A Guide to Implementing an Ecosystem Approach to Fisheries Management (EAFM) for the tuna fisheries of the Western and Central Pacific Region.

Version 5

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This 'Guide' is part of an on-going process by the Forum Fisheries Agency to implement EAFM for the tuna fisheries of the Western and Central Pacific region. It is based on the Australian ESD reporting framework developed by the Fisheries Research & Development Corporation (FRDC) - ESD Reporting and Assessment Subprogram. The input of the other members of the ESD Subprogram team that developed the initial ESD framework needs to be acknowledged – J. Chesson (BRS), K. Sainsbury (CSIRO), T. Hundloe (Univ. Qld) and M. Fisher (BRS).

This edition is unlikely to be the final version; changes are expected to be made at regular intervals when further information and experiences indicate that significant improvements can be made.

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Contents

Abstract

The Ecosystem Approach to Fisheries Management (EAFM) is one of a number of concepts being developed to more comprehensively manage natural resources, but with a specific focus on fisheries. Consequently, it deals with all the ecological consequences of fishing plus it recognises the social and economic implications of fishing and its management arrangements. It also assists in understanding how these activities interact and can affect the other.

The development of this guide to EAFM is part of the initiative by the Forum Fisheries Agency to assist introduce EAFM to the management of the tuna fisheries of the Western and Central Pacific Fisheries Commission (WCPFC). Given the high economic and social importance of the tuna fisheries within this region of the Pacific, it is expected that taking an EAFM approach will help ensure that the communities in this region will benefit from the optimal utilisation of these resources.

The guide outlines the five steps required to fully apply EAFM:

Step 1 – Determine the scope of the assessment – develop a clear description of what you are trying to manage/assess. This should include identifying the relevant societal values (e.g. species sustainability, food security etc) to be addressed.

Step 2 – Based on the scope, identify issues across all five EAFM components (target species, non target species, the ecosystem, community outcomes and fishery administration) and determine what objectives are to be achieved for each issue given any treaties, convention, country needs, local requirements and global attitudes. These can, therefore, be based on ecological concerns, economic realities or social attitudes.

Step 3 – Prioritise issues using some form of risk assessment and the precautionary approach, determine if direct actions are needed.

Step 4 - Where direct actions are required, a clear management system is developed that includes operational objectives and the ability to assess performance. It also includes the monitoring and review of performance and what actions will be taken if performance is not acceptable.

Step 5 - Based on the EAFM report, develop an operational plan that outlines the specific activities that will need to be done by all parties to deliver the outcomes needed for EAFM

For members of the WCPFC, this EAFM initiative will assist put into practice the concepts outlined in Article 5 of the WCPO Convention. Thus, the EAFM approach covers issues related to target species, non target species, other dependent species within the ecosystem, minimising waste and pollution, endangered species, biodiversity, optimum utilisation, the welfare of the various states involved including the interests of artisanal and subsistence fishers. Consequently, EAFM should not be seen as an additional burden for member countries, instead, this framework should help to plan, coordinate and prioritise current and proposed activities, making them clearer by giving a ‘home’ to the many strategies and monitoring programs underway. This should, therefore, help with the overall efficiency and effectiveness of the management agency.

Section 1 Why are we Implementing EAFM?

1.1 Background

Why is EAFM being promoted by the FFA?

In the past ten years there has been a worldwide shift to incorporate more holistic forms of management for natural resources. This change has been particularly evident within marine systems, and has been most commonly focused on fisheries management where one of the numerous titles for such a concept is the Ecosystem Approach to Fisheries Management (EAFM).

The major change required for these forms of management is that not only should there be management of the target stocks, but any impacts on the broader ecosystem arising from the fishing activity need to be considered, and importantly, the social and economic outcomes of fishing needs to be compared to other potential uses. This has resulted in assessments of impacts on bycatch species and a general drive to introduce more environmentally friendly fishing methods and techniques. The tuna fisheries of the Western and Central Pacific Ocean (WCPO) are one group that has been actively addressing these issues. Given the high economic and social importance of these tuna fisheries, taking an EAFM approach should assist in ensuring that the benefits from the utilisation of these tuna resources are optimised within each of the communities of this region.

Oceanic tuna fisheries are one of the major components of a complex marine ecosystem that exists in the western and central pacific region. Pacific island countries who are influenced by their obligations to various international and regional management regimes and treaties, have been involved in the development of viable management arrangements that will be effective in addressing issues such as resource sustainability, fishing capacity and effort control, maximizing benefits from resource utilization and mitigating impacts on the environment and non-target species. These issues are specifically covered by the objective of the Convention on the Conservation and management of highly migratory fish stock in the WCPO which is to ensure, through effective management, the long-term conservation and sustainable use of highly migratory fish stock in the WCPO in accordance with the United Nations Convention on the Law of the Sea (1982), and also many of the articles within this convention.

In addition to these externally based benefits, there are very good reasons for any fishery and fisheries management agency to implementing EAFM. The discipline that is involved in this process, which is largely based on risk management principles, can have significant benefits for the countries and agencies concerned. Therefore it is an extremely good strategic planning tool and can assist agencies to generate a clear understanding of how to prioritise their activities. Consequently, the system should be seen as a better way of undertaking all fisheries management activities, not as an extra burden to be completed in addition to normal management activities.

This guide forms part of an initiative of the Forum Fisheries Agency to assist member countries to introduce EAFM as a more holistic and practical approach to the

fisheries management in the WCPO region. It is designed, therefore, to be of assistance in efficiently implementing the objectives and articles that are outlined in the WCPFC Convention. One of the most likely outcomes from undertaking this process is that it will help WCPFC members incorporate all the required elements into their Tuna Management Plans, either by revising their existing plans or through the development of their first plan.

It is recognised that our general knowledge of the complex marine ecosystem in this region is often limited, and many of the possible affects of tuna fisheries are poorly understood. This does not mean that EAFM cannot be implemented. Thus, the first myth to dispel is that EAFM requires full certainty about all the possible ecological, economic and social interactions and issues associated with a fishery before you begin. EAFM must be undertaken using a risk-based approach; there is no automatic requirement to collect more detailed ecological data. The level of uncertainty for an issue only needs to match the level of precaution that has been taken in determining the management settings (Fletcher, 2008). The process helps determine what level of management action, inaction and future research is appropriate given the level of risk and the current level of knowledge available.

You don't need complete knowledge or certainty about issues to start implementing EAFM

Consequently, EAFM is a long-term undertaking for FFA member countries in an effort to reduce uncertainty in the decision making process particularly for the sustainable development of the region's tuna resources. It is expected that this initiative should increase the long-term benefits for the communities in this region from the optimal utilisation of these resources.

Finally, the EAFM process will itself develop as more information and experiences are generated. Thus the specifics outlined in the current guide (e.g. the specific risk analysis methods) may vary between different issues, regions, information levels and time, but the basic concepts (i.e. the five basic steps) will probably not alter greatly.

1.2 Introduction

A general explanation of EAFM concepts and how it relates to fisheries management and ecosystem related initiatives.

EAFM is just one of a large number of terms and concepts that are currently being used to describe how to manage natural resources in a more holistic manner; many of these concepts relate to the management of fisheries resources. Some are relatively new, including Ecosystem Based Management (EBM; e.g. Ward et al., 2002), Ecosystem Based Fishery Management (EBFM; e.g. Brodziak & Link, 2002), Ecosystem Approaches to Fisheries Management (EAFM; e.g. FAO, 2003) and Integrated Oceans Management (IOM; e.g. NOO, 2004). Others have been around for over 10 years, such as Sustainable Development (SD; WSED, 1987) and Ecologically Sustainable Development (ESD; CoA, 1992).

Such a large number of terms can be somewhat confusing but it is important to recognise that they are all just variations on a theme (Fletcher, 2006). Thus, sustainable development, (or ESD as it is known in Australia) should be the overall goal for governments and each of the other terms describe strategies that are being used by various sectors/agencies to work towards this overall goal (Fletcher, 2006). EAFM is, therefore, just one of a growing number of strategies that describes the taking of a more comprehensive approach to the management of natural resources (this term covers fisheries resources). All of these terms recognise that management must deal with the full set of ecological consequences of an activity and also understand the social and economic implications that the activity provides.

Thus another major myth to dispel is that EAFM (and all similar concepts) is just about ecology or the ecological impacts of fishing. It is equally about the people involved and the outcomes that are generated for society from undertaking these activities, plus having an understanding of the influences that natural variations may have on these systems and outcomes.

EAFM is not just about ecology, it also covers issues about the fishers, their administration and the community

The key difference amongst these various strategies is the scope of the issues that they are attempting to deal with. This can range from a single activity operating in a small locality, up to all the activities that may be occurring in an entire region of an ocean. The defining element for EAFM (and for EBFM), is that the scope of issues covered is restricted to those that can be managed, or at least directly influenced by, the relevant fisheries management agency (hence the “F”), plus those that you need to react to. EAFM can, therefore, cover part of a fishery, all the issues affected by an entire fishery, up to managing the full collection of fisheries operating in a region (which should also deal with their cumulative impacts and the allocation of access amongst the individual sectors). The level chosen will depend upon the scope of the assessment required and the jurisdiction of the agencies involved. To implement broader levels of management such as Ecosystem Based Management (EBM)

would, however, not only require the management of all fishing related activities, but all other activities operating within the region (See Fig. 1 for details).

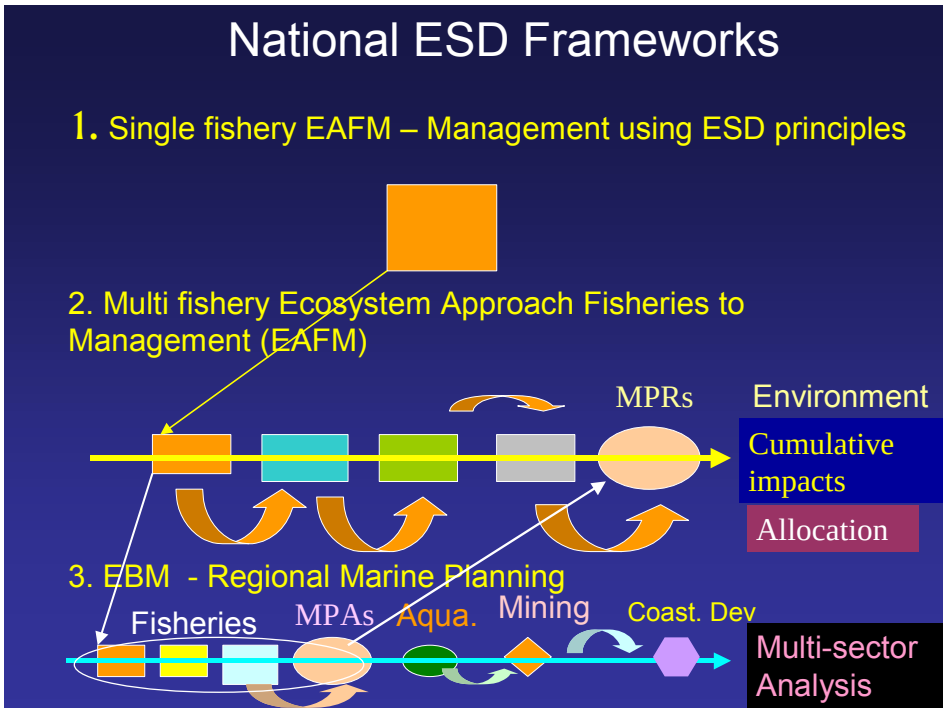


Fig 1. A diagrammatic representation of the relationships between three levels of ESD related frameworks (modified from Fletcher, 2006).

The issues outlined in the WCPO Convention are fully consistent with implementing EAFM. Article 5 of the convention outlined what is expected for "*target species, non target species, other dependent species within the ecosystem, minimising waste and pollution, endangered species, biodiversity, optimum utilisation, the welfare of the various states involved including the interests of artisanal and subsistence fishers*". Thus, the implementation of EAFM should not be seen as either a major change in direction for the WCPO Commission nor will it require adding EXTRA elements. Rather, it is a framework that should help coordinate current activities, making them clearer by giving a 'home' to many of the strategies and monitoring programs already being undertaken.

The implementation of EAFM is a way of meeting the WCPFC Convention and therefore does not add EXTRA elements.

Implementing these concepts has often proven difficult (e.g. Staples, 1997; Chesson et al., 2000). Since early 2000, Australia has been one of the regions where there has been substantial progress in developing a practical way forward. A major reason for these advances has been connected to the requirement for any export-based state fishery and all commonwealth managed fisheries to complete applications to the federal environment agency against a set of guidelines for sustainable fisheries (CoA, 2001). If the application was not accepted, the fishery was at risk of being

unable to continue exporting their catch. This was a powerful incentive to implement systems capable of providing the information needed across all the ecological elements of ESD.

Such incentives are becoming more wide spread around the world. This is occurring at both the government level (US ban on prawn/shrimp imports without turtle excluder devices); or at the market/wholesale level (e.g. Sainsburys, Unilever) leading to third party auditing schemes such as the Marine Stewardship Council system of certification. This situation is likely to get more common in the future.

Whilst external pressures will increase the need to implement EAFM style management, the real benefits to a fishery from undertaking this process should come from the increased efficiency and better management outcomes that should result from implementing these types of management systems.

Implementing EAFM should improve the agency's effectiveness.

In almost all cases, if the systems imposed do not clearly improve the management arrangements for the local stakeholders, they are highly unlikely to persist in the longer term. Consequently, the challenge is to make a system that not only produces outcomes that external parties may consider more appropriate, but also one that assists the management outcomes for all the local stakeholders in the fishery – including the fishers, managers and local communities. Thus, the ultimate drive for EAFM must come from within the country/community/ industry or it is unlikely to succeed.

To assist with meeting their increased assessment needs in an efficient manner; Australian fisheries agencies commissioned the development of a framework for the reporting and assessment of wild capture fisheries against the principles of Ecologically Sustainable Development (ESD). This framework (which was based upon an initial system developed by Chesson et al., 2000) outlined a four step, risk based process to generate reports on all relevant ESD issues for a fishery; including impacts on target species and the broader ecosystem, and the potential social and economic outcomes and the current governance systems (Fletcher et al., 2002, 2005; see Figs 2 and 3 for an outline of process and the framework).

1.3 Elements specific to the Tuna EAFM Framework and benefits for the WCPFC members

Given the success of these systems in meeting the needs of Australian fisheries, this approach was chosen by FFA as the basis for the development of a system specifically designed for use in the tuna fisheries of the Pacific region. A number of changes have been made to the basic ESD framework which relate both to the specific circumstances of fisheries management in the Pacific but also from further experiences using the system (e.g. it is now a five step process), but it is essentially the same concept with some details and complexity having been adjusted.

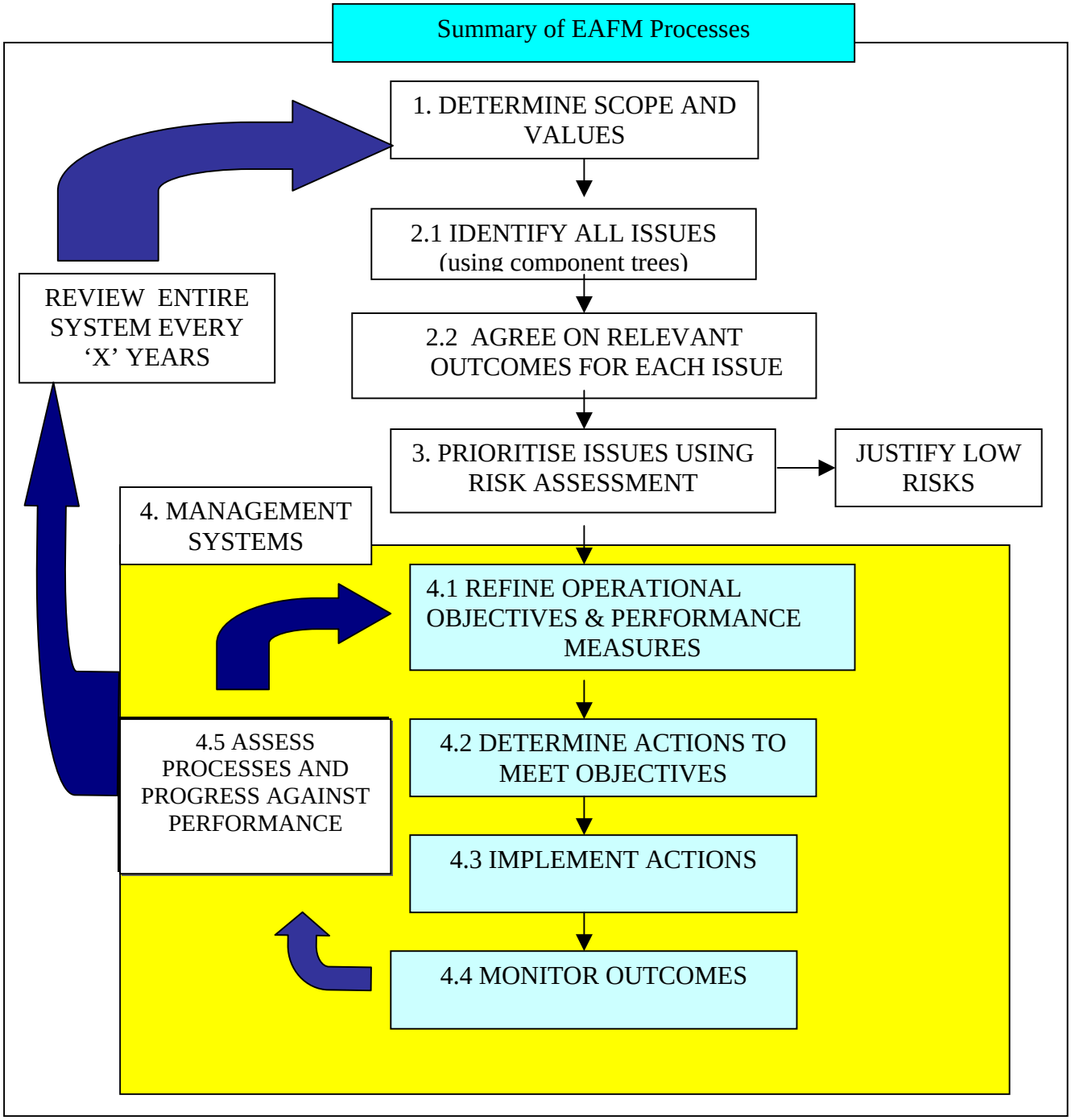


Figure 2 – Outline of the EAFM Process

One of the key issues that will be covered in more detail in this version is determining the scope. The scope may be difficult to define in some cases given that these are transboundary fisheries that capture highly migratory species such as tuna, and therefore management will often have to incorporate issues and operate at island, country and regional levels. Any complications that arise will not be a failure of the EAFM system, instead this framework helps identify where such issues are a problem so that they can be clarified and dealt with explicitly.

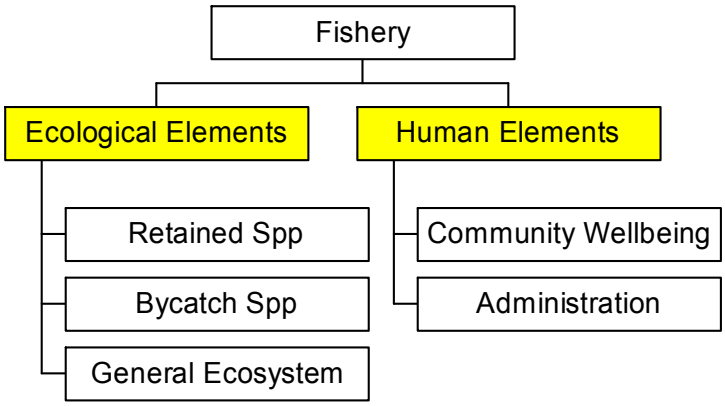


Fig. 3 The five key components of EAFM.

Given the importance of tuna fisheries to the economic and social structures of Pacific countries, the framework for assessing these fisheries has a strong emphasis on the identification and analysis of social and economic issues. Such issues are crucial in the decision making process for fisheries in Pacific countries especially given the co-management regimes that are currently practised. The EAFM system also recognises that there are likely to be different concepts about what is considered acceptable performance among countries and regions such as for interactions with species of customary importance.

Another benefit of the EAFM system is that it provides an effective way of ensuring that governance arrangements, such as the administrative activities of the agencies involved, are operating appropriately. It also an effective means of strategic planning for the agency by providing a clear home for all of the activities related to the fishery and assists determine which of these should continue and what is missing.

Fully implemented, this system should greatly assist decision-making because it provides an overall framework to understand the full implications of any management decision. Initially, however, its main value will be in identifying and assessing all relevant issues and the setting up of processes to enable their management to be undertaken effectively and efficiently. Therefore, this process should help all stakeholders recognise any impacts along with any overlaps between regions and between fisheries and any conflicts with outside country interests/benefits.

The system by itself, does not provide the 'answers'
it merely assists the process

A key point to remember though, is that the system by itself, does not provide the 'answers' – it merely assists you in the process of trying to find these. The issues that need to be addressed and how you address these must come from the people involved in the management of the fishery. These may vary among countries and the stakeholders who participate and are affected by the management of a shared resource.

Section 2 Details for Implementing EAFM

2.1 Step 1 – Identify the Scope of the Assessment/ Management System

Describes how to determine the scope of the fishery to be assessed

2.1.1 DETERMINING WHAT NEEDS TO BE MANAGED

The first step in developing any management system is to determine the scope of what is to be managed. This may seem a trivial task "of course I know what we are trying to manage" - has often been the response. Yet, when questioned further this has frequently revealed large differences of opinion amongst the individuals involved in the management process about exactly what they are managing, and what are the overall goals for management. It has, in some cases, taken half a day at workshops to resolve this question even for simple fisheries.

Spending time to clarify this scope is not, however, a waste of time because if there is not a clear understanding at the beginning of the assessment, there is a high probability that confusion will continue to spread through the rest of the process and it is unlikely that a sensible outcome will be generated. Without resolution, in some cases the entire process could fail.

So how do you work out what is the appropriate scope?

The EAFM framework we are using examines all the elements that are relevant to an activity – in this case a fishery, however this is defined. Thus, it examines all the outcomes from this activity and the issues that may be affecting this activity irrespective of where these may be operating (or who manages them). There is no absolute formula for defining what should be a 'fishery' - it is a term of convenience to describe the activities that you are trying to manage in a collective manner. Consequently, the fishery can be one that is based on the type of gear – e.g. long line, purse seine, trolling, pole and line – or it could be on a species/group of species (e.g. skipjack, yellowfin, bigeye and albacore tuna) as taken by all methods. Whether it covers part of a country, one entire country, or it covers multiple countries depends upon who is involved, and part of the process, along with who has management responsibility and authority.

General

The easiest situation is where the fishery to be examined has already been defined clearly in some form of instruments including legislations or a convention as in the UNCLOS, UN Fish Stock Agreement and the WCPFC Convention. Where this hasn't been done formally, answering the following questions can assist generate what the scope should be.

1. What groups or type of fishers should be involved in the management (e.g. all commercial, distant water fishing nations (DWFNs), local; artisanal, sport, charter)?
2. What fishing methods are involved – just one (e.g. purse seine) or all relevant methods (long line purse seine pole & line etc.)?
3. What is the geographic area it will cover (the EEZ, national waters, the WCPO region, specific depth strata, specific distance from land - waters in between islands; archipelagic waters, etc.)?
4. The species caught (tuna; billfish, etc)
5. The agencies involved in the management of the resource (e.g. the national fisheries agency, other national agencies – customs, police; a Regional Fisheries Management Organisation – e.g. WCPFC).
6. What authority do these bodies have to control what happens, over what area, species, activities, do they have control? (e.g. what controls does the Convention require, what controls do individual agencies have?)

Level of Control and Management Actions Available

Often there can be confusion about what should or should not be included in the scope due to uncertainties about how this interacts with the responsibilities of different agencies and groups. To assist with this issue it is important to understand that there are three types of management actions that can be taken depending upon the level of control that you have over an issue. It is clearly not possible to effectively manage something or be held responsible for the outcomes if you do not have any authority or real control. This doesn't mean that these elements should be ignored in the EAFM process, it just means that they must be taken into consideration for the planning for what you do have control.

The three types of issues are those that you:

1. MANAGE - These issues must come under your direct legislative responsibility (e.g. controlling the number of fishing boats in your EEZ). You can generate regulations/management plans etc to deal explicitly and directly with these issues. The agency must take full responsibility for these issues.

2. INFLUENCE - These issues are not under your legislative responsibility and therefore you cannot manage them directly, but because they come under someone else's legislative responsibility (e.g. another Agency/Department; the WCPFC for impacts of fishing by other countries on your fisheries) you can have input into the process and try and influence what they do.

3. REACT TO - These issues are generated by the external environment that you can neither manage nor influence but they still affect you. You can still be ready to deal with these issues (e.g. natural changes in the oceanography, cyclones, changes in currency exchange, market prices, fuel prices) as much as possible.

All three types of actions can be considered within the EAFM framework, although the specific actions and activities that need to be taken will differ depending upon what type of control the agency has.

Within the Pacific region, there will be many issues associated with being part of regional fishery because tuna fisheries operate across wide regions of the Pacific Ocean. This has been the reason that a number of regional agencies, multi-lateral and bilateral fishing agreements and Conventions have been generated (e.g. FFA,

WCPFC, US Multi-lateral fishing agreements, and bilateral fishing access agreements).

If the scope of the assessment is to only deal with part of a more widespread fishery, the assessment should still identify and include any relevant potential impacts and issues outside the scope of what is being directly examined – this could include other fisheries that may also be affecting the stocks, other activities that may be affecting the environment that the fishing activity operates within or other activities that may be competing for alternative uses of the space or resources.

The explicit identification of what can be controlled and what influences performance is one of the more useful outcomes from this system. For example, each country within the WCFPFC can directly control the fishing activities that occur within their EEZ, but they can only influence the level of fishing that occurs in other regions through the regional body (in this case the WCPFC) and they can, however, only react to issues such as any fishing that occurs outside of the WCPFC plus any shifts in oceanographic conditions that may influence local fish abundances.

For simplicity all subsequent references to the 'entity' being examine in this EAFM guide will be called a 'fishery' even if it is only part of a large entity or if it were a collection of what otherwise would each be called 'fisheries'. Given the focus on Tuna fisheries in this guide, a common distinction that will be made will be for those assessments and arrangements that relate to the:

- Regional level (e.g. WCPFC)
- Individual country level and;
- Within country (commercial, artisanal) level

2.1.2 DETERMINING VALUES AND HIGH LEVEL OBJECTIVES

The second element of determining the scope is what is the purpose of management? What am I managing for? Again this is often not as clearly understood as it should be. Not being really clear about what is trying to be achieved by management, and more importantly, who will benefit from this, is an extremely common problem. There are three elements to this that are assisted by undertaking the EAFM process.

1) The key element of undertaking an ecosystem based management is that all the values that a community wants to achieve from a resource need to be considered in determining what is the acceptable performance for an issue. In short, what do the communities want to 'get' from undertaking management? In many cases these values can be aspirational. To be useful in decision-making however, these values need to be defined in such a way that ultimately they can be made into operational objectives that are measurable.

2) Another critical element is that EAFM does not only assess issues from one type of value (e.g. just species sustainability). During the various workshops associated with the development of this guide, it was identified that there are at least five types of values/objectives that can often be relevant to the same issue (see Table 2). These values could be used as the starting points to identify issues and ultimately assess the priority (risk) associated with any specific issues (because risk is the chance of not meeting your objectives – see later for full details).

Table 2 *A brief description of the five different societal values that were identified as being potentially relevant for assessing risks within the fisheries operating in the Pacific region. nb - not all values were relevant to every issue.*

	VALUE	OBJECTIVE
1	Species Sustainability	keeping biomass levels above B_{msy}
2	Species Viability	avoiding extinction for a species (i.e. $B_{current}$ can be < B_{msy} but >$B_{extinct}$)
3	Economic Outcomes	Optimising economic benefits to the community
4	Social Outcomes	Optimising social benefits to the community
5	Food Security	Maintaining access to sufficient resources to enable survival

Depending upon which of these values are used, the outcomes of any risk assessment (outlined in the next section) may differ greatly. Similarly, the types of performance measures and indicators to monitor performance would also likely to differ.

3) The third element of undertaking EAFM is that it requires explicitly looking to see if the effective management of one objective is causing unwarranted problems in the performance of another objective. There are often situations whereby managing to optimise one objective can result in generating poor performance in another. In such situations a compromise will need to be made preferably by explicitly determining which of the objectives should have precedent over the other.

2.2 Step 2 - Identifying Issues

Provides details of how to identify all EAFM issues relevant to the fishery.

The scope of the assessment, including what activities and sectors are included and what societal values are expected affects what issues will ultimately need to be managed. Thus, while there will be a similarity in the issues managed across the various fisheries within the WCPFC, each fishery will almost certainly have its own unique set.

To help determine the collection of issues we use a set of component trees that cover each of the five key areas of EAFM (as outlined in Figure 2 and described in detail below). Each of the five key areas has a detailed generic component tree for which many of the potential issues have been included based upon experiences of what issues are likely to be relevant for fisheries operating within the Pacific region.

These trees are tools to help identify issues and to lower the chances of missing important issues. They also help by structuring the issues into related groups, which assists in determining their priority and developing management objectives and strategies. The generic trees just make a good starting point to help the process of identifying what issues are relevant to the fishery being assessed. So just because an issue is present on the generic tree does not mean that it will always be relevant to a particular fishery, nor does it mean that all relevant issues will be present.

The process works by modifying each of the trees[1] by adding any relevant issues not already included and deleting any issues that are totally irrelevant. If any of the generic issues are removed, written justification should be provided on why it wasn't applicable (e.g. bait collection for a fishery that does not use bait). Merely because you do not have data or direct information is insufficient reason to ignore a potential issue.

At this stage, the process is about issue identification, not prioritisation so there should be little discussion of the importance of an issue. If a stakeholder raises an issue that is known to be wrong, this is usually valuable to document because in many situations describing what is NOT important is more valuable than what is. So, if one group thinks it is an issue, deal with it.

Identifying the issues is best done during a workshop where all relevant stakeholders are present. This could include representatives of the fishers, managers, scientists, community groups, and environmental groups etc. Such workshops provide each of these groups with the opportunity to have input to the process. The more community-based a fishery (i.e. the less industrial), the more appropriate it may be to begin by identifying the community wellbeing issues, rather than starting on the ecological issues (but not always). This could help to engage the stakeholders, because you are clearly focusing on the issues most important to them, but it may also help decide what values the communities want to achieve from the utilization of their resources. In any case it is important for the facilitator not to impose their values on others; different societies have different concepts of what is acceptable and important.

[1] You can also use lists of issues rather than trees if this is more convenient.

At stakeholder meetings it is necessary that these are undertaken in the most common language of the participants. This may require the translation of some of the core documentation into the local language and distributing this prior to the meeting. It may also assist if there has been some communication with the whole community – via media - press radio etc. to ensure that the stakeholders come well informed and that they have been able to discuss the issues widely prior to the workshop.

It is often useful if the discussions on the individual issues were lead by a local fisheries agency person rather than a consultant – who should, nonetheless, still manage the overall process and ensure that the conversations don't drift too far.

If a large workshop is not possible to organise/hold, the issues can still be identified by a smaller group or even just the one person (scientist/manager) using the component trees. The fewer people involved in this stage just increases the chances of some issues being missed and it also reduces the 'ownership' of the process by groups that were not present. The impacts of this can be minimised by sending the modified trees (lists of issues) to these groups for their input.

Each one of the component trees has its own set of peculiarities; the following is a set of hints to help with the identification of issues within each of the five key areas.

Whilst the order below begins with retained species – this is not necessarily the order that has to be used in any workshop situation (see above).

2.2.1 RETAINED SPECIES

(those species that the fishery wants to capture and use)

General

Because these are 'species' based assessments, once a species/group has been included on any one tree, all elements are covered. This includes issues concerning their abundance, distribution, genetic changes, along with any impacts of discarding by this fishery for being undersize, over quota, or any other impact on it by other sectors (e.g. capture by other fisheries, illegal fishing).

This approach is taken because it is more efficient (and appropriate) to deal with the issues collectively for a species and it becomes confusing if the same species is dealt with in multiple places when ultimately this system is designed to understand the risk to the stock as a whole and, where necessary, manage it appropriately – so this should be done in a comprehensive manner.

To assist in classifying issues, the tree can be divided into three branches:

- Target species – the key species that fishers specifically try and catch. These are usually assessed at a species or at least a 'stock' level.
- Non-target (byproduct) species/groups – those which are those caught and kept whilst out trying to catch the target species. Normally they would only make up a small part of the catch and can often be assessed at the group level (e.g. billfish) rather than at the species level (e.g. blue marlin), unless they are especially at risk/vulnerable. The distinction is sometimes difficult to get agreement on and ultimately doesn't matter greatly – as long as it is identified in a box, which branch it is on is a minor concern.

• Bait collection – this covers those fisheries that capture their own bait.

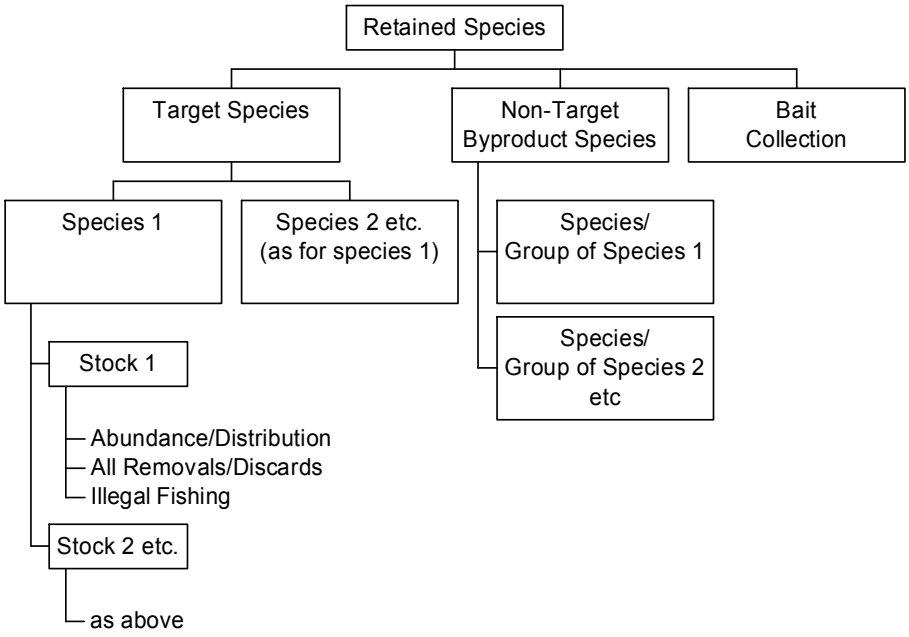


Fig 4. The generic component tree for the retained species (modified from Fletcher et al., 2002).

Target Species

These are the species that are the main focus of the fishery. Whether you need to divide a species issue into more than one stock or leave it at the species level depends on what is the appropriate level needed for management based on the stock structure of the species and how fishing effort/catch is managed. It needs to include all aspects of the management of the species/stock including all landed and non-landed catch by all fisheries, any discards and illegal fishing on the stock.

The process for determining the right level of division of the stocks can be used to check if the current management arrangements are appropriate. A useful question is: does the scale of our management match (as much as possible) the biology/dynamics of the stock(s)?

In the example for the WCPFC (Fig. 5), the target species include Albacore, Skipjack, Bigeye and Yellowfin. If, however, the retained species tree was generated for some member countries of the Commission, the list may differ because not all these species are a target everywhere.

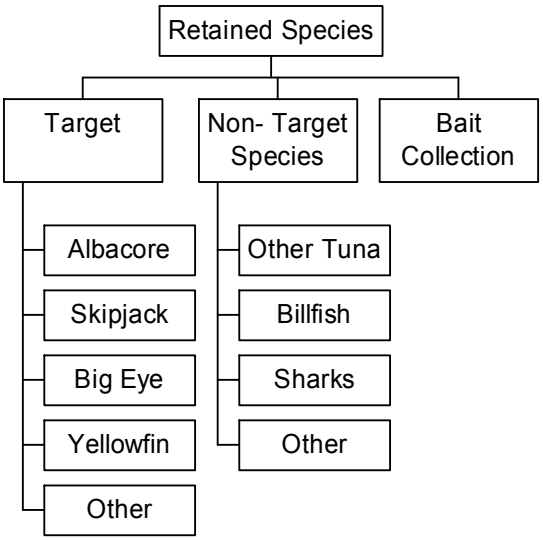


Fig. 5a A draft component tree for retained species in the whole WCPFC.

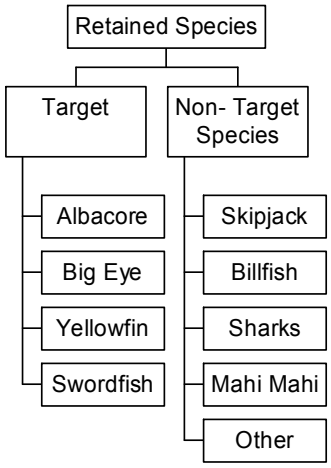


Fig 5b An example of a draft component tree for retained species for a long line fishery in the WCPFC.

Non-target (By-Product) Species/Groups

Within this branch, the decision to group species or assess them separately depends on the level of catch and the biology of the species involved. In the WCPFC example, a mixture of individual species and groups was identified. Where groupings are made, they should be sensible from a monitoring and management basis - e.g. similar quantities taken, similar life histories/vulnerability to capture etc. Many assessments also use an 'Other' category - which covers a wide variety of species each of which are only captured rarely. These byproduct species may include the target species of other fisheries. For example in the WCPFC (Fig. 5a) sharks are often the target species of other fisheries in the region.

Bait Collection

For fisheries that capture their own bait – e.g. many pole and line fisheries, an assessment of the impacts on these stocks is also required. The decision to assess these at a species level or at the group level will again depend upon the catch levels, and information available.

2.2.2 NON-RETAINED SPECIES

(those species caught or directly impacted by the fishery but not used – they are often called 'trash' species)

The issues that are covered in this tree relate to those species that no one in the fishery wants to keep at any time, irrespective of their size or life history stage. There are likely to be different types of objectives for trash species compared to target species - in most cases this would be to avoid or minimise their capture. This tree can also cover those situations where some species may not be caught but still affected by fishing activities (i.e. accidental collisions between fishing boats and dugongs). But remember if such a species is also caught by the fishery, just deal with it once.

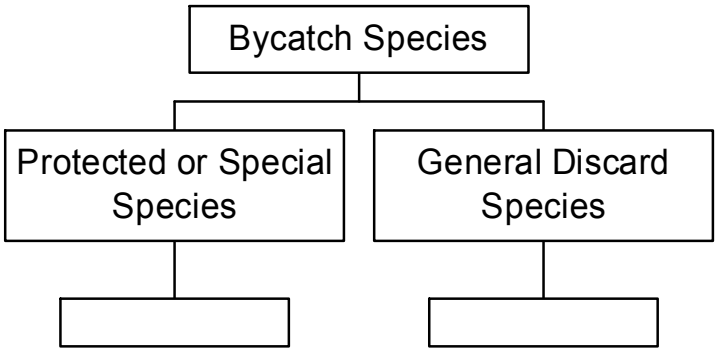


Fig. 6 Generic component tree for non-retained species (modified from Fletcher et al., 2002)

The two classes of non retained (bycatch) species are 'General Discards' (often termed trash fish) and "Protected" or "Special" species (listed in IUCN or they have some special cultural significance which prohibits them being kept). The number of species within this second category will vary greatly amongst countries. In the Pacific there are a large number of species in the protected or special category and some fisheries capture a variety of these species (Fig. 7a). At the WCPFC level, it was recognised that the impacts on species may vary across fishing methods and what was recognised as protected may vary amongst countries (Fig. 7b).

Again, the decision to examine the issue at a species level, group level or higher level depends upon what is considered appropriate. Often a large number of species can be identified separately during this phase, but the risk analysis phase often results in them being lumped because they have relatively similar risk profiles.

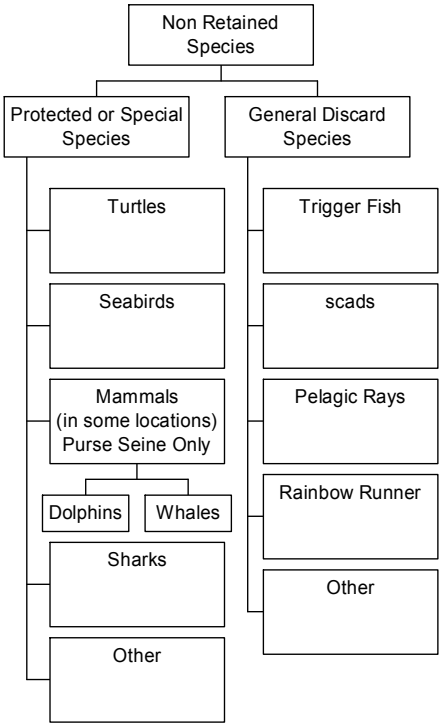


Fig 7a A draft by-catch (non-retained) species component tree for the whole WCPFC.

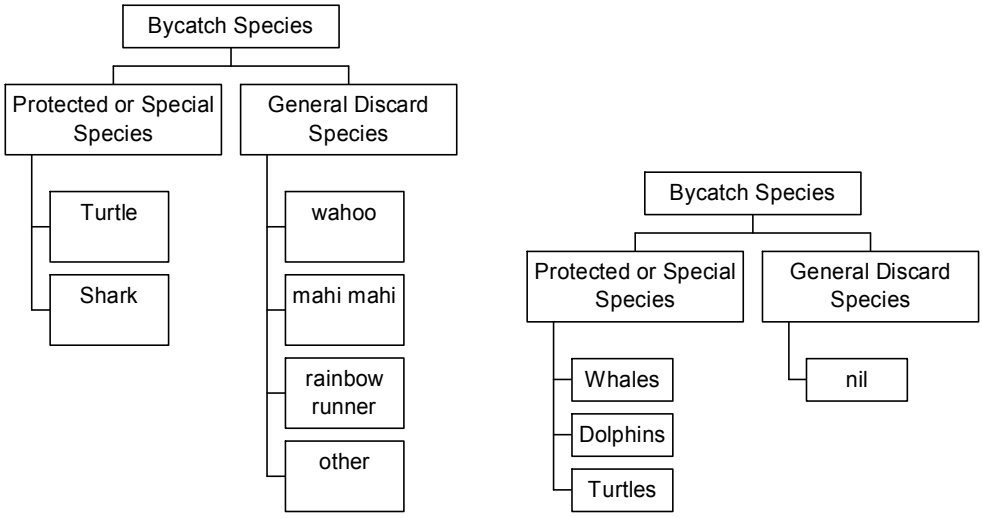


Fig 7b Examples of draft by-catch (non-retained) species component trees for two of the countries in the WCPFC.

2.2.3 ECOSYSTEM EFFECTS

(this tree covers the potential indirect and more general environmental impacts of the fishery).

The issues in the 'Ecosystem Effects' component tree cover the indirect and more diffuse interactions of the fishery with the broader ecosystem and environment. This includes the types of issues that have only recently begun to be dealt with by fisheries agencies and the industry. Consequently, there will generally be a greater degree of uncertainty about what is, or is not, likely to be an issue.

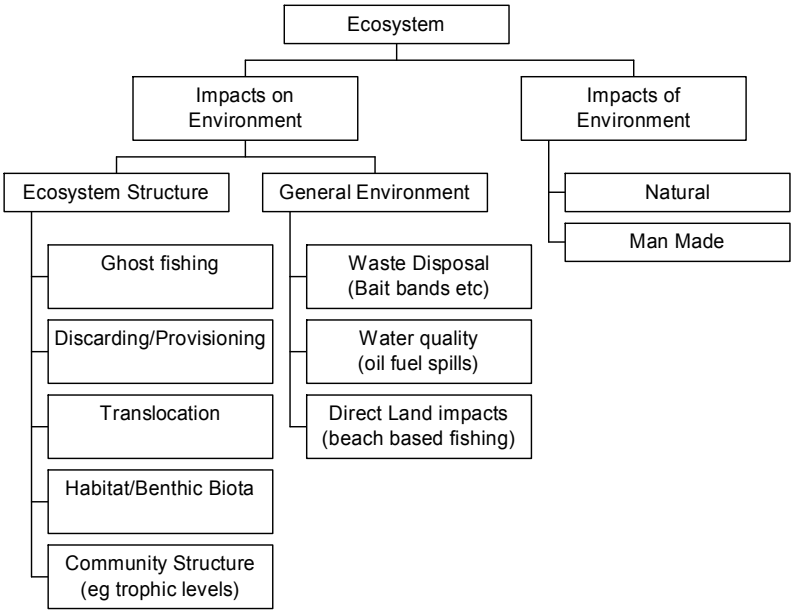


Fig 8. Generic tree for the ecosystem Issues (Modified from Fletcher et al., 2002)

The tree is split into three branches that cover:

• Impacts from the damage, removal or additions caused by the fishery to the rest of the ecosystem structure.
• The more general issues associated with fishing activities that could impact on the broader environment.
• The influence of the environment on the performance of the fishery.

Ecosystem Structure

The direct and indirect effects on the general ecosystem caused by damage to - or removal of - material due to the fishing operations are one of the highest priority issues for groups wanting fisheries agencies and the industry to take an 'ecosystem approach to management'. There are a number of possible elements within this branch that may need to be assessed.

Ghost Fishing

For many fisheries, the possible impacts of 'ghost fishing' need to be considered. This refers to fishing methods that use gear that continues to 'fish' even after it has been lost. One of the most well-known methods in this category is monofilament drift nets that have been lost. However, many other gear types, if poorly designed, can continue to capture fish when lost - this includes traps, pots, etc. In the example

completed for the WCPFC (Fig. 9), this was considered not to be an issue because the longline and purse seine methods used do not 'capture' fish when they are lost.

Discarding/Provisioning

The possibility that there could be impacts from the discarding of unwanted catch and the 'provisioning' that occurs from the addition of bait may need to be considered. These will only be relevant to fisheries where there is a significant level of unwanted catch (or old bait) discarded, particular if it is dead/or available for easy capture.

This process may be providing a source of food to other species that would not normally have access to it (e.g. birds), or at least not as readily. It also covers situations associated with loss of bait – especially when live bait is used.

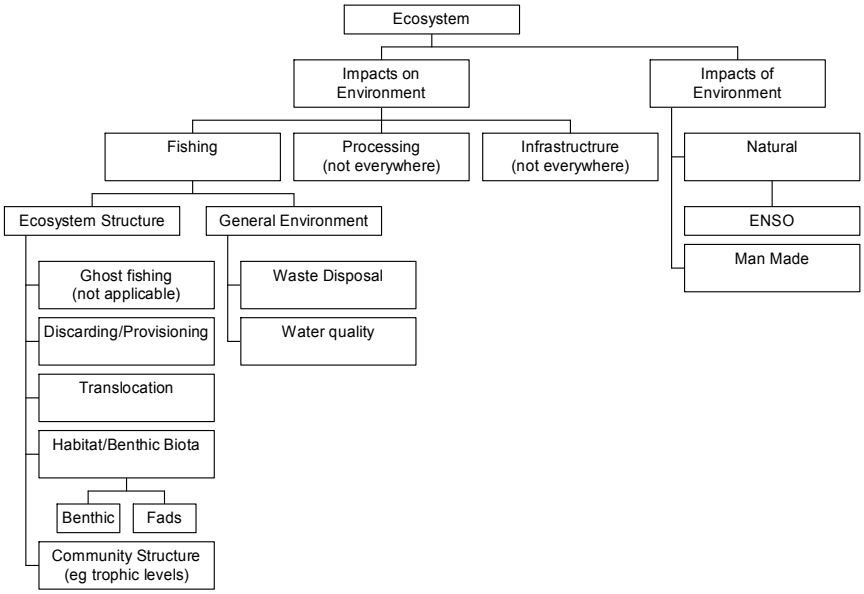


Fig 9. The draft general ecosystem tree generated for the WCPFC.

Translocation

This category covers the translocation of material by the fishery. This can cover both the movement of the target species outside of their normal distribution, or even the potential for the boats operating in the fishery to translocate fouling organisms from one region to another. There is also the possibility for the introduction of diseases through the use of imported baits.

Habitat impacts

One of the major categories in this branch covers the possible impacts of the fishing methods on benthos and benthic communities. This is likely to be relatively significant issue for a trawl fishery, and could required splitting this issue into a number of sub-categories, depending upon the number of habitat types affected. However, it is unlikely to be an issue for hand-gathering types of fisheries, such those for trochus. In the WCPFC example, it was recognised that the impact of fishing needed to be examined along with the impacts of FADs by creating 'habitat'.

Community Structure

The potential for disruptions to trophic interactions causing changes to the community structure of ecosystems that may arise from the removal of too many individuals of the target or bycatch species (such as taking too many predators or too many of their prey), changing the habitat or from provisioning; and it is an issue that needs to be considered in every fishery. In many respects this summarises and integrates all of the other elements in this branch along with all the removals outlined in the previous two trees – i.e. what is the cumulative impact of the fishery.

The level of potential interactions and changes to community structure will obviously vary, depending upon the species being harvested (some species are more likely than others to have an impact if removed – i.e. keystone species) and how much is taken (the more you take or affect, the more likely for flow-on effects to occur) and the methods of capture involved (some fishing methods are more likely than other to have an effect). Determining what may be an appropriate/acceptable level of impact is discussed in the next chapter.

General Environment

This branch covers the more general environmental impacts that could occur from the fishing operations. Many of these impacts may not appear particularly critical at this point, but as the debates over greenhouse gas emissions continue, the need for a fishery to have systems in place to report on this kind of environmental performance may become more necessary. Whether there is also a need to assess the associated port facilities, processing plants for a fishery will depend on whether they are specific to the fishery and where they are operating. These potential issues were identified in the example for the WCPFC (Fig. 9).

Waste Disposal

This covers the potential environmental impacts of debris from fishing operations, such as loss of bait boxes, bands, general rubbish, etc, dumped into the water.

Water Quality

This includes the impacts on water quality that could come from the possible accidental release of fuels, oils, etc, if appropriate codes of conduct/protocols are not in place. Transhipping risks in lagoons

Direct Land Impacts

Possible impacts on the foreshore can also be included, particularly where fishing requires the fishers to drive along the beach in a 4WD to reach their fishing locations and launch their boats. Port and processing facilities may be relevant here too.

Impacts of the Environment

The Impacts of the Environment on the Fishery tree has been designed to capture the major issues that are/or may at some time impact upon the performance of the fishery, but which are beyond the scope of the relevant legislation of the fisheries management agency. Even though they are not controllable directly by the management agency, these issues still need to be taken into consideration when developing management arrangements because they are likely to affect what is possible, which directly affects how strong or cautious management should be.

Natural

There are two major types of issues in this tree. The first are impacts that arise from natural changes to the environment, a good example of which is the strong link between the variations in the strength of the ENSO, La Niña and El Niño events which affects many fisheries throughout many oceans.

These impacts are much more likely to be noticeable at a country level rather than regional and will probably vary on an annual basis. Thus some shifts in oceanography may benefit some countries but result in negative impacts elsewhere by affecting the distribution of fish.

Man Made

The other branch covers the anthropogenic impacts from non-fishing activities on the performance of a fishery. These can include impacts on water quality such as those occurring from increased sediment loads or water pollution from land-based activities.

Other types of impacts come from the removal of nursery areas for coastal developments and the introduction of exotic species that may swamp or eat native species. In freshwater areas, the use and removal of water from the streams by agricultural activities is seen as probably the major potential issue for many of the native species living in these environments.

Not many examples have been identified for tuna fisheries in the open ocean. Impacts of mining in coastal waters have been identified.

2.2.4 COMMUNITY WELLBEING

(The local or regional communities and their dependence on the operation of the fishery)

The 'Community Wellbeing' tree covers the potential social and economic impacts (both good and bad) of the fishery on the wellbeing of the local or regional communities associated with that fishery. This includes the fishing industry itself, the small villages or local towns that may be directly and highly dependent upon the fishery for their existence, and the communities that are only indirectly affected by the fishery. The community wellbeing component tree is broken into two main branches, one dealing with the industry community (those directly employed in the industry and their families) the other dealing with the local communities directly or indirectly affected by the industry.

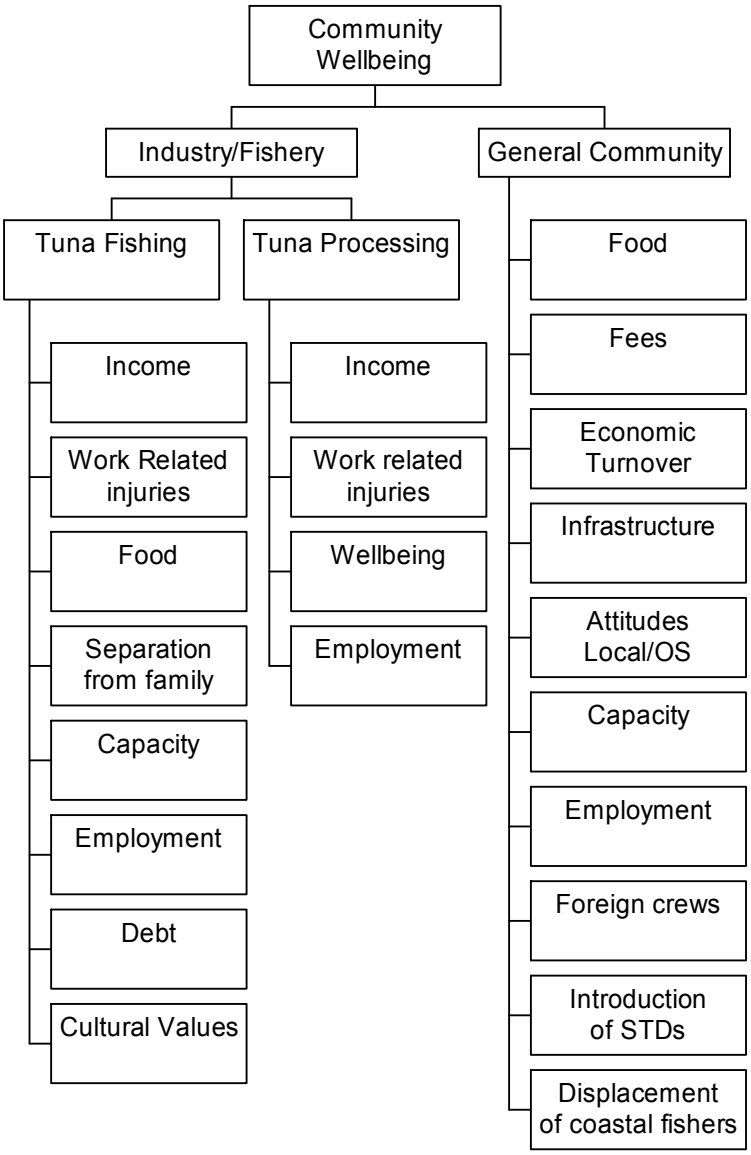


Fig. 10 The generic component tree for socio-economic wellbeing of affected communities (modified from Fletcher et al., 2002).

Industry

The 'Industry Community' branch can include contributions to wellbeing of the fishers and their families through a range of factors directly associated with the industry. The components often identified include income, contribution to the lifestyle along with their general wellbeing and occupational health and safety.

Income

A clear issue is the level of income that is generated by the fishing activity for the individuals involved. This can be assessed as a dollar amount but also in terms of the proportion of the average wages for the region.

Work related injuries

Fishing can be a dangerous occupation. There may be a need to monitor the level of such injuries and to ensure that there are policies used in the fishery to minimise

these. There may also be concerns with regard to other more indirect impacts, including the movement of communicable diseases of those who work on foreign boats travel to other regions.

Food

The fishery may not only or always generate income. In some regions the main benefit from the fishery may be the provision of food for the participants (and the community). This can include some of the non-targeted but retained catch.

Wellbeing

This issue covers both spiritual and physical elements. Fishing may instil a sense of pride or status within the community, or it may be considered a lower form of employment. It can also provide a good environment or in some cases it can be associated with high levels of injury and in some cases even death.

Separation from family

Work on tuna boats can regularly involve the separation of fishers from their families for extended periods. This can result in significant social problems associated with loss of contact with children, infidelity etc. which may cause the ultimate breakdown of the relationship.

Debt

The purchase of the vessels and gear may require a large level of debt to be generated. This can put a level of stress into a village or region and result in severe problems particularly if the enterprise is not successful.

Cultural Values

By undertaking tuna fishing activities this may or may not assist in maintaining cultural values of the community. This can also be a result of interactions with species that may have a high social value (e.g. whales, turtles).

General Community

The community wellbeing branch covers both the financial benefits/costs to local and regional communities of having the fishery continue to operate in the area, along with the social impacts of the industry, including the general attitudes of the community towards the industry.

While the importance of local industries to income and employment opportunities is obvious, other impacts could include attracting or maintaining services and contributions to the general infrastructure of the region.

It may also be somewhat difficult in some circumstances to identify and isolate for this component tree the issues associated with a single fishery from those issues associated with other fisheries that operate in the area.

Employment

Direct and indirect employment that result from activities such as fishing are easily understood as issues that can contribute to the well being of communities. The key

element is what proportion of employment does this industry contribute; a relatively small amount or a relatively large amount. This will affect how dependent the community is on this industry (see above). Whilst the fishing may not occur directly in the area, the income that is sent "home" by boat crews can be a major source of income in some countries.

Clearly one of the key drivers for understanding these linkages is that communities that are highly dependent on fishing will be vulnerable to the effects of any changes in the fishery. Of course, this does not mean that fisheries management decisions can be made in a way that prevents any community impacts. The value of understanding the community impacts of fisheries management actions is that:

- where a management decision is likely to have a severe negative social impact, the relevant government agencies can be informed so that they can target employment, business development etc assistance to the area;
- where there are two or more management options which are equally beneficial in ecological and economic terms, understanding the social impacts would allow managers to chose the option which causes the least community impact.

Food

In many locations the fishery is one of the main suppliers of protein to the local communities. In these situations, it will probably not be possible to implement major management changes that interrupt this without having some alternative source of food in place beforehand

Fees

In some cases the fishery may generate access fees from participants. This is often the case when they are operated by foreign owned fishing vessels. These fees may be a source of considerable foreign capital to a region.

Economic Turnover

The fishery resource may also contribute jobs related to fish processing, retailing, provision of boat fuel and parts, accountancy, groceries for fishers and their families, school teaching for the children of fishers, and so on. These are the multiplier effects of the fishery. Each dollar earned fishing that is spent in the community generates employment and income for other community members.

Infrastructure & Services

Fishery-related infrastructure can be identified as a component of the contribution of a fishery to community wellbeing. For example, a harbour and associated infrastructure that exists primarily to service commercial fishing provides benefits to other users.

Alternatively, if a fishery requires the construction of a significant level of infrastructure in order to develop (e.g. roads, wharves, freezers etc), then government may have to decide if the investment needed to complete this infrastructure is worth the value that is generated by the fishery.

As well as the direct and indirect employment/income/expenditure links between a fishery and local communities, access to services for a community may also depend to some degree on a fishery.

Attitudes

The perceptions of the local community about the fishery and its impact on that community are also seen as important. This could be especially the case where the fishery is not undertaken by local fishers.

Foreign Crews

For fisheries where a large number of foreign crews are housed in a region this can have a significant impact on the local community. Tensions can sometimes occur between locals and foreigners.

Displacement of coastal fishers

The commercial tuna fishery may affect small scale fisheries either by affecting their markets through the supply of high levels of cheaper fish, and/or through there fishing activities reducing local densities of fish and therefore affecting the catch rates of coastal fishers.

2.2.5 ADMINISTRATION

(The management processes and arrangements needed to assist achieve an adequate level of performance)

The administration tree covers all the legislative, administrative and bureaucratic processes that need to be completed to enable the issues in the previous four trees to be dealt with effectively. These issues may cover a number of levels of government and the industry. For the WCPFC, most of these elements are outlined in Article 10 of the Convention, under the function of the Commission.

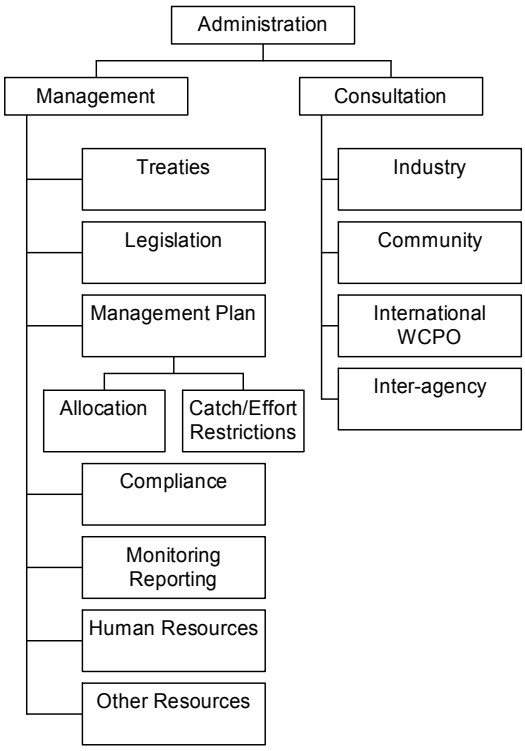


Fig 11 The Generic Component tree for Administration

Management

The management branch of this tree covers the issues which are relevant to the management agency.

Legislation

Is there adequate legislation that will enable all management plans, regulations etc that may be needed to manage the fishery in place and valid? For the WCPFC, the key legislation is the Convention. At a country level this includes having a "Fishery Act" and any subsidiary legislation or regulations.

Treaties

What treaties have been signed that relate to the operation of this fishery? What conditions are required to uphold this treaty and are they being met?

Management Plan

Is there a plan that outlines what is being managed and how it will be done (in many respects this is the plan that will be described in the following section)? If completed fully the EAFM outlines how this can be done.

For the WCPFC, the key elements of this are that it must operate at two levels- there must be a plan for the Commission that specifies allocation amongst the countries – this is spelt out in Article 8 (2) when in establishing compatible conservation and management measures the commission shall "*take into account biology, geography and "the extent to which stocks occur and are fishing in areas under national jurisdiction"*. Moreover, Article 10 (g) states that the commission "must develop, where necessary, criteria for the allocation of the TAC or TAE for the fish stocks in the Convention Area."

Similarly, at the country level Article 7 (1) states that principles and measures for conservation and management in the convention area shall be applied by coastal States. Moreover, Article 8 (3) states that each coastal State shall ensure that the measures adopted and applied within its jurisdiction do not undermine the effectiveness of measures adopted by the commission".

Compliance

Is there adequate observance of any regulations rules by the individuals in the fishery; is there any checking by officers of the relevant department? For the Commission this would entail the checking of catches and monitoring of vessels through VMS. These activities are managed by the Technical and Compliance committee (Article 14).

Monitoring and Reporting

Is the performance of the fishery against each of the objectives monitored on a regular basis and are these results reported in a manner that allows the general public or interested parties to be aware of these assessments? Are there peer/independent reviews of the fishery and the assessments?

For the WCPFC, much of this information comes from the Scientific Committee and Scientific services (Article 12 and 13).

Human Resources

To ensure that the administration operates effectively, there is a need to have adequate numbers of skilled people. The greater the complexity of management, the more people required.

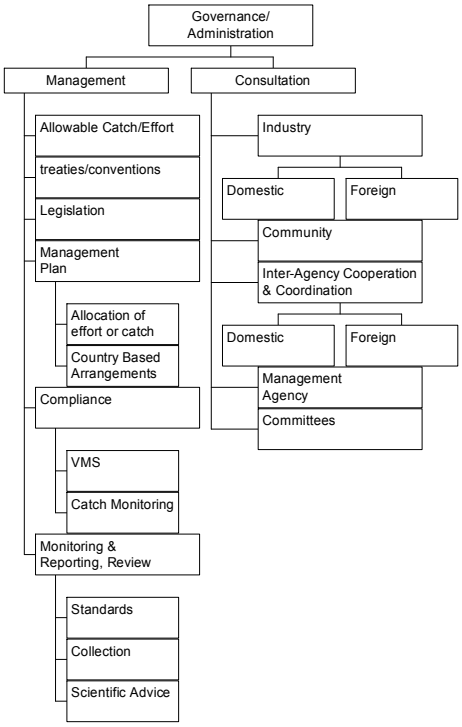


Fig 12 A draft governance/administration tree for the WCPFC.

Consultation

This branch covers the consultation issues that require the management agency. For the WCPFC this is the commission and/or FFA with the requirements outlined under Article 15 of the Convention.

Industry

Are processes in place for communication with the fishing industry?

Community

Is the community, at what ever levels is necessary, informed and are they able to input to the processes

Interagency

Are there appropriate linkages with other agencies within the country, with other countries or with regional organisations?

2.3 Step 3 - Using 'Risk Analysis' to Assist Prioritise Issues

This section outlines the methodologies and principles to help determine the priority of issues including which need direct management.

The methods outlined in this manual include a number of simple risk analysis methods that can be completed in a workshop forum but they are not the only possible risk analysis methods that can be used. More importantly, if appropriate risk values or priorities are already available for an issue, these scan be used.

2.3.1 BACKGROUND

Using risk assessment approaches to assist with fisheries management is not new (e.g. Lackey, 1994, Francis & Shotten, 1997; Lane and Stephenson, 1998). Complex quantitative risk assessments are now often employed in stock assessment analyses to calculate the probability that stock abundance will meet some agreed level of performance (e.g. Francis, 1992). These types of analyses, however, require significant levels of information and can only be applied in a small number of situations (usually stock assessments of key target species in large fisheries). Given the large number of issues and the different values identified as part of the EAFM process, many of which have minimal data, alternative methods of assessing priorities can be used.

There are a number of different risk assessment methods available for use in prioritising issues. The methods outlined in this guide are those that can operate with minimal levels of data and can be completed within a workshop environment. The determination of which risk assessment methodology (or priority setting process) is the most appropriate in any one circumstance will come from the level of information available and the level of knowledge and training of the participants.

One of the critical factors in the EAFM process is to get input from a wide group of stakeholders. So there will be often more than one set of methods used to obtain information from stakeholders and relevant experts on what level/type of management actions should occur. This can require different methods of consultation to get effective input from the different groups. It also means that you may end up with more than one list of risk scores - this may sound like a problem but the multi- level nature of EAFM may result in different risk scores if the issue being assessed has more than one possible objective so having to reconcile different priorities is a normal circumstance of taking this broader approach to management. This is not a problem of the system; it just explicitly recognises that has always been the case for fisheries that there are often multiple competing factors. What it does demand is that you identify upfront the criteria for determining which objective has precedence.

What is Risk?

Risk *"is the chance of something happening that will have an impact on objectives"*
(Standards Australia, 2000, 2004a).

This is a very important definition to understand because it covers all elements of the EAFM process and every issue that is identified. Given the different types of values and objectives that need to be assessed in this EAFM process and we need to be clear about "what" and "whose" objectives are being assessed. Different outputs may be achieved depending upon what values/perspective is chosen.

So risk assessment for EAFM is not just about the risks to 'ecological sustainability'. Whilst an Ecological Risk Assessment (ERA) is useful, it only covers one of the five societal values important to the EAFM process[2]. Consequently, there are likely to be many risks associated with a fishery that have nothing directly to do with ecological sustainability and could ultimately be the biggest risks for the country/community and the ones to which management actions need to be directed.

Just assessing ecological risk is not sufficient for EAFM

Including other Processes

The prioritisation process may occur by using the risk methods outlined in this guide or by using the outcomes of other risk assessment processes already available. For example a number of processes and analyses may have been generated prior to any stakeholder workshop, and it will often be necessary to determine how the assessment of issues completed elsewhere will be included within the EAFM process. An obvious example is the formal stock assessments completed for many target species by SPC. It will often be most sensible if the outcomes of these quantitative analyses are used to determine the stock sustainability risks where they are available (so long as the scale of the assessment is appropriate). In general, if other formal risk assessments are already available against a specific objective, the default status could be to accept these assessments unless the meeting could justify why not.

2.3.2 OUTLINE OF DIFFERENT METHODS

Basic categories ('non formal' qualitative)

In situations where there is little formal/quantitative knowledge, or where the participants would not be confident using more sophisticated techniques (which includes many community consultation processes), the simple use of a three level prioritisation process can be the most appropriate and effective method to use.

This process still uses the same basic concept as the more sophisticated approaches outlined below but targets the process at a level that can be undertaken without a high level of training. It is still important to make sure that the participants are assessing a risk to a clear objective – and which objective/societal value they are assessing.

For the assessment of the risks associated with economic, social and food security values, this methodology may often be the most appropriate to use. When assessing ecological elements, this method is probably best used in combination with one of the

[2] Generic objectives based on the societal values have been included for use where no specific ones are available, and where relevant, WCPFC objectives have been listed.

more formal methods that may be completed afterwards by more trained individuals. Nonetheless, even having individuals outline from their perspective explicitly if an issue is of high, medium or low priority/risk and why, can still be useful in its own right.

Formal qualitative (CxL)

The formal qualitative risk assessment techniques are now well documented. These are outlined in detail below and in the scientific literature (e.g. Fletcher, 2005).

The qualitative ecological risk assessment methods outlined here for the EAFM system were originally adapted for use within a fishery context to form a module of the Australian ESD framework (see Fletcher et al., 2002; Fletcher 2005 for details). This approach provides a consistent method for the calculation of the relative level of 'risk' from each issue, which can be used to prioritise issues and help determine which ones require direct management and monitoring (and importantly, which ones don't!). These qualitative risk analysis methods are based on the Australian & New Zealand Standard Risk Analysis (Standards Australia, 2000, 2004) and involve issue identification (which was covered in the previous section), the potential impacts (consequences) that may result from these issues and the likelihood (probability) that a particular level of impact will actually occur – which when combined together calculates the risk level.

The key element for these types of analyses is having good descriptions for each potential level of impact and likelihood. The more precise these are, the easier it is to assign the 'right' levels to each issue. Five comparable sets of impacts were developed that cover most of the ecological issues being assessed (Table 6). Thus, assessments of target species issues use Set A - where these were of highly targeted/vulnerable species; Set B is used for 'byproduct and most 'discarded' species, with the main exception being for the assessment of 'Protected Species' (for either cultural or conservation reasons) – these are completed using Set C. General ecosystem issues are either assessed using Set D for 'ecosystem (food chain)' issues or Set E for 'habitat' related issues.

Each of the sets has four levels of impact ranging from minor (no or little impact with a score of 1) to extreme (possibly irreversible with a score of 4), with the moderate level (with a score of 2) being defined as the highest acceptable level of consequence. The qualitative likelihood table (Table 7) also has four ordinal levels ranging from remote (never heard of, but not impossible; with a score of 1); to likely (expected to occur; with a score of 4).

The following two types of assessment methods may also be used. They are not outlined in this manual because they are too complex to include in this format but could, where appropriate be used as part of the EAFM process.

Semi-quantitative

Various semi-quantitative risk assessment processes are available for some types of issues. Within the animal health area, there are semi-quantitative approaches especially associated with the risk of disease and exotic pest introductions. There are also a number of semi quantitative ERA methods currently being developed. The critical point in using these systems is whether they are clearly assessing the risk against a specific objective. Some methods, such as the Productivity and Susceptibility Assessment PSA (e.g. Stobutszki, et al, 2001) are not strictly risk assessments, the scores they generate are only the relative/inherent vulnerability of

individual species and they are generally insensitive to major changes in management. Such analyses are nonetheless, very useful ways of collating available biological and fishery information for use within a risk assessment.

Quantitative

Quantitative risk assessments are now regularly done for many target stocks where there is sufficient information (see references above). Many of the formal stock assessments for target species completed by SPC assessment group would come under this category.

2.3.3 CALCULATING RISK RATINGS

For the purposes of this prioritisation process, a relatively high level approach is taken by asking

'What is the risk (for each issue) from having the fishery?'

The impact and likelihood levels are determined given the management controls already in place. The outcomes of a risk analysis should be different depending upon whether the current management arrangements are, or are not, included in the assessment. If they do not change then the management is not having any impact at all!

Risk is the likelihood of NOT meeting your objective –

Thus it is the likelihood of a BAD consequence occurring

Basic Category System

The risk associated with each issue is assigned to one of three categories – High, Medium or Low.

Low – Either the level of impact on the objective is expected to be low to non-existent, or the chances of a major impact are extremely small. So you are highly likely to achieve your objective.

Medium – There is a reasonable chance that unless some actions are started then the objectives wont continue to be met to a satisfactory level; or the reason the objectives are currently being met is because there are direct management actions currently operating that would need to be maintained.

High – The issue is already at a point where severe problems are known to be occurring or this is very likely to happen in the near future. If there is already management it is not working to a sufficient level.

The management outcomes from these categories are outlined in Table 5.

Qualitative System

In the formal system, the risk level for each issue is calculated as the product of the scores for impact and likelihood combination chosen as being the most appropriate for the issue. The possible values are between 1 – 16 (Table 4).

Table 4 - Risk Matrix – numbers in cells indicate risk value, the colours/shades indicate risk rankings (see Table 5, 6 and Appendix 1 for details).

		Consequence Level			
		Minor	Moderate	Major	Extreme
Likelihood		1	2	3	4
Remote	1	1	2	3	4
Unlikely	2	2	4	6	8
Possible	3	3	6	9	12
Likely	4	4	8	12	16

To correctly assign these levels, it is important to recognise that when assessing the likelihood of a consequence occurring, this is a conditional probability. It is the likelihood that, given a particular fishing management strategy (e.g., the current allowable catch levels for a tuna fishery), a particular level of impact (e.g., a reduction in spawning biomass to x% of unfished levels) may ultimately be the result (either from an accumulation of small events over time, or from a single large event). It is NOT, as is commonly done when beginning this process, mistakenly assessing the likelihood that the particular fishing activity (i.e., catching the species) will occur. This type of error must be avoided.

Each issue is placed into the appropriate combination of impact and likelihood levels based upon the information available and the collective wisdom of the people involved in the process. The decision about what levels should be chosen include an understanding of the scale of impact required. If more than one combination is considered appropriate, the combination with the highest risk score should be chosen. (i.e. this takes a precautionary approach).

The combination should be based on the risk of something happening over a defined time period - not the risk of it happening at any point in the future[3]. Because this process is assessing risks to objectives based on a management plan, a convenient time frame to use is the timeframe of the management plan - which is usually in the vicinity of five years. For example, if you are assessing the risk of the management arrangements on the stock of target species – you could assess the likelihood of it being at some consequence level within this period. This is simpler to conceive than assessing it at an undefined point in the future.

[3] If the time frame used to assess risk is infinite, then the risk of extinction for all species will be high – because it will almost always be certain to happen at some point in the future!

THE RISK OF AN UNACCEPTABLE OUTCOME SHOULD BE DETERMINED FOR A SPECIFIC TIME PERIOD

Whilst using the management plan period (5 years) is normal, it can also be useful for some issues to assess the risk at some longer time frame (10-20 years) this can be very useful for assessing the impacts of climate change, or fuel prices etc, those issues for which the time scales are longer than the management plan.

Whichever combination of consequence and likelihood is chosen, it is very important that the justifications for choosing these levels are recorded. The key element is that other parties who were not part of the process to generate the report need to be able to see the logic and assumptions behind the decisions that were made. It will also greatly assist the review of the risk at some time in the future if you know why the levels where chosen the first time.

The risk assessment is not just the scores generated but must include appropriate justifications.

2.3.4 OTHER QUALITATIVE RISK ANALYSIS METHODS

There are a relatively large number of qualitative risk analysis systems that could be used to undertake these analyses. The ones that have been presented here in this manual are representative and easily available. There may specific situations or data levels where other risk analysis methods (which are all fundamentally based on the C X L process anyway) may be more suited than those presented here (e.g. Hobday et al., 2005). Whatever risk analysis method is used it should be appropriate to the situation; the individuals undertaking the analysis should be confident in its use and the outputs and the rationale for the outcome must be documented so that they can be scrutinised by others where needed and reviewed at a later date.

2.3.5 LEVELS OF DATA, UNCERTAINTY AND RISK SCORES

Almost by definition, a risk analysis involves uncertainty- if you are certain of the outcome of something then undertaking a risk assessment is generally not necessary. Consequently, many risk assessments are completed with relatively little quantitative data. This is not uncommon nor is it an error. Dealing with uncertainty in a risk based nature is a feature of all facets of life – we generally just don't realise that we are doing it. If you do nothing because it is seen as too hard, you have actually made a decision by default – this is a problem. Risk assessment is a way of making the most informed decision you can with the information available.

Risk Assessment is about making the MOST informed decision you can

Even fisheries that have significant levels of data for their target species generally have limited information for many of their by-product species; by-catch species or

ecosystem issues (Whitworth et al., 2003). In such circumstances scientific inference from the literature, and management experiences associated with similar issues and impacts elsewhere, can be used effectively. There are very few issues for which no information is available to make an informed assessment. The key point to remember about the process is that it is trying to ensure that the level of resources applied to the future management and/or monitoring of an issue should be matched with the level of risk (this may include the need to collect more data to reduce the uncertainty – see below).

It is NOT necessary to have full certainty for issues to rate its risk

The level of uncertainty is a component of the risk calculation process, not a separate risk.

The level of uncertainty associated with an issue should be factored into determining which combination of likelihood and consequence are chosen that best reflect the level of understanding. For example, if there is some uncertainty about the effectiveness of management for a target stock, it is probably more appropriate to score the fishery as possibly having a severe impact rather than expressing it as likely to have only a moderate impact. Whilst the risk scores may be similar the former combination more appropriately reflects the current knowledge of its status. In other cases the risk score may be rated higher because of a higher level of uncertainty makes the likelihood of a bad consequence more appropriate to be at a higher level. The appropriate management response in these circumstances may be to reduce this uncertainty to a level that is acceptable.

It is also important to recognise that the methods outlined in this manual are just the first stage risk analysis techniques, and therefore may be just the first step in the process. Once an issue is rated as medium or higher risk, then it requires a more detailed assessment to determine what specific management, research or monitoring are necessary – which may involve a more detailed (semi quantitative or quantitative risk analyses). Where the process initiates the collection of more information (e.g. because of uncertainty), more precise, quantitative assessments of risk may be possible. In such cases these reviews could either confirm the need for direct management, identify that an even greater level of control is needed, or suggest that the initial risk rating was too high and that direct management may not be required. Where greater management controls are needed, this system should help the focus of additional measures to either reduce the potential consequence level resulting from the activity, or the likelihood of the unacceptable consequence occurring, or both.

2.3.6 MANAGEMENT OUTCOMES OF RISK ANALYSIS

The possible risk values are separated into three Risk Categories ranging from minor to high risk (Table 5). These categories identify the level of reporting needed and, more importantly, whether direct management of the issue (e.g., imposing increased levels of restrictions, collecting more data) would be required to reduce or maintain the current level of risk.

The outcomes from the risk assessment should be used a tool to help you decide what you should, and should not, be spending your resources (both people and operating) on.

(1) For issues you are not currently addressing directly this should help identify if:

- you should continue to do nothing directly (Low Risk) or,
- you really need to be doing something (Moderate or High levels of risk - e.g. imposing direct management, starting a research program)?

(2) For issues that are already being managed or investigated the scores should help decide if:

- you are doing an appropriate amount (moderate risk levels);
- not doing enough (high risk levels)
- or doing too much (low risk levels).

Table 5 Risk Categories and Outcomes

Risk Category	Qual. Risk Values	Likely Management Response	Likely Reporting Requirements
Low	1-4	None Specific	Full Justification needed
Medium	6-8	Specific Management/Monitoring Needed	Full Performance Report
High	9-16	Increases to management activities needed	Full Performance Report

2.3.7 SPECIFICS FOR RISK ANALYSIS FOR EACH EAFM CATEGORY

TARGET SPECIES

The WCPFC has the objective for target species to:

'maintain or restore stocks at level capable of producing maximum sustainable yield as qualified by relevant environmental and economic factors…"(Part II Article 5 (b))

An alternative objective that can be used to assess the risk to each of the target species (if one is not already developed) is:

"*maintaining spawning biomass at least above the level where it is likely that to result in recruitment overfishing*"

To assess the risk of the fishery on each of the target species against this (or any other objective), the risk assessment should integrate/incorporate the following:

- The removals, by all sectors (i.e. commercial fishing, recreational fishing, indigenous, illegal and discards). How many fisheries capture this species? Do you know what these amounts are? The greater the relative amounts of catch being removed and the larger the number of other sectors catching the species, the higher the possible consequence is likely to be.
- Species biological characteristics/dynamics. Does the biology of the species make it more likely to be susceptible to over fishing? For example, is it long-lived and low fecundity, short lived and high fecundity, widely dispersed, local populations only, etc?
- The current knowledge and understanding available on these issues (including distribution versus area fished) Is there a large amount of data on the species and the sources of mortality? The less data available, the higher the risk is likely to be.
- Current management arrangements - their effectiveness and problems. Are the current management arrangements, including compliance with rules and effort limitation methods, working?
- The assessment must be about the risk of where YOU WILL BE at the end of the specified period, not just where you are.

Obviously each of these elements interacts with each other. For example, you may be able to have a relatively large catch on a "susceptible" species if appropriate management arrangements are imposed combined with effective monitoring that demonstrates that these arrangements are working successfully. The consequence categories for this type of species are outlined in Set A in Table 7. Although, Set B may be an alternative depending upon the objective (see later).

The scope of the assessment of target species, particularly those within the WCPFC can be done at the commission level, and at the country level. Thus whilst the overall risk to the sustainability of stock within the WCPO region maybe high (e.g. Yellowfin), the risk generated by different countries may vary – those that take 1% of the catch would have a low risk of impact, whereas those countries that take 10% or more should generate a moderate to high risk.

There can also be issues of jurisdiction between inshore and offshore operations even within the one country. There maybe, therefore, a need to assess these areas separately.

NON-TARGET (BYPRODUCT) SPECIES

Default objective – (may be the same as target species – but the Convention has alternative objective to maintain viability of non-target species – see also section 2.5.1)

Assessing the risk of having this fishery for each of the byproduct issues should integrate/incorporate

- The relative impact of this fishery compared to the distribution of the species and other impacts on the stocks
- The biological characteristics and dynamics of the species/group
- The current knowledge and understanding available on these issues and current management arrangements.

To assess these issues, Set A, B or C may be appropriate depending upon the level of capture and the objective used.

BYCATCH SPECIES

Default objective

(Discards) – *To maintain appropriate levels of biomass of bycatch species to minimize any significant impact on their dynamics and the broader ecosystem*
Or- use the target species objective

(Protected) – "*To keep the level of capture of this species at acceptable levels*"

For the WCPFC, they must adopt measures for non-target species and dependent species with a view to maintaining or restoring their populations above levels at which their reproduction will not be seriously threatened (Article 10 c). This may be substantially lower level than the objective outlined above. This has implications for determining risk values, depending which objective is appropriate and used, different outcomes may be generated.

The questions covered (and the types of data used) for the assessment of bycatch - discard issues are generally the same as for target and byproduct species. The analysis can be complicated when assessing 'special icon' species, such as cetaceans and pinnipeds, which not only have different dynamics to finfish but for which different levels of impact may be accepted by the public. In such circumstances the second objective and Set D is used to assess the risk.

In some cases it has been recognized that separate assessment of the cumulative risk to some bycatch species from all fisheries/activities in the region (not just the fishery being examined) may need to be done where a full understanding of all impacts was not possible at the workshop. When this happens you need to clearly state in the report that it only relates to the one fishery, not all levels of impact.

ECOSYSTEM

Ecosystem Structure

Default objective '*To maintain any impact on the wider ecosystem by fishing to be within acceptable levels'.*

The assessment of potential overall consequences on ecosystem structure from the removal of biomass and other changes resulting from the fishery should also be done at the level of the entire ecosystem (Set E). This can often assisted by separately assessing the potential impacts on any prey and predators species and by determining whether any potential "keystone species" (*sensu* Paine, 1966; which is not equivalent to just being a higher order predator) are being affected. It is largely a result of the level of redundancy of function. If there is a large number of species that occupy this trophic level or undertake similar functions, there is minimal chance of there being a keystone species. If they are the only species that occupies a specific trophic level or form a clear majority, then this increases the chances of them playing a keystone role.

This is a difficult concept to grasp because there are very examples where these attributes have been measured in a quantitative manner. There is also few metrics available to define what is 'acceptable change' – this will be a much more qualitative process than for individual species. What we have tried to do is identify some reasonably clear descriptions of different levels of change to use as the consequence

levels that go from only a minor shifts in structure (recognising that changes occur without any human impact) up to the total collapse of the ecosystem.

The four graphs below (Figure 7) provide a schematic representation of the types of changes that may be associated with each of the four level of consequence as outlined in Table 7.

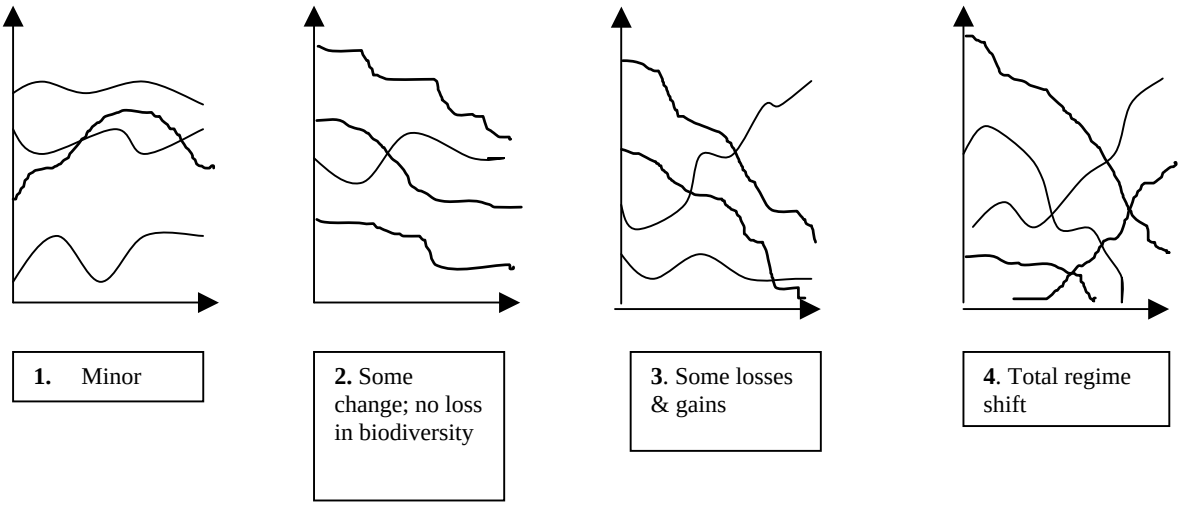


Figure 13 Schematic representations of the four potential consequence levels for ecosystem changes. The individual lines are meant to indicate relative abundances of different elements of the community/ecosystem.

Habitat

Default objective '*To maintain the spatial extent of habitat impacts from the fishing activity to a comparatively small percentage of the habitat/community*'

Assessing the habitat impacts that may result from each fishery should be done at a regional level, with impacts judged against the best estimate of the original extent of each of the habitats, not their current distribution (Set F). The assessment criteria have divided habitat into three categories which recognise that not all habitats are equal – some are more fragile than others - often due to slow recovery rates. Also some are more critical to the functioning of the ecosystem than others – providing substantially greater levels of fish recruitment or nursery habitat. This is why different levels of impact generate different levels of risk.

SOCIAL AND ECONOMIC ASSESSMENTS

The analysis of risk associated with social and economic objectives are vitally important in the analysis of EAFM. Within the WCPFC these elements are especially important given the relative percentage of GVP and other social factors that these resources provide to these communities.

The consequence levels generated for these issues are located in Tables A5, A6 and A7. The default objectives are:
Social - *Maintenance or enhancement of appropriate social structures*.

Economic - *Maintenance or enhancement of economic activity*

Food Security - *Maintaining access to sufficient resources to enable the survival of the communities*

2.3.8 INFLUENCE OF VALUES ON RISK OUTCOMES

As outlined above in section 2.2.6, there are a number of possible values and objectives that can be associated with an issue. The outcome of the risk assessment process may be affected greatly depending upon which objective is used. This will be illustrated by using examples of the assessment of two target species within the WCPO which have been identified during the workshops held to develop this guide.

Given the estimate biomass trajectories of the stock of Albacore within the WCPO region, from a sustainability perspective it is unlikely (2) that it will get to fully a moderate level of depletion (2) which is a Low Risk (See Fig. 14). However, from an economic perspective, the fishery needs to have the current catch rates levels maintained, hence any significant reduction in biomass will reduce the catch rates and generate unacceptable economic outcomes. Therefore, from an economic risk analysis, because it is possible to unlikely (L 2-3) that it will decline below current economic levels (C 3) – with a risk score of 6-9, this represents a moderate to high risk.

By contrast, for "Yellowfin" Tuna, the current biomass trajectory suggests that this will pass below the Bmsy line within the next five years (Fig. 14). Against the sustainability objective this represents a High Risk (C3 L4 = 12).

If however, this trajectory is assessed against a species viability objective, the risk score is reduced because it is only possible that the biomass will decline to the Brec level in the next five years which is a L3 C2 = 6 which represents only a moderate Risk.

These shifts in risk score with objectives demonstrate the absolute need to get clarity about what is trying to be achieved. It is recommended that if there are multiple possible objectives that the risk scores for each are developed separately. This will, nonetheless, require a process to determine which objective has primacy.

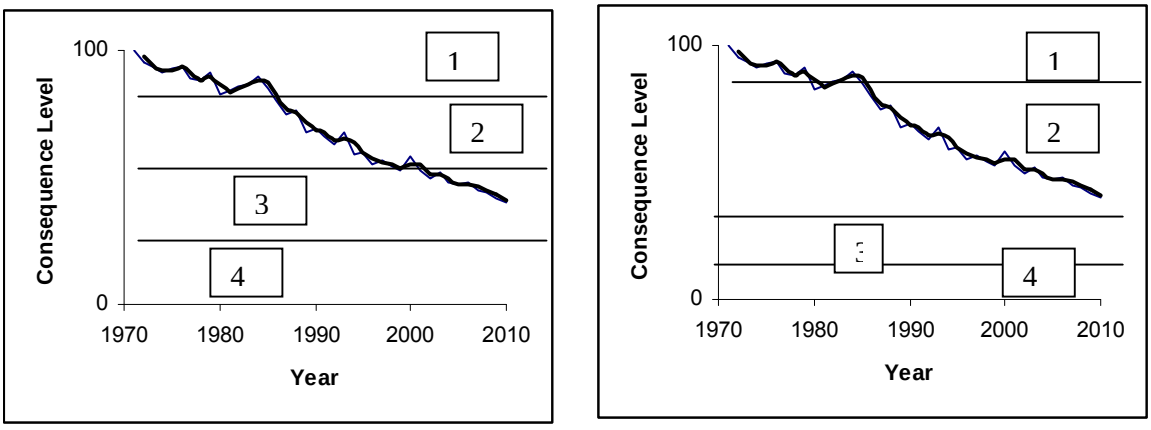


Figure 14 - Different consequence and risk levels using different objectives for "Yellowfin Tuna" using sustainability and viability levels as objectives. Note these trajectories are only for illustrative purposes.

2.3.9 DIFFERENT SCALES OF IMPACT

The overall risk to the highly migratory species caught within the WCPFC required an assessment of the cumulative impacts from all fishing activities across the entire Western and Central Pacific Ocean (WCPO) region (defined as a Commission Level Assessment). Given, however, that there are large differences in the catch levels taken within each country's fishing zone, the management responses of any one country should be related to their relative level of impact on the stock. This often required separate country level assessment of the relative risk, in addition to the assessment of risk at the Commission level.

There is, however, a potential problem with this approach. In situations where only small catches are taken in any one jurisdiction, but collectively this is still too high. Under such a scenario, all would need to lower their impacts. This level of risk should have been identified at the Commission level anyway and clearly would become a commission level initiative for all member countries to contribute. Given the pattern in catches of key WCPFC species, this situation is more likely to be relevant for bycatch and discard species than for target species.

2.3.10 COMBINING DIFFERENT RISK VALUES

Where there is more than one assessment of risk – such as when there has been one set developed by a stakeholder group and another set developed by an expert panel or where they are two or more objectives being assessed for an issue, there may be occasions where the risk levels are not identical.

As a rule of thumb, the expert group using a formal risk analysis system will probably come up with the most robust risk scores for sustainability objectives. But the stakeholder group using the more informal methods may come up with the most robust risk scores for social and economic objectives and issues. Nonetheless each issue should be treated on its merit and ultimately a judgment therefore needs to be made BY THE MANGAGEMENT AGENCY as to which risk score will be used to determine management actions for this, hopefully, small group of issues. In most cases the highest risk score was generally used to determine the actions to be taken.

Table 6 Likelihood Definitions – these are usually defined for the likelihood occurring within whatever is the normal review period (5 years is common).

Level	Descriptor
Likely (4)	It is expected to occur (Probability of 40 - 100%)
Possible (3)	Evidence to suggest this is possible and may occur in some circumstances (Probability of 10 - 35%)
Unlikely (2)	Uncommon, or has only been known to occur elsewhere (Probability of 2 -10%)
Remote (1)	Never heard of, but not impossible (Probability < 2%)

Table 7 Summary descriptions of the six sets of consequence levels covering the three environmental categories (modified from Fletcher et al., 2002). Full descriptions plus economic and social levels are presented in Appendix 1. *3 categories of habitat – normal, fragile, critical.

Consequence Level	A Target/Vulnerable (Sustainability)	B. Target/Vulnerable (Viability)	C Discards/Byproduct	D. Protected Species	E Ecosystem Structure	F Habitat*
1- Minor *Rapid recovery would occur if stopped - measured in days to months*	Possibly detectable but little impact on population size and none on their dynamics. Spawning Biomass 100 -70% unfished levels	Possibly detectable but little impact on population size and none on their dynamics. SPB > 70%	This fishery takes a small % compared to total take by all fisheries (covered explicitly elsewhere). Take and area of capture by this fishery is small compared to known area of distribution (< 30%).	Some are impacted but there is no impact on stock, and this is well below society's acceptable levels	No, or only minor, detectable changes in relative abundance of other constituents of region. None of the species removed play a 'keystone role'	Measurable but localised affects < 1-5% of total habitat area
2 –Moderate *Recovery probably measured in months – years if activity stopped*	Full exploitation rate where long term recruitment/dynamics not adversely impacted. SB < 70% > B_{msy}	Biomass above point where recruitment has been affected significantly SB < 70% > B_{rec}	Relative area of, or susceptibility to capture is suspected to be less than 50% and species do not have vulnerable life history traits	Level of interaction/ impact at the maximum acceptable level	Measurable changes to the ecosystem components (e.g. catch of some altered) without there being a major change in function. (i.e., no loss/addition of components)	Impacts more widespread but still acceptable 5-50 % of habitat area is affected
3 – Major *Recovery measured in years – decade if stopped*	Affecting recruitment levels of stocks/ or their capacity to increase. SB <B_{msy} - 5%	Recruitment affected but not stock will be sustained in longer term SB < B_{rec} > 3%	No information available on vulnerability to capture or life history traits of species; or relative levels of susceptibility known to be > 50% - should be examined using criteria in Set A.	Level of impact at above maximum acceptable level. Refer to Set A criteria for any higher levels associated with threatened species.	Ecosystem function altered measurably - non target components declined or increased well outside of acceptable range &/or new species to appear. Different species now the targets of the fishery.	Impact larger than sensible 20- 60% of habitat is affected/removed
4 – Extreme *Recovery period measured in decades if stopped.*	Likely to cause local extinctions if continues SB < 5%	Highly likely to cause local extinctions if left SB < 3%	N/a	N/a	A major change to ecosystem structure and function likely to lead to total collapse of the ecosystem if continues.	Removal may result in major changes to ecosystem if 60 - 100% affected

2.4 Step 4 – Developing Management Systems

This section details what processes and report headings need to be completed to ensure that a complete management system has been developed for each of the issues requiring direct actions

2.4.1 BACKGROUND

The management systems outlined below cover all the processes needed for a management agency to justify what and how their current and proposed management actions (or inactions) for each of the issues, given the levels of risk and current knowledge available.

Management Reports

There are four levels of management reports that can be generated; the suitability of each is dependent upon the requirements and resources available. The first two can be generated very quickly, in a matter of days to weeks, whereas the final two categories of reports would take considerably longer. In any case it is likely, however, that the outputs from the briefer reports would be used as the basis for completing the more comprehensive reports.

a) a very brief outline – component trees and a brief risk tables,

These reports may only be a few pages long but they could include an outline of the scope of the fishery/activity/region that was being assessed; a set of component trees that has been modified to fit the situation and a summary outcomes table (see format below) that captures the critical elements of the risk assessment but also includes a summary of what management actions were identified as needing to occur in the near future (e.g. about six months). This provides a very rapid way of an agency/group to understand what they need to do and why.

ISSUE	Objective	Conseq.	Likel.	Risk Score	Reasons	Management implications

b) Include brief management reports on key issues

This level of report is similar to (a) but it also includes a summary of the categories that will be used for management, including what indicators, performance measures and other management actions will be undertaken.

Issue	Objective	Risk level Stakeholders	Risk Level Expert	Indicator	Performance Measure	Management Actions

Issue	Objective	Risk level Stakeholders	Risk Level Expert	Indicator	Performance Measure	Management Actions

c)/d Comprehensive reports on risk and management (two levels)

These are more comprehensive performance reports that complete each category for each issue. This includes a description of the risk assessment analysis including appropriately detailed justifications and the completion of the full management system.

The following set of headings mostly relates to issues that the agency has full responsibility. Those issues for which the agency has an interest but not full responsibility (which includes many of the community wellbeing issues), some of the headings may not be required (see example for debt).

Performance Report Heading	***Description***
1. Reason for inclusion	*Summary outcome of Risk Assessment. Why is it important to mange directly, how do you know/ how certain are you? State knowledge base*
2. Operational Objective (plus justification)	*What specifically are your trying to achieve and why?*
3. Indicator	*How are you going to measure performance?*
4. Performance Measure/Limit plus (justification)	*What defines acceptable and unacceptable performance and why?*
5. Evaluation	*Monitoring programs needed and their results*
6. Robustness	*How robust are the indicators and performance measures?*
7. Fisheries Management Respons	
- Current	*What management actions are currently used to achieve acceptable performance?*
- Future	*Does any extra management need to be introduced?*
- Actions if Performance Limit is exceeded	*What will happen if performance is not acceptable?*
- Review Cycle	*What is the time frame for reviewing performance? And why (the basis of) this time frame?*
8. Other Issues	*What, outside of the fisheries control, could affect performance against the objective?*

The completion of these set of headings can be done at a number of levels. They can be filled in very quickly (a days) to get an overall understanding of how well the systems have been developed, or they can be done in a very formal manner requiring direct stakeholder input which may take some months to generate. It is suggested that the initial, rapid version is done prior to any public level scrutiny or consultation to identify where the likely gaps and issues will be. The two examples located at the back of this section (2.4.4) were both written within a day. Whilst they are not very polished, they still provide a very comprehensive understanding of what are the management systems for these two issues and what needs to be done.

2.4.2 DESCRIPTION OF HEADINGS

Reason for Inclusion and Identification of Management Scope

Providing the reasons why an issue needs to be addressed is useful for determining both the objective and the management responses. In most cases this will be the summary of the risk analysis process outlined above and should include the risk scores and their justification.

The section can also specify which management authorities are responsible for ensuring adequate performance for this issue. In cases where more than one agency is involved, this could record how the relationship amongst the relevant agencies will operate – particularly who is responsible for setting the objectives and monitoring performance.

Operational Objective

The operational objective to use for an issue needs to have a direct and practical interpretation for the management of the fishery and needs to measurable and auditable. It therefore needs to be outcome-based and can best be described by answering the question

“What do you want the fishery to achieve for this issue and why?”

The objective should also be consistent with any relevant legislation, policy statements or management plans. One of the most common objectives for target species is “maintaining spawning biomass above the level where it likely that there will be recruitment overfishing”. As stated above the relevant objective for target stocks in the WCPFC is to ‘maintain or restore stocks at level capable of producing maximum sustainable yield as qualified by relevant environmental and economic factors…”(Part II Article 5 (b).) Whereas for non-target species it is - they must adopt measures for non-target species and dependent species with a view to maintaining or restoring their populations above levels at which their reproduction will not be seriously threatened (Article 10 c).

The objective should not be how you will achieve it, or what you will need to achieve it, and, most importantly, you need to be able to measure how you are performing against this objective.

The reasons for choosing the objective should also be recorded. This may be important when reviews of the system are undertaken in the future – if you write down why you chose something, it is easier to see if the reasons are still valid.

Indicators

The indicator is used to measure performance – are you achieving the operational objective? An indicator can be a direct measurement of performance (e.g. the level of spawning biomass as estimated from a stock assessment model) or a surrogate (e.g. catch rates as an indirect indicator for measuring the level of the spawning biomass).

In some cases a number of indicators can be used for the same objective to provide a greater degree of confidence in the result, particularly where none of these by themselves is considered particularly accurate. If more than one is used, however, it is better to determine before hand how they will be used together to track performance, particularly for situations where they may show different trends.

Performance Measures

The performance measures are used to describe what is, and what acceptable performance is not. For example the Convention states that the members of the Commission shall .. determine, on the basis of the best scientific information available, stock specific reference points and the actions to be taken if they are exceeded" (Article 6 (a)).

A performance measure (reference point) can take a number of forms and there may be more than one for a single indicator.

Specific value measures

- Limit reference points – the values below which management is trying avoid reaching (either exceeding or falling below, depending upon the issue); and
- Target reference points – the values which management is trying to reach
- A range of values
- A range of values within which performance is considered acceptable, outside of which performance would not be considered acceptable.
- A trend in values
- A positive trend could be good, but a negative trend would be bad (or the reverse – depending upon the issue and indicator).

Justification for Performance Measure Chosen

Similar to the operational objective, it is important to provide the reasons for choosing each of the levels/limits/trends that will be used to assess performance. This is a key decision in managing an issue because it will greatly affect the outcomes. Each of the reasons should be recorded including any assumptions based on - historical trends, results from similar fisheries elsewhere, scientific references etc. Recording these will help provide the basis for any review at some later date.

The operational objective, indicator and performance measure are a package. All three are needed before any one of them is useful. Indicators by themselves are of little value because without an objective and performance limit, you cannot interpret performance (Chesson, et al., 2000)

NOTE THE OBJECTIVE, INIDCATOR AND PERFROMANCE MEASURE ARE A PACKAGE - ALL THREE ARE NEEDED.

Evaluation

If data are available, how well is the fishery performing against the objective? Graphs such as that shown in Figure 15 can be a useful way of showing both the indicator and how it relates to the various performance measures.

There should also be a written description of the information and a definite statement about whether the current performance is acceptable or not.

Robustness

The evaluation could also include some discussion about the robustness of the current indicator/performance limit/evaluation package. This could involve either a textual description or possibly choosing a summary level (High, Medium, Low).

Management responses

This section describes the management needed to achieve the operational objective. This includes the current management arrangements, what is already proposed in the future, and what is the plan if the performance levels are triggered. The types of management actions should take particularly note of the level of information available and the reliability of the evaluation. These responses for target species are often now being packaged together and called harvest strategies.

Current
This should outline the current management arrangements that are already in place to maintain or improve performance and help you achieve the objective. There should be an explanation as to how each of the arrangements will assist performance.

Future
This is where you can outline any extra or different management arrangements that have been identified as a result of completing the risk assessment. Thus, these are those that will be in addition to, or instead of, the current arrangements. It is not necessary to merely repeat the current arrangements here.

If the Performance Measure/Limit is “exceeded”?

Finally it is important to outline the processes that will occur if an assessment shows that performance is not acceptable – i.e. one or more of the Performance Measures has been “exceeded”.

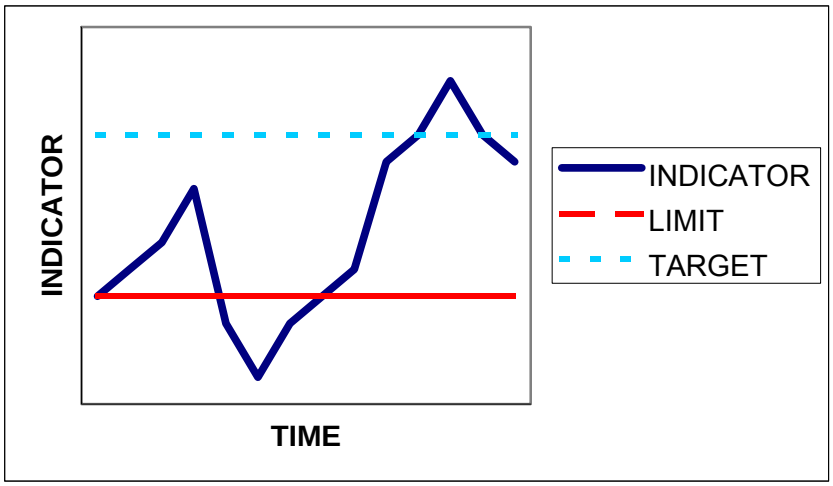
This is consistent with Article 6 part 3 of the Convention where it states that ... in the event they (the reference points) are exceeded members of the Commission shall, without delay, take the action determined under part 1(a) to restore the stocks.”

This process can range from initiating a review to determine the future actions that would occur, all the way through to having very clear, pre-defined management

actions that will occur. In general, the less accurate the indicator, the less likely it is that having preset harvest strategies can be used.

Review Cycle
The period for reviewing performance should be outlined. In most cases this will be an annual process, but it could be either shorter or longer depending upon the issue.

(a)



(b)

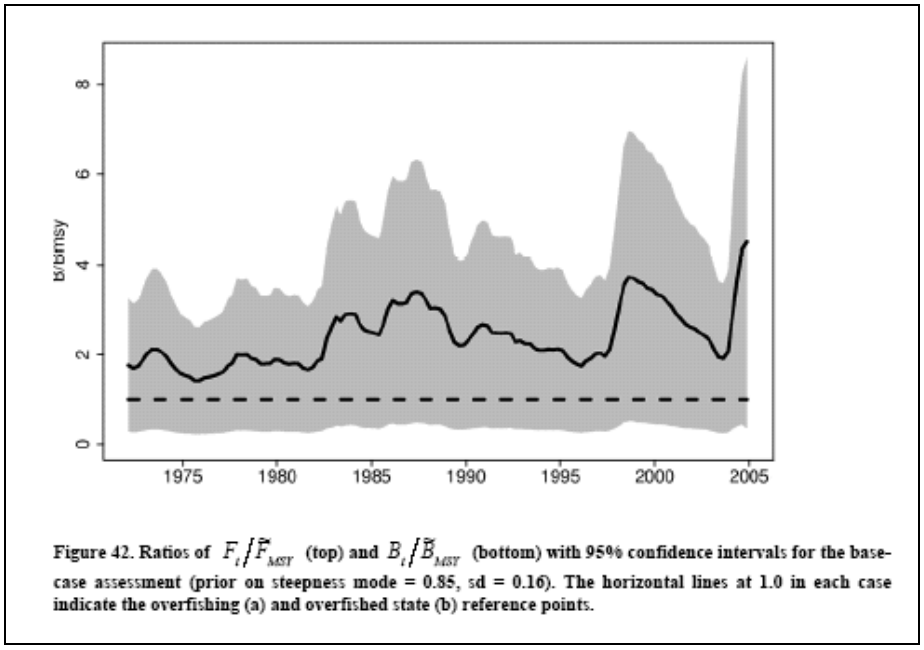


Figure 42. Ratios of $F_t/\tilde{F}_{MSY}$ (top) and $B_t/\tilde{B}_{MSY}$ (bottom) with 95% confidence intervals for the base-case assessment (prior on steepness mode = 0.85, sd = 0.16). The horizontal lines at 1.0 in each case indicate the overfishing (a) and overfished state (b) reference points.

Figure 15:
(a) The general relationship between indicators, target and limit reference points (from Fletcher et al., 2002)
(b) A real example for Skipjack Tuna in the WCPO fishery taken from Langley et al (2005) indicates the relationship between the indicator and a limit reference point (in this case when B = Bmsy i.e. = 1). If the solid line goes below 1 this would indicate overfishing had occurred.

Other Issues

This section is designed to enable any other factors, outside of the control of the fishery and the fishery management agency that could potentially affect this issue. These include natural environment effects but they can also include other human based effects such as the impact of urban runoff.

Thus Article 6 (6) of the Convention states that "If a natural phenomenon has a significant adverse impact… members.. shall…. adopt management measures to ensure that fishing does not exacerbate such impacts."

2.4.3 Example Reports

a) Example of a quick target species report for tuna at the WCPO level

Performance Report Heading	***Tuna* *4 Target Species* *(Skipjack, Yellowfin, Big eye, Albacore)* *WCPO Level***
1. Reason for inclusion	These are the management species in the WCPO Convention (Article 5). The specific risk assessments outcomes for these species can be based on Sustainability Viability or an Economic perspective. This alters the risks associated with these species dramatically.
2. Operational Objective (plus justification)	Sustainability of these species as qualified by environmental, economic and social factors
3. Indicators	S- Harvest levels in relation to Bmsy as measured using SPC based biomass stock assessments (multifan length based age structured model). E- Generation of fair and equitable economic benefits to all member countries.
4. Performance Measure/Limit plus (justification)	Harvest levels must be below that to achieve Bmsy (B/Bmsy > 1.0 for example, etc)
5. Evaluation	These are published regularly in the various SPC reports on each of the target species.
6. Robustness	Most precise estimates that can be achieved but there is a degree of uncertainty about the estimates.
7. Fisheries Management Response	
- Current	*Catch/Effort* There are currently a number of countries which have limits on total catch and or the level of effort (e.g. number of vessels) operating in region. *Allocation amongst countries*. Yet to be determined.
- Future	*Catch/Effort* Currently working on the decisions to determine the appropriate levels of catch and or effort for the region by species. "TACCC"

	Allocation Determine the process for allocation of relative access levels among countries within the commission.
- Actions if Performance Limit is exceeded	The commission needs to determine what action will be taken. This will be activated by the triggering of one or more of the above performance measures. This is yet to be determined
- Review Cycle	Annual assessments of YF and BE, and 2 years for SJ and Albacore
8. Other Issues	Fishing nations not 'member and cooperating non-members'. Climate and oceanography affect the fishery at the convention level but more so at the individual country level. Fishing from areas not controlled by the commission. Political instability Collaboration with other institutions (eg IATCC) – and non-fishing agencies/institutions.

b) Example of a By-product report – Sharks

Performance Report Heading	**Shark**
1. Reason for inclusion	Shark species are vulnerable. Their management is required under the FAO code of conduct for Responsible Fishing (IPOA-Sharks). A number of species are commonly caught.
2.Operational Objective (plus justification)	Maintain the catch of key shark species at historical levels and catch rates. If this is occurring then shark stocks should still be at acceptable levels.
3.Indicators	Monitor the CPUE and total catch by species
4. Performance Measure/Limit plus (justification)	Catch of species to remain in acceptable range not to exceed x tonnes. No declining trend in CPUE
5.Evaluation	Using observer based information to assess the catch and catch rates. This is assessed and reported to parliament and the WCPO commission at regular intervals.
6. Robustness	The CPUE trend for many species is acceptable, but discrepancy in data for lesser species due to identification problems.
7. Fisheries Management Response	
-Current	Catch/Effort limit: - Limited number of long line vessels are allowed to fish in this fishery and they are each only allowed to set a certain number of hooks per vessel per day -Fishing must remain outside of any Islands

	and reefs. -Tuna longline vessels are not allowed to use trace wire. -Catch must be landed in a home port before export
-Future	Given current evaluation, there will need to be a decrease in the number of vessels until sustainable TAC can be determined
-Actions if performance limit is exceeded	-Further reduce number of shark vessels potentially leading to a total ban on shark fining an even a total ban on shark fishing if things don't improve
-Review Cycle	After every two to three years-Need to get enough data.
8. Other Issues	Bycatch of shark in other fisheries, illegally targeted by other fisheries for shark fin. Environmental fluctuations.

c) Example of a Community Wellbeing Report - DEBT

Performance Report Heading	**Debt**
1. Reason for inclusion	Boats and licences are often bought using borrowed funds. This level of debt can lead to issues for the individual and the community in trying to service the debt and especially if there is risk of loan default.
2.Operational Objective (plus justification)	Encourage the use of business planning to ensure the sensible use of debt for the funding of fishing activities within this fishery .
3.Indicators	Number of boat/licence owners that go bankrupt. Level of turnover in boat/licences
4. Performance Measure/Limit plus (justification)	Minimal bankruptcies
5.Evaluation	Using observer based information to assess the catch and catch rates. This is assessed and reported to parliament and the WCPO commission at regular intervals.
7. Fisheries Management Response	
-Current	Provide advisory materials Provide training opportunities for business planning
-Future	Encourage the fishers to get advice Have other agencies aware of the possibility of this outcome.
-Actions if performance limit is exceeded	Work with other agencies to minimise impact of bankruptcy. Have staff aware of other assistance that is available to help those seriously affected.
8. Other Issues	Environmental fluctuations. Market Fluctuations Cost fluctuations - fuel

2.5 Step '5' – Developing Operational Systems to Implement the EAFM Report

2.5.1 INTRODUCTION

Having developed a set of management systems for each of the key issues associated with the fishery is a good starting point. To be useful however, these systems now need to be operationalised.

To operationalise these systems requires determining the specific activities that need to be done, who will do each of these and whether there are resources to undertake each of the identified tasks. This may sound trivial but ultimately it is the difference between making the management system that has been developed actually work or not and therefore generate the expected improved outcomes. This hopefully reduces the chances that the EAFM document and management system just being a nice document that gathers dust on a shelf - which all too often is the fate of major new initiatives.

Thus the operational framework has been defined as:

An operational framework based on the EAFM report to capture relevant current activities and identify additional activities, processes and resources that will be required to deliver the overall objectives of the tuna fishery.

The following section outlines the process that has been developed to assist in this process.

2.5.2 OPERATIONAL FRAMEWORK FOR EAFM

The following table outlines the set of headings that have been developed to help the process of making the EAFM management system operational. We have found it works best by making an Excel table with these headings as columns so that the material in the table can then be sorted easily by category, priority, person, issue, etc.

The process requires going through the EAFM Report, issue by issue and for those where a management system has been developed or where any actions are required determining precisely what activities, processes etc would need to be done for each of these to be implemented. For most issues there will be a number of different activities that will need to be done often involving multiple people or sections.

Operational Framework Headings

CATEGORY	DESCRIPTION
Issue	*The name of the issue*
Sub fishery	*If there are sub fisheries such as inshore, Artisanal, offshore etc. these can be identified here.*
Category	*What category of activity is this – e.g. Administration, Research, Monitoring, Compliance etc..*

Current Activities	*Are there already activities being undertaken?*
Current Resources	*What are the current resources available for this task*
Current Status	*What is the current status – ok, not ok?*
Regulations/ Notices /Condition/fines	*What legislation etc is needed for the activity/process to operate?*
New Activities	*Are there new activities needed to enable the management of the issue to occur?*
Additional Resources	*Are additional resources needed to undertake the new activites?*
Training	*Will this require training?*
Priority	*What overall priority does this activity have?*
Risk if not undertaken	*What is the risk if this activity is not done in the required timeframe?*
Timeframes	*What is the proposed timeframe for undertaking the activity?*

Categories of Activities – note these categories listed below can be adjusted (split, renamed or new categories) to suit the structure and activities of the relevant fisheries agency. Thus they are only presented as a starting point

CATEGORY	DESCRIPTION OF ACTIVITIES
Administration/Licensing	*Includes the collection of fees, issuing of licences and basic administration activities*
Compliance	*Those that determine if vessels/licenses are complying with their license conditions. This could include VMS activities, onboard inspections, patrol vessel activities, inspecting vessel logs. Validating catch reports etc.*
Consultation	*Those associated with consulting with industry, other stakeholders and other agencies*
Observers	*Those undertaken by onboard observers*
Onshore Monitoring	*Monitoring the catches in port.*
Other Agency	*Activities that agencies other than the fishery agency would need to undertake*
Ministry	*Things that the fisheries Minister or their office would need to undertake*
Policy/Management	*The development of policies, management plans*
Research	*Generation of assessments on the status of the stocks, or other information needed to make policy*
Training	*Training staff, industry etc*

2.5.3 METHODS FOR DEVELOPING THE OPERATIONAL PLAN

The following have been identified as suggestions in developing and filling in these operational frameworks.

1. First develop a check list of issues from the EAFM report to ensure they are all covered by the operational framework.
2. Keep potentially key issues (e.g. different species that use the same monitoring mechanism) separate until it is clear that the activities to address are identical- often there may be subtle but important differences. If they are

ultimately found to be fully covered by the one activity then they can be combined.

3. It may be necessary to have some separation of activities based on whether there are dealing with different functional components to the fishery – inshore, offshore, inside EEZ, high seas etc. Undertaking consultation, for instance, may need to be very different for these different groups and separate activities may therefore need to be generated.

4. Start with the most important issues identified as part of the EAFM, then move progressively to the least important.

5. The assignment of priorities and timelines should be undertaken by the relevant fisheries agency, in conjunction with any relevant advisory committee.

6. The process should also identify the activities that maybe outside the scope or jurisdiction of the fisheries agency. In these circumstances it may require advising other government departments of the issues they should be dealing with. Such interdepartmental governance issues are often a high risk area.

7. The process should also identify if there are any changes needed by the implementation or modification of legislation, regulations, licence conditions or policies. If so, these need to be scheduled in.

The only practical way to do this is by having a meeting with the consultant (e.g. the FFA expert) plus sufficient representatives from the fisheries agency that all parts of their operations are covered. Each issue is then discussed in detail and there is agreement about what would need to happen for the identified task to be completed.

It is vital that there is agreement by the fisheries agency about what activities are to be done and who will do this. Clearly, if they don't agree they won't do it! It is also absolutely necessary that there is an objective assessment of whether new tasks can actually be accommodated by the current level of resources. Again there is no point stating that something will be done if there are insufficient resources to do it. It is still useful to identify what must be done but it must also be documented that for this to occur more resources would be needed.

Given the size of most fisheries agencies in this region, it will be very common that there will be too few resources to undertake all the identified tasks. That is why it is very important to rate what priority each task should have, including those that are currently being undertaken, and what are the risks of something is not done. This may identify that some tasks that are currently being undertaken have a lower priority and risk level than some identified tasks that are not currently being done. Such situations may allow a shift in resources to occur.

3.0 Hints for developing appropriate objectives, indicators and performance measures etc.

3.1 Target Species

Objectives

A common objective for target species is:

*To maintain the spawning stock of {*insert species name here*} at or above an appropriate level that minimises the risk of recruitment overfishing.*

The WCPFC has the objective for target species to:

'maintain or restore stocks at level capable of producing maximum sustainable yield as qualified by relevant environmental and economic factors…"(Part II Article 5 (b))

The justification for the first objective relates to a normal fisheries management requirement to keep recruitment levels unaffected by a reduction in spawning stock. This does not mean that recruitment will necessarily be constant or high, just that it should only vary due to environmental factors – not from the impact of the fishery.

Meeting this objective should ensure sufficient spawning stock to continue recruitment at levels that will replenish that taken by fishing, predation and other environmental factors.

Depending upon the species and other issues, it may be required to have an objective that is more conservative than this (for example – if the decline in biomass that causes growth overfishing occurs before the level where recruitment overfishing occurs). There may be other economic or socially-based reasons for why this objective is not used, with either a more aggressive or more conservative approach taken. In either case, these would need to be justified. This may be the case where species is not the main target species but has a higher vulnerability – it may be agreed that this species can be 'overfished' to some degree. This degree would still need to be determined and justified.

Indicators

A variety of indicators that can be used to measure the performance of target species. A summary of these is presented in Table 9.

In general, the types of indicators and their robustness varies from relatively simple measures such as catch, to the use of sophisticated models that have estimates of actual spawning biomass derived from multiple fishery-dependent and independent inputs. There is a need to match the level of risk associated with the relative rate of exploitation with the types and quantities of data used to monitor performance (See Table 8). Where the risks (exploitation rate) are low, only crude indicators of performance are likely to be needed. Where the risks are higher and the management approach is more aggressive, leading to a relatively high exploitation rate, more robust and precise measures of abundance will be needed.

Table 8 Comparisons between the relative rates of exploitation of a stock and the different classes of indicators that could be used to measure performance.

Exploitation Rate/Risk	Likely Indicators/Performance Limits Required
LOW	Catch or Effort Only Crude (Catch Per Unit Effort - CPUE) (i.e. low robustness).
MODERATE	Reasonable CPUE, possibly some extra/occasional biological sampling (i.e. moderate robustness).
HIGH	Good CPUE &/or Fishery Independent Surveys, probably biological sampling - leading to estimates of biomass/exploitation rates (i.e. high robustness).

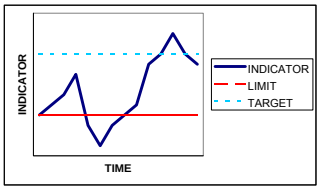
In completing the initial assessment for a fishery, where there is a mismatch between relative exploitation and the method of monitoring, there are two courses of action available. The level of exploitation may need to be reduced to a level commensurate to the data quality being collected. Alternatively, the level of data quality could be increased to an acceptable level. This decision on which of these is the most appropriate is likely to be based on the value of the fishery - can the fishery 'afford' to increase the level of monitoring or not?

Performance Measures

Possible performance measures are located in Table 9

Table 9. Variations on the objective-indicator-performance measure-management response package for abundance of target species (from Fletcher et al., 2003).

Objective	Indicator*	Performance measure*	Management responses	Comments
Maintain abundance so that it satisfies specified criteria over a given period of time. Criteria can be a combination one or more limits and/or targets.	Probability that criteria will be satisfied during the time period assuming a particular course of action. Probability can be estimated using a range of techniques. Does not necessarily	Probability must be greater than specified value, e.g. 0.9.	Select course of action, e.g. setting TAC/effort levels at regular intervals, so that required probability is achieved	Combines reporting and management response into a single, integrated process. Takes into account future as well as present stock status. Deals explicitly with uncertainty.

	require 'data rich' fishery.			
Maintain abundance so that it satisfies specified criteria. Criteria can be a combination one or more limits and/or targets.	Probability that current stock abundance satisfies criteria. Probability can be estimated using a range of techniques. Does not necessarily require 'data rich' fishery.	Probability must be greater than a specified value, e.g. 0.9.	If performance not satisfactory, take action to remedy situation, e.g. reduction in TAC, closures, effort controls. Switch to a rebuilding objective below.	Considers only current stock status for purpose of measuring performance. Deals explicitly with uncertainty.
	Estimate of stock abundance. Can be obtained from fishery-independent or fishery-dependent data using a range of techniques.	Abundance must satisfy criteria. If target is involved, could have the following form: 	If performance not satisfactory, take action to remedy situation, e.g. reduction in TAC, closures, effort controls. Switch to a rebuilding objective below.	Considers only current stock status for purpose of measuring performance. Does not deal explicitly with uncertainty.
Maintain abundance at current level.	Estimate of stock abundance relative to current level. Could use an indirect indicator such as catch rate in some cases.	Relative abundance must be sufficiently close to 1, i.e. no significant change. Could have following form:	If significant change then take action to remedy situation. Switch to a rebuilding objective below.	Special case of previous objective.
Return abundance to previous level within specified time. (Rebuilding	Probability that target will be achieved within specified time	Probability must be greater than a specified value, e.g. 0.9.	If performance not satisfactory, select a course of action that	Takes into account future as well as present stock status. Deals explicitly with

objective.)	assuming a particular course of action.		achieves required probability. If none, close fishery.	uncertainty.
Return abundance to previous level (Rebuilding objective.)	Estimate of stock abundance relative to previous level	Stock abundance should be increasing over time.	If stock abundance not increasing, take further action to remedy situation, including possible closure of fishery.	Considers only current trend in stock status for purpose of measuring performance. Does not deal explicitly with uncertainty.

3.2 Bycatch Species

Objectives

The types of objectives for bycatch species differ from the target species in that none are wanted to be caught. The question is whether the levels of removal are a real issue for the actual bycatch species, or whether the main impacts are generated from the discards they produce (i.e. provisioning) or whether the issue is largely socially driven community acceptance/wastage problems.

For some fisheries, the most practical objective is to reduce the levels of capture of non-retained species from the historical levels. For other fisheries, especially when dealing with threatened species, the total elimination of *all* capture may be the goal. Finally, for fisheries where the current levels are acceptable, the objective may merely be to avoid any future increases.

Consequently, the most common objectives developed for non-retained species so far are:

- *To minimise/decrease/eliminate the impact of the fishery on {insert name of species/group of species}.*
- *To maintain appropriately low levels of impact of the fishery on {insert name of species/group of species}.*

If it is largely a perception issue, or one only related to provisioning, then finding alternative markets for the species currently being dumped may be a sensible alternative. However, if it is because these species are being put at risk by the fishery, then the only alternative is to reduce/eliminate their capture in the first place. Finding alternative markets would probably exacerbate this problem.

Indicators

If the objective relates to a single species or a group of species then the indicator may need to be a direct measure of the levels of capture of these species.

Depending upon the species, the area of operation by the fishery compared to the area inhabited by the non-retained species may be a possibility to measure performance, with a justification that adequate refuge areas are available.

If the objective only relates to reducing a wastage problem or other perception issue, then processed based indicators relating to the percentage adoption of Bycatch Reduction Devices (BRDs), or some other fishing equipment based modification may be appropriate. These indicators are, however, unlikely to be appropriate in situations where the issue was related to specific concerns about one or more of the non-retained species.

Performance Measures

In general, precise performance measures for these objectives have not been developed so far. The most common form of limit/trigger used in the examples seen to date relate to using historical levels as the benchmark with some reduction on these levels used to gauge future performance. For example in some fisheries acceptable performance requires the amount of bycatch to be reduced to 40 per cent of current levels within five years.

Where there is specific concern about the stock status of a non-retained species, it is likely that a direct measure of their catch will be required and some threshold level of acceptable catch would need to be determined. This will be especially likely where 'icon' or highly threatened species are involved and would probably involve the use of observers.

3.3 Ecosystem Issues

Objectives

This is probably the least well understood element of this reporting system. Consequently, the types of objectives developed for the issues in this category are probably the least well developed of the most common objectives developed so far:

To maintain any impact on the wider ecosystem within acceptable levels.

To maintain appropriate levels of biomass of target and other by-product species to minimize any significant impact on the broader ecosystem

To maintain the spatial extent of the fishing activity to a comparatively small percentage of the habitat/community

Indicators

The type of indicators appropriate for these ecosystem issues includes:

Process/Pressure Indicators
- area trawled;
- effort levels;
- biomass reduction; and
- relative levels of biomass removed.

Direct Indicators

- Monitoring area of habitat; and
- Monitoring the community.

The latter group of indicators are only likely to be required if the impact of the activity is likely to be major and/or the fishery operates over a relatively wide area of the habitat (see Table 10). Precisely what can be measured beyond process/pressure-based indicators is not clear in most cases, except for the possibility to choose one or more 'indicator' species to measure overall performance.

The selection of these species would need to be justified. It is possible that the use of some multi-species analysis could be used, but this has not yet been seen in the completed studies to date.

Table 10 Comparison of impact versus likely management actions

Likely Level of Impact	Habitat interactions	Ecosystem Interactions
Low	Activity can occur across a large percentage of the area of the habitat	Stocks can be exploited to levels based only upon their own sustainability
Moderate	Activity may require some level of restriction in area	Consideration may need to be given to the level of exploitation on other species
High	Activity will need to be constrained to specific areas	Exploitation rate should be set based on avoiding major changes to other species or community structure

Performance Measures

Trophic Interactions/Biodiversity

Whilst much has been written in general about the need to maintain the ecosystem and have ecosystem-based management, there are few quantitative studies available upon which to base sensible performance measures for management. This is most notable in trophic level interactions, where studies in this area show that interactions of this kind are usually non-linear and vary greatly amongst systems and species within a system. Thus, there is no precise 'state' that an ecosystem should be at, as natural systems vary (particularly the individual components) even without any human 'assistance'.

Of note is that there are very few examples of strong trophic interactions leading to major changes in function (see Jennings & Kaiser, 1998 for review)[4]. Moreover, there are no examples of a fishery impacting indirectly on other trophic levels where the *initial* stocks targeted by the fishery are still in good shape.

The decision tree that could be used to assist in whether there is a high likelihood of interactions includes:

[4] Jennings & Kaiser (1998) *Adv. Mar. Sci*. 34:203-352

- Is there a single apical or keystone predator?
- Is there a keystone grazer in the system?
- Is there evidence or even a reasonable suspicion that strong interactions may be occurring in this system?
- Are there only one or two species within the affected trophic levels?

If all the answers to the above questions are "no", then it *may* be possible to argue that the mere maintenance of reasonable levels of the harvested species should be sufficient to maintain general ecosystem function.

If the answer to one or more of these is "yes", then there may be a need to directly monitor other elements of the ecosystem. Further, the level of reduction in target stocks may need to be set with this in mind – particularly with respect to minimising the risk of stock collapse.

Benthic Impacts

We have a reasonable understanding of the physical impacts of most fishing methods. A number of good reviews are available to start the analysis of what is likely to be acceptable or not. The most valuable of these is the review by Jennings & Kaiser (1998) and there are also a number of more recent publications such as the Meta-analyses done by Collie et al (2000)[5], which could be most helpful. As a general rule of thumb, the more destructive the fishing method, the smaller the area that it should be allowed to operate (see Table 10).

The most logical approach to deal with these issues is to limit the area of fishing such that it is unnecessary to have detailed monitoring within the area affected (see below for example).

3.4 Social and Economic Issues

Objectives – 'Preferred Outcomes'

The decision to directly get involved in setting specific objectives for socio-economic elements will vary amongst different countries. This is usually a reflection that most community level objectives are set by the government and fisheries agencies may only play one part of the achievement of adequate performance.

The types of objectives that have been suggested include:
- Minimise the negative community impacts of fishery management decisions (and maximise the positive impacts).
- To have a safe and healthy work practices that minimise deaths and injuries of persons involved in the fishing activity.
- Maximise/optimise net economic return from the fishery.

However, in many cases, a desirable outcome rather than an actual objective was identified. This includes recognition of the broader benefits to the community from having the fishery – such as increased sea-rescue readiness provided by the presence of the fishing fleet - rather than this being a specific objective of the fishery.

A number of comprehensive reports have recently been completed that outline how to go about collecting socio-economic data for fisheries (Hundloe, 2002, 2005;

[5] Collie et al. (2000) *J. anim. Ecol*. 69:785-798

Schirmer & Casey, 2005). A summary of the possible indicators is presented below in Table 11.

Table 11 Possible Socio-economic objectives, indicators and data requirements (from Fletcher et al., 2003).

Component	Objective	Indicator(performance measures)	Data requirements
Effects of fishery on communities ▪ Indigenous ▪ Economic	Maintain or increase jobs, profits and flow-on benefits to the community	Direct and flow-on contributions to the region	Regional input-output analysis done periodically (e.g. 10 years)
▪ Social ▪ Social capital	Maintain or increase the contribution the fishery makes to social capital at the local scale	Indicator not developed	Interaction of fishers, their families and people in closely-related industries (e.g. boat building) in local social fabric. One-off survey required.
▪ Employment	Maintain or increase regional/local employment in the fishery and related industries	Employment in the harvesting and processing sectors, and flow-on employment in other industries	Employment numbers
▪ Regional industry	Maintain or improve local/regional attitudes to the fishery	Positive and negative feelings to the fishery	Attitudinal surveys done occasionally. Ad hoc media comments
Effects of fishery on industry participants ▪ Economic	Maintain or increase income to fishers	Net income	See above: economic survey data plus employment data
▪ Social ▪ Health	Reduce death and accidents rate for fishers	No greater than National average for work-related injuries	Injury data from relevant government authority
▪ Lifestyle benefits and costs	Maintain or improve lifestyle for fishers	Indicator not developed	
Effects of fishery on national economic wellbeing	Maintain or increase the contribution of the fishery to the national economy	Net economic return for the fishery. (Achieving MEY)	Economic survey data gathered periodically (e.g. 5 years)
Import replacement	Maintain or increase the proportion of domestically-harvested fish	Consumption per capita of local seafood. To achieve at least an average consumption level of 6kg of locally-	Consumption surveys

	consumed	harvested seafood.	
Distribution of benefits	Equitable distribution of benefits to fishers	Indicator not developed	
Social ▪ Health benefits/risks seafood eaten	Improve human health/nutrition by increasing fish consumption	Consumption per capita of local seafood	Consumption surveys
▪ Seafood quality	Ensure seafood meets food safety requirements	Food safety reports	Food safety reports

3.5 Administration and Governance

Management Plans

The report on this aspect of governance should discuss the comprehensiveness of the management arrangements developed for the fishery. This can be done in terms of what elements are currently contained within the current management plan (or other formal arrangement) of the fishery against what be deemed 'best practice" arrangements.

A series of 10 points covering the possible elements that could be presented in a management plan are listed below, but each jurisdiction must determine, based on their legislation, what their 'best practice' management plan would contain and then report against these criteria for the fishery being examined.

The suggested list of management arrangements that make up 'best practice' for a fishery should contain:

1. An explicit description of the management unit.
2. The issues addressed by the plan.
3. Descriptions of the stocks, their habitat and the fishing activities.
4. Clear operational (measurable) objectives and their associated performance measures and indicators.
5. Clearly defined rules, including what actions are to be taken if performance measures are triggered.
6. Economic and social characteristics of the groups involved in the fishery.
7. Management and regulatory details for the implementation of the actual management plan.
8. The reporting and assessment arrangements.
9. How and when reviews of the plan will occur (including consultation mechanisms).
10. A synopsis of how each of the ESD issues is being addressed.

The possible objective and justification for this component are:

Objective - In consultation with the relevant industry groups and other relevant stakeholders, periodically review the management plan, related legislation, regulations and arrangements to ensure they remains relevant and aligned with the

fishery's management objectives and that collectively they cover as many of the 10 main principles as possible.

Justification - To have an effective and understandable plan for the management of this fishery, all 10 principles need to be covered within the suite of arrangements developed for the fishery.

Compliance

The success of any set of management arrangements depends upon how well they are complied with. Consequently, there needs to be some assessment of this issue within each fishery and any related fisheries.

The reports on this issue could provide the opportunity to discuss the current levels of compliance with the management arrangements. These could either involve purely qualitative assessments, but preferably there should be some move to include quantitative data on rates of non-compliance.

Consultation

This report should describe all the formal, or semi-formal, consultation processes that are used to assist in the effective management of the fishery. Thus, it should describe how management plans are developed and amended – who is involved in these discussions, how do they find out about the issues and how do they have their inputs included.

There should also be a description of how ongoing management occurs – is there an 'Advisory Committee'? If so, what are their terms of reference, which sectors are represented, and who appoints them, etc?

Reporting

What are the normal reporting arrangements for the fishery? It is important that the outcomes of the management processes administered by the fisheries department/agency are available for review by external parties. It is also important that the community is sufficiently informed on the status of the fishery, given that it is utilising a community resource.

The reports that may be provided on a regular basis include:

- Specific mention in the fisheries department/agency's Annual Report
- Publishing an annual status report of each fishery
- Less regular reports, possibly associated with some proposed change to management.
- Some jurisdictions also need to provide information to other departments for auditing purposes
- All information should, in most circumstances, be lodged on the relevant fisheries department/agency website, in addition to being distributed directly to the main stakeholder groups

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Appendix 1 – Details of Consequence Tables for Risk Assessment

Table A1 Consequence categories for the Major Target/Vulnerable species (modified from Fletcher et al., 2002)

Level	Ecological (Target/Vulnerable Species)
Minor (1)	Either not detectable against background variability for this population; or if detectable, minimal impact on population size and none on dynamics. Spawning biomass 100% - 70% unfished levels
Moderate (2)	Fishery operating at, or close to, full exploitation rate such that the long-term recruitment/dynamics are not being adversely impacted. Spawning Biomass < 70% - B_{msy}
Major (3)	Stock has been reduced to levels that are now directly affecting future recruitment levels or severely affecting their capacity to increase from a depleted state (i.e. recruitment overfishing). Spawning Biomass < B_{msy} - 5 %
Extreme (4)	Stock size and recruitment levels reduced to an extent that local extinctions or significant species range contraction > 50% have occurred. If it continues it would require listing in an appropriate endangered IUCN category and extinctions could result. Spawning Biomass < 5%

Table A2 Consequence categories for the By-Product Species/Minor bycatch species

Level	Ecological (By-product/General Bycatch)
Minor (1)	Take in this fishery is small (< 10%), compared to total take by all fisheries and these species are covered explicitly elsewhere. Take and area of capture by this fishery is small, compared to known area of distribution (< 20%).
Moderate (2)	Relative area of, or susceptibility to capture is suspected to be less than 50% and species do not have vulnerable life history traits.
Major (3)	No information is available on the relative area or susceptibility to capture or on the vulnerability of life history traits of this type of species Relative levels of capture/susceptibility suspected/known to be greater than 50% and species should be examined explicitly
Extreme (4)	N/A Once a consequence reaches this point it should be examined using Table A1.

Table A3 Consequence levels for the impact of a fishery on the general ecosystem/trophic levels.

Level	Ecological (ECOSYSTEM)
Minor (1)	Interactions may be occurring but it is unlikely that there would be any change outside of natural variation. The captured species do not play a keystone role – only minor changes in relative abundance of other constituents.
Moderate (2)	Measurable changes to the ecosystem components without there being a major change in function. (i.e. no loss of components).
Major (3)	Ecosystem function altered measurably and some function or components are locally missing/declining/increasing &/or allowed new species to appear. Recovery measured in years to decade.
Extreme (4)	An extreme change to ecosystem structure and function. Different dynamics now occur with different species/groups now the major targets of capture. Total collapse of ecosystem processes. Long-term recovery period may be greater than decades

Table A4 Suggested consequence levels for the impacts on habitats. (Three levels – standard, fragile, critical)

Level	Ecological (HABITAT)
Minor (1)	Insignificant or barely measurable impacts on habitat(s) but these are very localised compared to total habitat area. *(Suggestion – these impacts could be < 5%; < 3%; <2%) of the original area of habitat)*
Moderate (2)	There are likely to be more widespread impacts on the habitat but the levels are still considerable acceptable given the % of area affected, the types of impact occurring and the recovery capacity of the habitat *(Suggestion – for impact on non-fragile habitats this may be up to 50% [similar to population dynamics theory] - but for more fragile habitats, to stay in this category the percentage area affected may need to be smaller, e.g. 20% and for critical habitats less than 5%)*
Major (3)	The level of impact on habitats may be larger than is sensible to ensure that the habitat will not be able to recover adequately, or it will cause strong downstream effects from loss of function. *(Suggestion - Where the activity makes a significant impact in the area affected and the area > 25 - 50% [based on recovery rates] of habitat is being removed; whilst for critical habitats this would be < 10%)*
Extreme (4)	Too much of the habitat is being affected, which may endanger its long-term survival and result in severe changes to ecosystem function and the entire habitat is in danger of being affected in a major way/removed. *(Suggestion this may equate to 70 - 90% of the habitat being affected or removed by the activity; for more fragile habitats this would be > 30% and for critical habitats 10-20%)*

Table A5 Suggested consequence levels for economic outcomes.

Level	Economic
Minor (1)	Possible detectable, but no real impact on the economic pathways for the industry or the community.
Moderate (2)	Some level of reduction for a major fishery or a large reduction in a small fishery that the community is not dependent upon.
Major (3)	Fishery/industry has declined significantly in economic generation and this will have clear flow on effects to other parts of the community. May result sin some level of political intervention.
Extreme (4)	Total collapse of any economic activity coming from what was an industry that the community derived a significant level of their income or employment (resource dependency), including possible debts. High levels of political intervention likely.

Table A6 Suggested consequence levels for social disruptions.

Level	Social Implications
Minor (1)	None, or not measurable. Includes situations where there is no direct involvement by a community in the fishery.
Moderate (2)	Some direct impacts on social structures but not to the point where local communities are threatened or social dislocations will occur
Major (3)	Severe impacts on social structures, at least at a local level.
Extreme (4)	Changes will cause a complete alteration to some social structures that are present within a region of a country

Table A7 Suggested consequence levels for food security.

Level	Food Security
Minor (1)	None, or not measurable. Includes situations where there is no direct impact on the resources used by a community.
Moderate (2)	Some direct impacts on food resources of a community but not to the point where these are threatened.
Major (3)	Severe impacts on food resources of a community. Likely to lead to a level of health problems
Extreme (4)	Changes will cause a complete loss of some food resources that are present within a region of a country leading to starvation and or abandonment of region or requiring aid.