How to Manage A Fishery

A simple guide to writing a Fishery Management Plan

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Contents

Preface

Who is this guide for?

This guide is one of a two-part set written to help fishery managers and those involved in fishery management.

These two guides should be used as a pair to show how managers and scientists (and any co-management partners) need to work together to manage a fishery

- This 'Managers Guide' describes a simple, step by step process for writing and implementing a fishery management plan.
- The companion 'Stock Assessment Guide' shows how stock assessment tools can support fishery managers in designing their management plans and in managing the fishery. In particular, it refers to those stock assessment tools developed under the Fisheries Management Science Programme (FMSP).

These guides have been written for those with a responsibility for monitoring, assessing and managing fish stocks. The aim is to help better collection and use of fisheries data and to support fishery managers in using these data to creatme better management plans.

What is the purpose of the guide?

The purpose of this Managers Guide is to describe a step by step approach to the development of an effective fishery management plan. The guide has a number of distinctive features:

- It is aimed at busy fisheries managers - so we have kept it short and tried to make it easy to read.
- It focuses on the need for stock assessment scientists to provide fishery managers with better information about their fish stocks to allow good management plans to be written and action taken.
- It emphasises the need to be able to predict the impact of different management measures through using specific stock assessment tools.
- It stresses the importance of fishery managers working closely with those responsible for data collection, monitoring and data analysis.
- It provides examples of recently developed tools that will allow stock assessment personnel to make good estimates of fish stocks.

This guide and the complementary Stock Assessment Guide have been written to help fishery managers use the tools developed by the FMSP to

improve the management of their fish stocks. The management planning processes recommended are generally compatible with the management framework currently promoted by FAO in the Code of Conduct for Responsible Fisheries and the UN Fish Stocks Agreement. However, in a number of places we have tried to make the process shorter and simpler. Both guides, like the Code of Conduct, stress the need for participation and for proactive and precautionary management in the face of uncertainty.

The processes in this guide are generally compatible with the FAO Code of Conduct for Responsible Fisheries and the UN Fish Stocks Agreement

The guide can be read and used on its own. However, there are other publications that you may find useful when preparing and implementing your plan. These include:

- The Stock Assessment Guide or 'SA Guide' - the partner book to this guide.
- Publications produced by the United Nation's Food and Agriculture Organisation (FAO) such as the FAO Code of Conduct for Responsible Fisheries, the series of Technical Guidelines for Responsible Fisheries, and FAO Fisheries Technical Paper 424 - A Fishery Managers Guidebook.
- Detailed guidance on the use of the FMSP tools, recently published as FAO Fisheries Technical Paper (FTP) 487 (Hoggarth et al., 2005). This document and the other FAO documents are available on the FAO web site.
- Outputs from other FMSP projects, especially the guidelines for adaptive management produced by project R8292 (see http://www.adaptivelearning.info/); and the guidelines for data collection produced by project R8462 (see http://www.fmsp.org.uk/r8462.htm).

These publications are referenced along with some others at the end of this guide. We recommend that you have them available during the writing of your management plan.

Who has written the guide?

This guide is one of the outputs of the Fisheries Management Science Programme (FMSP see http://www.fmsp.org.uk). The FMSP was established by the UK Government's Department for International Development (DFID) to generate improved livelihood benefits for poor people through the application of new knowledge about fishery management. Since 1992, the FMSP has produced a series of outputs about the assessment and management of fish stocks. These range from new methodologies and

software for assessing fish stocks and providing guidance to fishery managers, to applied research on specific country fisheries. This guide has been written by a team from the United Kingdom, India and the Caribbean and has also been read and tested by practising fishery managers in India.

What are the steps in developing a management plan?

The guide is structured around a process of writing a management plan for a fishery. The four main phases in developing the plan are illustrated in Figure 1. The detailed stages involved in each of the four phases are outlined in Table 1. This guide will take you through each of these phases and stages step by step.

This guide will take you through each of these phases step by step

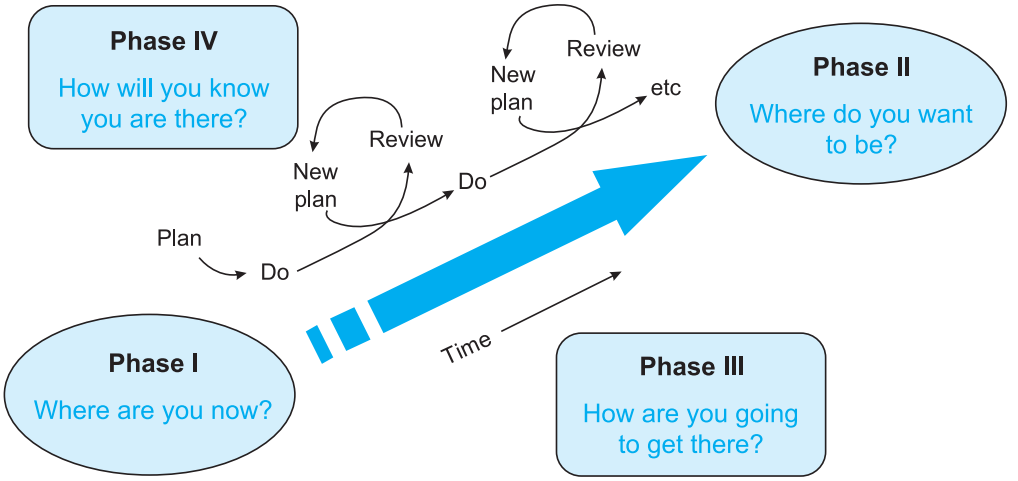


Figure 1. The four main phases in writing a fishery management plan.

Table 1. Phases and stages in the process of developing a fishery management plan

Phase	Stage	
I. Preparation for developing the management plan **Where are you Now?**	***1***	**Define** Define the fishery your management plan is for
	2	**Stakeholder analysis** Carry out a stakeholder analysis and decide how you are going to involve the stakeholders
	3	**Situation analysis** Carry out a situation analysis and list the problems faced by your fishery
	4	**Management approach** Decide on your management approach
II. Developing the management plan **Where do you want to be?**	***5***	**Purpose** Agree the overall purpose of your plan
	6	**Goals** Decide on the biological, ecological, social and economic goals needed to achieve your purpose
	7	**Objectives** Define objectives for each goal
	8	**Management standards** Agree the management standards – the reference points and indicators for each objective. In other words – what and how you are going to measure to show that you are achieving your objectives
III. Developing the management plan **How are you going to get there?**	***9***	**Management measures** Decide the management measures – in other words,the actions - you are going to take to achieve the objectives
	10	**Control rules** Agree a set of decision control rules stating which measures and which levels of measures will be applied depending on the status of the fishery
	11	**Resources** Decide what resources you will need to put your plan into action
IV. Planning to implement, evaluate and review the management plan **How will you know you are there?**	***12***	**Implementation** Make an action plan to implement your management plan
	13	**Monitoring** Monitor regularly how well your plan is achieving your objectives
	14	**Reviewing** Review your plan every few years

Writing a management plan is really more of a spiral process than a linear one.

It is important to emphasise right at the start of the process that writing a management plan is usually not the neat step by step process suggested by Table 1. You will often have to go back by a stage or two and review your ideas in the light of decisions you make at a later stage. This is especially true at certain stages, as shown in the example arrows in Figure 2. For example, you might have to reconsider the definition of your fishery after you have done the stakeholder and situation analysis. When you consider the management standards (indicators and reference points) in Stage 8, this might also cause you to go back and rethink your goals and objectives.

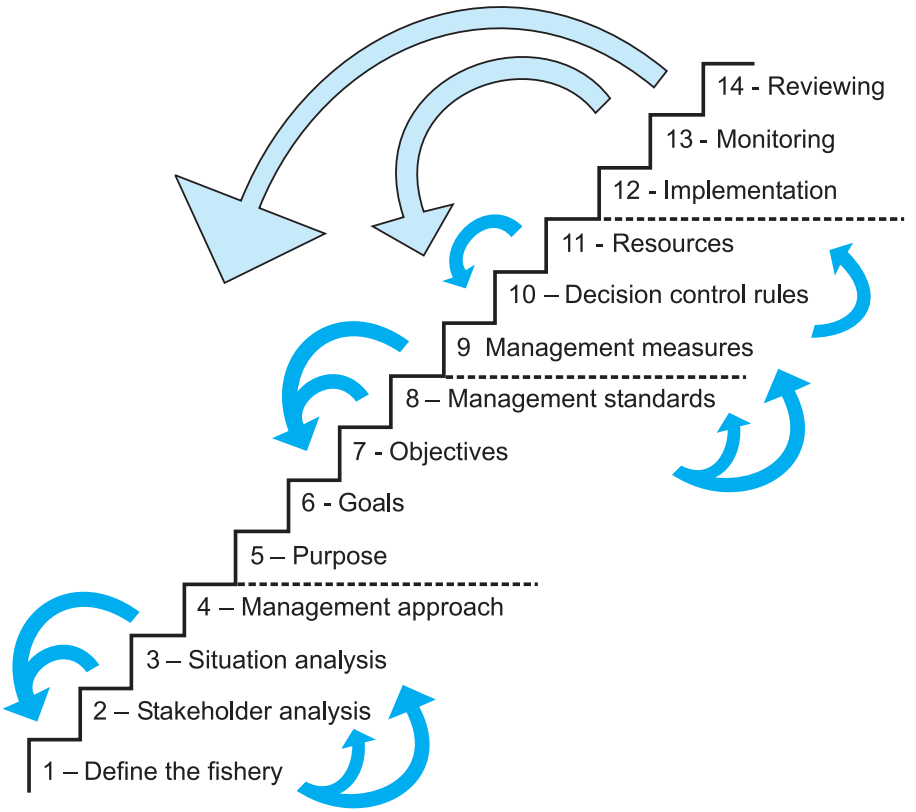


Figure 2. Illustration of management planning as a cyclic process.

In designing the plan, you will need to think ahead quite often, and you will also need to go back at times to review and revise an earlier stage. Places where this may occur are shown by the solid blue arrows. In the implementation stages, as shown by the light shaded arrows, the management measures may also need to be adjusted based on the monitoring process, and the whole plan may need to be revised occasionally based on the reviewing process.

The role of stock assessment in management planning

One distinctive feature of the approach to developing a management plan recommended in this guide is an emphasis on the role of stock assessment tools.

Fishery managers and scientists should meet regularly to develop the management plan

Stock assessment tools (SA tools) are ways of calculating different properties of your fish stocks. You can then use them to help make decisions about different management actions. SA tools are introduced in detail in the companion Stock Assessment Guide. They often involve mathematical models and use the data that are collected by your fisheries officers. If this sounds complicated, don't worry. As a fisheries manager you don't need to know exactly how these tools work – unless you want to. This is the job of your fisheries scientists. However, what you do have to know is that these tools can provide very useful (if not 'essential') information that you can use in management – and you have to know the kinds of questions that you should be asking your fisheries officers.

Table 2 below shows the information that your fisheries scientists should provide you with at different stages in the management planning process. It also shows the information that you need to provide to the scientists to guide their work. Fishery managers and scientists should be meeting on a regular basis during the development of a management plan to exchange information and ideas.

Table 2. Flows of information between the fishery managers and the stock assessment scientists or advisors

Information that the fishery managers need to provide to fishery scientists	Phase	Stage		Information required by managers from fisheries scientists
Decision on what fishery the plan is for	*I*	*1*	**Define the fishery**	The unit stock for the target fishery based on the of distribution fish stocks and fishing activities.
Stakeholders to be consulted		*2*	**Stakeholder Analysis**	Information on the distribution of the fishers etc engaged in the fishery.
		3	**Situation Analysis**	Historical data on fishin geffort and fish catch etc, showing fishery trends.
Approach to precaution and uncertainty		*4*	**Management Approach**	Pros and cons of alternative approaches to decision making, allowing for uncertainty.

Objectives for each goal	*II*	*5* *6* *7* *8*	**Purpose** **Goals** **Objectives** **Management standards**	Suggest what indicators and reference points could be used as targets or limits to measure progress towards each objective – noting the feasibility and cost implications of any SA involved with each.
Which management measures are seen as socially, politically and technically feasible for this fishery	*III*	*9*	**Management measures**	Strategic advice on the expected impact on the indicators of alternative possible management measures, and alternative levels of any control measures.
Approach to uncertainty and degree of risk tolerance		*10*	**Control Rules**	Estimates of uncertainty in the indicators and reference points, and suggested precautionary adjustments to reference points to allow for risk and uncertainty.
Resources available for monitoring		*11*	**Resources**	What resources are needed for effective stock assessment?
	IV	*12*	**Implement**	
		13	**Monitoring**	Tactical advice updating the estimate of the selected indicators – this is usually done each year – for comparison with the reference points and guiding management actions as agreed in the control rules.
		14	**Reviewing**	Up-dated stock assessment advice allowing for the latest data from the fishery and any changes in the goals and situation.

It is difficult to write a guide to developing a management plan. The danger is that the guide can be too theoretical. We have tried to avoid this and we would strongly recommend that you read at least one example of a management plan from another fishery to give you an idea of what a management plan looks like. We have given a few web references, and some of the plans are quite short.

We recommend that you read some existing management plans to get ideas

Finally, two words of caution at the end of this section of the guide.

Nearly all management plans use different structures and terms. You will find quite a range of terms in the plans we have referenced and you will notice that some management plans use different terms to those that we use in this guide. This can be quite confusing and where different words are used in examples, we have tried to point this out. The main thing to remember is that no matter what you call the different components of your plan, you should have a structured approach that shows *what* you propose to do, and *why*.

The main thing to remember in management planning is to have a structured approach that shows what you plan to do and why

Secondly, in technical fisheries management books you will find a lot of mathematical formulae. These can also be confusing if you are not used to reading them and working in that way. In this Managers Guide we have not used formulae to any great extent – except in the case of a few examples. We have left this for the stock assessment experts in your team. More details are available in the SA Guide and in the other FMSP manual published as 'FTP 487' (Hoggarth *et al*., 2005).

Introduction

Why are management plans needed?

Management plans are needed for a number of very simple reasons. Just consider these facts. They all come from the FAO document "The State of World Fisheries 2004", available on the FAO web site.

- Fish provide 2.6 billion people – around 40% of the world's population – with at least 20% of their average animal protein;
- The world's population is increasing faster than the total food fish supply;
- Capture fisheries are declining and aquaculture fisheries growing;
- Of the worlds fisheries:
  50% are fully exploited – there is no opportunity for catching more fish;
  25% are over exploited, depleted or recovering – this figure has risen from 10% in 1974; and
  25% are underexploited or moderately exploited – this figure has fallen from 40% in 1974;
- 97% of people who rely on fishing for income or food are found in developing countries;
- 50% of world fish catches are caught by small scale fishers.

The world's fish stocks are being increasingly overexploited

Good management is needed to sustain fishing livelihoods now and for the future

At a global scale, many fisheries are in trouble. We need to manage these fisheries more carefully to reverse the current downward trend and to sustain fish production into the future. Fish populations are less resilient than we once imagined, and the recovery of populations once over fished can be much slower than we once thought. Firm actions towards good management are needed now.

Improved fishery management will have a big impact on our ability to achieve the Millennium Development Goals, especially to reduce by half the proportion of the human population that suffers from hunger and malnutrition, and to ensure environmental sustainability. Our response must be to manage our fisheries better – to ensure that fish stocks are sustainable and to ensure that people who depend on fish for food and livelihoods continue to get these important benefits.

What is a sustainable fishery?

Fishing can be said to be sustainable when it can be carried out over the long-term at an acceptable level of biological and economic productivity, without leading to ecological changes that reduce options for future generations. If there is too much fishing, the fishery will produce less than its maximum potential. If this continues for too long, the fishery may decline to the point of collapse. For simple discussions on the relationships between fishing and catches, see Section 2.1 of the SA Guide, and 'Concept 2 – Fish Stock Dynamics' of the ParFish Guidelines produced by FMSP Project R8397 (see http://www.fmsp.org.uk/r8464.htm).

Although most parts of the world's oceans are covered by different agreements to promote sustainable management, many fisheries in developing countries are either not managed, or are managed with only basic regulations and without any real assessment of the status of fish stocks. Many fisheries appear to be managed with short term economic and social goals as the top priority with the result that these fisheries are at serious risk of losing the many benefits they should provide. In managing a fishery sustainably, we need to consider three components – ecological, social and economic. Each of these must complement each other for the system as a whole to be sustainable.

What is a management plan?

Putting it simply, a fishery management plan is a document that:

- Analyzes the *current situation* in a fishery;
- Sets out some *principles* that should be followed in management;
- Details *goals and objectives* for the fishery;
- Says how they are to be *achieved*; and
- Says how they are to be *monitored*.

The best management plans follow the KISS principle – Keep It Short and Simple!

The best management plans follow the KISS principle - Keep It Short and Simple! As an example, the Canadian plan for Atlantic Mackerel given in Box 1 is only around 16 pages long, excluding the appendices. Although to some extent the length of your management plan will depend on the complexity of your fishery it is well worth remembering that long management plans are rarely necessary. Successful management plans are working documents constantly referred to by fishery managers and open to changes in the future.

e.g.

Box 1. An example table of contents for a fishery management plan
The Integrated Fisheries Management Plan for Atlantic Mackerel

(see http://www.dfo-mpo.gc.ca/communic/fish_man/mackerel/mpam_e.htm).

1. Introduction – 0.5 page
2. Biological synopsis – 2.5 pages
3. Overview of the Fishery – 3 pages
4. Stock Status – 4 pages
5. Current Management Issues – 0.25 page
6. Long Term Objectives for the Fishery – 0.25 page
7. Specific Management Objectives – 1 page
8. Management Measures – 1 page
9. Enforcement Measures – 1.5 pages
10. Financial Responsibilities – 0.25 page

For another example, see the fishery management plan for the Queen Conch resources of Puerto Rico and the U.S. Virgin Islands (http://www.caribbeanfmc.com/qconch%20plan.htm). Lists of possible topics for inclusion in a fishery management plan are also given by FAO (1997, see Table 4) and by Die (2002). You might even use the 'phases' and 'stages' in our management planning process as the basis for the 'chapters' and 'sections' in your management plan.

e.g. If you start looking in different books about management planning, you will find many different ways of writing management plans. As we said earlier, this can be quite confusing. Our approach to writing a management plan suggested in this guide has deliberately been kept simple, not only to make it easier to follow, but because complex structures are not needed. When writing your management plan we encourage you to have the confidence to try out ideas and be flexible. If something doesn't work for you, don't worry, just try another approach. Models are meant to be adapted.

How do you start to write a management plan?

Firstly, writing a fishery management plan has to be initiated by a fishery management authority or other responsible body. A management plan is a formal policy document and usually must be formally approved. Writing a management plan is not a one man show but will require

Writing a management plan will require enthusiasm, commitment and practical support

enthusiasm, commitment and practical support both from the senior management levels and from the grass roots.

Secondly, the fishery management authority has to be convinced that having a management plan is important and that it will improve the management of the fishery. Management plans should be actively used documents, and are not only just for fisheries that are in trouble. We encourage the proactive and precautionary management of fisheries, as guided by the FAO Code of Conduct for Responsible Fisheries. You won't know if you are making the most of your fishery until you have a management plan that defines its goals and guides how they are to be achieved.

The first steps – setting up a management planning team

One of the first steps to take after being given the green light is to set up a fishery management planning team. The people on this team should be nominated by your senior managers and should have the authority from them to create the management plan. You should set up a system for communication so that your senior managers are kept informed of the progress. The members of this management planning team should all be committed to the importance of management planning and should be given the time to participate in the work of the team. The team should also have the 'right' people on it – those who can get things done.

Membership of the management planning team will vary from fishery to fishery, but the process should be managed by a senior manager and the team should include good stakeholder representation. When putting together your management team it will be important to review the capacity of your fisheries organisation and to ask questions such as:

- Are there people in your organisation who can help write the plan?
- Do you need any training to write the plan - for example in data collection?
- Do you have the resources in your department to write the plan – and if not…
- Where could you get them from?

You might need some outside help in this process.

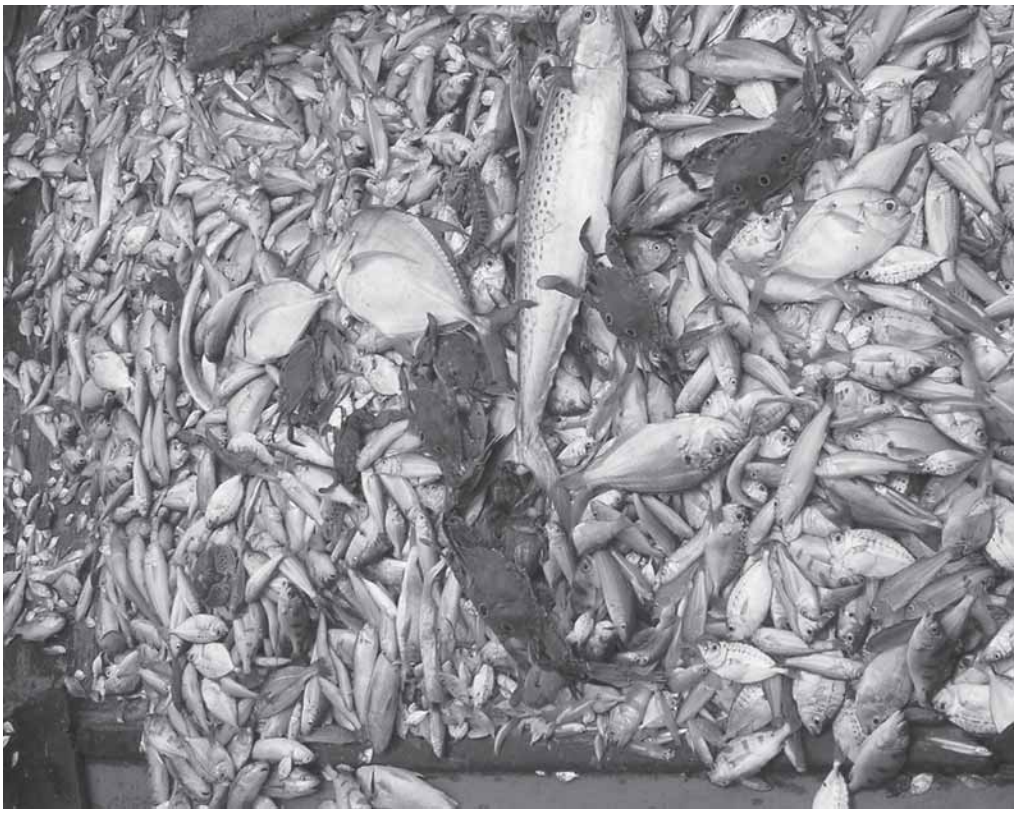
The first steps - making sure you have the data

If you are going to create an effective and workable management plan, then it will have to be based on the best available data. Most fisheries agencies collect some data about the nature of their fish stocks. A representative of the

team that collects and analyses fishery data should be on the management planning team. You should find out what data they have, and if they don't have the data you need, systems should be set up to collect them.

Because of the importance of making decisions based on data, the SA Guide pays more attention to the types of data that can be collected and the tools that can be used to analyse data and provide management advice. Those steps in the management planning process that involve stock assessment tools and fishery data are noted in each of the following sections.

The companion SA Guide describes the types of data needed to provide fishery management advice



The first steps – getting key stakeholders on board

We describe the possible roles of stakeholders and how to involve them in the management planning process in some detail in the next chapter. Before we get there, there are two groups of stakeholders that you should consider getting involved before you even start to write your management plan.

Firstly, it is important to involve other departments of local and state administration that have an impact on your fishery. This is because:

- you might need to get information from them to include in your situation analysis;
- the actions you recommend in your management plan might have an effect on what they are managing; and
- the management plans they create might have an impact on the fishery you are managing.

Secondly, if your management plan involves fish stocks that cross national administrative or even international boundaries, then you will need to involve the fisheries agencies from those regions, states or countries right at the start of the process. Fish stocks don't respect administrative boundaries created by people. This involvement should be done at the highest appropriate level and a system established to enable a joint management plan to be created.

Fish stocks do not respect the administrative boundaries created by people!

Phase I

Preparing to write your management plan - Where are you now?

As shown in the summary table below, extracted from our overall Table 1, there are four stages to this first phase of preparing to write your management plan.

Phase	Stages	
I. Preparation for developing the management plan **Where are you now?**	***1***	**Define the fishery** Define the fishery your management plan is for
	2	**Stakeholder analysis** Carry out a stakeholder analysis and decide how you are going to involve the stakeholders
	3	**Situation analysis** Carry out a situation analysis and list the problems faced by your fishery
	4	**Management approach** Decide on your management approach

Stage 1

What is the fishery you are writing the management plan for?

This is a basic but important point. The first step is to define the fishery you are writing a management plan for. A fishery is usually defined in terms of some or all of the following:

- The species or type of fish;
- The area of water or seabed;
- The seasonality of fishing;
- The method of fishing and class of boats; and
- The people involved in the fishery.

Management plans may also be written for different levels of ecological complexity such as listed below.

Management plans may be written for different levels of ecological complexity – you should start with a simple plan first!

(a) Single species management

The simplest management plan is for just one species of fish. In this plan you may assume that you only need to control fishing activities in ways that maintain the size of the stock and protect breeding fish in order to achieve a good

yield. However, most fish stocks share waters with many other fish species of various different sizes, some of which are caught and then discarded. So the single species management of one fish species may lead to the unsustainability of another.

(b) Multi species management

This is a more complex management plan but will take into account the challenges of managing the fishery when there are different species involved. Depending on the objectives, it should be designed to ensure that all of them are fished sustainably.

(c) Ecosystem management

This is a very different kind of management that places fisheries within the context of the whole ecosystem and among other uses of the marine environment such as tourism, biodiversity conservation and so on. This approach is now recommended by FAO and requires that fishery management be placed within the wider context of sustainable development. However, as you can imagine, this is the most complex kind of management plan to write, and as a result there are not many examples of ecosystem management plans to refer to.

Examples of management plans for fisheries with different geographic ranges and ecological scopes are given in Box 2. Your stock assessment team should guide you on appropriate ecological 'unit stocks' (see SA Guide Section 1.1). You also need to consider the geographic range at which you will be able to apply management rules. For example, for a shared or 'straddling' fish stock, you would have to work in collaboration with a neighbouring country.

If you have never written a management plan before and don't have the experience or people around you with experience – then writing a plan for a single species fishery is the best starting point. However, writing a management plan for a two or three species multi species fishery is not that difficult, and may be the most appropriate for your situation.

e.g.

Box 2. Examples of management plans for different types of fishery

Queen conch fishery of Puerto Rico and the United States Virgin Islands (a single species, multi island management plan including consideration of bycatch species)
http://www.strombusgigas.com/fishery_management_plans.htm

Western Atlantic dolphin and wahoo fishery (a two species, multi gear, multi country fishery) http://www.safmc.net/library/DW_FMP_FEIS_1_7_03FINAL.pdf

Stage 2

How are you going to involve the stakeholders?

Who should be involved?

Developing a management plan requires the involvement of a number of stakeholders

For your management plan to be successful you should involve all the people who have an interest in the results of the plan. These people are called *stakeholders* and they should be identified right at the start of the management planning process. In the past, management plans and the control of fisheries have often been 'top down' with fishery managers simply telling the fishing community how the fishery is to be managed. As a result these plans have often failed. The more common approach these days is some form of 'co-management' – a partnership arrangement in which government, local resource users (fishers), other organisations (NGOs, academic and research organisations), and other fisheries and coastal resource stakeholders (boat owners, fish traders, money lenders, tourism establishments) share the responsibility and authority for decision making in the management of a fishery. Co-management requires new ways of thinking by all stakeholders. Successful co-management requires all the stakeholders to be part of the process and to 'buy in' to the plan.

Your management plan, then, should clearly:

- list the stakeholders and their interests and influences;
- say how they were involved in the development of the plan; and
- say how they will be involved in the implementation, monitoring and review of the plan.

You probably know who the stakeholders are but you may find it helpful to complete a simple stakeholder analysis like the one shown in Figure 3. This shows the position of the different stakeholders in terms of their 'importance' and 'influence':

- *importance*: the degree to which the stakeholder is likely to be affected by the management plan (either negatively or positively);
- *influence*: the level of power a stakeholder has to control the outcome of the plan (again either negatively or positively).

Both important and influential stakeholders should be involved in the development of the management plan. Note that the positions of different

stakeholders will depend on the purpose and goals of the plan. If the main priority is to improve livelihoods of the poor, then the poor are the most important (highest priority) stakeholders. Useful guidance on stakeholder analyses and the types of questions you should ask is given in the Adaptive Learning Guidelines produced by FMSP Project R8292 (see www.adaptivelearning.info), and also in Tool 5 of the ParFish Guidelines.

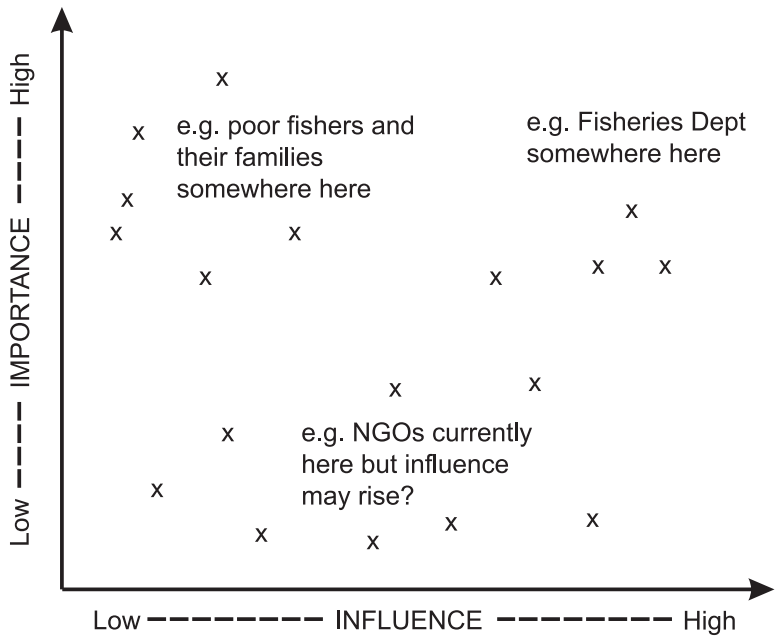


Figure 3. A diagram showing the relative positions of different stakeholders in terms of their importance in the fishery and the degree of influence they have on management.

How should the stakeholders be involved?

Participation is an important part of management

After identifying the stakeholders you should think how to involve them. As shown in Table 3 below, different stakeholders may participate in the decision-making process at four different levels. Guidance on engaging stakeholders and on developing appropriate communications plans with them is given as Tools 6 and 7 of the ParFish Guidelines (see website in Annex 2).

Participation is an important part of management. Unless you have the right level of support for the plan from the different stakeholders, the plan might fail.

Table 3. Alternative levels of participation for different stakeholders

e.g.	TELL	This is where you 'tell' the stakeholders what is happening. For example - you develop a management plan and then publish it in a newspaper or hold a meeting to tell fishermen what is in it. You just provide information.
	ASK	This is where you 'ask' some stakeholder for their ideas and opinions before you develop the management plan. You might or might not include those ideas in the plan you develop.
e.g.	DISCUSS	This is where you not only ask - but you have a discussion with the stakeholders about the management plan. For example, you talk to fishers and fish processors and discuss perception of problems in the fishery and ask them to help you put them in order of priority.
	DECIDE	This is a partnership approach to management where some aspects of management are delegated to specific stakeholders and decisions are taken together. 'Co-management', where decisions about fisheries are delegated to different groups, is based on a 'Decide' model.

So for example, unless fishermen themselves feel that they had participated in the development of the plan, they might feel that it has been imposed on them, and as a result they might actively or passively try to find ways to keep away from parts of the plan they do not like.

Co-management involves sharing power and decision making among the stakeholders

Making participation successful

Some important pointers for successful participation are given below:

Effective participation needs careful facilitation and good communication

- Make sure that the right people are involved at the right levels and that they know what their levels of responsibility are.
- Establish the boundaries and ground rules for participation. If people think they are attending a meeting to 'decide' an issue, but you think they are there simply to be 'asked' for ideas, then there is likely to be a conflict.
- Facilitate the planning process so that everyone has a chance to make their voice heard. Don't just listen to people who talk a lot.
- Give feedback after participation.
- Keep people involved through effective communication and continued consultation.

What participation IS and what it ISN'T

Some managers are afraid of participation or misunderstand what it is all about and as a result don't do it. It is important to realise for example, that participation is NOT local democracy. You are a manager and you have been given the responsibility to manage effectively. Unless you have specifically delegated responsibility for a decision, then you are not obliged to follow a majority opinion. However, if you do not follow the opinion of the majority, then you need to be able to give convincing reasons for your alternative. If, on the other hand, you think that following a majority opinion is appropriate, then it is important to make sure that you have a mechanism for reliably finding out what the majority opinion is. Once you have started the participation process then you should make sure that it continues. It should become a habit.

Some specific participation techniques

There are many ways of getting people to take part in a management process – some are simple and some are complex. Some are more costly than others and some are more effective at getting greater numbers of people involved in the process. Choosing a technique will depend very much on:

- what is your purpose – why are you asking people to participate?
- who are you asking to participate? You will need to communicate differently with small subsistence fishermen (who might not be able to read) and with large commercial fishing companies.
- where are the people you would want to participate?

Some common methods of participation are listed below. Others are given in the ParFish Guidelines (e.g. Tools 8-12).

Tell techniques – keeping people informed by publishing information in the different media that your stakeholders read or watch. Indirect methods include newspapers, television and exhibitions; direct methods include giving information directly into the hands of the target group – e.g. though a letter in the post or delivered by hand. Information is the important starting point for participation. If you are going to ask people and discuss ideas with them then they need to have the right levels and type of information.

Ask and Discuss Techniques – these usually focus on different kinds of meetings. These will only be successful if they are organised in the right way. Open meetings are often good ideas at the start of a new process. For example if you are starting to write your management plan then it would be good to hold special meetings for the fishermen involved to explain what is going to happen and how, and their potential roles. To be effective, you need to make sure these meetings are well organised (see e.g. Box 3).

e.g.

Box 3. Holding a good meeting

"The meeting we had was great. It was held in a café by the sea front – and we were give some snacks. It was really well organised. The day before the fisheries officer had given us all an invitation and also information about what we would discuss. We were welcomed to the meeting (that surprised me!) and the officer in charge was really good at getting us to express our views. I could understand what he said as he spoke my local language. At one stage, we were split up into groups and asked to write something on a big sheet of paper. No-one in our group except me could write well so I had to do that. I was nervous, but the officer in charge really seemed to welcome our views and said that they would take them into account when making the plan. He controlled the meeting really well and even Ramu didn't talk too much (as he usually does!) We were even invited to the next meeting to see the first draft of the plan."

Advantages and challenges of participation

If you have little experience in participatory methods, you should get help from another government agency or suitable NGO

Participation is not always easy to manage - especially if you haven't done it before (see Table 4). If your experience is limited, it might be a useful idea to get another organisation such as an NGO with good experience in participation or the government agency responsible for social development to help you in the beginning.

Table 4. Advantages and challenges of participation

Advantages	Some Challenges
Other stakeholders know a lot about a fishery and can make a positive contribution to the management plan. Fishermen often think of ideas that fisheries managers have not thought about.	Stakeholders will disagree – and you might not be able to manage the process smoothly.
Participation can reduce conflict and build trust.	It can take time – but time taken at the beginning of a process can save time later on.
If people feel part of the process and are listened to then they are more likely to support even difficult decisions.	Some people might not trust you. They might not be used to fisheries officers running a consultation process and may be sceptical about investing time and effort, particularly if they perceive only limited personal benefits.

Participation in writing a management plan

A recommended process for management plan consultation is as follows:

- Provide information to the stakeholders that a management plan is being developed – and invite them to a first meeting.
- Hold a meeting to get ideas from the stakeholders about their perception of the current situation – the problems that they face and what needs to go in the plan.
- Set up a management plan consultative group – an enthusiastic group of people you can talk to about the management plan.
- Draft a first version of the plan.
- Inform people about this and hold another feedback meeting. If you think they are needed, then hold more stakeholder meetings.
- Draft a second version of the plan and publish this after it has been approved. In the document, make sure that the contribution of the stakeholders is acknowledged.

Stage 3 What is your fishery like now? Situation analysis

Knowing what your fishery is like at the moment is an important step in preparing your management plan. To assess the situation in your fishery, you will need to gather information from a range of sources, such as:

- from the stakeholders through a consultation process;
- from primary data collected by your fishers officers; and
- from secondary data from publications and research etc.

The situation analysis should be a descriptive section of your management plan and is often placed at the front of your management plan document.

When undertaking your situation analysis you should start by describing the current management practices in your fishery along with any current regional, national and local legislation.

You may find it useful to structure your situation analysis to cover the four key ‘dimensions’ of your fishery, as listed in Table 5.

Your situation analysis should cover the four key dimensions of the fishery: biological, ecological, social and economic

This information will help you later to define your goals

Table 5. Key dimensions to consider in developing a management plan with examples

e.g.

Biological	These are the characteristics of your fish stocks – for example – number of fish species
Ecological	These are the characteristics of the ecosystem as a whole – for example, the relationship between fish stocks and coastal vegetation. In order to achieve a sustainable fishery for a specific species, it is important to keep in mind the health of the ecosystem as a whole
Social	These are characteristics of the population – for example- number of people depending on fishing for a living
Economic	These are characteristics of the economy – for example – the average income of fishermen.

For each of these four dimensions you will need to describe:

- The current situation and 'how it works';
- How the situation is changing – the trends over time; and
- Any problems and management questions.

This information will be useful in developing the goals and objectives for your fishery. Don't worry if you don't have full and detailed information, but do try to ensure that you are correctly identifying the trends in the fishery.

The current situation and trends – possible points to include

e.g.

(a) Biological Factors

These are the characteristics of your fish stocks. Information could include:

- catch, effort and abundance data;
- size compositions (catch at age and length frequency data);
- biological data (reproductive behaviour, size at maturity, etc); and
- any local indigenous knowledge about fish stocks.

You might not have all this information, but at this stage of the management planning process it is important to bring all the data you do have together in one place. The Stock Assessment Guide includes advice on how to decide what other data you will need to collect in the future.

(b) Ecological Factors

These are the broader characteristics of the marine ecosystem as a whole. They will include any changes in the ecosystem that might impact on the fish stocks, and any practices in the fishery that affects the ecosystem. It is not

possible to list all the factors you consider as these will vary from fishery to fishery, but some examples are given below:

- changes in the biodiversity of coral reefs, e.g. as affected by runoff and siltation from agricultural lands, or by destructive dynamite fishing;
- any reductions in the area or richness of coastal mangroves or sea grass beds, used as nursery areas by some fish stocks; and
- the levels of industrial and domestic pollution flowing into coastal waters.

(c) Social Factors

These are matters that are related to the local population, especially those people who are involved in the fishery. Information you may need to collect could include:

- education and literacy levels of the fishing community;
- numbers of fishermen, including the roles of women;
- growth rate of the population;
- services provided by any associations that fishermen join; and
- political and legal structures.

(d) Economic Factors

These are things that are related to the local economy associated with fisheries. Information you would need to collect will include the:

- average income from fishing among different types of fishermen;
- how this is related to the total family income; and
- any alternative sources of livelihood in the area.

In each of these dimensions, you should create your own list of factors for your situation analysis. Some issues are more important in some areas than others. An example of a situation analysis on Caribbean shark fisheries is available at http://www.fao.org/DOCREP/003/X2097E/X2097E07.htm.

Identifying problems

There are various methods you could use to identify the problems faced by your fishery. Two of them are described below.

(a) Pressure – State – Response

This is a simple framework, used by some organisations that manage the natural environment. It involves analysing the current state of the fishery system, the various different pressures that are being placed upon it, and what you are doing about each of these as a response. For further details, see the FAO's 1999 paper on fishery indicators.

The pressures on the fishery can be either biological stresses or they can be human influences. Both sets of pressures can cause changes in the state of

the environment at different scales from local through to global. Managers respond to those pressures and changes in the state of the environment with programmes and policies to prevent or mitigate pressures and environmental damage. In describing your fishery, your pressures might include, for example, increases in the number of small fishing boats or an invasive species. This might have affected the current state of the fishery, such as the average size of fish caught or the catch rates. Both of these can be compared to the situation in the past. Your management plan will be part of the overall management response to the situation.

The 'PSR' framework describes the current state of the fishery system, the pressures being placed upon it, and the responses that management is taking

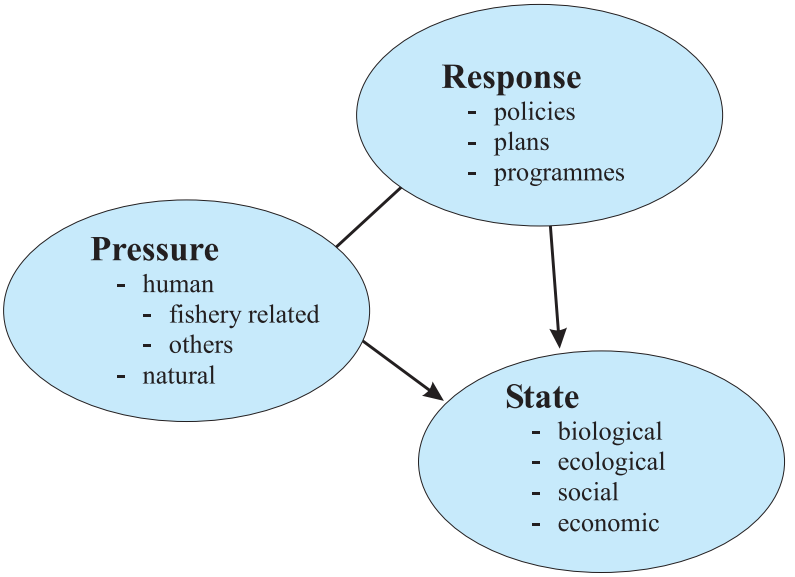


Figure 4. Illustration of the 'Pressure-State-Response' framework for analysing fishery processes (see FAO, 1999 for variations on this basic framework).

(b) SWOT Analysis

A SWOT analysis is also a useful tool to use in a situation analysis and will help identify factors to be covered in your management plan. It involves listing Strengths, Weaknesses, Opportunities and Threats in your fishery. You can carry out SWOT analyses for each of the different areas – biological, ecological, social and economic. This is a simple technique to use in participatory workshop. You divide the workshop participants into groups and ask each group to make a large SWOT diagram on poster paper. The ideas created by each group can then be shared.

Table 6. Elements of a SWOT analysis

STRENGTHS –These are the strong points of your fishery at the moment. When you make your plan you may develop some goals and objectives that build on these strengths.	**WEAKNESSES** – These are the weak points of your fishery at the moment. You may also develop some goals and objectives that tackle these weaknesses.
OPPORTUNITIES – These are things might happen in the future that will help you achieve your plan. You need to build on these	**THREATS** –These are things that might happen in the future and might stop your management plan from being successful. You will need to plan for these by finding ways to avoid them or reduce their impacts.

e.g.

Box 4. Examples of fishery SWOT analyses

You can find a detailed SWOT analysis in the strategic action plan for the development of the Welsh (UK) fisheries and aquaculture sector. See http://www.wda.co.uk/resources/AP_Action_Plan_-_Fisheries_and_Aquaculture1.pdf.

A SWOT analysis of the Vanuatu Fisheries Division is also available as Appendix 9 of: http://www.adb.org/documents/reports/vanuatu_agri_fisheries/appendix.pdf

Key Problems

Based on the information collected during the situation analysis you can make a list of the key issues - or key problems faced by your fishery. These are important points that your management plan should be designed to deal with. Examples of key problems for one fishery are given in the link in Box 5.

e.g.

Box 5. Example problem statements for a fishery in the Bay of Bengal

Key problems in the Bay of Bengal region are described as a series of threats and their root causes in the "India National Summary Report on the status and development potential of the coastal and marine environment of the east coast states of India and its living resources". For details see: http://www.fao.org/fi/boblme/website/sum_rep/INDIA_SUMMARY.pdf

How does stock assessment fit in?

If you have suitable data available, it will be useful to use stock assessment tools (SA tools) during the situation analysis for your fishery. You should work closely with your fisheries officers at this stage of writing your management plan.

For example, SA tools can help you estimate the current size of the fish stock compared to its status in the past. This information can help you to set a target for the size you want the stock to be in the future. SA can also estimate the chance that your fishery may decline further at current levels of fishing pressure, giving you an indication of the likely future trends in social and economic benefits. Tools for such analyses are described in the SA Guide.

Stage 4

Management approach

As a final part of this preparatory phase, you need to consider a number of general management issues, including the approach you take to management and uncertainty, and your obligations to any international treaties.

Precautionary and adaptive management approaches

When you are making your management plan and deciding which management measures you can use to achieve your goals and objectives, there will always be some uncertainty about the state of the fishery and which measures will best achieve the goals. The types and importance of uncertainty are described in some detail in Chapter 5 of the SA Guide. To allow for this uncertainty you can take one of two different approaches.

You will always have some uncertainty, both about the state of the fishery and about what needs to be done to achieve your goals

(a) A precautionary approach

This basically says – “let’s be careful!” For example, your analysis suggests it should be possible to catch 500 tons of fish a year in your fishery without causing it to collapse. However, you know you don’t really have enough data to estimate this value very accurately, and in any case there are several unknown factors that could also affect the situation. As a result you are careful and set a lower target of say 300 tons – ’just in case’. As your information improves and if you find that fish stocks are also improving, you may be able to increase catches in the future.

(b) An adaptive approach

An adaptive approach is where managers deliberately use ’trial and error’ or planned experiments to find the right management measures (see the FMSP website: http://www.adaptivelearning.info/). Using the same example as above, you might raise the catch limit from 300 to 350 tons and monitor the situation carefully to see what happens. If there are no problems, you might keep it at 350 tons or raise it again and monitor the situation carefully. In other words you will adapt the management measures to get the best catch possible without creating unsustainability. If your fishery can be divided into small stock units such as a number of coastal bays or lakes, you can also try fishing harder in some areas than others to see if they remain productive, or decline instead. Following this approach will require that you have the

capacity to monitor trends regularly and accurately, and that fishery management measures can be adjusted quickly if the need arises.

The precautionary approach says 'let's be careful' The adaptive approach uses 'learning from experience' to reduce uncertainty You could use both of these in your fishery!

The FAO recommends taking a precautionary approach to management while also using adaptation to reduce uncertainties where possible. You don't have to decide which approach you will take before writing your plan – you can make this decision during the process of writing the plan and as the levels and types of uncertainty become clearer.

Reactive or proactive management approaches?

Many management plans are what we call 'reactive'. In other words, there is a problem or crisis in a fishery and managers react to this by producing a management plan which it is hoped will help to solve the problem. This kind of approach to planning usually only tackles short term problems. In this case the *problem* 'drives' the management planning. A more 'proactive' approach to producing a plan would be to look further ahead and work out what should be done to achieve a sustainable fishery, preferably before those problems even start to exist. In this case it is the *fishery managers* and their partner stakeholders who 'drive' the management plan.

The FAO Code of Conduct states that the long term purpose of a fishery management plan should be the sustainable use of fisheries resources. This will best be achieved with proactive management. In practice, of course, given the current state of the world's fisheries, many management plans will include both reactive and proactive elements.

National and international strategies

You will also have to make sure that your plan matches any international conventions that your country has ratified or signed and any national or regional commissions that your country or region belongs to. These will each have policies or strategies that you should consult whilst developing your management plan. You can find the terms of many important international and regional conventions on the FAO or UNCLOS websites (http://www.fao.org/fi/ or http://www.un.org/depts/los/).

You may also consider referring to the UN Millennium Development Goals as part of your plan (see http://www.un.org/millenniumgoals/).

Phase II

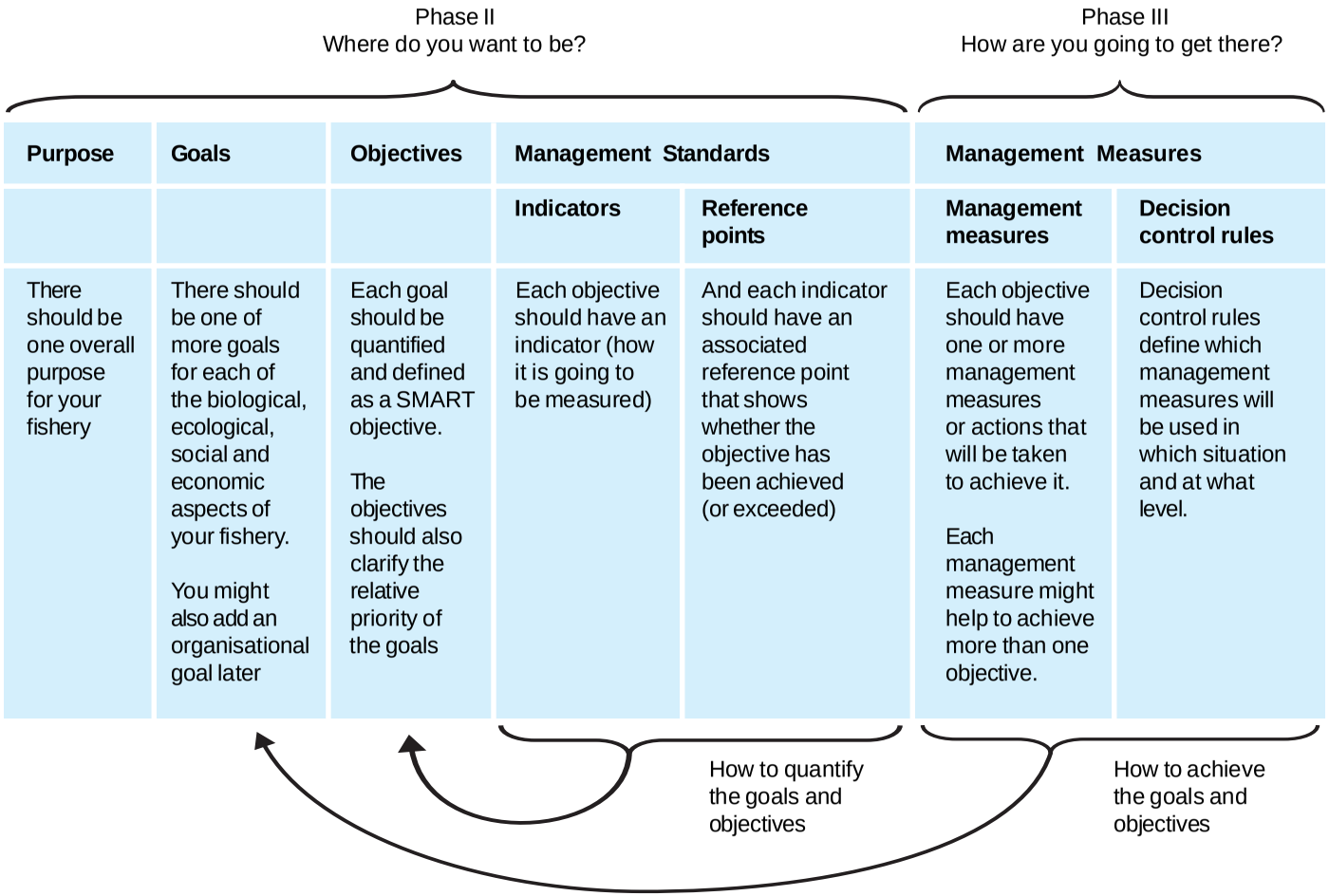
Developing the management plan - Where do you want to be?

The second phase of writing your management plan involves four stages and defines exactly what you and the other stakeholders want for your fishery in the future – '*where do you want to be?*'

Phase	Stages	
II. Developing the management plan **Where do you want to be?**	***5***	**Purpose** Agree the overall purpose of your plan
	6	**Goals** Decide on the biological, ecological, social and economic goals needed to achieve your purpose
	7	**Objectives** Define the objectives for each goal
	8	**Management standards** Agree the management standards – the reference points and indicators for each objective. In other words – what and how you are going to measure to show that you are achieving your objectives.

Figure 5 in the following page shows the key elements in both Phase II and Phase III of our plan-making process, and highlights some of the relationships between them. In the following sections, we are going to complete this table step by step using an example fishery. A table like this (with different rows for each objective) could be used to summarise the management plan for your fishery. Completed examples are given in Annex 3 of this guide. The example we develop here in the text is based on Example 1 of Annex 3.

Figure 5. Key stages in phases II and III of developing your management plan - defining where you want to be and how you propose to get there



Stage 5

Agree the overall purpose of your plan

Your first task is to define the overall purpose of your management plan. This is a statement that summarises and combines all of the goals of the fishery into one single sentence. An example is shown in Box 6 below.

The purpose statement summarises and combines all of the fishery goals into one single sentence

e.g.

Box 6. An example purpose statement

"The overall goal *(what we are calling the purpose)* of the fishery management plan for the South Atlantic, Mid Atlantic and New England Council's area of jurisdiction is to adopt a precautionary and risk averse approach to management which in the first instance attempts to maintain the status quo" (see page 21 – Fishery management plan for the dolphin and wahoo fishery of the Atlantic http://www.safmc.net/library/DW FMP FEIS 1 7 03FINAL.pdf).

The reason for writing an overall purpose statement is to help you stay focused as you write your plan. It is easy when writing a management plan to get bogged down in small details and to forget why you are writing it. A purpose statement helps to keep the big picture in view. The example purpose given for the Atlantic dolphin and wahoo fishery is a clear, proactive and precautionary statement.

Purpose statements are meant to be very general – and they will often focus on the sustainable development of the fishery. Your purpose statement should be *proactive*. As we said before, in practice, such proactive management may still mean fixing any immediate problems in the first place (i.e reacting). But it should also go beyond such initial 'patches' by striving to achieve a longer-term ideal, as defined by the fishery goals.

So, let's start writing our example management plan. The example we are going to use is a hypothetical ribbon fish fishery in Indian waters of the Bay of Bengal. The main perceived problem with this fishery is summarised in the following statement *"At the current rate of exploitation the ribbon fish fishery in the Bay of Bengal is unsustainable and the fish stock appears to be diminishing"*.

Reflecting on this problem, our overall purpose statement might be "*To create an ecologically and economically sustainable ribbon fish fishery in the Bay of Bengal*". In the following sections of this guide, we will gradually build up a summary management plan table in the format of Figure 5, showing how this purpose might be achieved and how the different elements of the plan relate to each other.

Stage 6

What are your goals?

Your next task is to develop the goals for your fishery. A goal is still quite a broad statement, but more detailed and focused than the purpose. While you will usually just have one overall purpose for your fishery, you should create one or more goals related to *each* of the four *dimensions* of the fishery – biological, ecological, economic and social. Taken together, your goals should reflect the overall statement given as the purpose.

With our example, the *biological* goal might be "*To maintain the ribbon fish stock at or above the level necessary to ensure its continued productivity*". This is a good goal because it says clearly what we want to achieve. It is not detailed, but it is simple and clear and if it was achieved then the biological part of the problem should at least be solved.

Which goals are most important?

When you are developing the social and economic goals it is important that you make them consistent with the biological and ecological goals and with each other. Assuming that a key purpose of any fishery management plan is to achieve the *sustainable* development of the fishery, the biological and ecological goals should always be seen as important constraints on the system. Social and economic goals can only be achieved within the limits imposed by the natural productivity of the fish stocks and the environment.

Social and economic goals can only be achieved within the limits imposed by the natural productivity of the fish stocks and the environment

Examples of biological, economic and social goals that could be defined for our example purpose are given in Table 7 below. Note that ecological goals are not included in this example in order to keep it simple. Ways of including ecological goals are given in Annex 3.

In an ideal world, we would usually like to achieve all of our social and economic goals to the maximum possible extent. Unfortunately, they will often be limited both by the biology of the resource, as noted above, and also by each other. Since catch rates and incomes per fisherman will generally decline as the numbers of fishermen increase (see Section 2.1 in the SA Guide), you will have to make a trade off between the social and economic goals selected here. The following sections show how this can be done by carefully defining the objectives and by selecting appropriate management measures.

You may need to make several trade offs between your goals – you will need to define priorities

Table 7. Defining the goals for our management plan summary for the ribbon fish fishery

Goals	Objec -tives	Management standards		Management measures	
		Indicators	Reference points	Management measures	Decision control rules
Biological To maintain the ribbon fish stock at or above the levels necessary to ensure its continued productivity					
Economic To maximise the net incomes of the participating fishers					
Social To maximize employment opportunities for those dependent on the fishery for their livelihoods					

Stage 7

Developing your objectives

Things get a bit more difficult at this stage. For each of your goals you need to develop a number of objectives. Objectives are measurable changes that will be realised when your fisheries management plan is successful. When writing objectives it is helpful to make them '*SMART*'. The meaning of this acronym is described in Box 7 below and you should check the objectives you write against this checklist

Box 7. Definition of a SMART objective

Specific – it is a clear objective
Measurable – you can measure some indicator to check if you have achieved it
Agreed – by the appropriate stakeholders
Realistic – within your timescale and resources
Time dependent – it includes a stated timescale for achievement

For each goal you should create one or maybe two objectives. In our example, a SMART objective for the biological goal could be, "*To maintain the ribbon fish stock at all times above 50% of its mean unexploited level*". This is a smart objective because:

Objectives should be SMART and should include the following key elements:

Verb – Indicator – Relation – Reference point

- it is specific;
- we can develop ways of measuring it.
- we assume it has been agreed (e.g. if it was developed with the participation of stakeholders);
- it is realistically achievable; and
- it is time dependent in that we would state that our management plan is for a specific time period.

One way of writing good objectives is to think about a sentence that includes: a verb – an indicator – a relation – and a reference point. We will be looking at these terms in more detail later in the Managers Guide (and see also Section 1.2 in the SA Guide), but we will illustrate the process below using this objective.

- *To maintain* – this is the verb – it describes what we want to do
- *the ribbon fish stock* – this is the indicator that we are going to measure
- *at all times above* – this shows a relationship
- *50% of its mean unexploited level* – this is a reference point – if the ribbon fish stock falls below this point, we may assume that the fishery will get into trouble.

Be careful not to develop too many objectives. Use just enough to clarify your goals and purpose. When you have developed objectives for each of your goals – you should ask yourself, "*If we managed to achieve all these objectives – would we achieve our goal?*" If your answer is "no", then you need some more objectives. If your answer is "yes", then you could ask yourself whether you have too many objectives. If you have more than are really needed to achieve the goal, then you could probably drop some of them.

Prioritising the objectives to make the goals compatible

Possible objectives for each of our biological, economic and social goals for the ribbon fish fishery are given in Table 8 below. These objectives are carefully written to give a clear order of priority to the goals. To ensure the sustainability of your fishery, we have put the biological objective as the highest priority and said that we plan to keep the stock above 50% of the

unexploited level. Within this constraint, we propose to employ as many people as possible in the fishery (the social goal) while also keeping the average income per fisher above a minimum defined level (the economic goal).

We prioritise the goals by carefully defining the objectives

Table 8. Adding the objectives for each goal in the plan

Goals	Objectives	Management standards		Management measures	
		Indicators	Reference points	Management measures	Decision control rules
Biological To maintain the ribbon fish stock at or above the levels necessary to ensure its continued productivity	To maintain the ribbon fish stock at all times above 50% of its mean unexploited level				
Economic To maximise the net incomes of the participating fishers	To maintain net income per fisher at a level above the national minimum desired income				
Social To maximize employment opportunities for those dependent on the fishery for their livelihoods	To include as many of the existing participants in the fishery as is possible given the biological and economic objectives above				

Note: As in Annex 3, new text in these tables is given in normal font, while previously existing text is in 'greyed out' font

When you have developed your objectives, then the next stage is to define the indicators and reference points. As shown back in Figure 2, this is one point where you might come back to look again at the objectives after you have thought about the management standards.

Stage 8

Setting management standards - Indicators and reference points

Indicators show the state of the fishery; reference points are particular values of indicators and show the states you would like to achieve or avoid

For each of your objectives you need to decide how you will measure whether you are achieving them or not. To do this, you need to set what are called 'management standards'. These include:

- 'Indicators', showing where you are at the moment, or where you might be in future; and
- 'Reference Points' for the fishery, showing where you would like to be.

Indicators and reference points are used in combination to clearly define the objectives in ways that can be estimated in *quantitative* fishery assessments. Stock assessment tools are particularly valuable in estimating many of these management standards.

Table 9. Adding management standards to quantify the objectives of the plan

Goals	Objectives
Biological To maintain the ribbon fish stock at or above the levels necessary to ensure its continued productivity	To maintain the ribbon fish stock at all times above 50% of its mean unexploited level
Economic To maximise the net incomes of the participating fishers	To maintain net income per fisher at a level above the national minimum desired income
Social To maximize employment opportunities for those dependent on the fishery for their livelihoods	To include as many of the existing participants in the fishery as is possible given the biological and economic objectives above

Our example

The management standards state exactly how the objectives will be measured

Let's look again at our example of the ribbon fish fishery in the Bay of Bengal and our objective "*To maintain the ribbon fish stock at all times above 50% of its mean unexploited level*". As we noted above, the '*ribbon fish stock*' is the indicator here and the '*50% of unexploited level*' is the reference point that we hope to keep it above. In defining these quantities in your plan, you need to specify the technical details of how you will measure them. If for example, you decide to use a Schaefer production or Biomass Dynamic Model (see SA Guide) to estimate the current and unexploited stock sizes, you would state this clearly in your management plan, as in the new text added to Table 9. For each of the management standards, you need to state which data you will use to estimate the quantity, and, where appropriate, what tool or analysis you will use to calculate it.

Management standards		**Management measures**	
Indicators	**Reference points**	**Management measures**	**Decision control rules**
Current stock size, B_{now}, as estimated by the Schaefer production model using X data and Y fitting method	50% of the carrying capacity, K, as estimated by the Schaefer production model (i.e. above B_{MSY}) using X data and Y fitting method		
Net income per fisher measured using A data and economic model B	The national minimum desired income (e.g. US$10/day)		
Number of fishers employed in the priority fishing fleets	Number of fishers that would maintain biomass above B_{MSY} (i.e. f_{MSY}) and allow at least the minimum desired income per fisher		

Targets and Limits

A target says where you would like to be

A limit defines a point you don't want to go beyond

Remembering the 'relationship' part of the objective definitions, we now need to explain how reference points can be set either as targets or limits. You should set a reference point as a target when you want to achieve a specific value, more or less, for a given indicator. Targets are used when it does not matter if you go beyond the reference point on some occasions. An example might be the income of fishermen. You would set a target – but if fishermen earned more than your target then this would presumably not be a problem.

You set a reference point as a limit when it represents a value that you really don't want to go beyond (either above or below, as the case may be). A minimum viable spawning stock size is often used as a limit reference point. If your indicator fell below the specified limit then you would know that your fishery would have a high risk of collapse. The difference between targets and limits is shown in Figure 6. All of the reference points in our example are set as limits, including the economic goal for the fishermen's incomes, where we don't want to fall *below* that point.

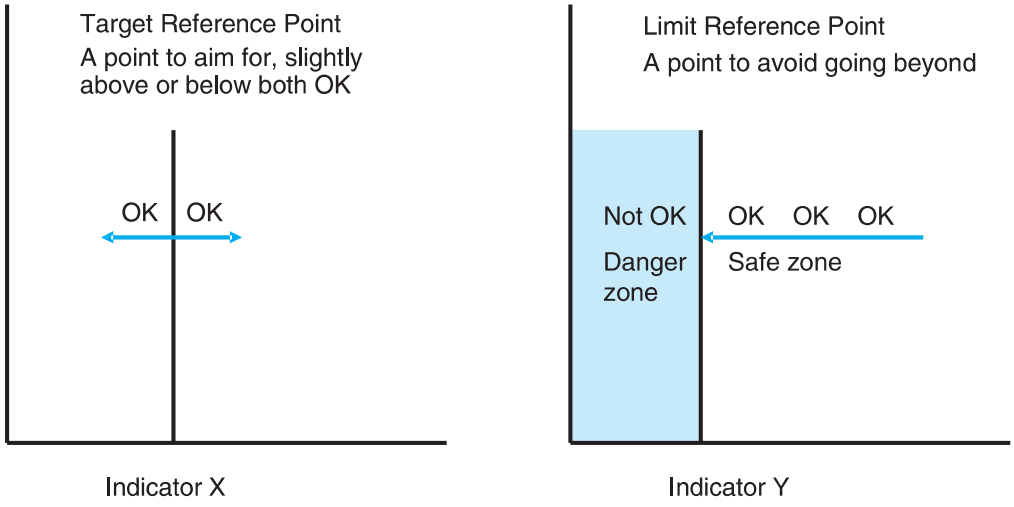


Figure 6. Setting of reference points as either targets (left) or limits (right). In this example, the limit reference point is a *lower* limit, as we do not wish to fall *below* that point into the 'danger zone', for example below a certain mimimum spawning stock size. Limit reference points can also be set as *upper* limits, for example when we do not wish to exceed a certain fishing rate.

The role of stock assessment tools (SA tools)

Reference points and indicators will usually both be developed on the basis of quantitative scientific information. Your fisheries officers should provide this for you by applying SA tools to data collected from your fisheries or in some cases just from simple analyses of routine survey data (see Example 3 in Annex 3 for instance).

Reference points and indicators should be based on quantitative data and can be developed using SA tools

In our example, for your biological indicators, you would need to have a time series of several years' worth of catch and effort data from your fishery to estimate the current stock size and the original unexploited stock size. These data would be collected directly from the fishery, and SA tools would be needed to estimate the indicator each year. The limit reference point stock size of 50% of the unexploited level would also be estimated from the stock assessment. For the economic indicators, you would need to analyse the incomes and operating costs of a sample of fishermen, and use a defined economic model to estimate their net incomes or profits from fishing.

In setting reference points you also need to bear in mind the uncertainty in your analyses of the fishery (see Chapter 5 of the SA Guide). If you are taking a precautionary approach to management, then you might choose to maintain stock size above 60% of the unexploited level instead of 50% – just to be on the safe side. This is a 'precautionary reference point', as illustrated in Figure 7.

You should use precautionary reference points to allow for the uncertainties in your system

Exactly how precautionary you need to be depends on two factors. Firstly, the degree of uncertainty in your estimates of the indicators and reference points; and, secondly, how much risk you are prepared to take as the manager of the fishery. Chapter 5 of the SA Guide considers these issues in detail. You can either take a qualitative approach to precaution (e.g. using a 60% limit to try to ensure that you achieve at least 50%), or you can try to estimate the actual risks of different reference points and management options using SA tools.

The ParFish approach is especially focussed on managing with uncertainty and gives a number of useful tools for communicating uncertainty (see Annex 2 for the ParFish Toolkit download site).

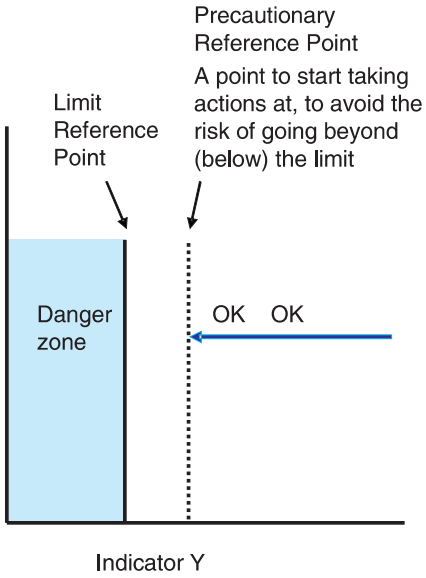


Figure 7. Setting a precautionary reference point to avoid the risk of falling into the danger zone below the limit reference point. See also Figure 3 in the SA Guide, and the decision control rule figures in Stage 10 below.

Phase III

Developing the management plan - How are you going to get there?

We are now half way through developing the example management plan. Having considered the current situation (Phase I), we have provisionally defined a set of goals, objectives and management standards showing where we would like to go (Phase II). We have defined the objectives and standards carefully as quantities we can measure to determine our progress towards the goals. And we have written the objectives to show their priorities and ensure that they are compatible with each other. The next phase is to think what actions we should take to achieve these goals – in other words, *how are we going to get to where we want to go?* As shown in the reminder table below, this phase includes steps 9, 10 and 11 in our overall plan.

Phase	Stages	
III. Developing the management plan How are you going to get there?	***9***	**Management measures** Decide the management measures – in other words, the actions – you are going to take to achieve the objectives
	10	**Control rules** Agree a set of decision control rules stating which measures and which levels of measures will be applied depending on the status of the fishery
	11	**Resources** Decide what resources you will need to put your plan into action

Stage 9

Action – Management measures

The actions we take to manage the fishery are called management measures. There are three different kinds of these, as listed below.

(a) Input measures – controlling the amount of fishing effort, e.g. by limiting:

- access to fisheries – such as by licensing;
- the size and power of boats; or
- the amount of time each month that a boat can fish.

(b) Output measures – controlling the amount of fish caught, e.g. by setting:

- individual quotas on the weight of fish landed by each boat; or
- a total allowable annual catch for the fishery.

(c) Technical measures – controlling where, when and how fish may be caught, e.g.:

- closed areas for fishing;
- closed seasons for fishing; or
- the size of the nets used, or the size of fish that can be landed, or the types of vessels or gears that may be used.

To achieve all of your goals, you will probably have to use a combination of different management measures

In thinking about which management measures to use, you should look at your management goals and objectives and think what it is that you want to achieve. If your goal is to protect mature fish and ensure production of new recruits in the fishery each year, you may be able to achieve these aims using only technical measures, so long as they are sufficiently restrictive. If your goal is to keep the stock size above a certain level (e.g. 50% of the unexploited size), then you will more than likely need to also use either input or output controls. To achieve all of your goals, you will probably have to use a combination of the different measures.

Input and output measures are commonly used as flexible controls that can be changed from year to year as necessary to achieve your goals. As explained in the following section, they can be adjusted up or down over time depending on the state of the fishery (as measured by your indicators) and according to the decision control rules that are set. Technical measures are usually put in place for a longer period of time. For example, in many fisheries you cannot reasonably expect fishermen to change the mesh size of their nets every year. Just as with input and output controls, though, setting technical measures will still need good information based on careful stock assessments, including consideration of uncertainties, to ensure that the measures implemented achieve the relevant objectives.

Our example

In our example, we proposed in our goals to employ as many people as possible (social goal) within the limits imposed by maintaining the stock size above 50% of the unexploited level (biological goal) and achieving a minimum net income per fisher (economic goal). We need to find a combination of management measures that should in principle achieve all of these needs as far as possible. In this case, we might recommend as follows:

- use technical measures, such as restrictions allowing only small types of boats, to ensure that as many fishermen as possible have access to the fishery; and

- set catch or effort controls at the levels that our biological and economic models predict would deliver each of our goals as far as possible.

These management measures have been added to our summary management plan table in Table 10. You may also need to use some other measures to achieve the ecological goals (see Annex 3), but these ones should go some way towards achieving both the biological and socio-economic goals in this case.

It is important to note here that it is your *combination* of management measures and how they are applied that should enable you to achieve all of the different objectives. It is rarely the case that each goal is addressed solely by a different management measure – this is why we have merged the management measures across the three goals in our Table 10. In our example, we are using technical measures (on the *types* of vessels allowed) mainly to achieve the social goal while the biological and economic goals are both achieved by the catch or effort controls (e.g. controlling the *numbers* of vessels allowed). In some plans, you may also use technical measures (such as mesh sizes) to help achieve the biological goals.

The role of Stock Assessment tools (SA tools)

The use of SA tools at this stage in developing the plan should help you in deciding which management measures might offer the greatest benefits. This is a time when you need to work closely with your fisheries officers and scientists. The companion SA Guide shows in detail how your scientists should make such ‘strategic’ stock assessments and present analyses as ‘decision tables’ or in other ways to help you at this stage (see Chapter 5 of the SA Guide).

In our example, SA tools should be used to model the impact of allowing different catch quotas or effort levels. If you are focussing more on the technical measures or using an ‘analytical’ SA approach (see Section 2.2 of the SA Guide), you could use SA tools to predict the impact of different mesh sizes on the catch of immature fish and the numbers that would survive to spawn each year. A very large mesh size, for example, might protect all the young ribbon fish, but not catch enough fish to give a reasonable income to the fishermen. A very small mesh size on the other hand might catch too many immature fish. SA tools can help you to find the right mesh size or catch quota or whatever management measure you consider putting in place.

Don’t forget those participatory processes

It is also very important that you use participatory processes when deciding which management measures to use. This includes how the measures are to be implemented and monitored, and what actions might be taken if they are not working. Unless the participation process is right then the management measures you suggest might not be as successful as you hope.

If, for example, your SA modelling suggests the use of a particular management measure – such as a catch quota or the size of a net – then you should consult with the key stakeholders including the fishermen to check what impact they think that measure would have on their livelihoods and on the fish stocks. You should be prepared to change or modify your management measures in the light of their feedback, unless there are very good reasons for not doing so.

Table 10. Adding the management measures and decision control rules, showing how the plan is to be achieved

Goals	Objectives
Biological To maintain the ribbon fish stock at or above the levels necessary to ensure its continued productivity	To maintain the ribbon fish stock at all times above 50% of its mean unexploited level
Economic To maximise the net incomes of the participating fishers	To maintain net income per fisher at a level above the national minimum desired income
Social To maximize employment opportunities for those dependent on the fishery for their livelihoods	To include as many of the existing participants in the fishery as is possible given the biological and economic objectives above

Stage 10

Decision control rules

Decision control rules define which measures or levels of controls will be used depending on the state of the fishery (as measured by the indicators)

Once you have considered which management measures you think will work best in your fishery and for your specific goals, you will also have to decide which measures to use in different circumstances and what actual levels you should set for any controls.

If, for example, we propose to protect the reproductive capacity of the stock (see Example 3 in Annex 3), we might set a reference point to only allow a maximum limit of 20% of immature fish in the catch. However, if our monitoring shows that 25% of the catch contains immature ribbon fish, what action should we take? Would we have to take a different action if monitoring showed that 30% or 35% of the catch were immature ribbon fish?

To guide these decisions, we use what are called decision control rules or sometimes just control rules. These say when you will use each particular

Management standards		**Management measures**	
Indicators	**Reference points**	**Management measures**	**Decision control rules**
Current stock size, B_{now}, as estimated by the Schaefer production model using X data and Y fitting method	50% of the carrying capacity, K, as estimated by the Schaefer production model (i.e. above B_{MSY}) using X data and Y fitting method	Catch controls and/or effort controls, set at levels estimated by the production model that would maintain biomass above B_{MSY}. In combination with: technical measures, e.g. gear controls, allowing only low powered fishing vessels thereby employing larger numbers of fishers.	If current stock size, B_{now} is less than $B_{MSY,}$ then set next year's catch or effort to zero. If B_{now} is greater than $B_{MSY,}$ then set next years catch or effort to the level that should achieve the long term MSY. (See also alternative 'sliding scale' options below)
Net income per fisher measured using A data and economic model B	The national minimum desired income (e.g. US$10/day)		
Number of fishers employed in the priority fishing fleets	Number of fishers that would maintain biomass above B_{MSY} (i.e. f_{MSY}) and allow at least the minimum desired income per fisher		

management measure and in what circumstances. Control rules are usually triggered by particular situations in the fishery, measured by comparing our indicators with our reference points. In our example in Table 10, we use a simple 'on-off' control rule, where fishing is allowed if the stock size is above the MSY level predicted by our SA model, and the fishery is closed if the stock size falls below this level. This is illustrated in Figure 8. We realise this might not be popular with your fishermen, but it provides a simple example of how a control rule can work.

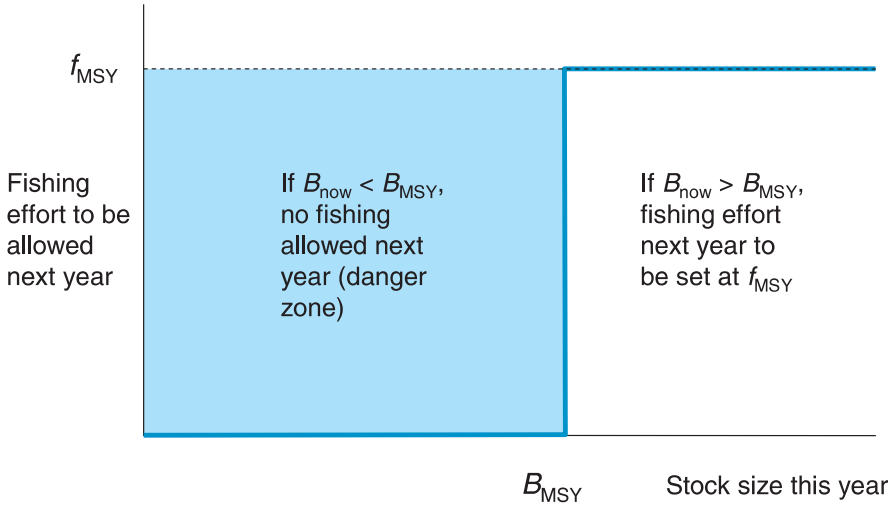


Figure 8. A simple example of a decision control rule, represented by the dark blue line, allowing a fishing effort level of f_{MSY} only if current biomass, B_{now} is above the limit reference point, B_{MSY}.

Table 11. Example of control rules in which different management measures are triggered by different levels of a selected fishery indicator - the % of immature fish in the catch

Percentage of immature ribbon fish in the catch	Decision Control Rule
20% or less	Management measure is working
Up to 30%	Introduce a mesh size limit of X cm
30 - 40%%	Increase the mesh size limit to X+5 cm
More than 40%	Introduce a closed area or closed season to protect the nursery grounds or the seasons in which juvenile fish are caught

To make the control rules more feasible, you could use a sliding scale of responses. In this case, the severity of the actions is increased gradually depending on the level of the indicator. Ways of doing this, for the example of controlling the numbers of immature fish are given in Table 11.

Figure 9 also illustrates the use of a gradual reduction in the allowable fishing effort level, as the biomass approaches the limit reference point. Control rules, indeed, are most commonly used for input and output measures such as this, defining how to react if the stock size (or any other indicator) appears to be falling beyond the limit that you have set. This is an example of taking a precautionary approach to avoid breaking a limit reference point (see also Figure 7). Other examples of graduated decision control rules are given in Annex 3, and in the section (5.2) about 'tactical' stock assessments in the SA Guide. As a final example, a short set of control rules from a real fishery management plan is given in Box 8.

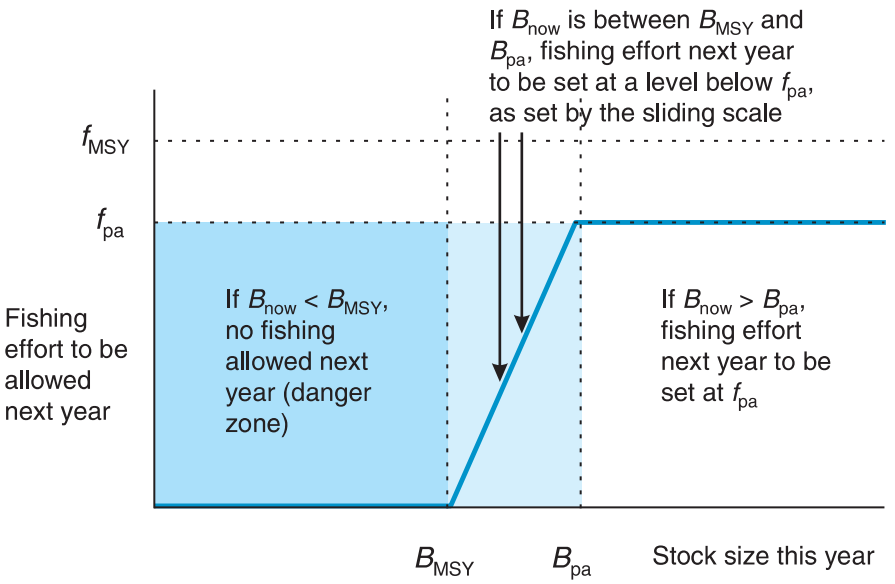


Figure 9. A decision control rule using a sliding scale to reduce next year's allowable fishing effort if current biomass, *B* (i.e. the stock size) is within the buffer zone between B_{MSY} and the 'precautionary' B_{pa}. Note that the allowable fishing effort level is also reduced in this example to a precautionary level, f_{pa}, below the limit value, f_{MSY} (see Section 2.5.4 in Hoggarth *et al*., 2005, for technical guidance on setting precautionary reference points)

Box 8. Decision control rules included in the Victorian abalone management plan

In the Australian management plan for the Victorian abalone fishery, the following statements define the possible actions to be taken when a 'trigger reference point' is broken in the fishery.

"Whenever a trigger reference point is reached the Minister will be notified. The Co-Management Fishery Committee will meet as a matter of urgency to determine its assessment and advice to the Minister. It will recommend one of the following actions:

- No immediate action taken but situation re-evaluated following observation of resource for another fishing year; or
- Immediate and intense investigation to clarify situation prior to further decisions and action; or
- Action taken which adjusts the Total Allowable Catch (TAC) and/or legal minimum length (LML) for the immediately following years, with the objective of restoring the mature biomass to above the trigger reference point within five years, or other actions as appropriate to achieve recovery from the trigger value with the minimum delay as practicable but not exceeding five years."

Source: Michael Sanders. Linking research and management through a fishery management plan. In FAO/RAP, 2002. http://www.fao.org/docrep/005/ac831e/ac831e00.htm.

e.g.

Thinking backwards

We have emphasised that writing a management plan is rarely a straight line process going neatly from one stage to the next (see Figure 2). Sometimes when you reach one stage, you will have to go back and reconsider decisions made in previous stages.

When you get to this stage in the planning process, i.e. to the right hand side of your own Table 10, you might want to think again about the management measures that you chose, or even reconsider your goals or objectives. Choosing these control rules and agreeing on them with your stakeholders is one of the most important, but most difficult parts of the planning process. Remember it is better to be flexible in the management planning stages, as far as you can be without violating the biological constraints, if that means that you achieve a plan in the end that most people can live with.

Stage 11

Finding the resources for your management plan

This is obviously a key point. You might develop a fantastic management plan but without the necessary resources it will remain just a plan on paper. You will need the following kinds of resources to implement the plan.

- *Budget* : Have you got enough money?
- *Staff* : Have you got enough staff – in the right places and with the right skills and qualifications?
- *Facilities* : Have you got the right technical resources and equipment?
- *Systems* : Have you got the right management structure and systems in place?

We put this towards the end of the planning process, but clearly you should have thought about this well before now!

If you haven't got these resources, then it is going to be difficult to deliver your management plan – no matter how good or how well written it is. The resources needed should be described in your plan. You might have considered some of them already if you did a SWOT analysis for your fishery (see Stage 3).

At this stage you may find it useful to create some organisational goals and objectives related to at least some of the resource areas listed above. Organisational objectives might relate to:

- staff recruitment and training – have you got a member of staff who is able to use and implement the stock assessment tools for example;
- the purchase of new technical resources, such as a research vessel or sampling equipment for surveying your fish stocks; and
- the development of new enforcement systems to ensure compliance with the rules.

Phase IV

Planning to implement, evaluate and review the management plan - How will you know you are there?

Having developed the basic structure of your management plan, you now need to give a bit more thought to the practical details and steps involved in implementing the plan. It is not the purpose of this guide to go into detail about this implementation phase, but your plan should include details on how it will be implemented and how you will monitor progress over time. This is where you say '*how will we know we are getting to where we want to go?*' This is covered briefly in the following three short sections.

Phase	Stages	
IV. Planning for implementing, monitoring and reviewing the management plan	***12***	**Implementation** Make an action plan to implement your management plan
	13	**Monitoring** Monitor regularly how well your plan is achieving your objectives
How will you know you are there?	***14***	**Reviewing** Review your plan every few years

Stage 12

Planning for implementation

For each of your management measures, you need to make a detailed plan of action saying exactly how they will be implemented. One way to plan these actions is to complete a planning form such as the example in Table 12 below. This breaks down each management measure into a number of specific tasks and for each task you should state – who is responsible for that task, when the task has to be completed, and who will check that the task has been done.

For each of your management measures, you need to make a detailed plan of action

Table 12. Examples of action plan steps towards limiting the mesh size of fishing nets.

Management measure	*Limit the mesh size on nets*		
Management plan goal(s)	***Biological goal*** *To protect the reproductive capacity of the fish stock by protecting the spawning stock*		
What tasks need to be done?	**Who should do it?**	**When should it be completed?**	**Who will check it has been done?**
Check current mesh sizes through survey of fishermen			
Consult with fisheries scientists to determine biologically optimum mesh size			
Hold a consultation meeting with fishermen – agree mesh size and implementation timescale (to allow new nets to be made)			
Publish information and make a poster explaining new regulation			
Enforce the new rules with l egislation as needed			
Check the regulation is being followed and enforce where necessary			
Review the regulation after checking the proportion of juvenile fish caught.			

e.g.

You should publish the final plan in forms suitable for a range of stakeholders

You should include these action plans in the management plan document itself, so that all stakeholders can see what you are doing and how the plan is intended to operate. This gives the plan some form of public accountability. Where some tasks are delegated to individual organisations, each of these stakeholders should be encouraged to make their own action plans related to their tasks. A management plan for a fishery should be a public document. Copies should be made available to stakeholders in forms that are convenient and appropriate to your situation.

Once you have produced your plan you should have a final consultation before putting the plan into action. It is also a useful idea to produce a summary of your plan for different target groups in easily readable forms such as a leaflet, booklet or poster.

Stage 13

Planning to monitor your plan

Monitoring is needed to provide feedback on the state of the fishery

There are two important reasons for monitoring. The first is to provide feedback on your indicators to make 'tactical' adjustments to management, as required by your decision control rules. The second is to check whether you are meeting your targets and if your plan is being successful or not. Monitoring data are used in the review process to help decide if your plan might need to be changed to improve the chances of success.

What should you monitor?

Your monitoring plan should be designed to collect data relating to the three blue headings in Figure 10.

In addition to monitoring your key indicators, you should monitor any changes in the situation. and how well you are carrying out the plan

Thinking back to your situation analysis (Stage 3), you need to monitor the situation in the fishery in case things are changing that might affect the success of your plan. For example, there might be new legislation related to fisheries or a new market opportunity for a type of fish in your waters, or some new fishing technology. These can affect your plan positively and negatively. A hurricane or tsunami in your area could change your situation dramatically for the worse.

You also need to monitor the inputs to your plan. If the expected inputs do not materialise, then it is unlikely that you will achieve your goals. For example, if your staff do not receive the stock assessment training they need, or if you do not get the budget or increase in staff you expected, you may need to change your expectations. Changes in inputs can also affect your plan positively and negatively.

Finally, you should collect data to re-estimate your indicators on a frequent basis. You may also need to update any reference points if you get new data or if things change in the fishery. These are the data that will tell you how to set your management measures, and whether or not you are on target to achieve your objectives and goals The monitoring programme should include the collection of any statistical data needed by the SA tools included in your plan.

Your management plan should state clearly how you will do all this monitoring. We do not cover this in detail here. Additional information on this

topic is available in the Adaptive Management Guidelines produced by FMSP project R8292 (see http://www.adaptivelearning.info/); and the Data Collection Guidelines produced by FMSP project R8462 (see http://www.fmsp.org.uk/r8462.htm). Detailed guidance on monitoring and the use of indicators has also been published by FAO (1998, 1999).

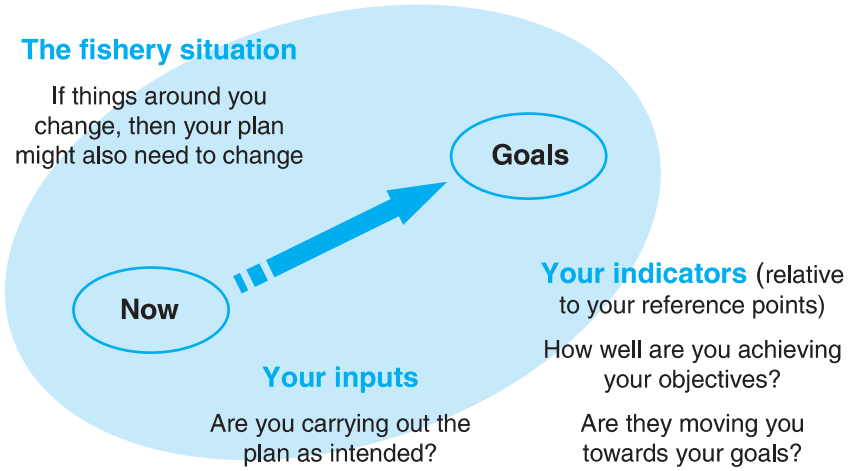


Figure 10. What do you need to monitor?

How often should you monitor?

Your plan should also state how often you will monitor. To some extent this will depend on the kind of data you are collecting and the resources that you have available with you for monitoring. Many plans are based on providing indicators and adjusting actions on an annual basis. In some cases though, you might need to provide monthly or even daily data, e.g. to set the closing date of a seasonal fishery closure. In general, when implementing any new management plan, the more frequently you can monitor the better. This will help you to make sure that you are on track, and if you are not – to put some new measures in place.

The results of the monitoring process should always be fed back to those implementing the plan so that they can amend their actions as necessary. You should also include meetings with fishermen and other stakeholders to get their feedback on the implementation of the plan.

Stage 14

Planning the review process

Monitoring and review are two words that are often used together – but they mean different things. Monitoring will provide the data that tells you if you are achieving your plan or not. A review is the process of looking back over the plan, making a critical examination of its success, and changing what needs to be changed.

We recommend plans of 3-5 years duration

You can develop a management plan for as long a period as you like, but experience has shown that a plan for more than five years is difficult to write, as predicting further ahead than this involves a lot of guesswork. Writing a management plan for less than a year is also not a good idea, because a worthwhile plan will probably take longer than this to implement and also you will not be able to see the results of your plan in such a short period of time. We recommend plans of 3-5 years duration.

Towards the end of your management plan period you should plan for a formal review of the successes and failures and at the same time start the process of developing a new plan. The review process can be undertaken internally or externally. It is obviously important for you to review the success of your plan yourself and conduct an internal review by your Fisheries Department and any partners. Having an external review of the plan may also be worthwhile. Firstly, external reviewers can be independent of any of the stakeholders in the fishery, and can hence look at data and feedback with a more critical eye and make more realistic assessments of successes and failures. Secondly, external reviewers may ask questions that those people working day to day with a fishery have not thought about asking. Finally, external reviewers often bring a wider experience of other fisheries with them and can therefore make original and creative recommendations that can be included in the next management plan.

You should be prepared to make changes to the plan every time you make a review

The review process should lead to a new management plan. The previous plan should be updated and all elements of the plan reconsidered in the light of the review and other changing circumstances. This does not mean that you have to start with a blank sheet of paper, and write a completely new plan, but it does mean that you should be prepared to look critically at the plan towards the end and be prepared to change.

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Annexes

Annex 1. Glossary of terms

This is a glossary of the main management terms used in this document. For terms that relate more to stock assessment please see the glossary in Annex 2 of the SA Guide, or the FAO web site glossary (http://www.fao.org/fi/glossary/default.asp). Many of the definitions below are taken from the FAO web site glossary.

For definitions of mathematical symbols, please see the FAO Fisheries Technical Paper 487 (Hoggarth *et al*., 2005).

Adaptive management	Adaptive management attempts to reduce uncertainties over time in a structured process of 'learning by doing'. Management actions are used or interpreted as experiments to learn more about the resource system at the same time as it is being managed. New knowledge is generated by the deliberate use of learning processes instead of sticking to rigid technical solutions that may be sub-optimal. In an adaptive approach, some areas may be deliberately heavily exploited to determine the response of the stock, while other areas are kept as reserves or only lightly exploited to reduce the risk of over fishing on the overall stock. See FMSP Project R8292 guidelines at http://www.adaptivelearning.info/.
Capacity (Management)	Resources available to different stakeholders, including suitably trained and experienced people, funding, rights to manage, and motivation.
Carrying Capacity	Represents the point of balance between reproduction potential and environmental resistance that is the maximum population of a species that a specific ecosystem can support indefinitely without deterioration of the character and quality of the resource. According to the MSY model, an exploited population reduced in size from its initial carrying capacity will tend to rebuild back towards this level.
Decision control rules	Rules agreed with stakeholders in advance that govern the management of a fishery, e.g. by defined adjustments to management measures in response to observed annual levels of the fishery indicators relative to the reference points. Recognising potential trade-offs between goals, decision control rules define the priorities that are given to different objectives.

Ecosystem Management	The management of ecosystems and natural habitats to meet human requirements to use natural resources, whilst maintaining the biological richness and ecological processes necessary to sustain the composition, structure and function of the habitats or ecosystems concerned.
FMSP	Fisheries Management Science Programme, of the UK Department for International Development (DFID). See www.fmsp.org.uk.
Goals	The broad aims or purposes of managing the fishery – may either be desired benefits and undesired costs. Their specification can be facilitated by putting them in the context of, "All else being equal, we would like to maximize/minimize …". Although most of these statements will be non-controversial, 'all else' is usually not equal and prioritisation among them may be difficult. Noting that different systems use different terminologies, this guide recommends the definition of goals and/or objectives in each of four or five main dimensions, such as biological, ecological, social and economic.
Indicator	A specific state, or variable, which can be monitored in a system (e.g. a fishery) to give a measure of the state of the system at any given time. In fisheries management, each indicator would be linked to one or more reference points and used to track the state of the fishery in relation to those reference points.
Input / output controls	See management measures.
Limit reference point	A reference point used as a limit in a decision control rule framework is a point that it would be dangerous or undesirable to go beyond. It may either be an upper limit (e.g. in the case of fishing mortality rates) or a lower limit (e.g. in the case of a minimum viable spawning stock biomass). Commonly used in combination with *precautionary reference points* to avoid being exceeded. *Cf. target reference point.*
Livelihood	Livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain and enhance its capabilities and assets both now and in the future, while not undermining the natural resource base.
Management measures	Specific controls applied in the fishery to contribute to achieving the objectives, including some or all technical measures (gear regulations, closed areas and/or closed seasons), input controls (on fishing effort), output controls (on catches) and any access rights designed around the input and output controls.

Management plan	A formal or informal arrangement between a fishery authority and other fishery stakeholders that identifies the partners in the fishery and their respective roles; details the goals and objectives agreed for the fishery (including their prioritisation); specifies the management rules and regulations that apply to it and provides other details about the fishery that are relevant to management.
Management standards	A 'catch-all' term for the elements of the management system that are *quantified*, either fully or partially, including the objectives, indicators and reference points, that guide management, and enable stakeholders to measure and judge the effectiveness of the system.
Mortality rates	The rate at which the numbers in a population decrease with time due to various causes. To facilitate calculations, scientists express mortality as an exponential or 'instantaneous' rate, where $N_t/N_0 = e^{-Zt} = e^{-(M+F)t}$ in which N_t/N_0 is the survival rate; M is the natural mortality rate (of deaths due to predation or disease); F is the fishing mortality rate (deaths due to fishing); Z is the combined total mortality rate; and t is time (see also Box 1 about the fishing mortality rate in the SA Guide).
Objectives	Statements that define quantify and prioritise the fishery goals, in terms of four key elements: 'verb' – 'objective' – 'relation to' – 'reference point'. Such statements should quantify the hierarchy of objectives and resolve any implicit trade-offs between them. Referred to as 'operational objectives' in some texts (e.g. Cochrane, 2002), reflecting their key role in re-expressing the goals in practical, compatible terms.
Precautionary approach	One that recognises the uncertainties in our knowledge of the system (e.g. the natural productivity of the stocks, the true values of reference points, the current size of the stock and the effect of future management actions), and adjusts management actions accordingly.
Precautionary reference point	Reference points used as thresholds for action to avoid the risk of going beyond limit reference points, at which irreversible damage may be done to the stock. They should be set at levels which reflect both the degree of uncertainty in the assessment, and the level of risk tolerance of the managers and/or other stakeholders.

Prioritisation (of objectives)	The process of deciding which objectives need to be satisfied first and which should be satisfied only after the others are met. Recognising the limits imposed by the natural productivity of the resource, and the need to ensure *sustainable* development, first priority should be given to the biological objectives. Where priorities differ between stakeholders, a quantitative process may be needed to help with prioritisation.
Reference point	A specific value of an indicator, used as a guide in fishery management (see also *technical, target, limit* and *precautionary reference points*)
Risk	The chance of something bad happening, e.g. expressed as the expected frequency of its occurrence over a stated number of y]ears.
Stakeholder	Any individual, group, organization or sector in society that has a clearly identifiable interest in (or influence upon) the outcome of a policy or decision-making situation. The interest may be in the form of a specific management responsibility, a commercial interest (resource supply, revenue, employment, trading activity), a subsistence need, or some other benefit.
Stock Assessment (SA)	The process of collecting and analysing biological and statistical information to determine the changes in the abundance of fishery stocks in response to fishing, and, to the extent possible, to predict future trends of stock abundance depending on alternative management options.
Stock assessment tools (SA tools)	Mathematical fishery models, software packages, or sets of guidelines that assist scientists to assess the state of a fish stock and the likely implications of alternative management actions.
Strategic stock assessments	Estimate both indicators and reference points, and may also use long-term projections and risk assessments, and thereby assist managers to choose between different management measures or levels of controls.
Tactical stock assessments	Provide short term ‘operational’ or ‘tactical’ advice to managers on the current state of the fishery system, as measured by the selected indicators, and any adjustments required to the management measures (usually input or output controls) to achieve the objectives.

Target reference point	A reference point used as a target in a decision control rule framework is a point to aim at. Actual values of the indicator slightly above or below the target are both acceptable. *Cf. Limit reference point.*
Technical reference points	Estimated values derived from agreed scientific procedures and/or models corresponding to a defined state of the resource and/or of the fishery, and used as a guide for fisheries management. Some reference points are general and applicable to many fish stocks (e.g. the MSY catch or the $F_{0.1}$ fishing mortality rate), others could be stock-specific (e.g. an average catch per unit effort of X tonnes, taken by vessel type Y using standard gear type Z). Some reference points explicitly specify the risks of defined undesirable events occurring.
Uncertainty	The incompleteness of knowledge about the state or process of nature: including the true values of reference points and other population parameters, and the relative importance of internal and external influences on the fishery resource.
Unit stock	A group of individuals in a species occupying a well defined spatial range, independent of any other stocks of the same species, that can be regarded as a single 'unit' for management or assessment purposes.

Annex 2. Links to useful internet sites

Examples of fishery management plans (see also the examples in the text)

For the small-pelagic fisheries of the west coast of peninsular Malaysia
http://www.fao.org/DOCREP/FIELD/006/X9214E/X9214E00.HTM

For the US Pacific Fishery Management Council.
www.pcouncil.org

FMPs of the US North Carolina Division of Marine Fisheries.
http://www.ncfisheries.net/fmps/index.html

Other examples of fishery management plans and links to useful web sites are given in David Die's Chapter 9 of FAO's Fishery Managers Guidebook (Die, 2002)
http://www.fao.org/docrep/005/y3427e/y3427e00.htm

FAO FishCode website

Established as a special programme of global partnerships to promote responsible fisheries.
http://www.fao.org/fi/fishcode.htm

FAO Fisheries Department Library

http://www.fao.org/fi/eims_search/publications_form.asp

FAO/SIFAR oneFish website

A fishery projects portal and participatory resource gateway for the fisheries and aquatic research and development sector.

http://www.onefish.org/

DFID Fisheries Management Science Programme (FMSP)

For downloads of SA Tools software, other useful guidelines and technical reports from all of the FMSP projects.
http://www.fmsp.org.uk/

Project R8292 Adaptive Learning Guidelines.
http:// www.adaptivelearning.info/

Project R8462 Data Collection Guidelines.
http://www.fmsp.org.uk/r8462.htm

Projects R8397/R8464 ParFish Toolkit and Software.
http://www.fmsp.org.uk/ r8464.htm

Annex 3. Example management plans for different goals and objectives

This annex provides examples of biological, ecological, economic and social fishery goals along with related objectives, management standards, measures and decision rules that may form the basis of management plans. It is important to note that these are just examples. The list is not exhaustive – many other goals and plans are possible. The examples have been partly selected to show where different stock assessment tools may be used to estimate the selected indicators and reference points (e.g. compare Examples 1 and 2).

This guide has highlighted the fact that biological, ecological, economic and social goals must be compatible with each other. It is the prioritisation of the goals that determines their relative importance, and defines precisely how

the management measures and control rules are applied to manage the fishery and achieve the different priorities. The full set of goals should therefore *always* be considered together – it is never appropriate to consider each goal in isolation.

Whatever the economic and social goals, it is the biological capacity of the resource that limits the level of exploitation. You must keep this in mind in prioritising your goals

We have also emphasised that whatever the economic and social goals may be, it is the biological capacity of the resource that limits the level of exploitation. Fishing cannot go beyond the biological limits of exploitation of the stock – if it does, *all* goals will ultimately be threatened. The social and economic goals, however, will have an influence over the selection of the biological reference points. If, for example, maximum catches are required then the biological reference points should relate to the MSY point. If maximising catch is not a priority, alternative reference points could be selected. You should also remember the need for precaution in setting your reference points and managing the fishery, although this is not specifically mentioned in the following examples, until the final ParFish Example 7.

In the examples below, we start by considering the biological goals that limit the level of exploitation together with common economic and social goals (Examples1-3). We then look at how ecological goals may further limit exploitation and affect management measures (Examples 4 and 5). Finally we look briefly at economic goals (Example 6) and emphasise how social objectives should be included in the plan.

The examples thus cover the situations in Table 13 below. As in the detailed examples, 'greyed-out' text is used in this summary table to distinguish the main differences between the examples.

Table 13. Comparison of the main features of the management plans given in the examples

Example	Fishery	First priority goal/s	Secondary goal/s	Assessment approach (see SA Guide)
1.	Single species	Biological (overall stock size)	Economic and social	Biomass dynamic (e.g. CEDA / ParFish)

2.	Single species	Biological (overall stock size)	Economic and social	Analytical (e.g. LFDA and Yield)
3.	Single species	Biological (spawning stock size)	Economic and social	Analytical (e.g. LFDA and Yield)
4.	Multi-species	Biological (target species) and ecological (by-catch species and habitat)	Economic and social	Analytical or biomass dynamic for target species. No model for ecological goals
5.	Multi-species	Biological and ecological	Economic and social	Analytical for both target and by-catch species.
6.	Multi-species	Biological and ecological	Economic	Analytical approach including economic sub-model.
7.	Single species	Biological (overall stock size)	Fisher's preferences	Biomass dynamic (ParFish)

Example 1. A summary management plan for a typical set of biological, economic and social goals for a single species fishery, managed using a biomass dynamic stock assessment approach (see main text for development of this example)

This first example is based on the one given by Cochrane (2002), excluding the multi-species, ecological goals (see Examples 4 and 5 below on how these could be included). Note how the selection of management measures

Goals	Objectives	Management standards	
		Indicator	Reference points
Biological To maintain the target species at or above the levels necessary to ensure their continued productivity	To maintain the stock at all times above 50% of its mean unexploited level	Current stock size, B_{now}	50% of the carrying capacity, K, as estimated by the Schaefer production model (i.e. above B_{MSY}) using X data and Y fitting method.
Economic To maximise the net incomes of the participating fishers	To maintain net income per fisher at a level above the national minimum desired income	Net income per fisher	The national minimum desired income (e.g. US$10/day)
Social To maximize employment opportunities for those dependent on the fishery for their livelihoods	To include as many of the existing participants in the fishery as is possible given the biological and economic objectives above	Number of fishers	Number of fishers that would maintain biomass above B_{MSY} (i.e. f_{MSY}) and allow at least the minimum desired income per fisher

Note: Subscript 'NY' indicates 'next year', i.e. C_{NY} = next year's catch quota; f_{NY} = next year's allowable fishing effort.

and the prioritisation of objectives enable the simultaneous achievement of the potentially conflicting goals as far as possible. The biological and social indicators and reference points here could be estimated using CEDA or ParFish or other biomass dynamic approaches. Additional economic analyses would be needed to estimate the net income (profit) per fisher as the economic indicator.

Management measures	
Management (or control) measures	**Decision control rule**
Catch controls (e.g. individual quotas or Total Allowable Catch etc) and/or **Effort controls**, each set at levels estimated by the production model. In combination with: **Technical measures**, e.g. gear controls, addressing the social and economic goals. In this example, the social goal (see left) could be achieved by technical measures allowing only low powered fishing vessels employing large numbers of fishers (instead of fewer, higher powered vessels).	Either simple or complex rules may be used (see Example 2 for a more complex rule). e.g. Simple rule • If $B_{now} < B_{MSY,}$ then set C_{NY} to 0 (i.e ban all fishing until B recovers to at least B_{MSY}) • If $B_{now} > B_{MSY,}$ then set C_{NY} to MSY (or set f_{NY} to f_{MSY} if using effort controls). Note that the decision rule ensures the achievement of the biological goal ensuring the sustainability of the resource as the first priority of the fishery. The biological standards are a limiting factor within which the social and economic objectives must be achieved as best as they can (i.e. optimised) through the choice of appropriate control and technical measures.

Example 2. A summary management plan for a typical set of biological, economic and social goals for a single species fishery, managed using effort controls and an analytical stock assessment approach

In this example, the 'greyed-out' text shows elements of the plan which are the same as in the previous Example 1. New or different text is shown as

Goals	Objectives	Management standards	
		Indicator	Reference points
Biological To maintain the target species at or above the levels necessary to ensure their continued productivity	To maintain the stock at all times above 50% of its mean unexploited level	Current fishing mortality rate, F_{now}	$F_{50\%B0}$ (or F_{MSY}) based on YPR analysis.
Economic To maximise the net incomes of the participating fishers	To maintain net income per fisher at a level above the national minimum desired income	Net income per fisher	The national minimum desired income (e.g. US$10/day)
Social To maximize employment opportunities for those dependant on the fishery for their livelihoods	To include as many of the existing participants in the fishery as is possible given the biological and economic objectives above	Number of fishers	Number of fishers that that would give a fishing mortality rate of $F_{50\%B0}$, and allow at least the minimum desired income per fisher

normal black text. The biological and social indicators and reference points in this analytical approach could be estimated using the FMSP LFDA and Yield software.

Management measures	
Management (or control) measures	**Decision control rule**
Effort controls (e.g. controls on number or power of vessels, or on gear etc, as required to achieve the reference point $F_{50\%B0}$) In combination with: **Technical measures**, e.g. minimum fish size limits or mesh size limits, set at a level that would maximise the allowable *F*, YPR, yield or profit (profit may be maximised with a larger size limit if larger fish are higher in value than smaller ones) Technical measures could also be used as in Example 1 to achieve the social goal by allowing only low powered fishing vessels employing large numbers of fishers (instead of fewer, higher powered vessels)	**e.g. Simple rule** • If $F_{now} > F_{50\%B0,}$ then set F_{NY} to 0 (i.e ban all fishing for a specified time) **e.g. More complex rule** • If $F_{now} > F_{50\%B0,}$ then set F_{NY} to $0.9F_{now}$ each year until F_{now} d" $F_{49\%B0}$ (i.e gradually reduce effort towards the target level) • If $F_{now} < F_{50\%B0,}$ then set F_{NY} to $1.1F_{now}$ (each year) where $1.1F_{now}$ d" $F_{49\%B0}$ (i.e. if desirable, increase effort up to, but not exceeding the maximum possible – here increasing by 10% per year)

Example 3. A single species management plan illustrating possible management standards and measures for a biological goal related to protection of the reproductive capacity of the stock

In this example, two objectives are expressed towards achieving the biological goal. In the first objective, note that we do not know exactly what percentage of juveniles in the catch (here given as 'X%') could be allowed without endangering the fish stock. This would vary with the biological characteristics of each species. sIt would need to be initially estimated from any scientific data available, and then adjusted in future with feedback from the fishery. Nevertheless, since size controls are commonly applied to limit the catch of juvenile (or undersized) fish and protect spawning potential, they are relevant to this example. Stock assessment tools would not be

Goals	Objectives	Management standards	
		Indicator	Reference points
Biological To protect the reproductive capacity of the fish stock by protecting the spawning stock	To limit the percentage of immature fish in the catch to X% of the total at all times	Percentage of the total number of fish in the catch that are < L_{m50} (the mean length at maturity)	X% Note that both of the reference points are used here as limits, not targets
	To maintain the SSBPR at all times above 30% of its mean unexploited level	F_{now}	$F_{SSBPR30\%}$
Economic and social goals e.g. as in Examples 1 and 2.			

required to monitor the first objective, but biological data would be needed to estimate the size at maturity and length frequency data would be needed to estimate the indicator percentages each year. The indicator and reference point for the second objective could be estimated using the LFDA and Yield software. A 'per-recruit' reference point as used here would be easier to estimate (lower data requirements) than an absolute one requiring stock size and recruitment data (see SA guide).

For the sake of simplicity, economic and social goals have not been given in detail below. As in the previous examples, the prioritisation of these goals would determine precisely how the management measures would be applied, within the biological constraints given here.

Management measures	
Management (or control) measures	**Decision control rule**
Technical measures, e.g.: Closed nursery areasSize controls (fish size and/or mesh size limits) Seasonal closures at times when juveniles recruit to fishing grounds.	If % of juveniles in the catch approaches or exceeds X% of the total catch, increase severity of technical management measures (e.g. increase size limit by a specified amount, enlarge closed area, or extend seasonal closure)
Effort controls, e.g. limiting fleet size or vessel power, or fishing days to a level that should deliver the reference level of *F* If an analytical model is used here, such effort levels should be adjusted for the adopted levels of the **technical measures** (the actual levels of *F* that deliver 30%SSBPR vary with size at selectivity and seasonality)	• If $F_{now} > F_{SSBPR30\%,}$ then set F_{NY} to 0 (i.e. ban fishing until SSB recovers) § • If $F_{now} < F_{SSBPR30\%,}$ then set F_{NY} to 1.1 F_{now} (each year) where $1.1F_{now}$ d" $F_{SSB30\%}$ (if desirable)

Annex 3 (continued). Considering ecological goals

In examples 1-3, for reasons of simplicity, we left out ecological goals. Even in a single species fishery, however, there will often be some by-catch of non target species, or there may be habitat destruction due to inappropriate fishing practices etc. The biological goals define the limits of exploitation for the main target species in the fishery. However, if ecological goals are also to be taken into account, additional measures should be used such as given in the following two examples.

In Example 4 below, simple or 'common sense' technical measures are added to the plan to attempt to reduce by-catches and limit destructive fishing. In this case, the ecological goal is just to *limit* the impacts of fishing activity to some reasonable levels. This may be appropriate where social and economic objectives are given priority, and where some ecological impacts are accepted as inevitable but reduced as far as possible. No detailed stock assessments are required for the by-catch species in this case, but the ecological indicators would still need to be monitored carefully.

Example 4 suggests the use of management zones as a way of ensuring some level of environmental (ecological) protection. The use of protected areas within a zoned fishery allows for 'reserve' areas where full habitat and biodiversity protection occurs. Other areas may also be used with different regulations and varied levels of protection. There is a large and evolving

Example 4. Simple ecological objectives and management measures that could be

Goals	Objectives	Management standards	
		Indicator	**Reference points**
Ecological To limit ecological impacts as a result of fishing activity to local, acceptable and reversible change	To limit the percentage of by-catch species in the catch to Y% at all times	Percentage of by-catch (non-target) species in the catch	Y%, set at a level agreed as acceptable by local stakeholders
	To prevent destructive fishing practices	Indices of habitat quality and gear-related damage	Relevant levels as set from baseline survey
Biological, economic and social goals e.g. as in Examples 1 and 2.			

literature on protected areas in fishery management that should be referred to here (see e.g. Hall, 2002 and Hilborn *et al.*, 2004). Outside any protected areas, other technical measures such as those suggested in Example 4 could be applied to limit ecological impacts.

In Example 5, *F*-based reference points are set for both the target and the by-catch species. In this case, technical measures are still used, but fishing effort may also be adjusted in response to low levels of the by-catch species, even if that means that the *target* fishery may be slightly under-exploited. This approach would require separate stock assessments for each main species in the fishery. Chapter 12 of FTP 487 provides guidance on identifying the *most vulnerable* species in the fishery – these may be used to set *F* levels which should then give protection to all species. Management plans for Antarctic fisheries use this general approach, emphasising the high priority given to the ecological goals (see CCAMLR web site: http://www.ccamlr.org/).

Chapter 12 of FTP 487 also gives guidance on the choice of 'indicator species' appropriate for other economic, social and ecological goals. If economic returns were prioritised, for example, then the indicator might be the *most valuable* species. Normally, whilst effort levels may be set for the indicator species, monitoring should still continue for each important species, and to the total catch of the multi-species complex.

added to the single species examples 1-3

Management measures	
Management (or control) measures	**Decision control rule**
To the above management measures (Examples 1-3), we could now add: **Technical measures (e.g.)** Management zones (marine protected areas / river fishery reserves) Selective closed areas or seasons Size controls to limit capture of non target species Exclusion or escape devices (e.g Turtle exclusion devices - TEDs) Gear controls designed to prevent destructive fishing impacts	In this simple example we have not defined biological indicators for non target species, so the fishery control rules still apply mainly to the target species. We are thus addressing the ecological objective only by selecting appropriate technical management measures. A feedback-based control rule could alternatively be used as in Example 3, e.g.: • If by-catch % exceeds Y%, increase severity of technical measures or add new measures.

Example 5. A management plan for a multi-species fishery with a main target species and one or more other by-catch species that are also given priority over the economic and social goals

Greyed-out text in this table is the same as in the single species Example 2. In this example, both the target and non-target species require stock

Goals	Objectives	Management standards	
		Indicator	Reference points
Biological To maintain the target species at or above the levels necessary to ensure their continued productivity	To maintain the target fish stock at all times above 50% of its mean unexploited level	Current fishing mortality, F_{now}, of the target species	$F_{50\%B0}$ (or F_{MSY}) of the target species based on YPR analysis
Ecological To minimise the impacts of fishing on non-target (bycatch), associated and dependent species	To maintain all non-target, associated and dependent species above 50% of their mean biomass levels in the absence of fishing activities	Current fishing mortality, F_{now}, of the non target or dependent species, that are most vulnerable to fishing	$F_{50\%B0}$ (or F_{MSY}) of the non target or dependent species, that are most vulnerable to fishing
Economic and social goals e.g. as in Examples 1 and 2.			

assessments, e.g. using analytical methods (LFDA/Yield software). The example assumes that management adjustments to the effort controls would apply equally to the target and non-target species.

Management measures	
Management (or Control) measures	**Decision control rule**
Effort controls (e.g. controls on number or power of vessels, on gear etc, as r equired to achieve the reference point *F*) **Technical measures** e.g. as in Example 4 In this case, management standards are set for both the target and the non target species. The same management measures could be used as in previous examples, but the control rules allow restriction of the fishery if F_{now} approaches the reference point for *either* the target or non-target species. In practice, if the indicator for the by-catch species approaches the limit value, it may first of all trigger a review of possible technical measures. If these can not be adjusted to control by-catch, then effort controls may still be necessary to protect the by-catch species.	**For Target species:** e.g. the simple or complex rules specified in Examples 1 or 2 may be used, or others. **For Non-target species:** • If $F_{now} < F_{50\%B0}$, no action required • If $F_{now} > F_{50\%B0}$, then review management measures (can by-catch be controlled through improved technical measures?) • If $F_{now} > F_{50\%B0}$ and no further technical measures are possible, then set F_{NY} to $0.9F_{now}$ each year until F_{now} d" $F_{49\%B0}$ (i.e gradually reduce effort towards the target reference point for the non target species)

Annex 3 (continued). Considering economic and social goals

As shown in Examples 1-3 above, the biological sustainability of a fishery defines the limits to catch or effort that may be applied. Example 5 showed how a prioritised ecological goal can further restrict the limits to catch or effort that may be applied in the target fishery. As we said earlier, although these biological and ecological goals thus set the limits to exploitation, the relative prioritisation of the social and economic goals will define what management measures are most appropriate and how best to apply them. We will now look briefly at economic and social goals, and give two final examples of how these may be included in the plan.

Economic goals may include the following:

- To maximise the net incomes of the participating fishers;
- To increase revenues from the recreational fishery;
- To reduce imports;
- To increase foreign exchange;
- To facilitate economically efficient commercial fisheries production;
- To encourage fisheries investment within the fishery by contributing to a positive investment climate and maintaining market access.

Some of these goals, such as the last one, do not require stock assessment analyses to monitor. Economic indicators would instead be used to evaluate the success of the management measures, such as the amount of investment. However, stock assessments would still be required to advise on the level of investment in the fishery that is appropriate (i.e. the maximum viable number of fishing vessels or effort).

In Example 6, the goals are achieved by using catch/effort controls and technical measures as with the other examples. Other measures may also be relevant here such as price controls, tax incentives etc, both for their economic benefits and to encourage targeting of particular species in the fishery.

Both the CEDA and Yield software are based on biological models, not economic ones. In considering economic goals, you may also like to try out another FMSP tool, developed by the 'Control of Foreign Fishing' project (see http://www.fmsp.org.uk/r8463.htm). This uses a bio-economic spreadsheet game to give guidance on how economic benefits may be maximised by developing licensing and monitoring, control and surveillance (MCS) strategies for foreign fishing vessels.

Some examples of social goals are given below (others are listed by FAO, 1999).

- To maximise employment opportunities for those dependent on the fishery for their livelihoods;
- To maximize benefits to all stakeholders;
- To minimize conflicts between artisanal, industrial and/or sports fisheries;
- To recognise the rights of other users of the marine environment consistent with the Government policy;
- To facilitate maximum benefit to the community where there is private commercial use of a common pool resource.

The first goal in the list was included in each of Examples 1 to 5 above and will often be a high priority. For some social goals, non fishery indicators and reference points will be required. You will need to determine how far the fishery can be expected to meet social objectives, and the roles that may also be played by other development sectors (e.g. in developing alternative livelihood options). As with ecological goals, there is often a need for integrated management approaches in order to achieve these goals.

Finally, Example 7 below shows how the ParFish software could be used to help achieve socio-economic goals as measured by the fishers' 'preferences' for alternative levels of fishing effort and catch. Example 7 also shows how uncertainty and precaution can be explicitly included in the management plan by including risk explicitly in the definition of the reference point.

Example 6. A summary management plan aimed at producing the Maximum Economic Yield (MEY) from the fishery while also recognising the biological and ecological constraints

Goal	Objective	Management standards	
		Indicator	**Reference points**
Biological To maintain the target species at or above the levels necessary …	To maintain the target fish stock at all times above 50% of its mean unexploited level	Current fishing mortality, F_{now}, of the target species	$F_{50\%B0}$ (or F_{MSY}) of the target species based on YPR analysis
Ecological To minimise the impacts of fishing on non-target … species	To maintain all non-target species above 50% of their mean unexploited biomass levels	Current fishing mortality, F_{now}, of the most vulnerable non target species	$F_{50\%B0}$ (or F_{MSY}) of the most vulnerable non target species
Economic To maximise the net economic return from the fishery	To achieve maximum economic return from the target species	Current fishing mortality, F_{now}, of the target species	F_{MEY} of the target species based on YPR analysis including bio-economic inputs
Social To maximise the benefit to the community from common pool resources	To generate maximum employment opportunities in the processing and marketing sectors	Number of people employed in fishing support service industries	A target figure for employment numbers could be set here.

Management measures	
Management (or control) measures	**Decision control rules**
Effort controls (e.g. controls on number or power of vessels, on gear etc, as required to achieve the reference point *F*) set here at levels estimated by a bio-economic analysis. In combination with: **Technical measures** addressing the ecological social and economic goals, e.g.: • Size controls • Closed areas or seasons • Gear controls to prevent destructive fishing practices Note that in this case, it will be necessary to monitor and evaluate indicators/reference points related to the economic and biological goals of the fishery and for the non target species for ecological goals. The control rules are based on feedback from all of these. Management actions related to the social goal will relate to creating the right enabling environment to achieve employment opportunities.	**For the economic goal:** • If $F_{now} < F_{MEY}$, then increase fishing • If $F_{now} > F_{MEY}$, then decrease fishing (complex rules similar to those in the other examples could also be used) **For the biological goal:** F_{MEY} should always be less than $F_{50\%B0}$ or F_{MSY}, so the economic control rule should also satisfy the biological goal (this should be confirmed) by the analysis **For the ecological goal, for the non target species:** • If $F_{now} < F_{50\%B0}$, no action required • If $F_{now} > F_{50\%B0}$, then review management measures (can by-catch be controlled through improved technical measures?) • If not, use direct controls on catch or effort as in Example 5 above.

Example 7. A summary management plan based on a ParFish stock assessment, aimed at maintaining or improving productivity for a small scale fishery which has little stock assessment data and no direct access to scientific research

This example differs from the examples above in that uncertainty is taken into account explicitly in the definitions of the reference points. This plan could be implemented using the FMSP ParFish approach to stock assessment and management (see SA Guide, Annex 5). In this example, the lack of information on a fishery is reflected in the simplicity of the indicator (the same indicator is used both for the socio-economic and biological objectives), and by explicitly integrating the monitoring with the management through an adaptive and precautionary management approach. With little historical information, it is likely that the initial control measures will prove not to be the exact levels required to reach the stated goals. This leads

Goal	Objective	Management Standards	
		Indicator	Reference Point
Biological To maintain the target species at or above the levels necessary to ensure their continued productivity.	To maintain the target fish stocks above 50% of its expected unexploited level with a defined level of risk.	Current CPUE ($CPUE_{now}$)	$CPUE_{limit}$ having a 20% chance that the stock biomass will fall below B_{MSY} (i.e. 50% of the unexploited level) in the long term, as estimated by ParFish
Socio-Economic To maintain or improve social and economic benefits for fishers.	To maintain fishers' utility (i.e. preference score) at or above the target level.	Current CPUE ($CPUE_{now}$)	$CPUE_{target}$ that gives the maximum expected preference score; that is the attainable CPUE which will maximise the expected preference of the fishers.

management to treat indicators not as exact measures of the state of the fishery, but as information on which management can decide on actions with considered risks. With more and better scientific information, it may be possible to move fishery management towards Examples 1-6 above. However, unless it is planned to subsidise the scientific work, small scale fisheries management will usually be based more on risk management than on absolute control. With ParFish, the socio-economic objectives can be included as in this example, by interviewing fishers to find out their 'preference scores' in terms of possible future changes in their income (catch) and the amount of work they have to do to (effort). With this information, the overall preference score or 'utility' for all of the fishers can be predicted for different management options (see SA Guide, Annex 5 and ParFish Toolkit available at www.fmsp.org.uk).

Management measures	
Management (or control) measures	**Decision control rules**
Effort controls (e.g. controls on number of vessels and/or vessel activities such as a closed season) set here at levels estimated by a ParFish. **Stock refuge** (closed area, particularly where young and immature fish are captured) protects a small percentage of the stock from exploitation. **Adaptive co-management** through collecting and monitoring performance through an assessment cycle conducted by stakeholders.	**e.g. Simple rule** • If $CPUE_{now} < CPUE_{limit,}$ then set f_{NY} to 0 (i.eban all fishing until test fishing suggests Bhas recovered to at least B_{MSY}) • If $CPUE_{now} > CPUE_{limit}$, then set f_{NY} to f_{target} (this may be adjusted by ParFish for the percentage of the fishing area that is effective as a 'refuge' – see SA Guide, Annex 5) Risks identified in ParFish assessments can be reduced by improved data inputs. If the $CPUE_{limit}$ is highly restrictive, management controls may also be deliberately set to test current management and improve information. For example, monitoring the recovery of fish stocks inside effective closed areas (refuges) may provide good information on productivity, even if they are not expected to help meet the socio-economic goal.

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