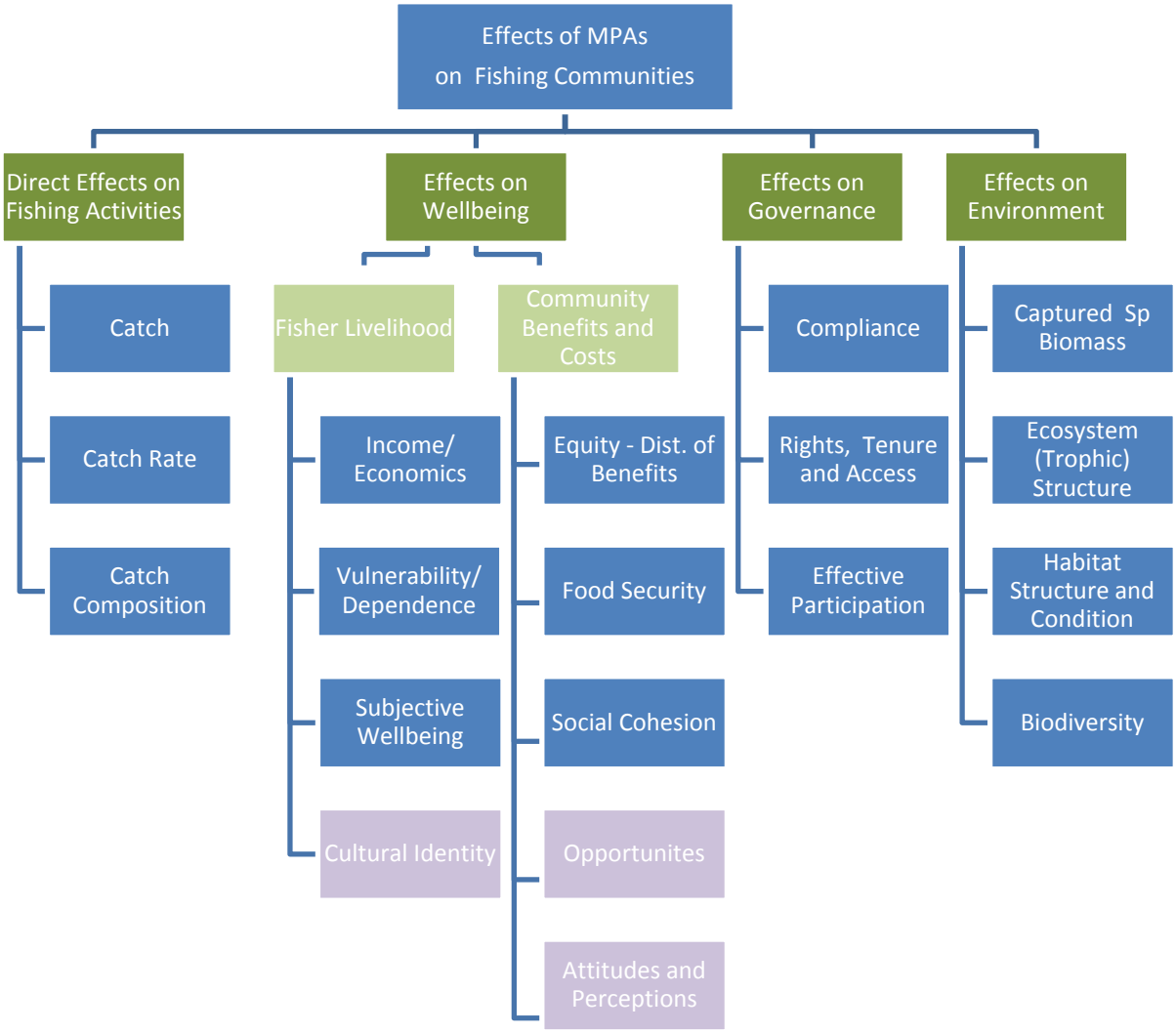
Priority 'variables' or components

The rather long list of variables or components that was the initial outcome of the 1st break-out group session was put through a 'voting process' for consolidation and a preliminary shorter list was created. Subsequent additional work after the workshop, led to the development of a comprehensive structure of aspects to consider when attempting to determine the impact of MPAs within a region (see Figure 1).
Given the likely level of resources needed to undertake such analyses, it was considered important that the final set of priority components that would be used for the more in depth analyses was kept to a realistic number (approximately ten).

Furthermore, the level at which these issues were defined also needed to be appropriate - not too broad or too narrow to be of value. The current 'tree' of components include components that were identified in the workshop and received high scores in the voting process (in blue) as well as additions after the workshop (in mauve) (see Figure 1).

It is proposed that for each of these high priority components, assessments could be undertaken to determine under what circumstances the potential responses following implementation of an MPA would be positive, negative or neutral. These different types of outcomes are expected to depend upon the specific 'biological, social, and economic context', the current status of the key resources at the time of MPA implementation in combination with the set of governance conditions that are present in the region and/or are imposed and maintained (See also APPENDIX G).

Figure 1: Priority categories and components identified for determining the potential effects of MPA implementation on fishing related communities



Potential consequences in different contexts: what questions to ask

In the second break-out group session where groups defined the likely effects or potential consequences of implementing an MPA in their respective chosen context, they also attempted to describe the logic for this to happen and whether the conditions could be influenced or if they were non-changeable. The likely availability of data and information for further investigating and validating the suggested logic was also assessed.

These discussions led to realising a need to identify the right questions to be asked when carrying out combined fisheries and MPA assessments for a better understanding of overall impact of MPAs on fisheries and livelihoods. After the workshop, a list of questions was put together for this purpose focusing on past performance of MPAs and covering various points of view: (1) ecological; (2) social (including cultural); (3) economic; and (4) governance (including legal, institutional and administrative)[2]. The list of questions as finalised shortly after the workshop is included in Appendix F

[2] In addition to the questions referring to these four categories or disciplines, questions of a generic nature were also identified, i.e. of relevance to all dimensions. These have been integrated in the sections below.

but should still be considered work-in-progress. The four categories, or disciplines, according to which the questions are sorted, do not, for example, correspond exactly to the groupings of key components in Figure 1.

Considerations for follow-up work and the establishment of working groups

In the third break-out group session participants summarized ideas and directions for the planned follow-up working group or working groups. The idea of establishing working groups that can take the work forward after the workshop had been discussed already before the meeting. The need for such arrangements was confirmed and the discussions focused on how this work could be organized.

Key working group tasks and expected outcome

The overall expected outcome of the working groups would be a clearer understanding of the interaction between MPAs and fisheries and the potential role of spatial management measures in fisheries management, in addition to their more general role on biodiversity conservation.

Types of work needed and working modalities were proposed relating to the aim of conducting comprehensive analyses of the impact of MPAs on the multiple dimensions of fisheries. It was noted that what is needed is concrete advice to those making decisions (e.g. fisheries managers, coastal communities, MPA managers, etc.) on and working with MPAs on how MPAs do or do not work in fisheries in specific contexts. Having defined the key 'variables' or components on which MPA effects can be expected (see above), there is a need to refine the questions (listed in APPENDIX F) to be asked in order to find out what happens with those components under different circumstances. Hence, if the components are the topical areas which influence outcomes of MPAs, then the questions and issues would refer to what needs to be known to establish what outcomes are produced and, more importantly, why. Or if not, what should be different and why.

Some observations made in this context included:

- Appropriate methodologies should be used for each separate part of the work defined within the working groups. For certain aspects (e.g. yield), there may be quantitative data available which will allow for a meta-analysis based on this information. However, regional-specific analyses will be needed to ensure appropriate results for diverse regions. For other aspects, e.g. governance and social and cultural perspectives, information on the basis of case studies may be the best source. This quantitative and qualitative knowledge must be integrated to gain the broad understanding of impacts.

- Some analysis should – and can – be done at a global scale while others may be better at a regional or national level. Both approaches will be useful. Keeping in mind those relevant locations where the effects of MPAs are the greatest may not be the easiest to identify or measure.
- An understanding of context is important. Multiple datasets and meta-analyses can overlook context but it is essential to ensure and understand where data are coming from (and problems) to be able to balance global trends with appropriate nuances.
- There should be commitment to both scientific knowledge and non-scientific/traditional knowledge. Cultural aspects can be equally important factors to consider in measuring and understanding impacts of MPAs. Participatory research and social learning, engaging with local communities and practitioners, will also be important.
- There also needs to be parity across disciplines; productive tensions that occur in meetings such as this are healthy and should not be avoided. Working groups need to cover all key disciplines and hence include bio-ecologists, sociologists, economists, anthropologists, policy/legal experts.
- There are already many tools and guidance available relevant to fisheries and MPAs, e.g. the ecosystem approach to fisheries (EAF) toolbox. These should be capitalised and built on.

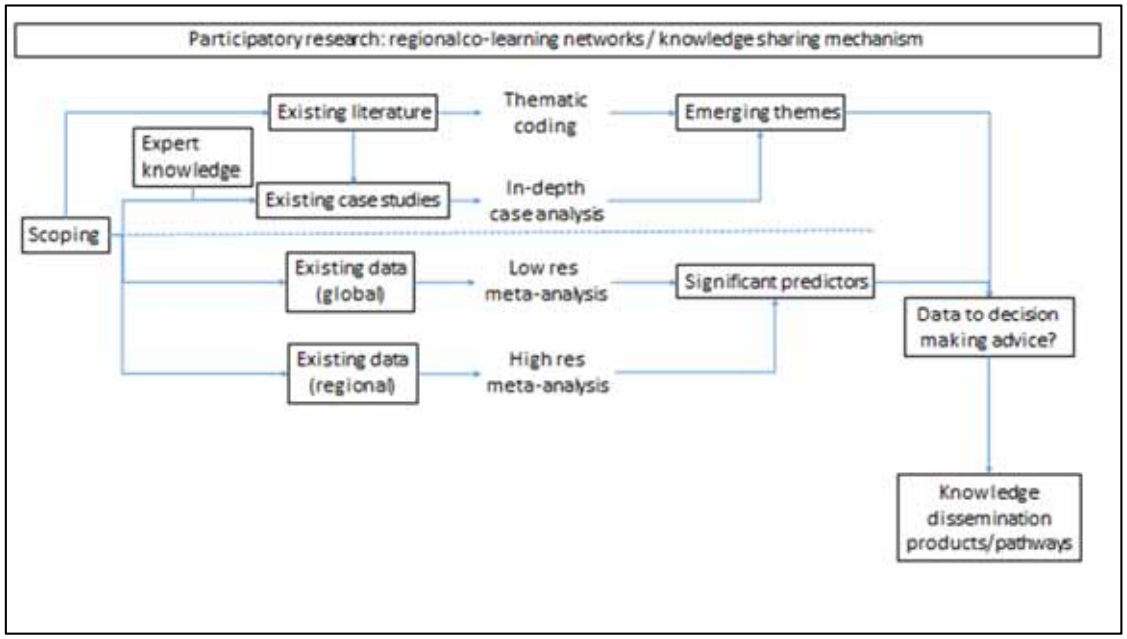
Process

A schematic overview of the possible process for carrying out the comprehensive analyses of the impact of MPAs on the multiple dimensions of fisheries through working group(s) is provided in Figure **2**, including:

- Scoping: brainstorming to assess the areas to address, further development of the components and questions (see above) and establishment of working modalities, including the need for disciplinary sessions for intra-disciplinary excellence but also multidisciplinary analysis.
- Interim products or outputs, needed for taking the process forward, could include:
    - Identified experts (contributors, analysts, writers) for which the participants of the workshop represents a valuable starting point.
    - Identified literature, case studies and (numerical) datasets (possibly including a database of MPAs and fisheries impact indicators).
- End products including data and conclusions that could be used by decision-makers. In practical terms, this could take the form of:
    - An FAO Technical Paper as a companion document to the FAO Technical Guidelines on MPAs and Fisheries[3] (containing the basic data, e.g. in a CD-ROM; the case studies, conclusions and recommendations);
    - A side event at the next session of the FAO Committee on Fisheries (COFI) where conclusions and recommendation will be brought to the attention of FAO stakeholders (members, Industry, environmental NGOs, etc.)
    - A set of policy recommendations for consideration by COFI (e.g. through a meeting or an information document).

It was also suggested that it would be useful to establish where we stand now with regard to existing knowledge. Accordingly, a very first exercise could be to prepare and publish one or several articles on the status of understanding of MPA impacts in which research gaps could also be identified. One idea would be to have four papers – one for each of the main component areas identified (fishing activities, wellbeing, governance and environment) – or there could be one article integrating the four perspectives and constituting a first effort to create a decision framework for MPA-fishery interactions.

Figure 2: Steps and tasks by working groups to enhance the knowledge on MPA impact for decision-making



[3] See www.fao.org/docrep/015/i2090e/i2090e00.htm

Some questions that will need to be considered when setting up the working group(s) and planning the work include:

- What sources of data or literature are available?
- What are the available methodologies and tools for a meta-analysis (or other forms of analysis)?
- Will the meta-analysis analyse only quantitative data or also qualitative data, narratives, published conclusions (literature reviews), etc.? How should case studies be analysed?
- Should the standards for reviews established by the medical/pharmaceutical disciplines (fullest possible coverage of the literature; full checking of all cited results; self-standing outcome) and peer review be followed?
- Should both aspects of how MPAs affect fisheries and how fisheries affect MPAs be included?
- Where are the preferred case studies needed to provide empirical evidence?
- Is there enough evidence so that, whatever result are found, it can be extrapolated to other areas, and circumstances?
- Is there a need to have data on experimental areas as well as control areas or acceptable proxies for them?
- Should assessment of the "network effect" be included? Is it possible to get some conclusions about the effect of functional networks as opposed to single MPAs?
- How can fair representation of experts from regional (and socioeconomic situations), gender, disciplines (including social sciences) and experience (fishing and conservation) be ensured?

Funding

Based on the above, there is a need to better define the exact terms of reference and work of the proposed working groups. There will also be a need for funding to allow for the working groups to function. Funding opportunities would need to be investigated and project proposals prepared accordingly. The basis for such proposals should be broad collaboration and partnerships.

SUMMARY OF WAY FORWARD

At the end of the workshop, a list of next steps and key tasks to undertake was agreed and workshop participants signed up to different tasks. Some of these have already been carried out as reported on above but there is still a need to develop a coherent and detailed proposal and terms of reference for the proposed working groups along the lines suggested in this report.

It will be important to build on work already carried out and to ensure that the work focuses on advancing the knowledge in a way that is useful for decision-makers. MPAs are increasingly being implemented and there is an urgent need to ensure that they contribute as effectively as possible to food security and sustainable livelihoods. For this, we need to better understand how MPAs impact fisheries and how MPAs and fisheries interact. There is important and challenging work to be carried out in this respect requiring collaboration among a broad range of stakeholders, including researchers, practitioners and fishing community members from across the world.

APPENDIX A: Workshop concept note

SCOPING WORKSHOP AND WORKING GROUP PROPOSAL:
How marine protected areas impact fisheries yield, fishers, fishing communities and ecosystems

INTRODUCTION

Fisheries management has a range of tools available and chief among them are regulations affecting catch, and regulations affecting time and place where fishing can occur. As there is an obvious interaction between these and country priorities on environmental, economic and social sustainability, including with regard to food security and biodiversity conservation, improving the understanding of how these tools interact is a requisite condition for developing management plans regardless of the objectives.

The theory of harvest regulation relies on an extensive body of work and empirical data that explains how changes in fishing pressure affect the long term abundance and sustainable yield of fish stocks as well as incomes and livelihoods of fish communities.

The theory of marine protected areas (MPAs) suggests that they can improve fisheries yields when fisheries are poorly regulated, but will decrease fisheries yields when fisheries are well managed. However, despite the growing number of MPAs and associated monitoring, there has been few comprehensive attempts to evaluate the impact of MPAs on fisheries yields and on socio-economic factors through a global meta-analysis.

While there has been considerable analysis of the impacts of fishing pressure on fish abundance and yields (in general, not in the context of MPAs) and of the impact of MPAs on the abundance of species within protected areas, there has been no major synthesis of the data on how these two approaches interact. Specifically, what is the relationship between fishing pressure and areas closed to fishing (total area and average size of closures) and the impacts on food security, total abundance and diversity of ecosystem components, fishing communities and incomes?

There is substantial demand in the fisheries community for better understanding and information on MPAs in the context of fisheries. In order to provide better information on this topic, the proposed working group will seek to gather data from different regions around the world and bring together experts from a diverse group of regions, disciplines and backgrounds to identify how MPAs affect fisheries and fish and fishing communities, and provide guidance on how to maximize biodiversity, fisheries and livelihoods benefits.

DATA

The working group will focus on a meta-analysis of data sets from around the world. This will include analyses of MPA impact on fisheries yields, costs and income, and on fishing communities, taking into account of fishing pressure outside of reserves. Such data sets are available and a preliminary list of over a dozen studies on protected areas has been identified that can provide information on the impacts on fisheries. In addition, there are over 100 studies where the abundance and yield of fish stocks is measured in addition to the fishing pressure and an estimated amount of area in protected areas (based on available global information).

We believe that there are many more studies and data available and that a more extensive list could be drawn up. There is hence a unique opportunity to explore data from different regions, and to share and compare work across regions, in the context of fisheries, and to develop robust recommendations based on both natural and social science.

Accordingly, the intention is that the meta-analysis includes work on:

- Fish stock abundance before and after a protected area is established, both inside and outside the protected area
- Fishing effort, practices, catch and yields before and after protected area establishment
- Socio-economic factors including changes in fishing costs and fisher incomes related to the establishment of a protected area; and
- Governance arrangements.

The results of the proposed meta-analysis would be considered in the context of community well-being and livelihoods in order to develop policy recommendations. Data related to these aspects will be utilized when available.

The data sets would ideally include controls well away from the reserve and the immediate change in fishing pressure that could help determine what would have happened without the reserve.

STRUCTURE AND OUTPUT

The outputs will include:

- A workshop report and a final report with recommendations (published in an FAO Technical Paper as a companion document to the FAO Technical Guidelines on MPAs and Fisheries)

The recommendations and outputs from this working group will also be communicated through side event on the results at relevant venues such as the next FAO Committee on Fisheries (COFI), Convention on Biological Diversity's SBSSTA and others. We also anticipate that a detailed scientific paper would also be submitted to a major scientific journal.

The working group will commence with an initial FAO expert workshop to discuss available data sets, methodologies and questions to be addressed. This will provide the basis for the group (e.g. an expert group that works with data for 1–2 years) working on a meta-analysis of available data sets. The working group should have balanced regional representation including fair representation of developing countries, experts with backgrounds in a variety of disciplines and hopefully will include the support of two post doctorate positions (with the aim to provide opportunities to developing country researchers).

APPENDIX B: Workshop agenda

Day 1:	
1. Opening session	
09:00 – 10:00	Welcome remarks
	Self-introductions
	Workshop introduction, objectives and expected outputs
	Announcement of chairs and rapporteurs and other practical arrangements
	Workplan for the coming days
2. Introduction and describing the problem	
10:00-12:30	Preliminary definition of problem/hypotheses Discussion
	Coffee/tea break
	Survey results
	Discussion on background: - Background presentation 1: Governance - Background presentation 2: Socioeconomic - Background presentation 3: Biological / ecological
12:30-14:00	Lunch
14:00 – 14:30	Discussion on background: - Fishery benefits of marine protected areas
14:30 - 17:00	Refinement of the problem and discussion on analytical frameworks Working Groups
17:00	Close of the day

	Day 2:
09:00 – 10:30	Case studies Presentations from participants - Review of data sets or analytical frameworks
10:30 – 11:00	Coffee/tea break
10:30 – 11:00	Case studies continued
11:30 – 12:30	Refinement of definition of problem/hypotheses - What are the questions we need to answer? (revisited after the discussions on the first day) Discussion on analytical frameworks - How we would go about asking these questions? - How will we ask these questions in a data sense?
12:30 - 14:00	Lunch
14:00 – 17:00	Group work on recommendations, data sets and key problems

	Day 3: Working group plan and format – planning day
09:00 – 10:30	Plenary discussion on outputs from group work Presentations from each group and discussion
10:30 – 11:00	*Coffee/tea break*
11:00 – 12:30	Agreement and discussion on key conclusions, gaps and outstanding questions
12:30 - 14:00	Lunch
14:00 – 17:00	Overview of working group plan/concept
	Agreement on working group modalities and objectives
	Development of and agreement on Workplan and roadmap and roles/responsibilities

APPENDIX C: List of participants

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APPENDIX D: FAO Welcome statement

Ladies and Gentlemen,

I would like to welcome all of you to Rome and to thank you having kindly accepted to provide your expertise to this *Workshop on the Impacts of Protected Areas on Fisheries Yield, Fishing Communities and Ecosystems*.

There is still substantial demand in the fisheries community for better understanding and information on MPAs in the context of fisheries. This workshop has been organized to meet that request and is bringing together experts from a diverse group of regions, disciplines and backgrounds to identify how MPAs affect fisheries and fish and fishing communities, and provide guidance on how to maximize biodiversity, fisheries and livelihoods benefits.

Improving the understanding of how management tools interact is a requisite condition for developing management plans regardless of the objective to meet country priorities on environmental, economic and social sustainability, including with regard to food security and biodiversity conservation.

Your task this week will be to participate in and contribute to the development of an analytical framework. Your work at this meeting will ultimately contribute to the improved understanding of the impacts of protected areas on Fisheries Yield, Fishing Communities and Ecosystems.

For those of you who are not familiar with FAO rules and procedures, I should perhaps clarify your role in this workshop. Each of you is attending this meeting in your individual capacity, and not as a representative of your government or organization. In this line, there is no difference in status between those of you who work with government and those of you who work with a private or non-governmental entity; more importantly, all of you are encouraged to freely share your views and comments, as well as provide your intellectual input to the various subject matters identified for this workshop.

I would like to thank you all for taking the time to assist FAO with this task and for providing your knowledge, wisdom and insights. I wish you a productive workshop in the coming days and look forward with interest to the results of your work.

APPENDIX E: Presentations

Background presentations

Fisheries and MPAs: Considerations on governance[4]: Serge Garcia, IUCN-CEM Fisheries Expert Group

The presentation illustrated trends in fisheries and conservation governance, with their respective objectives; the implications for fisheries of bio-ecological and socio-economic scientific findings on MPAs effects; the main managers concerns; the spatial fishery instruments already in use in fisheries that MPAs would complement or replace; the standard queries of a fishery manager regarding MPAs; the expected effects (positive and negative) of MPAs on fisheries; the degrees of tolerance of IUCN-MPAs for fisheries; the similarities in the types of governance and planning cycles prescribed in both governance streams and the specific features (and potential complexities) of MPAs in a 3-D ocean multi-jurisdictional ocean.

Conclusions are: (1) Space-based management is unavoidable and advisable and fishers are familiar with space-based fishery instruments; (2) However fishers are as reluctant to use the name "MPAs" in fisheries as conservationists are of accepting fishery closed areas as *bona fide* IUCN-MPAs; (3) There is tension between the proponents of a more inclusive World MPA database (to take account of fishery-MPAs) and those fearing "dilution" of the primary conservation objective by socioeconomic considerations; (4) MPAs (including NTZs) could be used as one of the many fishery management tools and adopted after case-by-case comparative costs/benefit analyses; (5) The respective performance of MPAs and fisheries governance are interdependent and coherence between the respective policies is vital for both; (6) However, differences in the perception of risk and its allocation between nature and people hamper a tight integration; (7) In any combination of fisheries and MPAs in a territory, the respective roles of the Ministers of Environment and of Fisheries should be clearly specified; (8) Local governance and effective participation of the actors directly (and indirectly affected) are indispensable to ensure legitimacy and compliance; (9) Both fisheries and MPAs need to consider their impact on national poverty reduction and food security policies; (10) The impacts of existing MPAs on fisheries should be openly assessed to optimize their relations; (11) Multi-use MPAs are only one of the space-based management frames and broader cross-sectoral national frames would facilitate integration of conservation and development.

Effects of MPA coverage on fishery yield with observational and snapshot data: Michael Melnychuk and Ray Hilborn, School of Aquatic and Fishery Sciences, University of Washington

In this talk, we consider possible sources of data that are already on hand and relevant to the question of how spatial closures may interact with other fishery management attributes to affect fishery yield. We approached this question from three different aspects, and for each of the three approaches we considered three metrics of fishery yield as response variables: the mean, the inter-annual variability, and the trend in yield over a recent 5-year 'snapshot' period.

In the first approach, at the stock level, we quantified the relationship between yield and the percentage of a stock's area of distribution under permanent closures and under temporary closures while simultaneously accounting for the influence of several other management attributes. Lower mean yields were associated with greater percentage coverage of permanent spatial closures, but this influence was weak compared to those of recreational catch, taxonomic group, region, ex-vessel price, and targeting status on mean yield. There were no observed associations with temporary closures, and no observed effects on the variability or trend in yield. Further details are described in the background report prepared for EDF, "Effects of spatial management and harvest management on fishery performance".

In the second approach, at the country level, we quantified the relationship between an index of MPA coverage (percentage of territorial waters under MPAs, compiled by the United Nations Environment

[4] Brief note on a presentation made at the Workshop on How MPAs impact fisheries yield, fishers, fishing communities and ecosystems. FAO, Rome, 16-18/06/2015

Program) and the metrics of fishery yield while accounting for several other country-level covariates (EEZ area; ratio of coastline length:land area; population; per-capita GDP; year of fisheries development). No influence of percentage MPA coverage was observed on the metrics of fishery yield at this country level.

In the third approach, also at the country level, we quantified how an index of enforcement around MPAs may affect fishery yield to address the concern that percentage area coverage is not likely to matter if compliance and/or enforcement are not addressed. As part of a recent study of fishery management systems across 28 countries at the species level, we asked fishery experts from each country whether or not enforcement measures are in place to ensure compliance with regulations designed to reduce negative fishing impacts in locations of sensitive habitats. After controlling for several other country-level covariates (the five listed above, 'good' and 'bad' subsidies, and random intercepts for each country in a mixed-effects model), we found that higher percentage area coverage of MPAs were associated with lower mean catch and an increasing trend in catch, while greater levels of enforcement around MPAs were associated with greater interannual variability in total catch (although this was balanced by a nearly-significant effect of reduced variability at higher percentage area of MPA coverage).

All three approaches were at highly aggregated spatial scales (i.e. they did not account explicitly for closed areas and control areas), and the second and third approaches were also highly aggregated across taxa. It is perhaps not surprising that little influence of spatial closures was found at these very coarse scales, but again these were only preliminary explorations using data already on hand. Future work could synthesize available case studies that are each conducted at higher spatial and temporal resolutions (e.g. BACI studies) for a better representation of how spatial closures affect fishery yield or other variables of interest.

Fishery benefits of marine protected areas (MPAs) - expectations from modeling of marine protected areas: Louis W. Botsford (University of California, Davis), J. Wilson White (University of North Carolina, Wilmington), Kerry M. Nickols (California State University, Monterey), Elizabeth Moffitt (UC Davis), Mark Carr (University of California, Santa Cruz), Dan Malone (UC Santa Cruz), Marissa Baskett (UC Davis), Alan Hastings (UC Davis)

We summarize how modelling results from the past several decades are useful in describing the effects of MPAs on fishery yield. While the term "MPA " described a broad range of spatial management at this FAO meeting, the modelling results we focus on here address the population dynamic and economic effects of setting aside areas of no take. These modelling results suggest that we are unlikely to find a simple, general increase or decrease in yield with movement rates of individuals (larval dispersal and juvenile/adult home ranges) because yield depends on opposing factors. Yield requires both: 1) persistent populations, which favours *low* movement; and 2) spillover, which depends on *high* movement. A potentially valuable general modelling result is the dual nature of management by MPAs and conventional means. It implies that MPAs will produce an increase in yield (relative to existing management) only when the population is currently fished at a rate greater than the rate that would produce maximum sustained yield (MSY). At best, MPA management could produce fishery yields equivalent to, but not greater than, MSY. The initial, short-term response to implementation of an MPA involves the "filling in" of the age structure that has been truncated by fishing. This will occur on a time scale of 1/M (M=natural mortality rate), and produce an increase in density of (M+F)/M (F=fishing mortality rate). Increases in biomass and egg production will occur on similar time scales. Long-term responses, which depend on MPAs producing changes in recruitment, will have high variability due to an echo effect when age of maturity is high, and when F is high. Analysis of the spatial distribution of changes in abundance following implementation of MPAs indicate that before/after sampling produces more reliable results than inside/outside monitoring. If inside/outside comparisons are used, the outside abundance must be sampled two movement scales away from the MPA to be accurate, and large differences due to the MPA may not emerge until two generation times after MPA implementation. Environmental variability in the observed variables (e.g., abundance, biomass) will lead to longer times being required to detect responses to MPAs. Because MPA responses depend on current fishing level, for adaptive management of California's MPAs, we have developed a method for estimating local levels of fishing rate F, from size distributions. Projections using these estimates with observed levels of

environmental variability indicate detection of MPA effects could take 10–15 years, rather than the typically presumed five years. Accordingly, empirical observations through both hook-and-line sampling, as well as diver surveys after seven years do not indicate an increase in abundance due to MPAs.

Case study presentations

Empirical examination of fisheries production in GBR before and following a large-scale expansion of no-take closures: Rick Fletcher, Bob Kearney, Brent Wise and Warwick Nash

The closure to all forms of fishing of an additional 28.4 percent of the 348 000 km^2 Great Barrier Reef (GBR) region of Queensland, Australia in 2004 provided a rare opportunity to test hypotheses about potential fishery benefits of large-scale closures. The advice to government supporting this initiative predicted the additional closures would generate only minimal (10 percent) and short term reductions in both catch and landed value. The closures were also predicted to benefit fisheries through "improved recruitment and 'spillover' benefits" and such benefits were expected to "be realised within three years". To test these predictions, commercial fisheries data from the GBR area and from the two adjacent (non-GBR) areas of Queensland were compared for the periods immediately prior to, and after the closures were implemented using a beyond BACI design.

Following implementation, the total annual catch and value within the GBR declined from pre-closure (2000–2003) levels of 12 780 tonnes and US$160 million, to initial post-closure (2005-2008) levels of 8 143 tonnes and US$102 million; decreases of 35 percent and 36 percent, respectively. No such declines were observed in either reference areas. There were differences in the level of observed effects among fishing methods and taxonomic groups (0- -60 percent). There was also no evidence of recovery in total catch levels or any comparative improvement in catch-rates within the GBR nine years after implementation.

Criticisms of the study have included the inadequacy of the controls. It was, however, recognised that there is only one GBR and no absolute control was possible. Therefore, the most relevant comparisons were catches by the same or other Queensland-managed fisheries (12 of 13 GBR fisheries also operate elsewhere) within 'reference areas.' Subsequent analysis of the residuals of the inter-annual variations in catch and catch rate were both found to be significantly correlated between GBR and non-GBR areas supporting the validity of these comparisons. Furthermore, given that most (all) other fishery catch based studies of MPAs have not attempted use of 'control areas' this criticism would suggest that all such comparative studies were invalid.

Other criticisms include that non Queensland fisheries operate in the reference areas and that additional fishery management actions occurred during the study period were not considered. The only non-Queensland managed fishery that operates within study area is the Commonwealth Northern Prawn Fishery. Its operations extend well outside of the study region and catches by this fishery have actually increased since 2003. Similarly, the catch reductions observed within the GBR were all substantially greater than can be directly attributable to any non-zoning management interventions.

The magnitude of the observed declines and the absence of recovery of catches within the GBR after nearly a decade do not currently support the predictions within the advice to government that the observed increases in some species within closures are now benefiting fisheries from increased recruitment or spillovers. Instead the catch results currently support an alternative hypothesis that where there is reasonable fisheries management, the closing of areas to all fishing will generate reductions in overall catches of a similar magnitude to the area closed.

Tarcoles, Costa Rica: Can traditional knowledge and management support MPAs environmental objectives and spatial planning for the good? : Vivienne Solis Rivera (CoopeSoliDar R.L.)

In the last 30 years, CoopeTárcoles R.L. has been a national and regional representative of a small-scale fishing community promoting a participatory marine conservation governance model process in the Central Pacific coast of Costa Rica.

Since 2001, the Self-Managed Professional Service Cooperative for Social Solidarity (CoopeSoliDar R.L.) and the Tárcoles Fisherfolk's Cooperative (CoopeTárcoles R.L.) have been having a mutually beneficial relationship.

The interest of the small scale fishers in carrying out more sustainable practices in artisanal fishing has made possible the mission of these organizations: to "promote forms of sustainable management of the natural and cultural resources" and to have a recognized marine responsible fishing area co-managed with the government through the INCOPESCA (National Fishing and Aquaculture Institute).

Coope SoliDar R.L. and Coope Tárcoles R.L. have a database built on information regarding total catches reported by fishermen. This information provides kilos per species per fishing trip on a variety of species caught by the local fisherfolk of Tárcoles. To complement this basic data, we have carried out several brief studies that have provided a better understanding of the populations of the most economically important species, as described in the next table:

Species	**Spanish common name**	**English common name**
Lutjanus guttatus	Pargo manchado, pargo rojo (when in juvenile state)	Spotted snapper
Centropomus viridis	Robalo	White snook
Cynoscion albus	Corvina reina	Whitefin weakfish
Penaeus spp.	Camarón	Shrimp

For the three fish species (snapper, snook and weakfish), we conducted a study during 2009 and early 2010, in which the individuals of these species were counted and classified as adults or juveniles.

During 2012 and 2013, Coope Tárcoles joined forces with INCOPESCA, to do a more comprehensive study about the catches and bycatches of sine net fishing. This provided information on these three fish species as well.

No precedent existed in Costa Rica of a Marine Area for Responsible Fishing; nor has any set of norms existed up to this point by State Institutions (responsible for developing and conserving marine territory) that guarantee recognition of marine territories for community use.

CoopeTárcoles R.L. and CoopeSoliDar R.L. analyze the data and use it for decision making in sustainable fishing management. Sharing this information with society from month to month has been a major element in generating knowledge concerning the importance of the locally-marine responsible fishing area in the sustainable use of this local fishery.

A review of fisheries closed areas in northwestern European Union waters: Mark Tasker, Joint Nature Conservation Committee (UK) and International Council for the Exploration of the Sea

A small working group (chaired by Mark Tasker) was commissioned by the EU's Scientific, Technical and Economic Committee for Fisheries (STECF) in 2007 to evaluate a set of areas closed to fisheries in the eastern North Atlantic and North Sea. The objective was to determine, for each closed area, its value for conservation and to make recommendations on the future of the closure (renewed, modified or deleted). In cases where there was insufficient evidence, the group was asked to identify what further studies might be required.

Overall the group found that most closures had been established without clear objectives. This made it difficult to evaluate their effectiveness, regardless of the amount of evidence that might be available. The group's first task was thus to devise, on the basis of knowledge and logic, some objectives for each closure. The effectiveness of each closure was then evaluated against those objectives. It is important to note that if the objectives were not correctly devised, then it is likely that the evaluation of effectiveness was also not fully correct. Another feature of all closures that needs to be borne in mind is that most were established as part of a package of measures to achieve a wider objective, for instance, recovery of a fish stock. The measure of 'success' in this case would be the recovery of the stock, but

it is usually very difficult to evaluate the role that a part of the overall package has played in the achievement (or otherwise) of the objective. If the stock has recovered, just how much was due to the closed area and how much was due to other measures?

Despite these difficulties, the group made an evaluation of most of the areas under consideration, although some of these evaluations were made on a small base of evidence. Further details on each evaluation can be found in the relevant chapter of the report of the group (STECF/SGMOS 2007).

The group noted that in several cases current fisheries advice appears to be based solely on TAC with occasional notes on technical measures. In many cases, closed areas received little or no mention in the years after their establishment. For none of the closures considered here was its effect explicitly addressed in the respective stock assessment.

Based on the above points the group therefore recommended that when a closed area is established, explicit consideration be given to its objectives and ways of measuring whether or not those objectives have been met. If possible, these measures should be based on pre-existing data series, the spatial scale of which should be taken into account when designing closed areas. This will minimise extra costs of monitoring and place any future changes in conditions in context. Furthermore the group recommended that closures be reviewed on at least a 3–5 year cycle, both for effectiveness and for appropriateness.
STECF/SGMOS (2007) Working Group Report on evaluation of closed area schemes, ISPRA, 15-19 October 2007, available at: http://stecf.jrc.ec.europa.eu/documents/43805/44876/07-09_SG-MOS+07-03+-+Evaluation+of+closed+areas+II.pdf.

The Coral Triangle Initiative: Patrick Christie, School of Marine Affairs, University of Washington

Patrick Christie presented the findings of an evaluation of the Coral Triangle Initiative. The Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (CTI-CFF) is an ambitious marine conservation and governance program engaging six countries in Southeast Asia and Melanesia that has attracted significant international support, including an investment of over US$ 40 million from the United States. Five years after its inauguration, social surveys of resource users and policy makers in the Coral Triangle region and the United States document that the CTI-CFF has resulted in impressive management outcomes, including: improved MPA enforcement, increases in national and regional management capacity, leadership creation, and integrated conservation-fishery-climate change planning. Significant challenges remain to ensure that overall planning processes effectively link regional, national, subnational (district/provincial) and community-level efforts and that international donors and policy-makers, managers, and resources users in the region remain committed to this conservation experiment.

Solving the Mystery of MPA Performance - Linking Governance to Ecological Outcomes: David Gill, (National Socio-Environmental Synthesis Center)

Marine Protected Areas (MPAs) are increasingly being employed as a tool to promote biodiversity conservation, however, their implementation has had varying levels of success. Results from numerous case studies suggest that MPA governance is a major factor in explaining this variation in MPA success, however few studies have sought to examine the effects of MPA governance at multiple scales. Drawing upon the seminal work of Elinor Ostrom, the SESYNC MPA Pursuit is a four year project that seeks to identify the governance and contextual factors that contribute to successful marine conservation outcomes.

This research utilizes a cross-disciplinary theoretical framework (Mascia et al. *in prep*) to test our central hypothesis that ecological outcomes at MPA sites are affected by governance. More specifically: inclusive decision making arrangements, active and accountable monitoring and enforcement systems, clearly defined and equitable resource user rights, and accessible conflict resolution mechanisms. By developing and utilizing a cross-disciplinary theoretical framework and a common analytic platform (i.e. database), the results will provide considerable insights into the relationship between governance attributes and ecological outcomes.

To date, we have compiled ecological data from over 15 000 underwater surveys and governance data from over 370 MPAs to explore the relationship between MPA governance and ecological outcomes at a global scale. While controlling for potentially confounding factors, preliminary analyses of over 250 MPAs/MPA zones demonstrate (on average) increases in fish population metrics (e.g. species richness, total biomass) within MPA boundaries. Preliminary analyses also suggest that designating part or all of the MPA as a no-take zone enhances these metric levels even further. Detailed governance data were available in approximately 50 MPAs/MPA zones, and from that sample, the results show a positive relationship between governance attributes such as inclusive decision making arrangements and well-defined resource use rights, and fish biomass.

More information about the project is available at https://www.sesync.org/mpa-performance or by contacting David Gill at dgill@sesync.org.

How can marine protected areas affect fishing communities? : Xavier Basurto, Esther Blanco, Mateja Nenadovic, and Björn Vollan

Globally, marine protected areas are prominent conservation tools. Yet understanding of their social effects remains limited. Advances in this regard are increasingly considered crucial for the long-lasting conservation prospects of MPAs. We used a multi-method approach to determine how MPAs affected individuals' willingness to cooperate and hyper-compete with each other, two key behaviours influencing the social sustainability of MPAs. We relied on our sustained engagement in the region since 1999 to design and deploy lab-in-the-field economic experiments (n=127) in two communities with access to MPAs and two control communities without access to MPAs in Baja California, Mexico. We found statistically higher levels of cooperation and hyper-competition in MPA communities. In addition, a substantial proportion of subjects are 'hyper-competitive cooperators', showing simultaneously high levels of cooperation and hyper-competition when given the choice to do so in an anonymous environment. We verified the external validity of our findings through a standardized fishers' survey (n=544) spanning almost all MPAs along the Baja California peninsula, and used interviews with expert informants (n=77) to assure the absence of selection bias and explore potential mechanisms behind our findings. Evidence suggests social processes and a new regulatory environment created as part of the process of MPA formation and implementation, triggered cooperation and hyper-competition among stakeholders. In particular, the desire for social differentiation — and not vengeance or conflict — could explain observed hyper-competitive behaviour.

Biodiversity and Protected Areas Management Programme (BIOPAMA): Mariagrazia Graziano and Patrick McConney

The Biodiversity and Protected Areas Management Programme (BIOPAMA) is a four-year initiative of IUCN, European Commission-Joint Research Centre (EC-JRC) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and the African, Caribbean and Pacific (ACP) countries Secretariat that is funded by the European Commission (EC). BIOPAMA aims to improve the conservation of biodiversity in ACP countries. Specifically, the programme will enhance existing institutions and networks by making the best available science and knowledge available for building capacity to improve policies and better decision-making on protected areas. The focus is on providing and integrating information on ecology, livelihoods and governance.

The BIOPAMA information system is supported by the Reference Information System (RIS) which is a platform developed by the Joint Research Centre based on a set of web services to assess, monitor and forecast the state of protected areas. A central component of BIOPAMA is to establish Regional Observatories for Biodiversity and Protected Areas Management that will host scientific data, traditional knowledge, and lessons learned from field activities in an online sub-component of the RIS named Regional Reference Information System (RRIS) customized to regional information needs and priorities.

Data on trends and the management of MPAs are crucial for maintaining biodiversity and the ecosystem services in order to improve the social conditions of communities. Publishing, storing and sharing information in several formats (maps, datasets, and reports) facilitates better MPA decision-making.

For example, the RIS provides an indicator of habitat complexity for MPAs larger than 100 km^2. This measure has been used to identify habitats most likely to support a larger variety of species. The analyses are also related to countries and ecoregions, highlighting the role of the MPAs in a broader context. In the Caribbean RRIS (branded “Caribbean Protected Areas Gateway”) the indicators present a clear picture of the region's protected area coverage in relation to the Aichi targets and protection of key habitats such as seagrasses, mangroves and coral reefs. Hence the data accessible through the Caribbean Gateway offers reference points for more effective and sustainable management of protected areas and biodiversity.

Thought for food: MPAs impact on seafood production: Bridget Green, Reg Watson, Ray Hilborn, Klaas Hartmann, Anna Farmery, Adrian Kitchingman, Gabrielle Nowara, Jessica Andre, Caleb Gardner, Sarah Jennings, Robert Parker, Sean Tracey, Colin Buxton, Brett Molony, Beth Fulton, Tony Smith

MPA’s are a central part of global efforts to preserve marine biodiversity and we identify a trade-off between conservation and food-security. We examined the potential impacts loss of foregone catch through the closure of MPA’s by overlapping the level of conservation associated with the MPA (IUCN classification) with the catch that was potentially forgone. We then examined at a country level the vulnerability to this potentially foregone catch using the IPCC vulnerability framework of Vulnerability = exposure + sensitivity –adaptive capacity.

There were unequal impacts of potentially foregone seafood around the globe. Of the top ten countries of catch displaced by MPA’s six were really vulnerable to the loss of catch. We propose explicit inclusion of food security measures in developing frameworks for more effective marine protected areas, where both conservation and food security requirements are met.

APPENDIX F: Questions arising around the effects of MPAs on fisheries

The questions arising around the effects of MPAs on fisheries are numerous when the various points of view are considered: (1) ecological; (2) social (including cultural); (3) economic; and (4) governance (including legal, institutional and administrative). In addition, there will be questions of a generic nature (i.e. of relevance to all dimensions).

The following draft list of potential questions was drawn up after the workshop and constitutes work in progress.

1.0 Generic questions on the interaction fisheries-MPAs

- Is time (since the interaction has started) a significant variable affecting the effect? Does effect change with time? When is it stabilized if ever?
- How to deal with multiple-use MPAs?
- How to integrate the assessments at sector and ecosystem level?
- How to combine model-based and empirical information. Qualitative and quantitative information?

1.1 Bio-ecological dimension

- At "micro level": What is the best way to ensure sustainability of target resources (maintain reproductive capacity; limit fishing pressure; optimize fishing patterns in terms of biomass, yield, species composition, resilience)?
    - "Conservation" indicators (biomass, abundance, yield, mean size, specific richness; habitat extension and quality; Target resources and associated species)? Baselines? Optimization criteria? Define "outside". What is the impact range of the MPA? The response range of the fisheries?
    - Spillover effect: of biomass, of larvae.
- At macro level (multiple-use MPAs, EEZ or regional levels): What is the overall effect of a suite of MPAs? Of a functional network of MPAs?
    - Similar subsidiary questions
    - Is it possible to assess the impact of a 10 percent coverage of ALL space-based measures (CBD Target 11 2010)? And of 30 percent total protection (IUCN WPC 2014). If so how?
    - Impact of functional networks? Is there any example of really "functional" network?
- At all levels: How to reduce collateral impact: on the ecosystem, associated and dependent species and habitats?
    - Reference values? Level of "acceptable" impact? Model assessment? Empirical assessment? Considering the natural variability and chaotic history of most fisheries, and the time series needed to "see" any measurable impact, what is the signal/noise ratio?

1.2 Social dimension

- Is there/what is the impact on social identity and cohesion? On culture; livelihoods; human rights?
- Perceptions versus data-based conclusions? How do perceptions influence social acceptance and ideas versus scientific evidence?
- How do MPAs impact the most vulnerable people? Role of safety nets? What are examples of safety nets?
- Differentiation between Small Scale and Large Scale fisheries?
- Origin and processes (manifestations) of conflicts? How and why?
- How does MPA planning incorporate traditional fisheries and marine habitat management? What about the converse?

- Conventional (state-mediated) or market-based approach?
- Equity: gender and other issues?

1.3 Economic dimension

- Description of the fishery or fisheries in and out of the MPA. Range dynamism, history, baselines or reference states (empirical or modelled)? Present and future values, revenues, key economic species. Conflicts for space?
- Identification of goods and services MPA can provide
- Identification of conflicts, of social or economic nature associated with MPA
- Methodologies: Cost/benefit; Cost/efficiency; Multi-criteria decision analysis; Reference price; Effects; Modelling (conventional bioeconomy; agent-based modelling?); Indicators; Spatial analysis of impacts? Importance of fishers "perceptions" versus hard data?
- Examine short-term versus long-term impacts and trade-offs.
- Establish what the opportunity costs are
- Are there loss of livelihood options?
- Establish how to integrate non-market values
- What is the distribution of costs and benefits: in the fishing community, in the broader community? How do these change over time?
- How do we use, or should we use pilot projects versus real size situations? How do we scale up conclusions?
- Assessment of the impact of complementary initiatives (Additional Livelihoods and Income Generating Activities, ALIGAs) addressing the fishery sector or the community as a role.
- Role of external drivers? Globalization; de-ruralization; impacts of the progressive shift to the ultra-liberal economic paradigm. Role of State-driven aid programmes (e.g. to fleet restructuring, of buybacks)
    - What MPAs are being established for conservation? Fisheries management? Economic interests: e.g., to receive royalties from industry development?
- What are funding mechanisms supporting MPAs, what are the financial institutions involved? What is the role of BINGOS vs local governments?
- Are there existing well defined jurisdictions and mandates?
- Indicators of MPA (management) effectiveness: group cohesion; quality of participation; local/central leadership? Efforts towards empowerment? Tenure systems? Local organization responsibilization and transparency;
- What is the economic viability; Differentiation between Small Scale and Large Scale fisheries

1.4 Governance

Low level governance: management issues

- What is the jurisdiction? Local, national, regional (e.g. RFMO), international (e.g high seas)?
- What type of governance? Top-down? Bottom-up? Co-management? Delegated? Private? International? Community-based? How do these differences affect outcomes?
- What are the 'cultures of practice' within NGOs and donors that support MPA implementation? How do these influence outcomes?
- Is there a formally agreed management plan? How was it elaborated? How is participation in design, implementation and evaluation ensured in various contexts? How does it impact outcomes?
- Is there a system of rights (use rights, territorial rights)
- How to control fishing capacity: Regulation of access. Revenues or employment? What equitable distribution? Illegal fishing.
- Enforcement and compliance with access rules and fishing regulations?
- Manager's concerns: How do we deal with competition for space with other sectors, which MPAs may ease or aggravate?
- What is the impact of non-fishery sectors including climate change? Can we separate the impacts of MPAs from them?

High level governance issues

- Is there an overall MPA or MPA & Fisheries policy in place? Country based?
- What type of MPA are we talking about? Coastal? High Seas? National? International? Demersal? Pelagic? Very large (mega MPAs)?
- Who created the MPA? Will manage/decide (or has been managing/deciding) at the interaction. Minister of environment? Of fisheries? Both? How is this articulated? Inter-ministerial conflict resolution mechanism? Coordination processes? Presence/absence of integrated spatial frameworks (ICAM, MSP, etc.). Coherence of the legal framework? Government level: national/federal, state/province, municipal/county/district? Community level?
- Overarching objectives? Fisheries? National? Articulation between them?
- Governance processes? Participation (in what? To what level?)? Legal frames? Good governance: squarely applied, or paying lip service to it?
- Participative knowledge building?
- What is (how to evaluate) the local level of capacity to participate?
- What type of administration: statal (top-down? Laisser-faire, e.g. community-based? Actively co-managed)
- What is the synergetic or contrasting impact of overarching national policies of environmental, economic, social, maritime, foreign policy, food security and poverty-reduction nature?
- Any spatial integration frame for cross-sectoral issues?

APPENDIX G: Outcomes or components potentially affected by MPAs

REFINED LIST OF OUTCOMES/COMPONENTS POTENTIALLY AFFECTED BY MPAS/CLOSURES

DRAFT VERSION 3
29 July 2015

Background

A key outcome of the June workshop was to identify a priority set of components or issues that are considered to be most important when determining the potential effects on fishing related communities that would result from the implementation of MPAs/closures within a region. This could be in the context of either responding to proposals for the creation of an MPA/closure by other groups or where these are being considered as an appropriate fishery management tool for this region.

It was proposed that for each of these high priority components, follow up assessments would be undertaken to determine under what circumstances the potential responses following implementation of an MPA/Closure would be positive, negative or neutral. These different types of outcomes are expected to depend upon the specific 'biological, social, economic context', the current status of the key resources at the time of MPA implementation in combination with the set of governance conditions that are present in the region and/or are imposed and maintained.

Given the likely level of resources that will be available to undertake such analyses, it was considered important that the final set of priority components that would be used for the more in depth analyses was kept to a realistic number (approx. ten). Furthermore, level at which these issues were defined also needed to appropriate - not too broad or too narrow to be of value.

The refined list presented here will then be used as the basis to 're-canvass' the entire workshop group to (1) ensure that the set of refined issues is appropriate and (2) for each workshop participant to be able to re-score their top three issues.

Methods

The final set of components presented in Table 1 was based upon a consolidation of the full list of issues ('variables') that were identified by participants at the June workshop. This initial list was refined by a process of sorting the individual issues into higher level categories similar to those that are present within the generic EAF component tree structure (see Figure A1 and Annex 2 for full set of relevant trees).

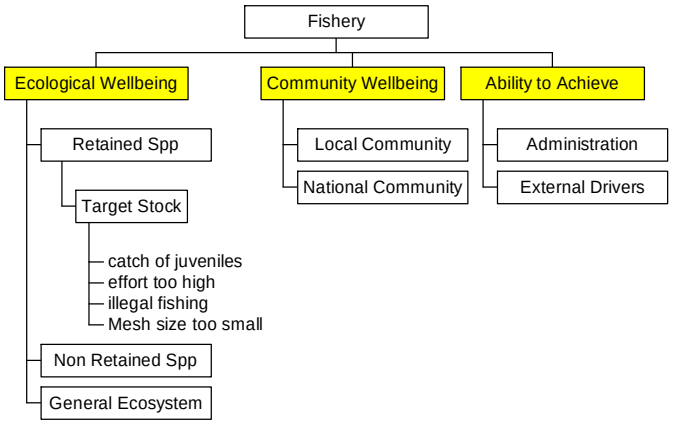

Figure A1: EAF Component Tree Structure used to examine the effects of a fishery against the principles of sustainable development (See EAF NET for details - http://www.fao.org/fishery/eaf-net/eaftool/eaf_tool_54). Note this includes an example list of sub-components relevant to the Target Stock Component.

The final set of components was also structure into trees based upon this EAF structure but noting that the EAF examines the effects of the fishery against ecological, economic and social outcomes whereby this current MPA initiative is examining the effects of the MPAs against these three categories of sustainable development (Figure A2) therefore there are some key differences.

The full set of 'variables' identified at the June workshop is located in Table A3 Annex 1. This identifies into what component category each of the individual items was assigned. Similarly the votes that were cast at the workshop for each of these individual items have been combined and included in Table 2 to indicate the highest priority areas.

In some cases the consolidation process was simply identifying where different versions of the same term (e.g. trophic structure versus trophic level structure) was used. In other cases, the issues identified were what, in line with the EAF tree approach, could be considered as 'subcomponents' of higher level components.

Some of the issues identified while important to control for (e.g. markets) are not effected by MPAs, while others are conditions that are important for the success (e.g. compliance). Where this is the case, these have been identified in the full list presented in Table 3.

Finally while the consolidated list presented here is considered to include the most relevant set of components for the assessment of an MPA on fisheries, some of these may not all be relevant in all situations, while components not included may be highly relevant in some circumstances.

To assist interpretation, each of the components in the refined list has a short description to ensure they are clearly understood. Where relevant, sub-components were also explicitly listed in the description of a component.

Consolidated List	Description
Direct Effects on Fishing (Measured at Fishery Level – outside of MPA)	
Catch (Level and Variability)	
Catch Rate	
Catch Composition	
Effects on Human (Fisher and Community) Wellbeing: (Measured at fishery, community or regional level – inside and outside of MPA)	
Food Security (Community)	
Income/Economics (Income, Costs and Physical Assets)	
Equity/Distribution of Benefits	
Dependence/Vulnerability	
Attitudes and Perceptions	
Social Cohesion	
Cultural Identity	
Opportunities	
Effects on Governance (Measured at Community Level)	
Compliance, Legitimacy, Acceptance	
Customary rights, Practices, Tenure and Access	
Effective Participation	
EFFECTS ON ENVIRONMENT (Measured at ecosystem or regional level – i.e. both inside and outside of MPA)	
Captured Species Abundance/Biomass	
Biodiversity	
Habitat structure and condition	
Trophic Structure	

Table A1: Consolidated list of priority components and their descriptions relevant to fisheries communities that may be affected by implementation of an MPA/Closure.

Consolidated List	**Consolidated Count of Votes**
Direct Effects on Fishing (Measured at Fishery Level – outside of MPA)	
Catch (Level and Variability)	19
Catch Rate	18
Catch Composition	12
Effects on Human (Fisher and Community) Wellbeing : (Measured at fishery, community or regional level – inside and outside of MPA)	
Food Security (fisher and community)	14
Income/Economics (Income, Costs and Physical Assets)	19
Equity/Distribution of Benefits	17
Dependence/Vulnerability	15
Attitudes and Perceptions	3
Subjective Wellbeing	9
Social Cohesion	12
Cultural Identity	2
Opportunities	3

Effects on Governance (Measured at Community Level)	
Compliance, Legitimacy, Acceptance	13
Customary rights, Practices, Tenure and Access	12
Effective Participation	18
EFFECTS ON ENVIRONMENT (measured at ecosystem or regional level – i.e. both inside and outside of MPA)	
Captured Species Abundance/Biomass	16
Biodiversity	15
Habitat structure and condition	14
Trophic Structure	11

Table A2 – Consolidated list of priority components relevant to fisheries communities that may be affected by implementation of an MPA and the votes recorded at the meeting.

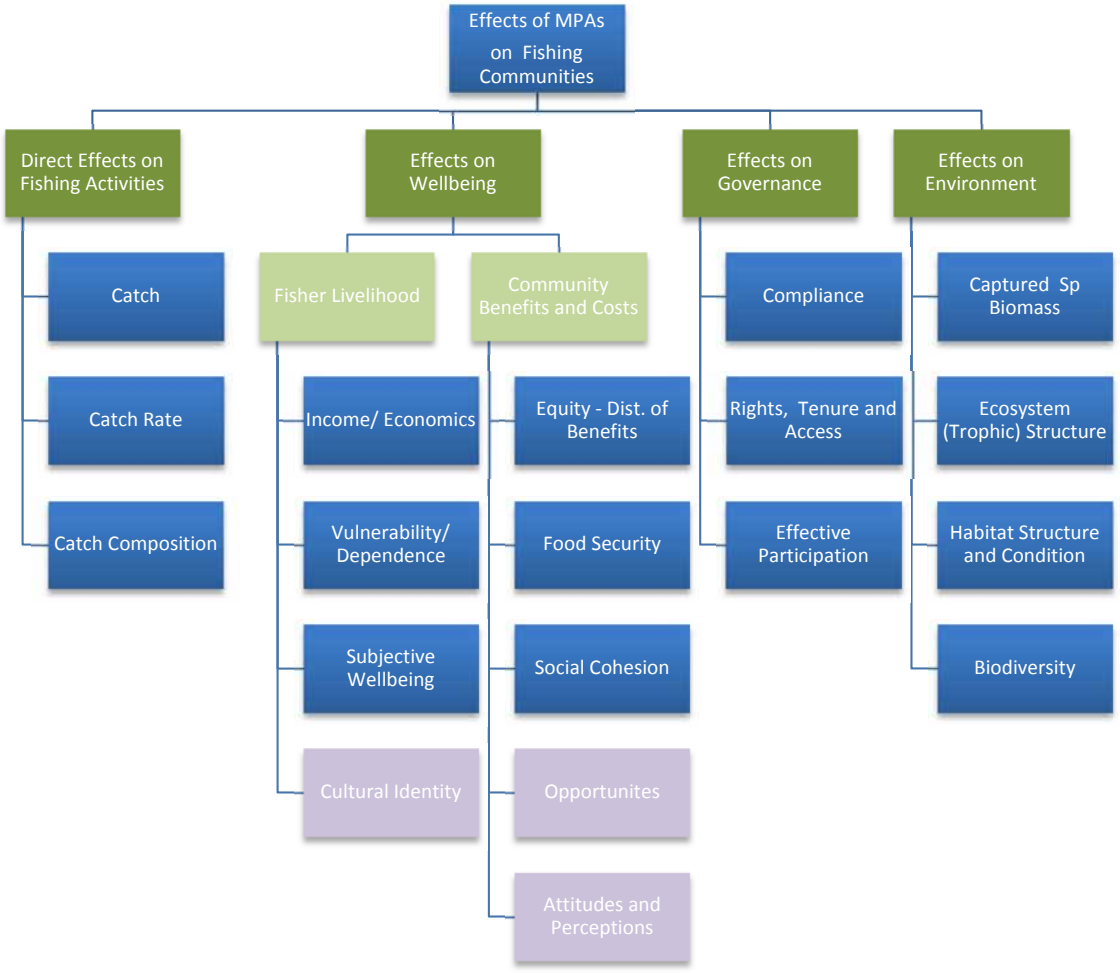

Figure A2: Priority categories and components identified for determining the potential effects on fishing related communities from the implementation of MPAs within a region. Components in blue represent the three highest polling items within each category based on the consolidated list, those in mauve have been raised after the meeting (Table 1). Note controlling factors such as rules, compliance etc. are not included here – another tree should be developed that have these listed.

ANNEX 1. DETAILED VARIABLE STARTING LIST

STARTING LIST	WHERE THESE WERE PLACED IN THE REFINED LIST and Comments
FISHERIES	**Direct Fishing Effects**
Catch Level	Catch Level and Variability
Catch Rate	Catch Rate
Catch Composition	Catch Composition
Inter-annual variability Stability in total catch	Part of Catch Level and Variability
Landing value	Fishery and Human Wellbeing
Stability of the catch	Part of Catch Level and Variability
Total catch	Part of Catch Level and Variability
Length structure	Catch Composition
Cost of effort	Human Wellbeing (Economics)
Economic performance	Human Wellbeing (Economics)
Amount &Distribution of employment along the value chain	Human Wellbeing – Distribution of Benefits (1)Within the value chain, (2) between types of fisheries; (3) between fisheries and other sectors (tourism, etc.)
Certification.	Human Wellbeing component Not really an impact of MPA – but MPA may affect whether certification is granted
CPUE	Catch Rate
Heterogeneity	Catch Composition
Larval recruitment	Part of Catch Level and Variability (conventional R is part of catch variability). Larval production is too remote from catch. Relations between micronecton and catch have always been very weak)
Spawning stock biomass	Ecosystem (SSB and ecosystem are 2 different things)
COMMUNITY (HUMAN) WELL-BEING	**Split into -Fisher Livelihood and Community Benefits and Costs**
Food Security	Food Security (access, availability, affordability, etc.)
Distribution of benefits	Equity/Distribution of Benefits within the fishery sector and within other community sectors
Income (stability)	Economics (fishery income; Household composite income (including non-fishery incomes)
Access to resources	Rights, Tenure and Access
Fisher Wellbeing	Subjective Wellbeing
Dependence on fishing	Vulnerability-Dependence
Markets	Controlling Factor – will affect income rather than be affected by MPAs
Conflict	Social Cohesion (intra and inter-sectoral including with conservation groups
Demographics	Part of Vulnerability of fisher community including age, gender, years fishing, education level, etc. Manpower? Pension capital?
Attitude and perceptions	Social Cohesion

Poverty alleviation	Food Security, Opportunities, active programmes, connected to employment and job flexibility
Assets	If this referred to boats and gear part of Economics – affecting value of gear if not able to be used. If it referred to social assets part of social cohesion
Safety at sea	Part of vulnerability and dependence
Education	Part of vulnerability/dependence (part of demographics) also related to **capacity** (contribution to governance)
Youth engagement	Part of vulnerability/dependence or is this an opportunity? This is not clear – but only 1 vote
Gender representation? (also race, class equity, migrants/residents; immigration, emigration rates, sub-sectors, sectors)	Part of Equity and/or Participation
Health	Part of Safety/Health, nutritional security
Social cohesion	Social Cohesion
Cultural identity	Cultural Identity (ethnic groups? kins?) a sense of place and space (e.g. historical relationship with the environment
Recognition of Local knowledge	Part of cultural identity and participation
Employment options – decent jobs, alternatives	Opportunities /Adaptive Capacity
Sustainable fisheries livelihoods (very broad)	Subjective Wellbeing
Equity	Equity/Distribution of Benefits
Sense of place	Part of cultural identity
Subjective wellbeing	Subjective wellbeing
Vulnerability	Vulnerability/Dependence
Fisher Behaviour/Response	This is an action not a component. Behaviour is an input as well as an output
Public Confidence/Satisfaction	Attitudes and Perceptions
Recreational fisher amenity	Opportunity
Tourism/Diving	Opportunity and competitors
Equity	Covered above
Stakeholder Concerns	Covered above
Economic Returns	Covered above
Imports/Exports	Covered above
Impact of governance	Governance
GOVERNANCE	**Effects on Governance**
Governance accountability	Compliance, Legitimacy, Acceptance, rule of law, performance assessment
Governance transparency	Part of Effective Participation, communication,
Representation, legitimacy	Compliance, Legitimacy, Acceptance, representativeness
Customary rights and practices	Customary rights – Practices and Tenure. Rituals?
Tenure rights	Customary rights – Practices and Tenure
Participation in governance	Effective Participation
Conflict resolution	Social Cohesion
Empowerment	Effective Participation.
Compliance	Controlling Factor – i.e. Governance Condition.
Enforcement	Controlling factor - Governance Conditions

Rules	Controlling Factor - Governance Conditions
ECOSYSTEMS	
Abundance/Biomass	Captured Species Abundance/Biomass
Total exploitable biomass	Same as above but at ecosystem level, not at single stock level)
Diversity	Same as below NO: species composition, size composition, trophic structure
Biodiversity	Biodiversity (species, habitats, genetics)
Within Species diversity	Part of above
Habitat health / condition	Habitat structure and condition
Habitat structure	Same as above
Connectivity	Part of biomass (no, biomass, per se, does not describe connectivity. If this is connectivity between MPAs, it is an impact of an MPAs on a system of MPAs, not on fisheries (could be a justification for setting an MPA). The question is whether an MPA network has more effects on fisheries than the sum of the parts: complex!!!
Invasive species	Part of biodiversity
Water quality	Often more of a condition unless fishing affects water quality through discards of offals, pollution, plastics, etc.)
Trophic level structure	Ecosystem (Trophic) Structure
Health of top predator populations	Part of above
Number of RED listed species present in the ecosystem	Part of biodiversity (and ecological vulnerability)
Resilience (eg. bleaching resilient coral stands) Not an effect of fishing? Not an effect of MPA setting?	Part of Habitat condition (yes)
Habitat protection, Integrity	Same as Habitat condition
Trophic Structure	Same as above
Connectivity	Same as above

Table A3: Detailed starting list, indicating where each of these ‘variables’ ended up in the refined list. Where the variable was considered a ‘controlling factor’ of the outcome of implementing an MPA rather than something that would be affected by the MPA, this is noted.

ANNEX 2. EAF COMPONENT TREES FOR COMPARISON

Only the most relevant trees were included and where relevant the same term has been used above (See EAF NET for details - http://www.fao.org/fishery/eaf-net/eaftool/eaf_tool_54)

Tool Fact Sheet - Relevant Generic Component Trees

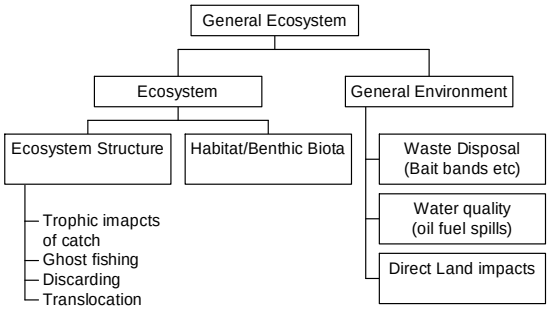

Figure A4: Starting generic component tree for the **General Ecosystem**. The two main components in the ecosystem structure branch are the ecological assets, with some of the possible impacts on these assets listed.

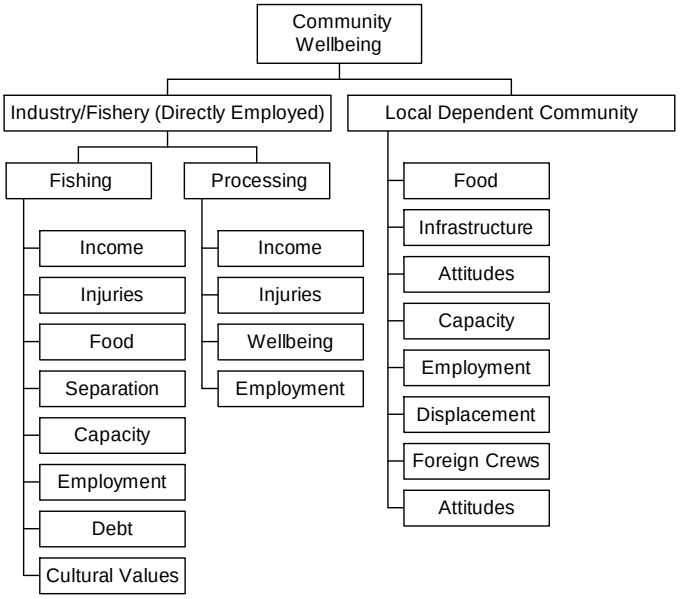

Figure A5: Starting generic component tree for the **Community well-being** component. Note each of the components in this tree can be considered community 'outcomes'.

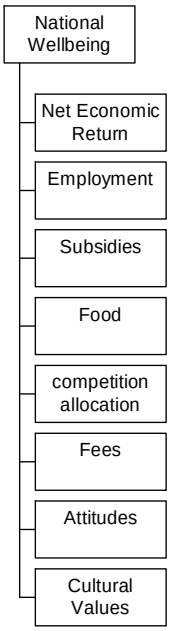

Figure A6: Starting generic component tree for the national **well-being** component. Note each of the components in this tree can be considered 'outcomes'.

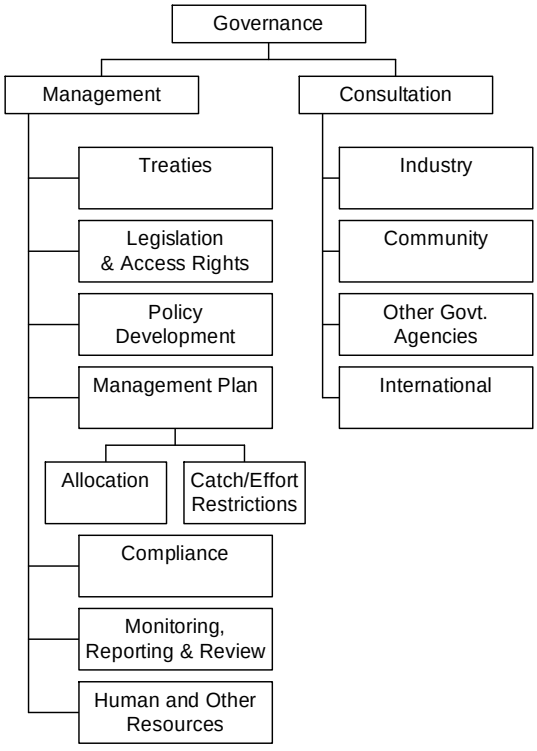

Figure A7: Starting generic component tree for the **Governance/Administration** component. Note each of the components in this tree can be considered 'systems'.

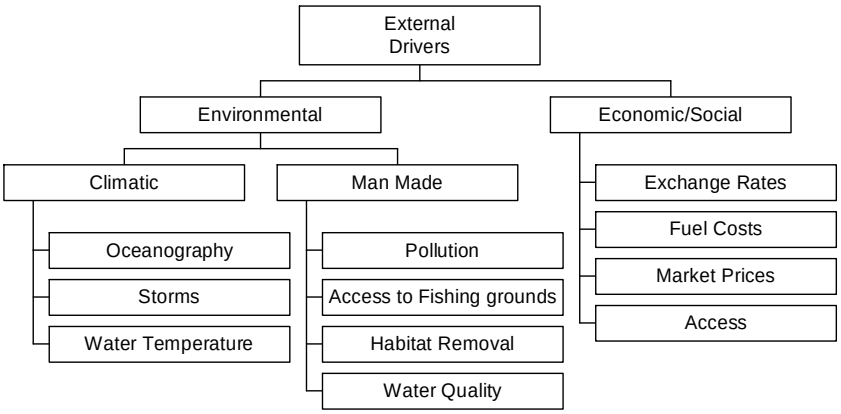

Figure A8: The starting generic component tree for the **External Driver** component. Note each of the components in this tree can be considered ‘drivers’

While MPAs are increasingly being implemented, there is still an apparent lack of knowledge on how MPAs and fisheries interact. Specifically, what is the relationship between fishing pressure and areas closed to fishing (total area and average size of closures) and the impacts on food security, total abundance and diversity of ecosystem components, fishing communities and incomes? In order to address this lack of knowledge, a workshop was convened to bring together experts from different disciplines and parts of the world for an initial discussion that would lay the foundation for one or more future working groups that would examine how MPAs affect fisheries and fish and fishing communities, and provide guidance on how to optimise biodiversity, fisheries and livelihoods benefits. The workshop agreed on some tentative elements that could form the basis for further global and regional analyses including fisheries, environmental, social, economic, and governance dimensions. The workshop outcomes provide a basis for further collaboration through multidisciplinary including experts from around the world.

ISBN 978-92-5-109066-4 ISSN 2070-6987

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I5363E/1/01.16