parfish

PARTICIPATORY FISHERIES STOCK ASSESSMENT

Synthesis Document

Fisheries management decisions with limited resources and data

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The aim of this document is to:

Draw attention to the importance of small-scale fisheries and the need for information-based management;

Raise awareness about ParFish, a new methodology for carrying out stock assessments in small-scale fisheries that does not rely on long-term data, involves fishers in the assessment and promotes co-management;

Outline recommendations for managers, policy makers, scientists and facilitators, to improve information-based management decisions for small-scale fisheries.

This document is aimed at:

Fisheries decision-makers, scientists, managers and facilitators, including government and non-government organisations.

Contents:

Summary

Fisheries management decisions with limited resources and data

Key points:

- *Small-scale fisheries are important to livelihoods but often lack resources for information collection and management;*
- *ParFish is a new approach to stock assessment that is suitable for small-scale fisheries and promotes participation and co-management*
- *More information and the ParFish Toolkit can be obtained from www.fmsp.org.uk*

Fisheries play a vital role in the livelihoods of millions of people and provide the main source of animal protein for nearly one billion people, predominantly in developing countries. An estimated 100 million people depend on fishing, many of them among the world's poorest, and small-scale fisheries are particularly important for employment and income generation in rural areas.

The valuable contribution that small-scale fisheries make to people's livelihoods and the economy are often not taken into account, resulting in many small-scale fisheries being under-represented in fisheries policy and lacking the resources required for effective management. Information is key to sound policy making and responsible fisheries management, to maximise the benefits that fisheries can provide to livelihoods and the economy. The FAO Strategy for Improving the Status and Trends of Capture Fisheries highlights the need for improving data and information for the small-scale fisheries sector.

Stock assessment provides information on sustainable levels of exploitation of fish stocks, and is a key part of fisheries management, helping determine what management measures should be applied to achieve the required outcomes. However, conventional approaches to stock assessment tend to be data-intensive and costly, and are difficult to apply especially in small-scale fisheries.

New approaches to fisheries management and assessment are needed for the small-scale sector, which is already seeing a move towards participatory and co-management.

Participatory Fisheries Stock Assessment (ParFish) is a new approach to stock assessment that addresses many of the problems of applying stock assessment to small-scale fisheries. It is based on conventional models, but does not require long time series of data, using instead Bayesian Statistics to incorporate fishers' knowledge on the resource, which is collected through structured interviews.

An assessment can be carried out rapidly, and the participatory process that surrounds the data collection and stock assessment supports co-management by bringing together fishers, scientists, managers and other stakeholders in a dialogue for more effective resource management.

More information and the **ParFish Toolkit**, which contains guidance on the approach and a software package for data analysis, are available from Marine Resources Assessment Group Ltd or the Fisheries Management Science Programme (FMSP) website:

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The importance of small-scale fisheries

- ✓ Small-scale and multispecies fisheries play a vital role in the livelihoods of millions of people, predominantly in developing countries.
- ✓ Information is key to sound management and policy making, but limited resources results in a lack of information concerning these fisheries.
- ✓ ParFish is a tool that enables management recommendations to be identified quickly, based on an initial stock assessment, even where no previous data exist.
- ✓ ParFish supports co-management by bringing together scientists, fishers, government and NGOs.

Fisheries are the main source of animal protein for nearly one billion people, predominantly in developing countries. There are an estimated 10 million full-time, traditional fishers in developing countries, and a further 10 million part-time fishers. When families and dependents are included, an estimated 100 million people depend on fishing, many of them among the world's poorest. The employment and income generation that small-scale fisheries provide in often-remote coastal areas is important to livelihoods and the rural economy.

For example, in Tanzania, there are an estimated 92,000 people employed full or part time in commercial and subsistence fishing and aquaculture activities. Although fisheries often only contribute a small amount to a country's GDP compared to other sectors, in some regions they can be the most important activity, providing the main source of employment, income or tax revenue in a certain province or district. For example, in the Rufiji Delta in Tanzania, 61% of households are involved in fishing. Fish also provides an important source of protein that can be bought in small quantities, which is important to poor consumers who may not be able to afford to purchase other types of protein sold in larger quantities such as chicken.

The need for stock assessments

Information is key to sound policy making and responsible fisheries management. The FAO Strategy for Improving Information on the Status and Trends of Capture Fisheries recognises the importance of small-scale and multispecies fisheries, particularly in developing countries, and highlights the need for improving data and information for this sector. The use of rapid appraisal methodologies and participatory processes are specifically identified.

Many fish stocks are under increasing pressure due to growing human populations. Responsible fisheries management is needed to ensure their sustainability, and should be based on the best available information so that appropriate decisions can be made that take into account the social, biological and economic aspects of the fishery.

However, due to a lack of investment in management, many fisheries, especially in developing countries, lack the resources to collect and analyse data for management, such as stock assessments. This results in a lack of information on which to base management decisions, which may jeopardise the sustainability of the fishery and put many people's livelihoods at risk. This lack of information concerning their importance in turn often results in small-scale fisheries in particular being under-represented in fisheries policies, and their valuable contribution to people's livelihoods and the economy is not taken into account in political decisions.

Conventional approaches to fisheries stock assessment work well where resources are available, such as in large-scale commercial fisheries. However, they tend to require large amounts of data, are complex and costly, and as a result they are often not feasible for many fisheries. Different approaches to stock assessment are needed for small-scale fisheries. Flexible approaches are required, which use minimal resources and should involve the fishers through co-management (see box).

Co-management

Co-management is increasingly being introduced as a solution to the problems encountered in centralised, top-down management approaches. Co-management is the sharing of responsibility and/or authority between the government and local resource users to manage a specified resource such as a fishery, coral reef or waterbody.

Often the role of government in co-management is to support the process, and co-ordinate policy and data collection activities across several co-management units. Information and stock assessments are still required for co-managed fisheries, so that decisions taken for management are based on sound information.

How ParFish can help

ParFish, or Participatory Fisheries Stock Assessment, is a new approach to stock assessment that addresses many of the problems associated with stock assessments for small-scale fisheries:

- It does not require long time series of data, but instead uses fishers' knowledge to provide a starting point for the stock assessment;
- An initial assessment can be carried out quickly through the use of rapid data collection techniques;
- The approach brings together fishers, managers and other stakeholders helping them enter a cycle of learning, management planning and implementation, that can support co-management.

Conventional vs ParFish Stock Assessments

- ✓ ParFish is an extension of traditional approaches to stock assessment and uses the same models and principles.
- ✓ Traditional stock assessments are very data intensive. ParFish stock assessments are based on fishers' knowledge of the resource and an initial assessment can be carried out in a matter of weeks.
- ✓ Traditional stock assessments are the realm of scientists, whereas ParFish brings together fisheries scientists, facilitators, managers and fishers and takes social and economic concerns into account.
- ✓ A principal objective of ParFish is to involve fishers and other stakeholders in a participatory process to carry out the stock assessment and develop management actions based on the results of the assessment.

Conventional stock assessments require large amounts of data that may take years or decades to collect. They are not usually suitable for small-scale fisheries, which are difficult to sample because of their dispersed nature, and often lack financial and human resources for data collection and analysis. ParFish is an alternative approach to stock assessment that is appropriate for small-scale fisheries.

Rapid assessment

ParFish can be applied rapidly, even in fisheries for which no previous data exist, providing a starting point for management decisions, which can later be reviewed in an adaptive process. This is achieved by collecting data through rapid techniques including interviews and fishing experiments.

Use of fishers' knowledge

ParFish achieves a rapid assessment by incorporating fishers' knowledge on the resource into the stock assessment. Fishers are in day-to-day contact with the resource and have a wealth of information about it that is usually not harnessed in conventional stock assessments.

Based on conventional models

ParFish is based on the same models as conventional stock assessments. Currently the logistic biomass model is used, and a yield-per-recruit model is being developed. The difference from conventional methodologies is in the way ParFish is able to combine data from different sources, including information from fisher interviews, in a single assessment.

Combines different data sources

ParFish uses Bayesian Statistics to combine data from different sources (see p11). As a result, ParFish can incorporate conventional stock assessment data where they are available, such as long-term catch and effort time series, with interview data and fishing experiment data.

Promotes participation & co-management

Participation of resource users and other stakeholders is key to the ParFish process. This starts with the identification of problems in the fishery and objectives for the assessment, to their participation in data collection and the identification and implementation of management measures.

Incorporating social and economic aspects

ParFish uses Decision Theory to incorporate social and economic aspects into the stock assessment and to identify the outcome in the fishery that would be most preferred by the fishers. This is used to identify the expected best control measure to apply. Fishers indicate their preferences for scenarios of different levels of fishing effort and associated catch (i.e. costs and benefits), which reflect relative trade-offs each individual faces between fishing and other livelihood activities that he or she could be engaging with instead. If fishers have few other livelihood options they may prefer to be able to fish every day, even if their catch rates are lower, than to be able to fish only one or two days a week with a higher return. In this way, ParFish incorporates the social and economic trade-offs and priorities of fishers in the assessment and takes account of them in the recommendations.

Comparative matrix of Conventional vs ParFish stock assessments:

	Conventional Stock Assessments	ParFish Stock Assessments
Models used	Many models exist and are being developed for available data e.g. production models for catch and effort data, length frequency data analsyes, and catch-at-age data models.	In principle, can use all the same models as conventional stock assessments. Currently available: production models for catch and effort data. In development: models able to use length frequency and weight data. Other models can be incorporated on demand.
Data requirements	Data intensive. Long time series of data needed, e.g. catch-effort or length-frequency.	Data can be rapidly collected. Required: Interview data. Optional: catch and effort, fishing experiments and other available data
Involvement of fishers & other stakeholders	Not usually. Dependent on management structures.	Yes, integral to process.

Case study - Andhra Pradesh

ParFish enabled a stock assessment to be carried out where none had been done before, and for management issues and recommendations to be discussed amongst stakeholders

The mud crab fishery in the Coringa mangroves in Andhra Pradesh, India, is a valuable export-orientated fishery. The larger crabs are exported to Japan, Malaysia and Singapore. Smaller crabs are sold on the domestic market. Despite its value, no assessments or monitoring are carried out and no specific management measures are currently in place.

A ParFish assessment was carried out over a period of 6 weeks through interviews with fishers. The assessment results indicated some uncertainty but did not suggest that the stock was currently over-fished. It was recommended that management should be put in place to avoid future problems and maintain the productivity of the fishery for those that rely on it.

The process, including a meeting that brought together fishers, managers, scientists, politicians and NGOs, brought other broader management issues to the surface, such as mangrove rehabilitation by an NGO that may have negatively affected the crab nursery grounds.

Recognition of these issues is the first step towards their resolution. Stakeholders supported co-management in principle for the fishery, and are keen to gather more data to improve and update the assessment.

The use of fisher knowledge in ParFish

- ✓ Fishers are in day-to-day contact with the resource and have a lot of knowledge about its behaviour, which provides the starting point for a ParFish stock assessment.
- ✓ Fishers' knowledge is gathered through structured interviews to collect information that directly relates to parameters of the stock assessment models.
- ✓ Fishers' knowledge is balanced with other rapidly-collected data, or previously collected data.

There is increasing interest in the use of fishers' knowledge in fisheries management and assessment. Movements towards co-management are one part of this, where fishers have a greater say in how the fishery is managed. The development and increasingly widespread use of participatory techniques is also part of this movement, but these usually provide only qualitative information. ParFish enables the formal incorporation of fishers' knowledge into a stock assessment framework in a quantitative manner.

Case study - Turks and Caicos Islands

Use of fishers' knowledge through a ParFish stock assessment would have prevented the queen conch stock collapse of the 1980s in the Turks & Caicos Islands

Queen conch (*Strombus gigus)* is a high value mollusc that is fished in the Caribbean by divers. It is principally aimed at the export and tourist markets. The stock was heavily overfished in the 1980s, resulting in temporary closure of the fishery and the loss of livelihoods for the people that depended on it.

ParFish interviews were carried out with the fishers. The Department of Fisheries also had good data on catch and effort dating back to 1974. These data were used to compare the results of a conventional stock assessment using catch and effort data with a ParFish stock assessment using only fishers' knowledge.

The results showed that using fisher interviews alone produced a sensible result that could have been used in isolation if catch and effort data were not available.

If ParFish had been carried out in the 1970s or early 1980s, using only fisher interviews, and the recommended quota had been implemented, it would have avoided the crash in the conch stock, together with the associated negative impacts on people's livelihoods. This assumes that the fishers would have known the same amount about the resource in 1974 as they did in 2003 when the assessment was carried out.

Structured interviews to gather data for the stock assessment

Structured interviews are used to collect specific information for the stock assessment. The answers from the interviews are converted by the software into information on each parameter in the stock assessment model. In the case of the logistic biomass growth model, this involves questions about fishers' catch rates, currently, in the past, what they would expect if they were to fish in an unexploited area, and how long they think the stock would take to recover to the unexploited state. As many fishers as possible are interviewed, to gain a representative sample, and the answers are converted into probability functions for each parameter (p11) using the ParFish Software.

Building up a common understanding

In order for the fishers to participate fully in ParFish, for their knowledge to contribute to the assessment and for them to understand the assessment results and be able to contribute to management decisions based on them, there needs to be a common understanding of key concepts involved. Tools and techniques have been developed in ParFish to discuss concepts such as fish stock dynamics, stock assessment and probability with the fishers. One of these is the 'oranges in a jar' example to demonstrate uncertainty. Fishers are asked to guess the number of oranges in a jar in different situations (without seeing inside the jar, and after seeing inside the jar), and the range of estimates is used to demonstrate the uncertainty surrounding the estimate, and how this is affected by the prior information available.

Can fisher knowledge be relied upon?

For ParFish, fishers are not expected to know the 'correct' answer, or to all give the same answers to the interview questions. Because the analysis is based on probabilities, the range of answers and opinions is used to construct probability density functions to estimate the model parameters.

Experience suggests that most fishers do not try to distort the results, but this concern underlines the importance of building up a relationship of trust between the fishers, scientists and other stakeholders involved, and ensuring the fishers understand the objectives of the assessment and how it will benefit them.

How ParFish promotes participation

- ✓ ParFish is based on a six-stage process (see diagram below) that brings stakeholders together.
- ✓ Interviews incorporate fishers' knowledge and preferences in the stock assessment.
- ✓ Participatory techniques help support the building of a good relationship between scientists, fishers and managers, and can contribute to co-management.
- ✓ Results are discussed with the fishers and other stakeholders and management options are planned together.

Participation of fishers and other stakeholders in the stock assessment helps ensure their support for the process and increases their understanding of the results enabling them to take an active role in planning management actions.

Based on participatory principles

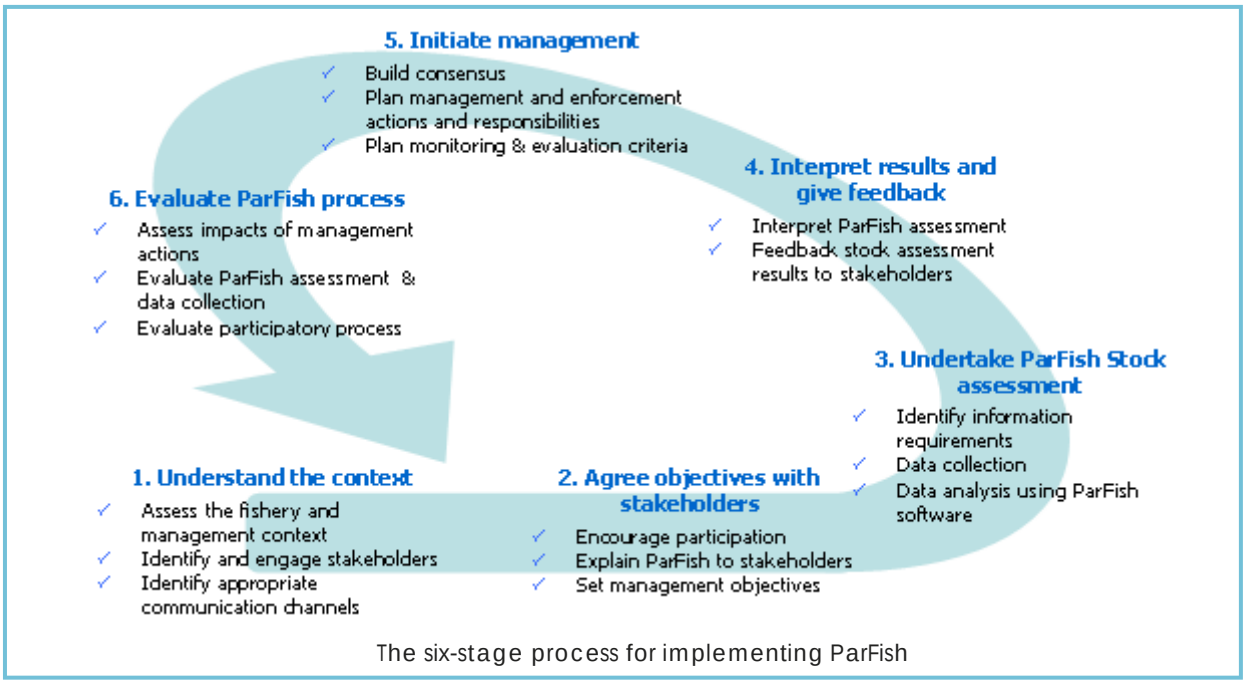
The ParFish process (see diagram) brings stakeholders together to discuss the management of the fishery. Participatory techniques are used to encourage stakeholders to engage with the process and to explain stock assessment concepts to fishers, so that they can understand the implications of the management recommendations from the stock assessment.

Participatory data collection

The data collection techniques in ParFish involve resource users. The interviews and fishing experiments help fishers consider different aspects of their fishery, its sustainability and the trade-offs they face.

Supports co-management

ParFish supports co-management by guiding resource user involvement; sharing information with relevant stakeholders (e.g. local government, NGOs); and providing a forum for discussion of possible management options.



The six-stage process for implementing ParFish

Case study - Kizimkazi, Zanzibar

ParFish helped build a relationship of trust between fishers and scientists, increased the knowledge of fishers on responsible management, and the fishers felt they really had their voice heard

The fishery at Kizimkazi, Zanzibar, is a mixed species coral reef fishery on the fringing reef and outer patch reefs. The fishers use mainly handlines and traps, and some nets.

For ParFish, the fishers were involved in introductory meetings and collecting background information about the fishery. Interviews were carried out with the fishers to gather data for the stock assessment. Fishers also participated in a depletion fishing experiment, where they concentrated fishing effort on a defined area of reef for 8 consecutive days, and their catches were weighed and measured each day.

The whole process illustrated a commitment for cooperation between fishers and scientists and built up a relationship of trust. The interviews provided a forum where fishers could think about and discuss the impact of a range of scenarios on their fishing incomes. One of the local scientists involved felt it laid down firm ground for *"establishing a knowledge base on responsible resource management in the participating communities".*

Jamhuri, a fisher from Kizimkazi who fishes with handlines and sometimes nets, said *"I have been able to voice my concerns on the fisheries and to discuss with them how to make effective marine protection measures".*

Participatory techniques are also used in ParFish to gather background information about the fishery, the species fished, fishing areas and techniques, estimated current effort, management structures and regulations, problems encountered in the fishery, and socio-cultural background to the communities in question. This helps frame the stock assessment and direct the data collection. Participatory identification of issues in the fishery and objectives for the stock assessment also helps define a common vision and ensures fishers and other stakeholders are involved in the assessment from the start.

Management planning

The ParFish process includes a stage for management planning for stakeholders to discuss the results of the ParFish assessment, other problems encountered in the fishery and to consider possible management solutions. This stage, which is not necessarily covered by conventional stock assessments, helps ensure that the results are translated into practical actions for fishery management.

The inside workings of ParFish

- ✓ ParFish is based on Bayesian Statistics and Decision Theory.
- ✓ ParFish Software is available for data processing and analysis.
- ✓ All available data are converted to information (probability density functions) relating to the parameters of the stock assessment model.
- ✓ Data from different sources (e.g. interviews, catch-effort, fishing experiments) can be combined in a single assessment.
- ✓ The Software gives outputs on the state of the stock, standard fisheries management parameters such as MSY and F at MSY, and the level of control (e.g. effort or quota) that would be most preferred by fishers.

The ParFish Software

The ParFish Toolkit includes a software package, for analysing data, assessing the state of the resource and recommending the best actions that balance the risks between losses and gains of each decision.

Bayesian Statistics

The ParFish Software uses Bayesian Statistics which is a technique for calculating the probability of an unobserved event based on probability estimates from samples or observations. It can be applied to estimate the probability of certain outcomes in a fishery, such as overfishing, based on estimates obtained from fishers themselves and existing data about the fishery. Data are converted to estimates of model parameters, and used to construct probability density functions (PDFs). PDFs from different data sources for each parameter can easily be combined to an overall estimate. The analysis and outputs are based on probabilities so uncertainties are explicit in the result.

Decision Theory

ParFish uses Decision Theory to identify the best management action under uncertainty. Each action (i.e. management/control measure) as an expected outcome (on the state of the stock and resulting catch per unit effort). For each action considered, the probability of each outcome happening and its utility (preference) can be calculated. Combining these allows calculation of the average or expected utility for each management action. The best action is that which maximises the expected utility i.e. balances the risks and benefits.

Models available

- Logistic model: ParFish (Version 2.0) is based on the logistic biomass growth model, which represents the basic biological behaviour of populations. It is broadly applicable to most fisheries, and serves as the introductory model for ParFish.
- New software versions: a yield model incorporating mortality rates, von Bertalanffy growth and Beverton and Holt recruitment. More data analysis support will also be made available in new versions.
- Programmers' version: A programmers' version of the software will be released that will enable people to customise the software. Any model can in theory be incorporated into the ParFish Software and approach.

Probability and uncertainty

The outputs from the software are given as probability density functions, rather than point estimates. In this way the uncertainty inherent in the estimates is explicit rather than hidden, allowing the user to assess the confidence in the results and whether more data should be gathered to improve the stock assessment. Mean, median and modal values with confidence limits are also specified for each indicator.

Controls

Currently, the control types that can be explored with the ParFish Software are: effort controls, catch quota controls and closed area controls (protecting a proportion of the stock).

Software Outputs

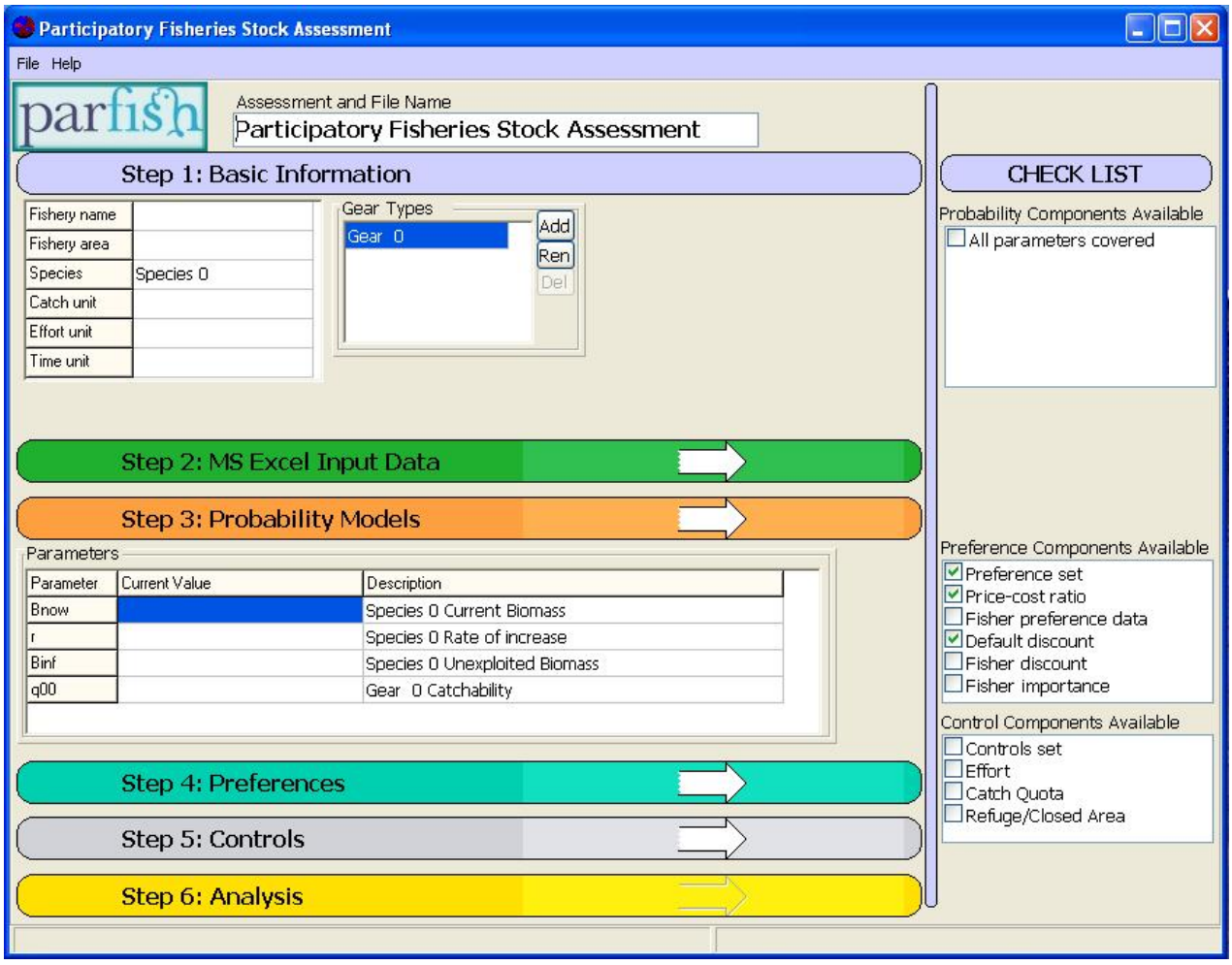
The software provides the following outputs:

Standard stock assessment indicators and reference points:

- State of the stock in relation to the unexploited state
- Maximum Sustainable Yield (MSY)
- Fishing mortality (F) at MSY
- Effort at MSY
- F at Maximum utility

Recommended control levels

- Limit control: control level (effort, quota or closed area) that would reduce the chance of the stock being overfished to a defined probability.
- Target control: control level (effort, quota or closed area) that would result in expected rates of catch and effort most preferred by fishers.



The ParFish Software main interface

Key Challenges & Recommendations

- ParFish as a tool can help bring fishers, managers and scientists together to promote dialogue, providing a starting point for information-based participatory management and decision-making.
- Information is key to responsible and effective fisheries management. However, for many small-scale fisheries, the necessary information is absent due to a lack of human and financial resources.
- ParFish addresses this technical gap in fisheries science by enabling rapid stock assessments to be carried out for fisheries where no previous data exist, based on fishers' knowledge and other rapid data collection techniques. If good conventional stock assessment data exist, ParFish can also incorporate them into the assessment.
- There is an increasing recognition of the need to incorporate fishers' knowledge in fisheries management. ParFish provides a methodology for doing this in a quantitative manner.
- For ParFish to fulfill its potential in supporting the identification and implementation of management measures between government and resource users, there needs to be a commitment to co-management, from all sides and especially from the government to implement the necessary policies, otherwise resource users do not have the authority or support to implement management decisions. Long-term commitment is needed to effectively translate recommendations into management plans.
- Government should support co-management by providing resources for expert advice to co-management bodies, such as through stock assessments; resource users should contribute to the process through their participation and the identification and implementation of acceptable management measures.
- Participatory processes are time-consuming and require dedicated people to work at local level, but have the benefits of building trust among the stakeholders, and establishing a common dialogue.
- ParFish interviews can be lengthy and some interview questions can be difficult for fishers to understand, so well-trained and patient interviewers are needed who are able to explain concepts in ways that the fishers can relate to.
- ParFish has been developed and tested in small-scale fisheries involving a defined fishery area and up to 10 villages, although the approach is broadly applicable to any fishery, subject to appropriate sampling strategies. Strategies for scaling up implementation to larger spatial scales, such as across districts or provinces, could be developed to enable its implementation on a wider scale.
- ParFish can be customised for specific fisheries. Please contact us for more details.

This brief is produced by Marine Resources Assessment Group Ltd, as an output from the Fisheries Science Management Programme (FMSP) funded by the UK Department for international Development (DFID). The views expressed do not necessarily represent those of FMSP or DFID.

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