

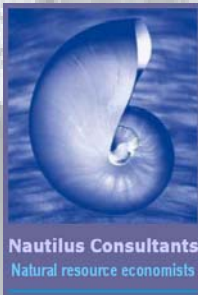


# INSHORE FISHERIES Sustainability Pilot

UK Inshore Fisheries Sustainability Project – Pilot Phase

## Stage 3 Report: recommendations and action plan

December 2009



## Client:

Sussex Sea Fisheries Committee

## MSC certifier:

Food Certification International

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# Contents

<b>1. Introduction</b> .....	<b>1</b>
1.1 <i>Background</i> .....	1
1.2 <i>The MSC standard</i> .....	1
1.3 <i>Report structure</i> .....	2
<b>2. Summary of pre-assessment findings</b> .....	<b>6</b>
2.1 <i>Ranking fisheries against the MSC standard</i> .....	6
2.2 <i>Pre-assessment results in greater detail</i> .....	8
<b>3. Moving these fisheries towards meeting the MSC standard</b> .....	<b>14</b>
3.1 <i>Setting the priorities</i> .....	14
3.2 <i>Devising a programme of actions</i> .....	16
3.3 <i>Scheduling</i> .....	18
<b>4. Conclusions</b> .....	<b>22</b>
<b>Appendix 1 – Pre-assessment findings</b> .....	<b>24</b>
A1.1 <i>Updating management to meet changed circumstances</i> .....	24
A1.2 <i>Need for species specific management plans</i> .....	24
A1.3 <i>Addressing stock assessment and management issues</i> .....	25
A1.4 <i>Addressing environmental impact issues</i> .....	27
A1.5 <i>Addressing fishery policy and management issues</i> .....	30
<b>Appendix 2 - Addressing P1 issues</b> .....	<b>31</b>
A2.1 <i>Approach</i> .....	31
A2.2 <i>Data collection and indicators</i> .....	32
A2.3 <i>Implementation</i> .....	36
A2.4 <i>Initialising reference points and Harvest Control Rules</i> .....	36
A2.5 <i>Establishing adaptive management</i> .....	38
A2.6 <i>Administration and monitoring performance</i> .....	40
<b>Appendix 3 – Information on stock status, by species</b> .....	<b>42</b>
<b>Appendix 4 – CITES listing of species found in UK waters</b> .....	<b>52</b>
<b>Annex 1 – Example of Harvest Control Rule testing: Suriname Seabob</b> .....	<b>57</b>

Stage 3 Report – Programme of work to  
strengthen management of Sussex fisheries

# 1. Introduction

## 1.1 Background

This report is the third report of a project undertaken by Food Certification International (FCI) on behalf of the Sussex SFC to assess the status of the region's fisheries, the quality of the management of those fisheries and, where appropriate, to identify how management might be improved.

The overall project comprises 3 stages as follows:

**Stage 1:** Analysis of landings and fleet data, identification of selection criteria and justification of fisheries taken forward to pre-assessment.

**Stage 2:** Marine Stewardship Council (MSC) pre-assessment scoring against Principles 1, 2 and 3 and details of recommendations for taking the assessment forward.

**Stage 3:** Identification of how weaknesses identified in Stage 2 can be addressed within a coherent programme of work intended to strengthen the fisheries of the region, and present the industry with the opportunity to take a number of fisheries through to certification to the MSC standard for "*sustainable and well managed fisheries*".

The current report uses the findings of Stage 2 of the project (current status and practices in each of the fisheries) to develop a programme of research and development that will strengthen the standing and management of these fisheries:

changed status	benefit to fishermen and others
<ul style="list-style-type: none"> <li>improved management of the underlying stocks</li> </ul>	- bringing about a better balance of fishing capacity and fishery resources
<ul style="list-style-type: none"> <li>improved management of the marine environment and the impact of fishing on that environment</li> </ul>	- maintenance of maximum ecosystem function and increased overall productivity
<ul style="list-style-type: none"> <li>improved management of fishing activity</li> </ul>	- improved security of fishing opportunities and reduced costs / higher revenues

## 1.2 The MSC standard

The measuring stick or standard against which fisheries status and management is gauged is that of the Marine Stewardship Council. In part this is used as a pre-cursor to full assessment of some of the region's fisheries against this standard (noting, for example, that a number of the Hastings fisheries have already been certified as compliant with this standard), but also because this standard (and the assessment methodology associated with this standard) provides a balanced and tested<sup>1</sup> set of criteria against which fishery status and management systems can be judged – a simple audit tool.

The MSC assessment methodology in its simplest form focuses on a grid of three by three:

biological stock	impact on the environment	fishery management
status	status	rules
management	management	management

<sup>1</sup> Several million pounds have been spent over the last ten years in the development and testing of this standard and methodology, and it has been found to be a robust and effective means of gauging the sustainability of fisheries.

monitoring & feedback

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A fuller representation of the assessment tree is shown in **Fig 1**. The way that scoring of a fishery against the MSC standard is described in **Box 1**.

### **Box 1 – Scoring of a fishery against the MSC standard**

Just to re-cap on the modalities of the MSC standard and interpretation of the standard, each Performance Indicator (shown in the yellow boxes at the bottom of each branch in **Fig 1**) is scored out of 100. A score of 80 is set to represent “good practice”, and a score of 60 is set as a level of practice that just meets the minimum that is considered compatible with the term “well-managed” and “sustainably managed”. It is quite possible for a “well managed” fishery to reasonably score 100 under a number of Performance Indicators; a score of 100 is seen as representing “best practice”.

To achieve MSC certification, a fishery must have no scores below 60, and must score an average of 80 or above on each of the three Principles – stock management, environmental impact, fishery management. Where a Performance Indicator is scored below 80, it is a requirement of certification that during the period of certification (5 years) the client agrees to implement an agreed programme of work to bring about a raising of the score for that Performance Indicator to 80 or above.

It is the intention of the MSC programme to reward fisheries, through the market, for management at a standard equivalent to industry “good practice”, and to encourage improvement of management towards industry “best practice”.

The MSC default assessment tree shown in **Fig 1** is what may be considered the conventional approach to assessment, focused on the assessment of the data, other information and research evidence presented in support of compliance with each Performance Indicator. An alternate assessment process has been developed for certain criteria and Performance Indicators to address those circumstances where there is not the weight of direct evidence in support of compliance with a Performance Indicator, but where there is good circumstantial evidence that fishery practice is nevertheless in compliance with the intent of the Performance Indicator. This is particularly relevant to situations where data is not routinely collected and/or where limited research has been undertaken. This alternate approach is based on the systematic assessment of the risk that practice falls short of the standard expected – for example that there is a 95% probability that the bycatch associated with this fishery does not compromise the sustainability of the populations of any of the species occurring in bycatch.

This approach has particular value in the examination of P2 issues, where it can be used to score the “status” and “information” Performance Indicators on retained bycatch, discarded bycatch, and on habitat impacts. It is still a requirement that for each of these criteria a management strategy has been developed and implemented to manage the impacts of the fishery on the environment, in line with the information and analysis available to managers and fishers. Because this process is using indirect rather than direct information on the nature and extent of these impacts, any assessment needs to be necessarily more precautionary than if direct information were available. To this extent, applying a risk-based approach to assessment of these Performance Indicators is intended to score Performance Indicators at a lower level than if direct information were available – and is thus not an “easier” option to presenting directly relevant data.

It is also evident, however, that even a conventional assessment of P2 Performance Indicators can benefit from at least a partial application of the assessment tools required as part of any risk-based assessment – helping to highlight those areas of greatest risk, and thus where the assessment team should focus its assessment.

An alternate risk-based assessment approach is also available for some Performance Indicators under P1 – as alternate assessment approaches to “stock status”, “harvest strategy” and “harvest control rule”. This is intended to facilitate early certification of fisheries where there is insufficient evidence for assessment using the conventional approach, but where it can be shown that there is a low probability that the fishery might be exploited unsustainably. In practice this “low probability” can only realistically be applied to stocks that are lightly exploited. For fisheries where there is a higher probability that the stock could be exploited unsustainably, a more conventional stock assessment is required as evidence that the fishery is being exploited and managed sustainably. In addition, however, even where a fishery has been certified as compliant with the MSC standard using the risk-based approach to assessment under P1 there is an expectation that when that fishery comes up for re-certification (i.e. after 5 years) that a more conventional stock assessment will have been completed, and the re-certification assessment will be based on the conventional assessment methodology.

In the case of the fisheries of the Sussex SFC that have been examined under Stages 1 & 2 of this project, none of the stocks are considered to be only lightly exploited, and thus none are considered to

present a low probability of being exploited unsustainably (i.e. suitable for assessment using the Risk Based Framework for small-scale and data poor fisheries). For all these fisheries a more conventional stock assessment will be a pre-requisite of entry into full assessment under the MSC certification process. In this context it will be necessary to develop stock assessments for each of – lobster, crab, cuttlefish, black seabream, red mullet, whelks, native oysters and scallops. We have developed a generic stock assessment methodology (see **Appendix 2** and **Annex 1**) that can be used with smaller data-sets and time series than would be typically used in international assessments which, by drawing on a more risk-based assessment process, presents the necessary information and confidence in the analysis of that information to satisfactorily address assessment of the P1 Performance Indicators dealing with “stock status”, “harvest strategy” and “harvest control rule”. We recommend that this stock assessment procedure is applied to those stock that are exploited in the fisheries of the Sussex coast and which are not otherwise assessed as part of wider international assessment programmes.

### 1.3 Report structure and contents

In the following report we describe how to address the weaknesses identified in pre-assessment of the 16 main species exploited and 11 fishing techniques used within the Sussex SFC district. We also look at how these actions might be best brought together under a programme of work within the SFC, providing some guidance with respect to prioritisation, cost implications and programme management.

The body of the report presents the main argumentation behind the proposed programme of activities put forward as a means of both improving the overall management of fisheries within the Sussex SFC area, and taking fisheries to the point where they can be entered into full assessment to the MSC standard with a better than reasonable chance of being successful. The outcomes and implications of the pre-assessment of the various fisheries are described in **Chapter 2**, and the programme of works is presented in **Chapter 3**.

In **Appendix 1** the pre-assessment results as presented in the Stage 2 report are reproduced here for reference purposes.

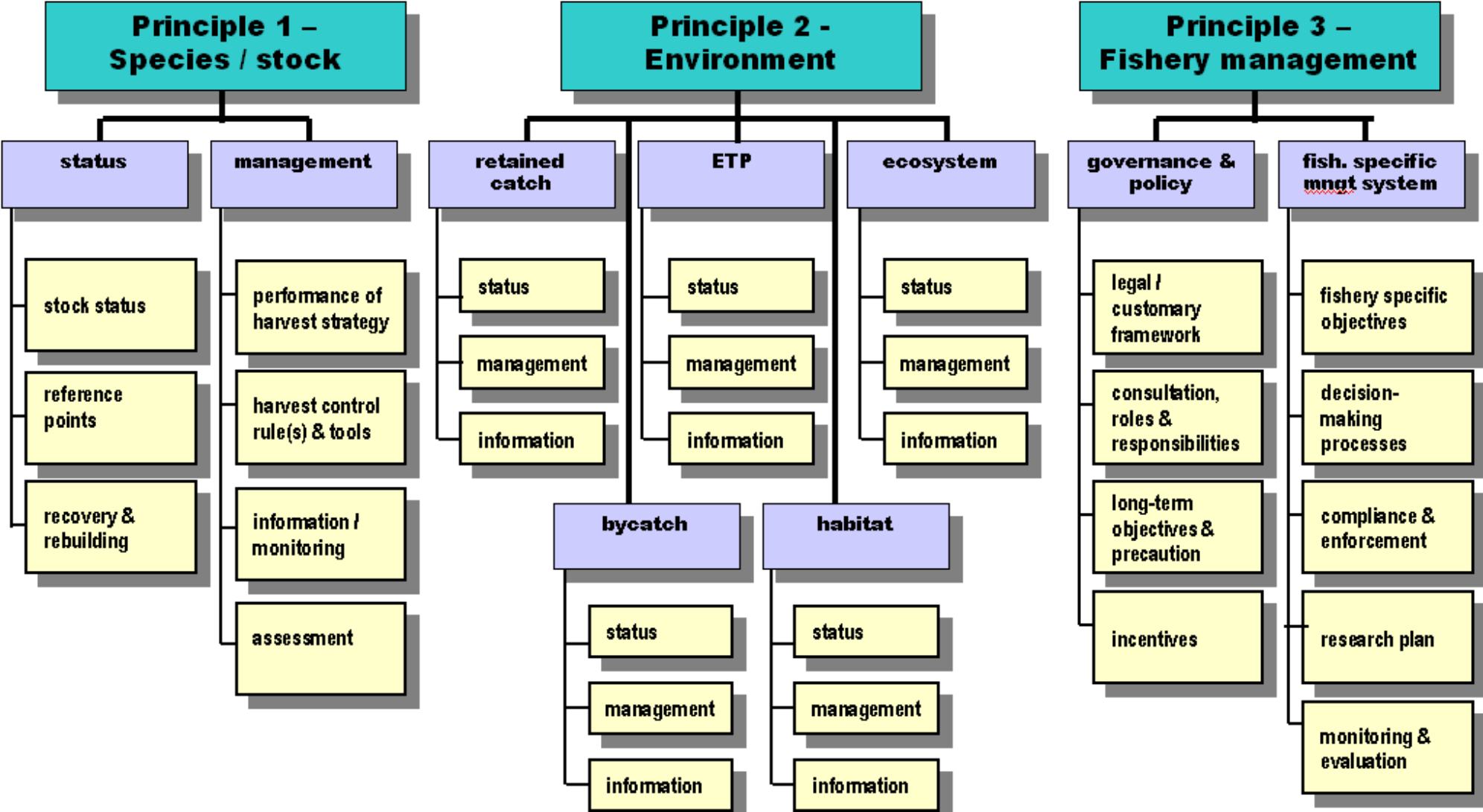
At the core of the programme to bring the fisheries up to the standard of evidence required by the MSC standard is the undertaking of stock assessments for each of the fisheries. A simpler and lower cost method of stock assessment that is compatible with the requirements of the MSC assessment process has been developed by Paul Medley, a member of the study team, that does not involve the level of complexity that is typical of an ICES stock assessment for a pressure stock, but does nevertheless require the availability and input of a detailed suite of data to work the models and simulations. Whilst the main rationale behind such an approach is described in the main text of the report (**Chapter 3**), a more detailed and generic description of the proposed processes for stock assessment, setting of reference points, and negotiation of harvest control rules is described in **Appendix 2** to this report. A worked example of how such a stock assessment might be undertaken is presented as **Annex 1** to this report – the example of the South American Suriname seabob.

As a part of the research undertaken to inform this study, assessment was made of data held by a selection of fishermen, traders and processors – with a view to assessing the extent to which this information could contribute to stock assessment. The overall conclusion was that this information had the potential to be of very significant value to the stock assessment process, and that use of this sort of historical data should be incorporated into the design of the assessment process itself. The sort of data that is available through this avenue, and how this might be utilised to inform individual stock assessments is presented in **Appendix 3**.

In **Appendix 4** is shown a listing of those marine species that are listed as Endangered, Threatened or Protected (ETP) under CITES – the Convention on the International Trade in Endangered Species – and which may be encountered in the waters around the UK. This is included because where the location of the fishery under assessment and the known distribution of the species listed under CITES might overlap, there is a requirement in the MSC assessment methodology that clear strategies are in

place to minimise interaction, and to ensure the maximum level of survival of any ETP species following any interaction.

Fig 1 – A schematic showing the Principles, Criteria and Performance Indicators that together make up the MSC standard



## 2. Summary of pre-assessment findings

### 2.1 Ranking fisheries against the MSC standard

The Stage 2 report examined 16 species and 11 fishing techniques – a combination resulting in 26 separate fisheries, or “units of certification” (Table 1).

Table 1 - Fisheries selected for pre-assessment, and their assessment against the MSC standard

	<div style="display: flex; justify-content: space-around; font-size: small;"> <span>✓ ready for certification</span> <span>✓ nearly ready for certification</span> <span>✓ needs significant further work</span> <span>✓ needs significant further work</span> </div>											
	Static gear						Mobile gear					
	Gill nets (all types)	Mixed pots	Whelk pots	Cuttlefish pots	Rod and line	Handline	Otter trawl	Scottish fly seine	Pair trawl	Beam trawl	Scallop dredge	Oyster dredge
sole	✓											
plaice	✓											
cod	✓											
herring	✓											
mackerel	✓					✓						
bass												
turbot	✓											
brill	✓											
black bream												
red mullet												
lobster		✓										
crab		✓										
cuttlefish	✓			✓								
scallop												
whelks			✓									
oyster												✓

As can be seen from this table, the static gear fisheries for **herring and mackerel** are considered ready for full assessment (the Hastings based fisheries for these species have been previously successfully certified to the MSC standard). It should be noted, however, that the total value of landings from these two fisheries currently yields less than £40,000 per year (a low value relative to the cost of certification).

The **static gear fisheries for sole** are also ready for full assessment, though under the new default assessment tree “good practice”<sup>2</sup> requires that a Harvest Control Rule has been established and is being applied (this was not a requirement under the earlier assessment tree which was used in the previous successful certification of the Hastings-based fisheries for sole). As long as practice under this Performance Indicator meets at least the 60 score this may not prevent the successful re-certification of this fishery under the new default assessment tree, but it remains the case that “good practice” suggests that an appropriate Harvest Control Rule should be developed and applied.

For the **sole under-10m trawl fishery** there remain some concerns about the possible negative impact of this gear on seabed habitats, and the paucity of information on bycatch and discard composition and impacts. These have been raised as conditions and recommendations within the Hastings sole trawl and gill net assessment, requiring that improved monitoring, research and mitigation be undertaken within the term of the certification. The new default assessment tree (introduced in July 2009) and revisions to the MSC Fishery Assessment Methodology (also July 2009) are such as to require some additional evidence of “good practice”, most notably in the areas of Harvest Control Rule and management of environmental impacts.

Table 2 - The ease with which information and practice could be brought to “good practice”

	Static gear						Mobile gear					
	Gill nets (all types)	Mixed pots	Wheik pots	Cuttlefish pots	Rod and line	Handline	Otter trawl	Scottish fly seine	Pair trawl	Beam trawl	Scallop dredge	Oyster dredge
sole	✓✓✓						✓✓✓			✓✓✓		
plaice	✓✓✓						✓✓✓			✓✓✓		
cod	✓✓✓											
herring	✓✓✓											
mackerel	✓✓✓					✓✓✓						
bass					✓✓✓				✓✓✓			
turbot	✓✓✓						✓✓✓					
brill	✓✓✓						✓✓✓					
black bream									✓✓✓			
red mullet								✓✓✓				
lobster		✓✓✓										
crab		✓✓✓										
cuttlefish	✓✓✓			✓✓✓								
scallop										✓✓✓		
whelks			✓✓✓									
oyster												✓✓✓

<sup>2</sup> The term “good practice” is used here as synonymous with a score of 80 under the MSC assessment methodology

For the rest, none are considered close enough to meeting the MSC standard at this present moment, each requiring significant additional work – work that might be expected to take between one and two years to complete. In the case of most of the mobile gears, issues relating to gear interaction with the seabed and seabed communities, and management / reduction of bycatch, may require significant additional work. This is illustrated in more detail in **Table 2**.

Our analysis suggests that a relatively small amount of work should bring up the P1 credentials of the **bass rod & line and pair trawl fisheries** to a point where full assessment could be considered, but further work is required in demonstrating / mitigating the impact of shallow-water pair trawling on the seabed.

For the **lobster fishery** it might be necessary to collect further data over, for example, a twelve month period, but it is considered that this fishery is close to meeting entry requirements for full assessment.

The **crab and cuttlefish fisheries** are only slightly behind lobster, mainly because fishing on these same populations also takes place outside the area under the direct management of the SFC.

For **plaice**, stock status is not sufficient to warrant entry into full assessment, but in all other respects is likely to meet the standard.

For **cod**, stock status is rapidly, on current evidence, returning to a level compatible with “good practice”, but the raised national and international concern associated with the nearby North Sea stock of cod may make full assessment of this stock untenable in the short-term.

For those species exploited by mobile gear (including pair trawling), there remains some way to go before it can be clearly demonstrated that the levels and impacts of gear-seabed interaction, and the management of such interaction, are compatible with the MSC standard. This is particularly so with respect to use of beam trawl and scallop dredge fisheries. Providing the evidence to demonstrate “good practice” will require significant and long-running research. Even then, it may not be possible to demonstrate that the nature of the impact of these gears on seabed communities is compatible with sustainable fishing. This said, almost any commitment to sustainable fisheries management requires that such impacts are measured, and practices changed to moderate such impacts – whether or not this can result in certification to the MSC standard – and therefore such work should be undertaken.

It is considered feasible that the specialist fisheries for black seabream and red mullet could be compatible with the standard – once suitable stock assessments and associated management measures had been undertaken, and the issue of seabed impacts resulting from shallow-water pair trawling quantified and mitigated.

The same might apply with respect to turbot (and possibly brill) – particularly in respect of the gill net fishery for these species (currently valued at £90k for turbot and £40k for brill).

In addition to the above, under P1, P2 and P3 there are practices that could and should be improved upon across the board – i.e. practices where Performance Indicator scores should be improved from below 80 to above 80, and in some cases from near 80 to 90 or higher.

## 2.2 Pre-assessment results in greater detail

For detailed assessment of each fishery to the MSC standard the reader should refer to the Stage 2 report. In the following section we provide a ready-reckoner of where each fishery scores against the standard on the basis of pre-assessment within this project.

**Figs 2 to 5** show the pre-assessment results in simplified graphical format – by species and by gear. Each graphic has been divided into “under-10m” and “over-10m” fleet components – which in part reflects the level of intensity of the fishery, and in part the weight / scale of the gear employed.

Each roundel represents a scoring range for each Performance Indicator as shown in Fig 1.

In these graphics **red** indicates a score below the minimum standard commensurate with the term “sustainable” – i.e. if this fishery were entered into full assessment without any further work there is a high likelihood it would be rejected as non-compliant because one or more Performance Indicators attract a score of less than 60.

**Yellow** indicates a scoring range above this minimum threshold (between 60 and 75), but below what would be termed “good practice” (80). **Green** represents a scoring range between “good practice” and “best practice” (between 80 and 100).

Where a roundel is split, this signifies that two or more characteristics are scored under that particular Performance Indicator, and the scoring ranges have been allocated to best represent this.

The value shown in bold at the top right-hand corner of each section of each graphic indicates the total value of landings of all species from fisheries deploying that particular gear. The other amounts shown in the right-hand column are estimates of the value of that particular species caught using that particular gear.

In terms of assessment against the MSC standard, any fishery where a red roundel or partial roundel is shown would be failed immediately. For any fishery to stand a chance of certification to this standard, these reds would need to be converted to yellows or preferably greens.

For fisheries to be certified as compliant with the standard, the balance of scores between those falling above and below “good practice” needs to be positive for each Principle. And even where a fishery is passed as compliant, during the five-year period of certification there is an expectation that the standard of any Performance Indicator registering a yellow at the time of assessment will be improved such that it can be scored as a green. If at the point of re-certification Performance Indicators are still scored as yellow, then the assessors will raise serious questions as to the commitment of the client fishery to the sustainable management of that fishery.

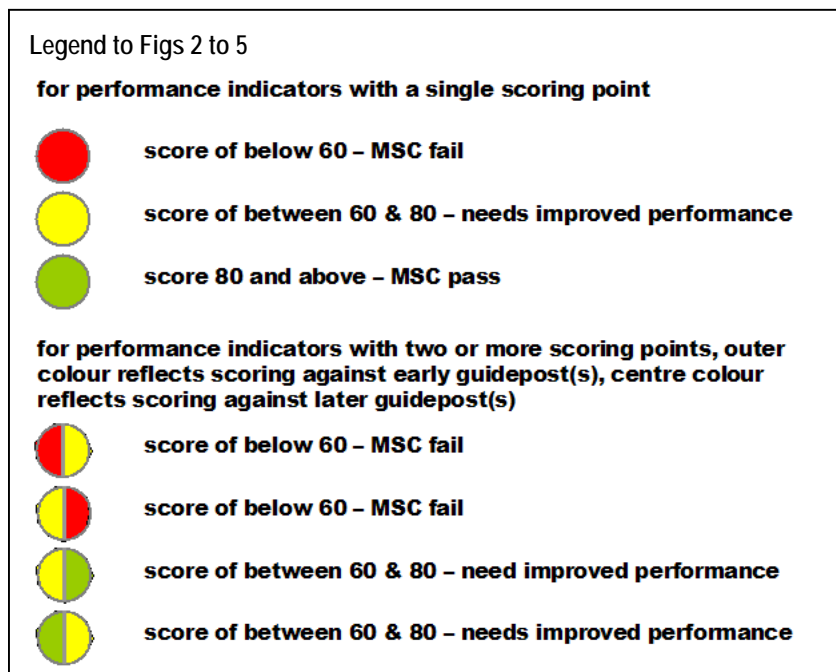


Fig 2 – Indicative pre-assessment scoring ranges of gill net (gill, trammel and drift net) fisheries in the Sussex SFC area

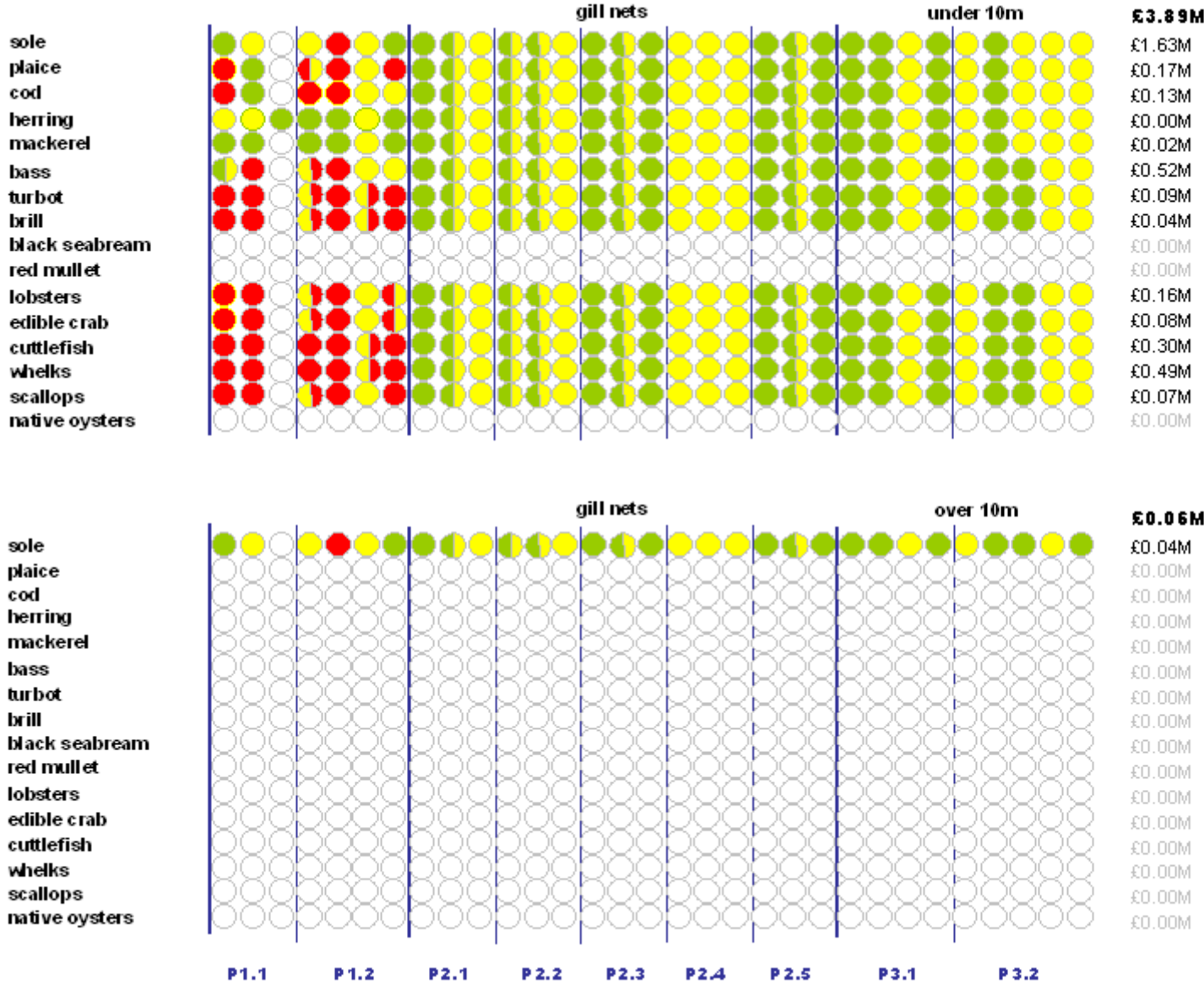


Fig 3 - Indicative pre-assessment scoring ranges of single gear fisheries in the Sussex SFC area

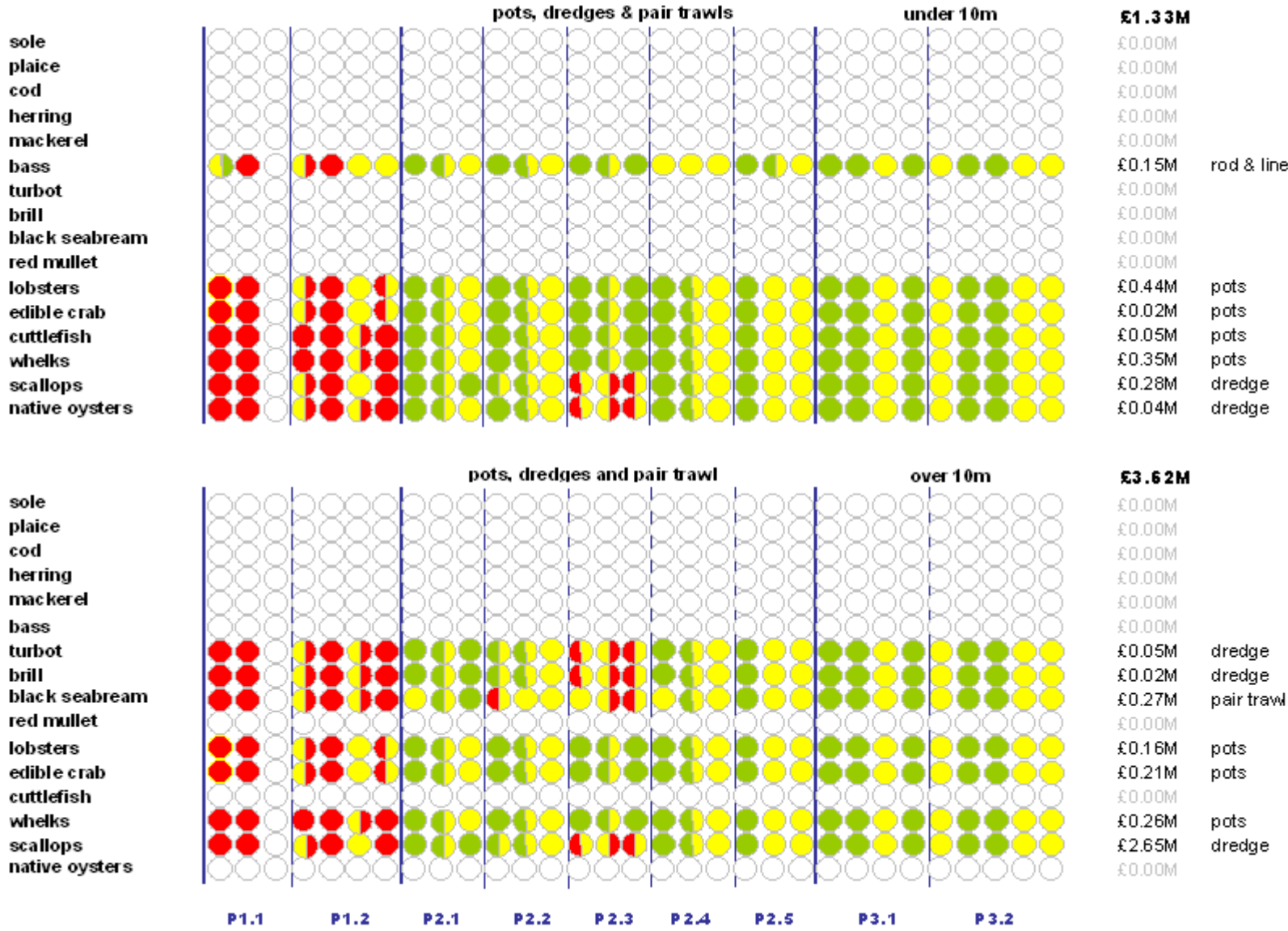


Fig 4 - Indicative pre-assessment scoring ranges of beam trawl fisheries in the Sussex SFC area

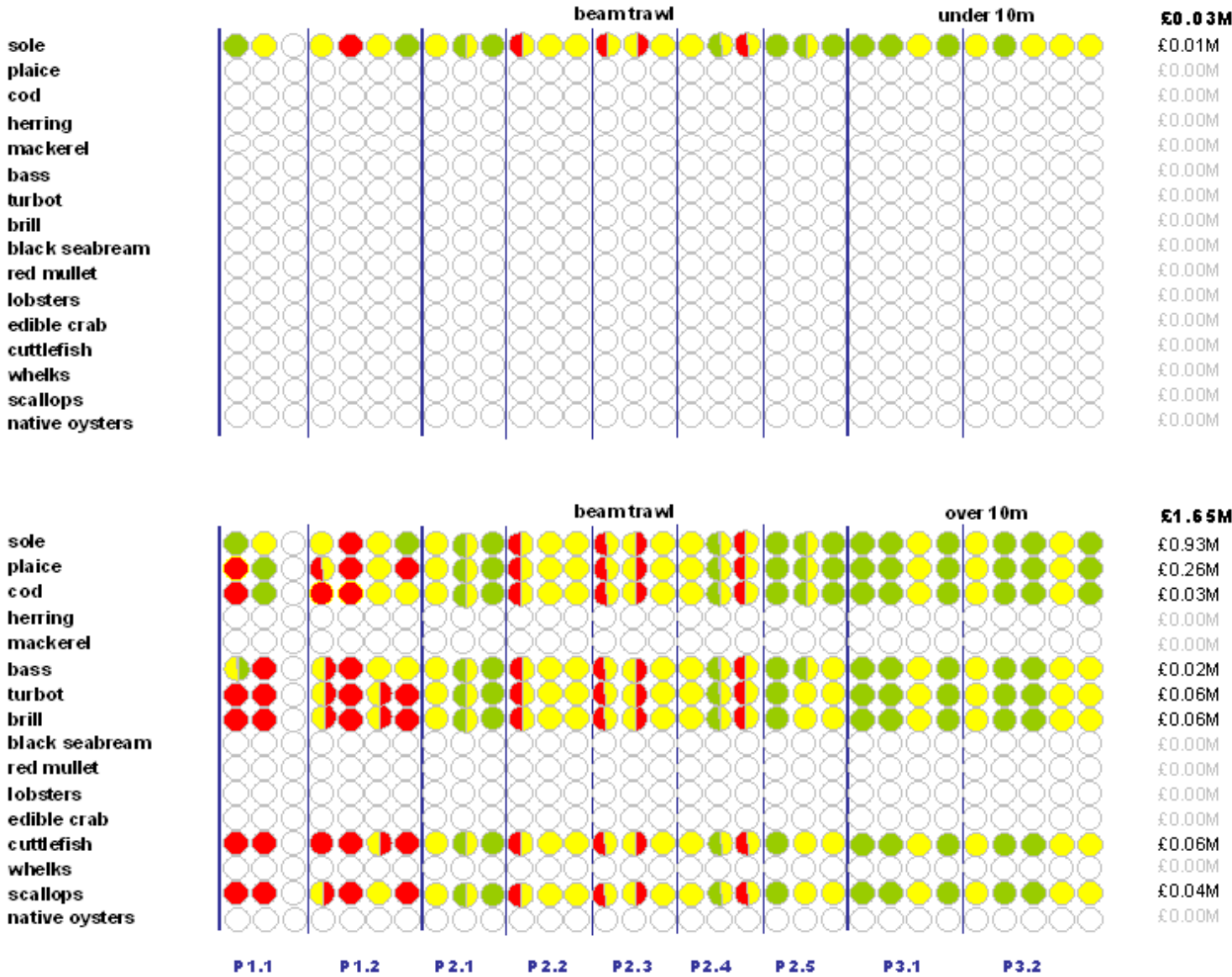


Fig 5 – Indicative pre-assessment scoring ranges of trawl fisheries in the Sussex SFC area



Scottish fly seine

## 3. Moving these fisheries towards meeting the MSC standard

### 3.1 Setting the priorities

#### Study objectives

The overall objectives of this study are two-fold:

- to assist in the provision of the evidence base that will allow the good practices of industry and managers to be publicly recognised and fishermen rewarded for such good practice;
- to develop strategies to strengthen practices so that more fisheries can achieve such public recognition.

Underlying these objectives is the intention to both improve the standard of fisheries management in the SFC area, and to demonstrate that such management is in line with the good stewardship of the marine environment – as required in terms of public policy and supporting legislation, but also in terms of public expectation.

Pre-assessment against the MSC standard shows that there can be reasonable expectation that all the fisheries reviewed can, in time, be brought to the point where certification under the MSC standard is feasible. This is considered relatively straightforward for those fisheries that have already been taken forward to certification by the Hastings industry, and for those fisheries with minimal physical impact on the seabed (gill netting, and potting). For the mobile gears, and particularly those with significant impact on the seabed – such as beam trawlers and scallop dredgers – the evidence requirements (to show that impacts are compatible with what might be considered “sustainable” practice) are likely to be more demanding, and may, in the end, defeat certification of scallop dredging.

#### Stock assessments

But the most glaring impediment to certification is the fact that no stock assessments and stock management systems are in place for most of the species under examination – a requirement under Principle 1 of the MSC standard. It is this area that will require the greatest focus of work in the coming years, and is an area that will require cooperation between the SFC and industry, but also Defra (and the newly established MMO) and Cefas. Again, there is nothing to suggest that these stocks cannot be managed sustainably, or that current fishing practices are necessarily over-exploiting these stocks, simply that (i) they are not subject to regular stock assessment, and (ii) fishing is not managed in a way that specifically takes into consideration the demonstrated state of the stock.

For most stocks managed under the CFP by TAC and quota, stock assessment is based on time series and scientific research going back decades, and in some cases over a century. Considerable resources are deployed in undertaking data collection, modelling, and supporting research – resources that can be reasonably valued in terms of hundreds of thousands of pounds. This has become the norm when fishery scientists talk about stock modelling and stock management. But clearly this level of investigation and resource allocation is impractical when it comes to stock and fishery management at the smaller scale. But in addition, this level of complexity is not a specific requirement of the MSC assessment process, where rather greater emphasis is placed on assessment of *the risk that stocks may be exploited unsustainably*, and on the practical inter-relationship between assessments of stock condition and the management of fishing activity.

In these situations an alternate approach to stock assessment is required. At one extreme the Risk Based Framework (RBF) developed by the MSC for assessment of small-scale and data-poor fisheries has considerable merit, but is thought to be most appropriate to those fisheries where the stock is only lightly exploited – and thus where there is a low risk of the stock being exploited unsustainably. In the

case of the Sussex fisheries none fit this condition, and application of the RBF is considered inappropriate. Instead it is proposed that an alternate approach to issues of stock assessment, setting of reference points, and negotiation of harvest strategies and Harvest Control Rules is used – as developed by study team member Paul Medley, and described in **Annex 1** to this report.

This approach does not require the intensity of data typically required in ICES assessments, and makes up for the reduced availability of data using risk assessment tools and simulation. Application of this sort of approach requires at least one year's detailed data focusing on catch and effort, a further five years of more general catch and effort data, and some supporting research on the basic biological and life-cycle characteristics of the species under assessment (research that for many species has already been carried out). Accordingly, from a standing start, at a minimum fifteen months is required to undertake such an assessment – 12 months data collection, and 3 months to undertake and test the modelling and simulate management options. In some instances much of the required data may already be available, and so it may be feasible to shorten the time it takes to undertake the assessment.

Three key features strengthen the argument for use of this approach:

- it has been successfully pioneered in the assessment of a shrimp fishery in South America (see **Annex 1**);
- the same approach (with minor modifications) can be applied to most species of fish and shellfish;
- the data formats, data handling systems, model programming, simulation structures and reporting formats have already been developed by Paul Medley and are available for use at no cost (the matching and analysis of data sets, models and simulations involves specialist input of some 15 to 20 man-days per stock).

## Environmental impacts

A second area that needs to be addressed in supporting certification of Sussex fisheries is that of the impacts of fishing on the environment. Here the main weaknesses are two fold:

- There is limited coherent and available data on the bycatch composition of Sussex fisheries (information that would allow the requisite more detailed assessment of the impact of these fisheries on the populations of other organisms)
- Whilst there is considerable information on the marine environment in the Sussex SFC area (seabed types, underlying geology, habitat maps and location and composition of ecological communities), this is not available in a coherent and accessible form, or assessed in such a way as to allow identification of the impact of fishing on the marine environment.

The MSC standard is an evidence based standard. It is not sufficient to argue that such and such an interaction is benign or compatible with the term "sustainable practice", clear evidence has to be provided to support such arguments. Where the risk that such interactions are not benign is considered high, the requirement to provide evidence that this is not the case is all the more demanding – for example in the case of otter trawl, beam trawl and dredge fisheries.

Accordingly, programmes of consolidation of already available information and the undertaking of new research need to be drawn up to address these short-comings. And even for a fishery where it is assessed that the likelihood of meeting the MSC standard is slight, good management practice suggests that the scale and nature of any gear / environment interaction is monitored, and the fishery managed to reduce and mitigate the impacts of such interaction.

## Improved management systems

In the area of governance, policy and management of fisheries, whilst there are areas where improvements can be made, there is little to suggest that there are major impediments to compliance with the MSC standard once the management systems to be developed under Principles 1 and 2 of the standard are interpreted and codified in the context of Principle 3.

In terms of what might be considered “good practice”, this involves the development of species specific management plans that stipulate the rules that are applied to the management of the fishery (harvest strategy, Harvest Control Rule, licensing and technical measures), and the practice requirements that are in place to manage environmental interactions (record keeping, procedures to reduce bycatch, management of interaction with sensitive and ETP species). In addition, it is “good practice” to establish and sign-up to codes of conduct to be applied to each fleet segment – something similar to the Seafish Responsible Fishing Scheme.

One other area where some greater clarity may be required is in establishing who is responsible for managing these fisheries. It is clear that the CFP provides the over-arching policy direction and legislative boundaries to fishery management within the European Union, and that this is applied at the national level by Defra. At the local level some of the roles, responsibilities and obligations in management of fisheries are passed on to the SFC – notably in upholding technical measures, and managing and controlling fishing activities – but responsibility for policy formation and the monitoring of (most) outputs is retained by Defra – and particularly in the monitoring of catches and landings of quota species. If more coherent, and stock condition related, fishery management plans are to be applied to non-quota species, with the main locus of management resting with the SFC (and the IFCA that will replace it), then there needs to be greater clarity in the practicalities of arrangements between the two management and control bodies.

In a separate but related issue, where a more flexible and adaptive management regime is to be operated – where effort will be altered between years in the light of assessments of stock condition and changes in indices of stock condition (for example CPUE), then management systems need the flexibility to apply this. Current legislative arrangements, both in terms of national legislation and local byelaws, are not sufficiently flexible and responsive to such changes, and alternate legal provision may be required. This is another matter that should be taken up as part of the discussions relating to the formation and operation of the proposed IFCA.

## 3.2 Devising a programme of actions

On the basis of the above, the main elements of a programme of work to take forward the ambitions of this work are as follows.

### Principle 1

- Extend programmes of stakeholder engagement on specific issues with a view to improving fisheries management within the SFC District.
- Confirm the prioritisation of stocks to be assessed – bass, lobster, crab, cuttlefish, whelks, oysters, black seabream, red mullet, turbot, brill, scallops.
- Establish a normative catch, effort and weight reporting system that meets the requirements of simplified stock assessment.
- Establish a system for collating trade information routinely recorded by traders and processors.
- Further develop local data collection and management systems and seek modification to existing systems to enable appropriate disaggregation of local information.
- As far as practicable assimilate historical information held by traders and processors.
- Undertake literature review on life cycle and stock assessment information to clarify stock assessment strategies particularly with regard to – crab (fished inshore and offshore), cuttlefish (selection for males), black seabream (spawning aggregation).
- Work-up stock assessment, harvest strategy and harvest control rule information for each stock. This will develop “straw man” proposals for each stock while identifying key weaknesses, which in most cases is likely to be the inability of an SFC harvest strategy to account for exploitation of the

stock by non-Sussex stakeholders. Activities carried out for each fishery (although fisheries would be considered together where possible) would consist of the following:

- Establish overall objectives, then possible data collection and indicators through a stakeholder workshop.
- Conduct initial analysis and estimate appropriate reference points with all the available information, including data from past data collection activities. With agreement from the stakeholder workshop, some rapid data collection could be carried out to improve the available data on each stock.
- Establish a harvest control rule accounting for various risks through a stakeholder workshop. Facilitation for the workshop will be provided using information and stock assessment models developed for each of the fisheries.
- Evaluate fishery performance, and confirm or establish alternate reference points and HCR after several years data collection (at least 3 years). This can be conducted by repeating activities 2 and 3 with the new information.

## Principle 2

- Instigate a programme of stakeholder consultation on improved fisheries management within the SFC.
- Confirm the prioritisation of fishing methods to be researched – gill nets, pots, handline and rod & line, oyster dredge, bottom pair trawl, Scottish fly seine, otter trawl, beam trawl, scallop dredge
- Collate information on available research into bycatch associated with each fishery / gear.
- Collect data on bycatch associated with each fishery / gear.
- Research opportunities for achieving further reductions in bycatch / discards.
- Draw up a management strategy for minimising fishing impact on sensitive species and communities – sharks and rays, rare sessile organisms, etc. that are typically the subject of some form of protection.
- Draw up a management strategy for minimising fishing impact on Endangered, Threatened or Protected species (those species listed in CITES as being found in UK waters – see **Appendix 4**); for this, ETP is defined as those species listed under CITES, plus any specifically designated as protected under specific local / national legislation.
- Develop a programme for researching impact of different gears on seabed communities – particularly for otter trawl, beam trawl and scallop dredging.
- Develop a GIS to consolidate all available spatial information relating to the area managed by the SFC.
- Examine the costs and benefits associated with the introduction of simple vessel tracking systems as a strategic tool for management of small-scale fisheries in the SFC area (links closely to P2 and P3 issues), and its possible incorporation into the SFC GIS.
- Draw up management strategies for the management and evaluation of bycatch, bycatch reduction, and habitat interactions.
- Collate research information on the ecosystem impacts of fisheries in the inshore zone.
- Compile information on previous work and identify gaps for developing appropriate biological reference levels for bycatch, discards, ETP, habitat and ecosystem indicators.

### Principle 3

- Instigate a programme of stakeholder consultation on improved fisheries management within the SFC.
- Further examine how to moderate the inconsistencies in policy formation, decision-making and management of the fisheries area of the SFC between national and local institutions (SFC, Defra, MFA, MMO).
- Draw up species specific fishery management plans that incorporate the management elements of P1, P2 and P3.
- Review the fishery control functions and systems that apply to the fisheries of the SFC – in particular inconsistencies in responsibility and jurisdiction between the SFC and the MFA.
- Review the extent, openness and effectiveness of the stakeholder consultation systems and mechanisms in place in relation to management of fisheries in with the area of the SFC.
- Draw up codes of conduct for each fishing method – addressing standards and crew qualifications, general on-board practices, data recording and other record keeping, guidelines on gear-environment interaction, guidelines on how to minimise bycatch, guidelines on what to do in the circumstance where an ETP species is caught.
- Review the mechanisms that might be deployed to review the effectiveness of the fishery management systems deployed in the area of the SFC – including independent external review.

Clearly there is a fair range of activities incorporated in the above listings, and it would be impractical and inappropriate to consider undertaking all these at the same time. Accordingly some temporal priority needs to be applied to the listing. Indicators of the bases of such priority are provided by the relative economic importance of each fishery (primarily landed value), and the ease with which practice and the evidence base can be brought up to the standard required by the MSC.

In terms of the core activities of the Sea Fisheries Committee the Committee should give consideration to sanctioning programmes to substantially upgrade the data handling systems and capacities of the SFC, and the establishment of an integrated and comprehensive Geographical Information System (GIS) to manage and communicate the wide range of spatially arranged data that is already available to the SFC, and to incorporate new data.

As a means of establishing the priorities that should be given to addressing each species stock and the different fisheries of the SFC area, it is essential that a programme of stakeholder consultation should be prepared and rolled out across the region. The intention is to establish the level and nature of interest in this programme of work, and the extent to which the different parts of the industry are willing to participate in this programme. An example of how pre-assessment information could be simply displayed for consideration by stakeholders is shown as **Annex 2** to this report.

As a means of taking Principle 2 type investigations forward – fishing interactions and impact on the habitat and ecosystem – the SFC should engage with stakeholders in marine conservation and the marine environmental research (statutory bodies, research institutions, academia and NGOs) to establish the level and nature of interest in this programme of work, and the extent to which the different elements of this stakeholder community are willing to participate in (and to champion application for funding) this programme. Since each of these investigations will also require the input of professional fishermen, this matter should also be taken up during stakeholder consultation with the industry.

### 3.3 Scheduling

Pre-assessment suggests that the first fishery to be presented for assessment is the sole gill net and trammel net fishery, incorporating fleets working out of Dungeness, Rye, Hastings, Eastbourne, Newhaven, Brighton, and Shoreham. At one and the same time, programmes should be put in place to develop the necessary data and evidence to take other priority fisheries forward for stock assessment, and to demonstrate that their interaction with the environment is managed in line with the MSC

standard. This will enable other fisheries to be presented for assessment some twelve to fifteen months into the programme of work.

Outlines of how these various activities might be scheduled is shown in the following three graphics.

Fig 6 – Proposed programme of activities to be managed by the SFC

		2010				2011				2012				2013				2014			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
System improvements	improved data management systems within the SFC	█				█				█				█				█			
	upgraded data collection on all species and gears - necessary pre-requisite to the modelling of stocks	█				█				█				█				█			
	collation of existing trade information on landing - weight, size, seasonality	█				█				█				█				█			
	installation and population of an integrated GIS	█				█				█				█				█			
	consideration of the use of on-board data loggers to collect further information on fishing patterns	█				█				█				█				█			
Projects	bycatch and discard monitoring programme - gill nets	█				█				█				█				█			
	bycatch and discard monitoring programme - other trawls	█				█				█				█				█			
	bycatch and discard monitoring programme - beam trawls	█				█				█				█				█			
	identification of existing conservation areas based on spatial arrangements of habitat type and fishing activity (from GIS)	█				█				█				█				█			
	programme to develop a plan for management of interactions with sensitive species and communities (ETP species, and other species recorded as potentially subject to unsustainable impact)	█				█				█				█				█			
	habitat impact assessment programmes - for beam trawl and for scallop dredge	█				█				█				█				█			
	development of Ecosim modelling of Sussex SFC management area / Eastern Channel	█				█				█				█				█			
Short-term inputs	development of basic Harvest Control Rule for sole gill net and trawl fisheries	█				█				█				█				█			
	consolidation of bycatch and discard data for sole gill net and trawl fisheries	█				█				█				█				█			

light blue areas signifies continuation of the activity at a lower level of intensity

Fig 7 – Proposed schedule for undertaking stock assessments per species

		2010				2011				2012				2013				2014			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
sole	regularly monitored - ok																				
plaice	regularly monitored - currently below B <sub>pa</sub>																				
cod	regularly monitored - currently below B <sub>pa</sub>																				
herring	regularly monitored - ok																				
mackerel	regularly monitored - ok																				
bass	considerable data already available - needs some augmenting	█				█				█				█				█			
black sea bream	highly seasonal fishery - should be possible to extract data from past couple of years, plus data from next season	█				█				█				█				█			
lobster	good data already available - need to collect new information for at least a further 9 months	█				█				█				█				█			
brown crab	need to collect new information for at least 12 months	█				█				█				█				█			
cuttlefish	need to collect new information for at least 12 months	█				█				█				█				█			
whelks	need to collect new information for at least 12 months	█				█				█				█				█			
native oyster	need to collect new information for at least 12 months	█				█				█				█				█			
red mullet	need to collect new information for at least 12 months	█				█				█				█				█			
scallop	need to collect new information for at least 12 months	█				█				█				█				█			
turbot	partial assessments already done for North Sea - but may need further local data	█				█				█				█				█			
brill	partial assessments already done for North Sea - but may need further local data	█				█				█				█				█			

Fig 8 – Earliest times when assessments to the MSC standard can be undertaken – depends on completion of stock assessments and environmental impact management

		2010				2011				2012					
		1	2	3	4	1	2	3	4	1	2	3	4	£M	
<b>1st opportunity to enter fisheries into full MSC assessment</b>															
sole	gill net	█	█	█										£1.67	values based on 2008 landings data high priority - need to address HCR requirement
herring	gill net													£0.00	this is a very low value fishery
mackerel	gill net and handline													£0.02	this is a very low value fishery
sole	otter trawl			█	█									£0.45	need to address P2 issues
bass	rod & line					█	█	█						£0.15	
bass	trawl					█	█	█						£0.18	
black seabream	pair trawl													£0.27	
sole	beam trawl													£0.94	valuable fishery - but likely to be difficult to pass on P2
lobster	potting						█	█	█					£0.60	
brown crab	potting													£0.23	
cuttlefish	traps													£0.35	traps + gill nets
whelks	potting													£0.61	
native oyster	dredge													£0.04	caché for restaurant market
red mullet	Scottish fly seine													£0.06	low total value - probably not worth it
cod	gill net													£0.13	possible - stock status improving
plaice	gill net													£0.17	possible - stock status improving
plaice	otter trawl													£0.17	possible - stock status improving
scallop	dredge													£2.65	difficult to pass on P2
turbot	gill net, beam trawl and otter trawl													£0.22	existing high unit value - probably not worth it
brill	gill net, beam trawl and otter trawl													£0.12	existing high unit value - probably not worth it

light blue areas signify likely duration of the assessment process; ochre areas signify where, for various reasons, there is a reduced likelihood of the fisheries being submitted for assessment

## 4. Conclusions

In undertaking pre-assessment of the above fisheries, three main areas of management were identified as needing attention:

- **Stock management**

- Most effort would be needed to collect and collate the information necessary to undertake simple assessments of each of the stocks being fished (international stock assessments are already undertaken for sole, plaice, cod, herring and mackerel, and also for turbot and brill, but their main focus is on North Sea stocks and stocks in the English Channel / Western Approaches – the extent to which these are likely to meet the requirements of local Sussex SFC MSC assessments needs to be carefully re-examined);

- **Management of environmental impacts**

Further effort is needed to monitor and manage environmental impacts

- some information is available on bycatch and discards but it is not sufficient or routinely used for management purposes;
- there is a wealth of information available on the marine environment in the SFC area, but it is not drawn together as a coherent whole, nor is it routinely used as a management tool;

- **Fishery management**

There remain some fundamental structural weaknesses and inconsistencies in responsibilities for management of the region's fisheries

- policy, plans and monitoring of fishing outputs remain with central government, whilst monitoring of (most but not all) technical measures and environmental impacts of fishing (and other activities) are managed at the local level;
- management by central government relies on large-area legal instruments that take many years to modify; management by SFC relies on local byelaws which also take time to modify – neither of these systems are particularly attuned to adaptive management at a local level.

In turn, these findings prompt three high level strategic issues:

- To what extent is it sensible to contemplate undertaking stock modelling and management at the level of a single SFC (we know it is inappropriate for some, and we know it is achievable for others, but there are some species for which the answer is less clear)? This has a fundamental bearing on how to approach Principle 1 issues.
- There is a wealth of environmental (and particularly spatial) data available for the Sussex SFC district, but it comes from a wide diversity of origins (different institutions, different funding mechanisms, different purposes). As a result, using and interpreting these data beyond their original purpose can, in their current form, be problematic. In addition, there is current focus on the increased use of zonal systems for the management of the marine environment (including fisheries) through a mosaic of fisheries and marine conservation areas – which are likely to incorporate the increased use of vessel tracking technologies. It therefore makes sense, leading to a multitude of benefits, to draw together all currently available information within a single GIS (Geographical Information System) integrated with catch position and landings data sets (not currently collected or routinely used by the SFC). Whilst Principle 2 issues can be resolved through a programme of sub-projects, a more integrated approach would yield medium and long-term advantages, not least in the area of costs.

- With the current remodelling of the SFCs as IFCAs (Inshore Fisheries and Conservation Authorities), and the incorporation of increased responsibilities for environmental monitoring and management, now is the time to clearly establish how the IFCAs can fully participate in the management of the fisheries under their jurisdiction using an “adaptive fishery management regime” (linking management decisions to knowledge of the status of the particular stock under management). At the very least this requires the IFCAs to have more ready access to landings and vessel monitoring data, but also there needs to be some clarification as to how decisions are to be made in the management of stocks / fisheries within the areas under the jurisdiction of the IFCAs. At present, Sussex SFC’s management of its fisheries is likely to score poorly on four out of the nine Performance Indicators under Principle 3 – four areas where improvements will be required under any certification. These are:
  - The setting of long-term (P3.1.3) and fishery specific management objectives (P3.2.1) (in part to be derived from work to be done under P1 and P2)
  - The structure and operation of decision-making systems (outstanding issues relate to clear and transparent allocation of responsibilities between national and regional structures, integration of fishery management responsibilities, and tightening up of co-management systems)
  - The establishment of monitoring and evaluation systems to assess and re-assess the fishery management plans and systems against long-term and fishery specific management objectives.

## Appendix 1 – Pre-assessment findings

### A1.1 Updating management to meet changed circumstances

In summary, the assessment of the fisheries of the Sussex SFDC area indicates that as a generality the fisheries are managed in a manner commensurate with the scale and nature of those fisheries and in line with the zonal nature of the management regime – 0-3nm, and 3-6n limits. Management reflects the diversity of the fleet, and the opportunist nature of much of the fisheries conducted – where many of the smaller vessels switch gear to meet seasonal fishing opportunities available to them.

The current approach to management is, at its core, pragmatic – a good thing – built up steadily over time. But it falls down in that it is slow to adapt to change. This has worked well in times where fleet capacity has been in line with resource availability, but recent decades have seen:

- conditions where many resources have become fully or over-exploited, and where fishing effort has been diverted from these to other fisheries, which themselves have become fully or over-exploited fisheries, and
- conditions where fleet capacity has increased substantially – through increases in vessel numbers, increases in the size and scale of vessels, and improvements in the technologies employed and the efficiency of the gear used.

It can now be argued that the management systems in place have failed to keep pace with the speed and scale of such changes, and as a result imbalances are evident – expressed in terms of reduced profitability across the fleet, and concerns about the health of the various fish stocks exploited. In addition, there is substantially increased demand on the marine environment from a wide range of other user groups, and in part this is evidenced by declines in indicators of the health of the marine environment. Together these make for instability – and a poor prognosis for both the health of the local fishery economy, and for the good health of the marine environment.

What is now required is a more responsive management regime – one that can articulate clear resource management objectives, assess ruling conditions against those objectives, and vary management according to the comparison of “state” against those objectives. Such management regimes are broadly in place for those species and fisheries managed by quota, but they do not currently exist for the many other species that are harvested within the Sussex SFDC. Obligations on both the SFCs and Defra to responsibly manage what is a public resource require that managers adopt a strategic approach. Such an approach is at the core of the MSC assessment methodology, and use of this methodology as an audit tool provides a very clear and effective means of revealing where existing practice meets or falls short of industry “good practice”.

Assessment against this standard reveals two core weaknesses in the Sussex SFDC management regime:

- The absence of species specific management plans for those fisheries that are not currently managed by quota; and
- The failure to systematically monitor important fishery and environmental parameters - information that would / could be routinely used to improve management of the fish stocks, and management of the impacts of fishing on the marine environment.

### A1.2 Need for species specific management plans

Scoring of Performance Indicators under Principles 2 and 3 has been marked down for most fisheries because of the absence of species specific management plans. This gives the impression that there are very many things that are “wrong” with the management of these fisheries, but in fact once the species specific management plans have been drawn up and implemented, many of the other aspects that have otherwise been marked down will all but automatically correct themselves. Drafting species specific management plans is thus the major strategic objective arising from this analysis.

A secondary strategic objective is to look more closely at the impact of the various fishing techniques and fisheries on the marine environment. It would be quite wrong to suggest that no such examination is currently undertaken; what needs to be recognised is that such information as is generated is not readily available, or readily available in a consolidated form. There is much research conducted relating to such aspects – whether conducted in the Eastern Channel or further afield, and whether conducted by Cefas, or research partnerships under the SFP programme, or indeed by laboratories elsewhere in Europe – but accessing such information does not currently form a normative function in the management of the SSFDC fisheries. It will also be found that some information relevant to the effective management of local fisheries is either not currently conducted or outputs available, or that more locally relevant research is necessary.

In this latter matter, the Sussex SFDC is not well positioned to remedy matters – it is poorly resourced (at least in this regard), it is not actually responsible for setting policy (and thus it is questionable if it is sensible for it to draw up species specific management plans), and it is not responsible for monitoring the outputs (catches and landings) of these fisheries. This is an area that needs urgent clarification, particularly at a time when the structure and operation of this type of fishery management structure is under current review and imminent change.

Finally, and linked to the above issue, is the matter of “stock” boundaries. The MSC process is applied conceptually and in practice to a “Unit of Certification”. This unit comprises definition of a target species, a fishing method, a fleet or fleet component – and, crucially, a bounded stock or stock component that is amenable to management. Amenable to management in this context means that it is feasible:

- to measure the health of that stock or stock component,
- to monitor changes in the health of the stock,
- to establish positive linkage between the health of that stock and the scale and nature of the fishing of that stock, and thus
- to demonstrate that change in the scale and nature of fishing activity impacts on the health of that stock or stock component.

Few if any of the stocks exploited in the fisheries of the Sussex SFDC are confined to the area managed by the SSFDC. For management purposes many will be defined as North Sea stocks, English Channel stocks (eastern Channel and Western Approaches), and perhaps areas at still larger scale. But it may be feasible to demonstrate that other fisheries can indeed be managed – within this concept of “amenable to management” - at a more local level. It is this element of stock definition that lies at the heart of on-going debate on the possible use of “risk-based” approaches to assessing whether or not a “stock” unit is managed sustainably.

## A1.3 Addressing stock assessment and management issues

### Pressure stocks

The pressure stocks – those managed by TAC and quota – are subject to close scrutiny at national and international levels through the work of the national fishery laboratories, ICES and STECF. As such, whilst stock status may not be in good health (i.e. above the precautionary reference level), each would be expected to be closely managed, and where the stock is below the precautionary level, then to be at least in active recovery. But whilst ICES is the main source of stock management advice with respect to these pressure stocks, it does not overtly provide advice on fisheries management – at the very least on the basis that fisheries management infers that scientific advice is modified by other considerations in what is a “political” process. ICES is also keen to point out that its advice and protocols are in no way linked to the MSC methodologies, and that it provides its advice as an independent scientific agency and guided by international best practice. As a result, a number of the pressure stocks exploited within the Sussex SFDC area fall short of the MSC P1 standard in one or more areas.

Principle 1 – stock management assessments – pressure stocks

	Stock Status	Reference Points	Re-building	Harvest Strategy	Harvest Control Rule	Information & Monitoring	Stock Assessment
Sole	Green	Yellow	n/a	Yellow	Red	Yellow	Green
Plaice	Red	Green	? if nec	Red	Red	Yellow	Red
Cod	Red	Green	Re-assess	Red	Yellow	Yellow	Yellow
Mackerel	Green	Green	n/a	Green	Green	Yellow	Green
Herring	Yellow	Yellow	Green	Green	Green	Yellow	Green
Key	Automatic Fail			Conditional Pass		Unconditional pass	

Of the five species fisheries subjected to pre-assessment, the fisheries for mackerel and herring might be expected to pass P1, but those for sole, plaice and cod would be expected to be scored as non-compliant – i.e. with practices scored below that compatible with the term sustainable.

In the case of cod this is simply a reflection of the poor state of the stock, though there is every expectation that this is strengthening, and could be considered “in recovery” (i.e. with status recorded as between limit and precautionary reference points) in the next year or two. For Eastern Channel plaice there is concern that stock assessment is presented on a relative basis only, and that available evidence results in there being low confidence that current stock status is above the limit reference point. At the very least more evidence is required to demonstrate that this is a well-managed stock.

But for each of the fisheries for sole, plaice and cod there is no effective harvest control rule (HCR) – a clear mechanism where any change in stock status is automatically reflected in a fishery management action expected to bring the stock back into balance. This is an area that ICES is reluctant to rule on, though it is happy to comment on the likely impact of any HCR presented to it by managers and industry. Unfortunately it is also any area that the EC and industry have shown reluctance to embrace – instead preferring to rely on the outcomes of annual “horse-trading” over TAC and quota setting. Such a process does not meet even the minimum compatible practice under the MSC assessment process. It should be noted that Hastings sole fisheries have been certified as compliant with the MSC standard. This is at odds with the current pre-assessment of SSFDC area fisheries, and is an anomaly reflecting minor differences in assessment methodology between the “old” MSC assessment guideposts, and the new default assessment tree and accompanying guideposts, where rather more prominence is given to the issue of feedback loops and Harvest Control Rules.

### Non-pressure stocks

In the case of the non-pressure stocks, for all but the bass stock there is currently insufficient information available on which to deliberate on stock status and suitable reference points, let alone harvest strategies and HCRs. And in the case of bass, this fishery is not managed by reference points or HCR. As matters stand, none of these fisheries would meet the minimum required practices under P1.

This is not the same as saying that these stocks / fisheries are in an unhealthy or unsustainable condition – what is lacking is the evidence – but rather to show clearly that these stocks / fisheries are not subjected to the type of management that good practice dictates. For many of these fisheries a focused effort to draw together species specific management plans will go a long way to remedying this situation. In developing these plans it will be necessary to focus on how best to assess stock condition, to set management boundaries (reference points) that can be readily reflected in indicators of stock and fishery performance, and to find HCRs that both industry and managers can apply in practice. The guiding term should be “practicality”.

Principle 1 – stock management assessments - non-pressure stocks

	Stock Status	Reference Points	Re-building	Harvest Strategy	Harvest Control Rule	Information & Monitoring	Stock Assessment
Bass			n/a				
Lobster			? if nec				
Crab							
Scallops			? if nec				
Brill			? if nec				
Turbot			? if nec				
R. Mullet			? if nec				
Black Bream			? if nec				
Oyster							
Whelk							
Cuttlefish							
Key							

But even taking the above into consideration it is not a foregone conclusion that all these fisheries are susceptible to management on this basis, or that all these stocks can be demonstrated to be in good health (above the precautionary level). But what is clear is that “good practice” strongly suggests that these stocks and fisheries should be managed on this basis, and that embarking on a course to bring these fisheries into compliance with the MSC standard will result in improvements – even if these still fall short of the “good practice”. Collection and consolidation of the information needed to produce such species specific plans will quickly indicate to what extent these fisheries are readily susceptible to a more strategic approach.

## A1.4 Addressing environmental impact issues

### Static gear

All static gears deployed within the SSFDC area are expected to pass Principle 2, meeting the overall standard of “good practice” at Principle level. But such a pass would also be expected to carry conditions applying to each fishery – where current practice falls short of “good practice” at the level of Performance Indicator.

In general, static gears are benign in their impacts on the marine environment. Retained bycatch and discards species mix and levels are expected to be within the realms of what is reasonable, and habitat and ecosystem impacts are minimal. There is some concern about capture of ETP species – relating to cetaceans, rays and the like – but the incidence of interaction is thought to be low.

But where practice is considered to fall short of expectation is in the active demonstration of what the levels of impact are, and what strategies are applied to minimise or reduce such impact. Such information is not routinely collected or analysed, and little to no effort is made to put in place mitigation strategies. This simply indicates that the systems to manage environmental impacts of fishing are weak, and efforts need to be significantly strengthened. So saying, however, much work has been undertaken in examining the impacts of fishing on the marine environment, but maybe not in the Sussex SFDC area. The findings of such work need to be collated and assessed in respect of possible relevance to the situation found in the Sussex SFDC area. Where relevant, this information can be used to inform appropriate minimisation / mitigation management strategies.

Principle 2 – environmental impact - assessments

		Retained			Discards			Habitat			ETP		
		Status	Mgmt.	Info	Status	Mgmt.	Info	Status	Mgmt.	Info	Status	Mgmt.	Info
Static Gear	gillnets	Green	Green	Yellow	Green	Yellow	Yellow	Green	Yellow	Green	Yellow	Yellow	Yellow
	mixed pots	Green	Green	Yellow	Green	Yellow	Yellow	Green	Yellow	Green	Yellow	Yellow	Yellow
	whelk pots	Green	Green	Yellow	Green	Yellow	Yellow	Green	Yellow	Green	Yellow	Yellow	Yellow
	cuttlefish pots	Green	Green	Yellow	Green	Yellow	Yellow	Green	Yellow	Green	Yellow	Yellow	Yellow
	rod & line	Green	Green	Yellow	Green	Yellow	Yellow	Green	Yellow	Green	Yellow	Yellow	Yellow
	handline	Green	Green	Yellow	Green	Yellow	Yellow	Green	Yellow	Green	Yellow	Yellow	Yellow
Mobile Gear	otter trawl	Yellow	Green	Yellow	Red	Yellow	Yellow	Red	Yellow	Red	Yellow	Yellow	Yellow
	pair trawl	Yellow	Green	Yellow	Red	Yellow	Yellow	Red	Yellow	Red	Yellow	Yellow	Yellow
	beam trawl	Yellow	Green	Yellow	Red	Yellow	Yellow	Red	Yellow	Red	Yellow	Yellow	Yellow
	scallop dredge	Green	Green	Yellow	Green	Yellow	Yellow	Red	Yellow	Red	Yellow	Yellow	Yellow
	oyster dredge	Green	Green	Yellow	Green	Yellow	Yellow	Red	Yellow	Red	Yellow	Yellow	Yellow
	driftnet	Green	Green	Yellow	Green	Yellow	Yellow	Green	Yellow	Green	Yellow	Yellow	Yellow
Key		Automatic Fail			Conditional Pass			Unconditional pass					

Mobile gear

As might be expected, mobile gears have the potential to exact rather more impact on the environment, and some of this is considered to be moderately to significantly damaging to the environment.

The trawl gears, for which probably most information is available, can be indiscriminate in what they catch, and can have significant and long-lasting impact on the seabed communities as most are operated in close and physically intimate contact with the seabed. In general, it is the case that the heavier the gear, the greater the potential for damage.

Dredge gears tend to exert greater and more physically damaging impact on the seabed, but they also tend to be deployed in more specific seabed environments, targeting a very limited range of organisms. Oyster dredges tend to be deployed on well-defined oyster grounds, and thus both bycatch and physical impacts tend to be more limited as a result. The same sort of argument can be presented for scallop dredging, though the size and power of the vessel and gear is such that the potential for damaging impacts is all the greater.

Poorly managed deployment of both trawl and dredge gears has the potential to impact the environment to a degree that is incompatible with “good” environmental practice, and as such the severity of impact could mean that such fisheries are deemed non-compliant with the MSC sustainability standard.

Principle 2 – ecosystem - assessments

	Ecosystem		
	Status	Mgmt.	Info
sole	Green	Yellow	Green
plaice	Green	Yellow	Green
cod	Green	Yellow	Green
herring	Green	Yellow	Green
mackerel	Green	Yellow	Green
bass	Green	Yellow	Yellow
turbot	Green	Yellow	Yellow
brill	Green	Yellow	Yellow
black bream	Green	Yellow	Yellow
red mullet	Green	Yellow	Yellow
lobster	Green	Yellow	Yellow
crab	Green	Yellow	Yellow
cuttlefish	Green	Yellow	Yellow
whelks	Green	Yellow	Yellow
scallop	Green	Yellow	Yellow
oyster	Green	Yellow	Yellow

But it is also the case that “well managed” trawl fisheries can be shown to have moderated impact on the environment, and mitigation measures can be successfully put in place to further manage and moderate impacts.

The responsible deployment of otter trawl and beam trawl gears requires that maximum use is made of mitigation tools. These should include the nomination of areas closed to trawling, the rigging of gear to minimise seabed impacts, and the positive identification of the long-term impacts of trawling on the seabed through research comparing seabed communities in trawled and non-trawled areas of similar seabed. Of the trawl gear, beam trawling is generally recognised as posing the greater threat to seabed communities, though it is also recognised that both otter trawl and beam trawl categories encompass a wide range of gears and sets. From a management perspective it makes sense to clearly discriminate as to exactly what type of gear is used in what fishery.

Similar arguments apply to scallop dredging. Here the gear is inherently more damaging to the seabed, but it tends to be deployed in more narrowly defined areas of seabed. Again clear distinction needs to be made between the exact types of gear deployed.

**Principle 3 – fishery management - assessments**

	governance & policy				fishery specific management systems					
	legal / customary framework	consultation, roles & responsibilities	long-term objectives & precaution	incentives	fishery specific objectives	decision-making processes	compliance & enforcement	research plan	monitoring & evaluation	
static quota										
	>10	Green	Green	Yellow	Green	Yellow	Green	Yellow	Green	
	<10	Green	Green	Yellow	Green	Yellow	Green	Yellow	Yellow	
	non-quota									
		>10	Green	Green	Yellow	Green	Green	Green	Yellow	Yellow
		<10	Green	Green	Yellow	Green	Green	Green	Yellow	Yellow
mobile quota										
	>10	Green	Green	Yellow	Green	Green	Green	Yellow	Green	
	<10	Green	Green	Yellow	Green	Green	Green	Yellow	Yellow	
	non-quota									
		>10	Green	Green	Yellow	Green	Green	Green	Yellow	Yellow
		<10	Green	Green	Yellow	Green	Green	Green	Yellow	Yellow
Key	Automatic Fail			Conditional Pass			Unconditional pass			

In terms of retained bycatch and discards, there is some concern about the range and volume of species caught, particularly by the trawl gears, and this needs close monitoring. Whilst all such monitoring activity

within the Sussex SFDC is considered to be short of “good practice”, and this impact’s negatively on the development of appropriate management strategies to reduce / minimise impacts, there has been considerable research undertaken on this issue but perhaps not in the Sussex fishery area. The outputs of this sort of research need to be collated, analysed to establish their relevance to the local fisheries, and information used to draw up management strategies for each of the relevant fisheries. Where such information is not sufficiently relevant to local circumstances, specific programmes of information gathering need to be designed and put in place.

## A1.5 Addressing fishery policy and management issues

In relation to P3 issues none of the fisheries are expected to fail against the MSC standard. This said, there are, however, a number of key conditions are likely to be raised against some Performance Indicators – notably in respect of:

- development of species specific management plans,
- the processes for establishing long-term management objectives for fisheries,
- the development of fishery relevant research programmes, and
- resolution of who and how the non-pressure stock fisheries are managed in compliance with the MSC standard (as referred to in the opening section of this Chapter).

But by addressing the P1 and P2 issues, it is very likely that most if not all of the P3 issues will be naturally addressed as part of the process.

## Appendix 2 - Addressing P1 issues

### A2.1 Approach

An important task of fisheries management is to ensure adequate information is obtained to evaluate the fishery performance. This is a core function of the management authority. It is not possible to manage a fishery well unless such information is obtained.

The recommended approach is to use simple statistics as monitoring indicators and construct appropriate management decision-making in relation to these.

Each fishery will require one or more indicators for their status.

Simple indicators are not only easier to understand by stakeholders, but they are simple to calculate and their statistical properties (error variance) are easier to incorporate into the decision-making.

Reference points and harvest control rules for simple indicators based on their relationships to fishing mortality and biomass can be estimated through standard stock assessment methods. They can be treated as proxies for these underlying variables of interest.

The possible indicators will be limited by the data which can realistically be collected on a routine basis. Appropriate indicators will need to be calculated with the limited data that can be collected from each species / gear. It is likely that a trial period of collection will be required for each fishery to obtain a sample of data.

The properties of the indicator will need to be investigated in each case. The behaviour of the indicator and its interpretation can be tested through simulation after some data have been collected. The indicator will need to be robust in that it should not be too sensitive to assumptions which may not strictly hold.

The indicator's statistical properties are important. It is likely that where data are taken from a small number of fishers, the resulting indicator will be very noisy (wide variation in data points, making interpretation difficult; this tends to resolve itself as the number of data points is increased). Once there is a sample of data taken from the fishery, the variance and behaviour of the indicator can be estimated.

It is not enough only to collect standard data, since the data may not contain sufficient information on the relevant management decisions. Management must also ensure that management actions do not decrease the information content of monitoring indicators and as well as take action to enhance the value of indicators wherever possible.

The tasks in developing indicators, reference points and harvest control rules are identified as twofold:

- Initialise the system through rapid information collection and assessment to propose and agree among the stakeholders the indicators, reference points and harvest control rule that will be used to manage each fishery.
- Implement the management system to apply the harvest control rule, and adaptive management techniques to improve the management and increase benefits to the fishery over the longer term. The management should include a research programme to test and evaluate the management system performance and update it as necessary.

It is recommended that the management system for small scale fisheries be as participatory as possible. This lowers the cost of management and greatly increases the probability of success particularly in diverse small-scale fisheries.

The management system needs to be commensurate with the scale of the fishery. All the recommendations here take this into account. The proposal is not an extensive scientific endeavour to understand the population dynamics of the exploited stocks, but a pragmatic proposal to apply reasonable management controls which are expected to work together with an adaptive system applying the principle of trial-and-error.

## A2.2 Data collection and indicators

**Table 1** outlines the simple indicators which are likely to be of use for small scale fisheries. These are based on fishery dependent data which should be routinely available. **Table 2** provides an outline of the data which might be recorded for each stock and gear type in the Sussex fisheries.

Routine data collection forms the fundamental information gathering for the management authority. It is a core responsibility because good management cannot be implemented without some sort of monitoring. Ecosystems are too complex and unpredictable to be managed without constant feedback to adjust controls.

Total catch weight will be required for all stocks. It should be possible to obtain total catch weight from each stock with the current level of data collection. It should also be possible also to obtain catch values from the same sources (i.e. processors) for economic monitoring.

Size related monitoring will require two types of measures:

- Fishers can report, for many species, the number of fish they land as well as the total weight. This can be used to estimate the mean weight of the fish being landed.
- A sampling programme can be conducted where fish are measured by data collectors. This would require employing staff to carry out measurements in sufficient numbers so that there is enough data to represent landings size composition. Such a programme is already in place for sea bass. Given the cost of such an exercise, it should probably be reserved for only the more important stocks, if any.

These measurements are already collected by MFA and Cefas scientists as a part of their normative monitoring programmes, but a more management specific data collection, collation and analysis system may be required to better direct local management of these fisheries.

For a number of species, notably the crustaceans (lobster, crab) and molluscs (cuttlefish), fishers should also be able to report the sex composition of the catch. Depending on the life history characteristics of the stock, reporting catches by sex or sampling to obtain the sex ratio may provide useful information.

Measures of fishing effort are more complicated than catch due to differences in fishing gear and the way they are used. Measures of effort are used as proxies for fishing mortality and for costs of fishing. Different measures may be useful for each type of use, but here the discussion will be limited to measuring for fishing mortality and, by extension, CPUE as a measure of abundance.

Effort needs to relate to the proportion of the stock which might be caught by the gear. This usually involves measures of swept area for active gears such as trawl, or the soak time multiplied by the volume of gear for static gears (Table 2).

Effort is often standardised. This uses different covariates to try to generate a common measure of effort and CPUE between different gears and fishery operations. Specifically, covariates need to be recorded which account for different fishing efficiencies. It is likely in the case of Sussex fisheries that gear will be relatively consistent among the fishing vessels. However, recording gear specifications will be necessary to monitor potential changes in gear efficiency over time, which can otherwise render fishing effort useless as an indicator.

Fishers will need to review the data collection programme for the practicality of providing the required data as well as the value in providing the relevant information. Particularly in respect of gear specifications, it is important that the fishers who use each gear indicate the parameters which are important and which should be recorded.

Sampling error will be an important consideration in choosing any indicator. Error can be minimised by maximising the number of fishers who provide data, applying a rigorous sampling methodology where necessary and using simulations to develop data treatment which can reduce error to acceptable levels. It is possible however that some indicators may have to be rejected because they do not provide accurate enough monitoring at a low enough cost.

Efficient data handling will form a necessary part of the monitoring system. Paper based methods are expensive, liable to error and often do not report back to those providing the data. As the system would be based on voluntary data submission, the most simple and cost effective method would be to require fishers enter data directly on to the computer themselves. Computer applications would not only store data for monitoring purposes, but also report to users information relevant to their fishing activities and business as required, making such a system of greater direct use. It should be noted that processors already have databases, which can be extended to report management data.

Therefore, a database and data entry system would be required. Fishers and processors enrolled in providing data would need computer and internet access. The system would also need to respect data confidentiality as required by the users. It is likely that users would be comfortable with aggregated data been reported, but not the individual detail records. Confidential data could be made inaccessible and only available for an individual's applications. It would be important that any of these data not be available for enforcement purposes.

It is recommended that a simple inexpensive data management system might be set up based on an Excel spreadsheet for data entry, and a data loading facility to transfer data to a database, which can be used for reporting. This would provide a test system which can then be further developed as a more expensive internet-based system if so desired.

Data verification and auditing programme: A short term programme should be implemented to ensure data are correct. This should consist of using independent sources of information for comparison. Only one source need be designated as the primary source (minimum error).

Table 1 Variables likely to be used as the main indicators for the stock status.

Variable Name	Proxy	Reference Points	Main Assumptions	Recorded Data
Effort	Fishing mortality	Target: 120% Effort at MSY Trigger: Effort at MSY Limit: 60% Effort at MSY	Fishing mortality proportional to effort Catchability constant	Total effort each trip
CPUE	Biomass	Target: 120% CPUE at MSY Trigger: CPUE at MSY Limit: 60% CPUE at MSY	Biomass proportional to CPUE Catchability constant CPUE when stock unexploited estimated	Total catch each trip Total effort each trip
Mean Weight	Fishing mortality (Yield-per-recruit)	Target: $F_{0.1}$ Trigger: $SPR_{40\%}$ Limit: $SPR_{20\%}$	Constant selectivity Growth and length weight parameters known and constant Natural mortality known Size at 50% maturity known	Total catch each trip Total numbers of fish each trip

Table 2 The data collection by stock which could be carried out for the calculation of indicators. Not all indicators will be calculated for all stocks, but will depend upon what data might be obtained. Final choice of data collection programme and indicator will be decided upon by the management authority when initiating the process.

Species	Gear	Data Collected	Possible Indicators	Issues
Seabream Seabass Red mullet Sole Mackerel	Angling	Number of rods Time fishing Total catch weight Number of fish Sampled length	Mean length Mean weight CPUE	Stocks shared outside Sussex region Stock assessment already covered by ICES assessments
	Set Net	Number of nets Net length Hours fishing Total catch weight Number of fish	Mean weight CPUE Effort	
	Trawl	Trawl net width, speed and time of trawl (swept area) Total catch weight Number of fish		
Lobster Crab Cuttlefish Whelk	Traps	Number of traps by type Hours soak time Total catch weight Number of fish	CPUE (catch per trap soak time) Mean weight Mean carapace/shell length by sex Sex ratio Weight and sex composition Length and sex composition	Stocks adult and/or recruitment shared outside Sussex region Trap CPUE usually poor, so may need research
Scallop Oyster	Dredge	Number of dredges Dredge width, speed and time of dredge (swept area) Total catch weight Number of oyster	CPUE (catch per dredge swept area) Mean weight Mean shell width Weight composition Length composition Age composition	Stocks recruitment shared outside Sussex region

## A2.3 Implementation

The harvest control rules (HCR) must be applied through a quota control. The quota will need to be subject to review to ensure that the correct decision is made and to apply any extenuating circumstances in a measured fashion. An alternative quota to the HCR could be set temporarily under special circumstances similarly to applying a temporary subsidy, although there should be a clear cost associated with this.

The type of quota will need to be decided and may vary between fisheries. For quotas, whether an individual quota is transferable or not will also need to be considered. Quotas are likely to be:

- Catch quota: The traditional control which works well if well enforced. The appropriate level of catch may be difficult to calculate and may require re-estimation each year.
- Effort quota: Effort quotas are particularly useful as they limit fishing mortality on the bycatch as well as the target stock (see Appendix A). However, catching efficiency will need to be limited or the effort quota adjusted as efficiency increases.
- Area access: Area use rights could be agreed for static gears such as traps. To an extent access to areas is already controlled through traditional activity, but not necessarily formalised. Formalising could probably be linked to effort quotas above, but it would also be possible to link area exploitation to a rule which would increase the area set-aside if the stock decreased in size. This approach has not been widely applied, but is used in traditional management systems in the Pacific Islands.
- Seasonal Access: It would be possible to establish seasonal closures for some fisheries. These would not be individually based but apply to the whole fishery. Seasonal closures could be variable length to meet the requirements of a harvest control rule and would in effect work in a similar fashion to the effort quota.

Each fishery needs a management authority made up of stakeholders or stakeholder representatives. The management authority should be responsible for making decisions and administering the system, including allocating the quota among the relevant stakeholders, monitoring the uptake of the quota, and ensuring that fishing is not in excess of the quota.

As well as the harvest control, additional fixed controls can be implemented to protect spawning or nursery areas, or spawning times as required. Fixed closed seasons and areas are often used in addition to other controls. Generally, the more controls that are successfully applied, the lower the risk to the fish stock. Some fixed controls can be highly effective at protecting the stock and yet may have a minimum impact on fishing activity.

## A2.4 Initialising reference points and Harvest Control Rules

### General Approach

The target reference point needs to be agreed by stakeholders, with the constraint that the biomass should be greater than or equal to the MSY level. The target represents what the stakeholder wants from the resource in terms of catch rates and size composition over the long term. Agreement can best be reached through a workshop with technical / scientific support.

The limit reference point will be related to the biology of the stock and specifically identified to protect recruitment. It is likely that the most accurate limit reference point that could be estimated would be 20% of unexploited stock or 50% of the stock size at MSY.

The reference points and harvest control rule need to be established even if the science is lacking. It is unlikely that all information necessary to provide full scientific advice would be available when initialising the

management process. Nevertheless, innovative methods and precautionary approach can still be used to arrive at decisions over appropriate reference points and controls.

The indicators, reference points and harvest control rule would best be established through a stakeholder workshop facilitated by management and technical support. The task of the workshop would be:

- For stakeholders to understand the current scientific information, including the stock assessment, and any relevant scientific research.
- For stakeholders to supply their information for inclusion with the technical data,
- To identify critical issues where there is disagreement among stakeholders, if any, and identify tasks to resolve those issues. Science has an important role in resolving such disagreements.
- To agree the management controls, indicators, reference points and harvest control rule for an initial management plan. To facilitate this, simulation tests of various management options should be conducted and presented during the workshop.
- To agree a research plan to close out issues and improve the management of the fishery.
- To identify management activities and controls which will be needed to implement good management practice.

## Harvest Control Rule

Appendix A describes a harvest control based on fishing effort and catch-per-unit-effort for a tropical shrimp trawl. Although constructed for a specific fishery, many of the results for this rule would apply generically to any fishery as long as the basic assumptions hold. Clearly, the parameters for the rule would change and need to be estimated for each fishery, but the general form and structure would remain the same. A similar HCR including mean size might be proposed, but it would require testing using simulation.

Catch-per-unit-effort is a particularly useful indicator, since it relates the HCR to controlling the catch rate and therefore controls profitability of fishing. Fishing effort is a good indicator and control as long as the catching efficiency does not change. A stock assessment can be used to estimate reference points and harvest control rule based on these native indicators assuming that they are proxies for biomass and fishing mortality.

The key assumptions are:

- That the fishery is dealing with a management unit. This is weaker than the requirement for an isolated population. The key attribute of a management unit is that the fisheries management can control the local abundance.
- That catchability remains constant if using fishing effort or selectivity remains constant if using size as the indicator. If catchability or selectivity change, this will need to be estimated and additional data and research may be required.
- That sampling and other errors remain small compared to changes in indicators related to abundance or fishing mortality. This can be verified as data are accumulated over time.

## Stock Assessment

Stock assessment will provide stock status and estimate reference points. The assessment method will be largely decided upon by the available data, and indicators required. Methods do exist which are less sophisticated than ICES-type age-based assessments, but still make use of limited data. These can be applied in most cases with a variety of additional methods used to fill in data gaps.

Stock assessments should not have to be undertaken annually, but will be required to initiate the management process and perhaps every 3-5 years as part the monitoring process. A stock assessment is technically difficult to conduct and would require professional help. There is a shortage of stock assessment scientists and conducting assessments is therefore relatively expensive. However, with careful choice of indicators which are relatively inexpensive to calculate, stock assessments need only be conducted infrequently.

It is recommended that stock assessment applies Bayesian fitting methods so that all sources of information can be used and uncertainty can be taken into account in providing the best scientific advice. A stock assessment is unlikely to have sufficient data from the fishery to estimate reference points or a robust harvest control rule. It is therefore likely that additional information will be required from some supporting research carried out in the short and medium term for each fishery. The different sources of information can be most easily incorporated through Bayesian statistics.

## Supporting Research

A literature review to identify information and, where necessary, develop “priors” including estimated uncertainty, will be required. Various stock assessment methods require independent information on growth, length-weight, reproductive rate, fecundity, natural mortality and so on. These often cannot be estimated from fishery data alone, but require specific research. Even if research has not been conducted on the stock or species concerned, information may be obtained from similar stocks, species and/or fisheries.

As well as standard scientific methods, methods based on ideas from participatory management can be used to include the views of stakeholders in the stock assessment as well as the decision-making process. It is better to use information in this way, as the views of stakeholders are balanced against scientific and other information within the process. Alternative methods tend to introduce bias as there is no natural weighting applied to the different views. Priors and preferences can be obtained from interviews of stakeholders.

A rapid short term data collection programme should be conducted to allow morphometric conversions for the stock, mainly conversions from length to weight and the reverse. The data are simple to collect and the analyses simple to undertake, and results are very useful for a variety of purposes in stock assessment as well as validation of various reported statistics.

It may be necessary to conduct specific studies on population dynamics such as growth and recruitment. This research will reduce uncertainty. Research specific to the stock may be considered desirable even if relevant research on the species exists in the scientific literature. Growth rates will vary with average temperature, and local conditions may be considered sufficiently different to justify a specific scientific programme. The costs involved in this sort of research would form an important part of the decision over whether such research would be desirable.

## Simulation Testing

Harvest control rules can be tested through simulation before they are put into practice. This can be used to design the system in such a way that management errors are minimised. Simulations can be used to represent a very wide range of possible scenarios and therefore improve the robustness of management tools. However they are limited in that not all eventualities can be tested and the scenarios are tested on a model which is a simplification of the real world.

Simulation testing can be carried out rapidly, as long as the proposed procedures are simple, and should form part of the process for deciding upon the harvest control rule. Simulations can be conducted during the management authority meetings to give immediate feedback on proposals and provide advice on various options among which the participants must choose.

Simulations are particularly important in considering risks not only of sampling and structural error, but also of violating of key assumptions (see Appendix A). This should help in designing robust harvest control rules and monitoring systems to ensure management is sustainable.

## A2.5 Establishing adaptive management

### Approach

It is an important task of management to obtain information on the status of the resource and monitor its own performance. Collecting data is not enough as much data is uninformative on the decisions which must be made. Data needs to be collected, which allow comparisons between the management options. This is achieved

by obtaining data representing contrasting states for the fishery. Information is obtained from routine data collection, special scientific research and specific management actions designed to provide information rather than just management of the stock.

Fisheries management should take advantage of life history characteristics of the stock being exploited. Closed areas and closed seasons can not only help protect particular life history periods or sections of the population, they can also be used to enhance signals related to population dynamics effects such as recruitment or state of the unexploited stock.

## Fishing Experiments

Fishing experiments provide a rapid method useful for producing data on the behaviour of a stock when subjected to intensive fishing which can then be used in stock assessment. They require a relatively isolated but representative portion of the stock, which has been left unfished for a period allowing the population to increase, then a short period of intense fishing followed by another period of recovery. Importantly, by involving fishers in the experiment and purposefully depleting an area, the process demonstrates that fishers can directly affect the status of their local target stocks and reaffirms the importance of developing a management process. The method however is not suitable for highly migratory species, such as many pelagic fish or where no isolated sub-population can be found.

A fishing experiment should cause no overall harm to the ecology and may actually reduce fishing mortality albeit by only a small amount. While it is true the local population will be depleted, this would be by drawing fishing effort from elsewhere in the fishery. The result should be no overall increase in fishing mortality, just targeting fishing to a smaller area (similar to no take zones which may just divert fishing effort to different areas).

Fishers would be fully involved in designing and conducting the experiment. They should want to participate in an experiment because it seeks to provide information which will benefit the fishery and their knowledge.

Fishing experiments should provide detailed information on the target and bycatch stock abundance, size composition and sex composition. Detailed effort information (fishing times and characteristics of the gear and boat) could be useful in determining how effort can be recorded routinely.

If possible, as well as recording fishing effort, an index of stock size should be obtained before, during and after the experiment. An index could be visual census, the CPUE from some standardised gear or other method to measure local density. Any method can be used as long as it can be assumed that the counts are proportion to the size of the fishable stock.

It is necessary to raise the experiment area to the total fishing area to obtain correct estimates for the relevant parameters. The simplest way to do this, which is recommended as an initial technique, is simply to raise the total catch in proportion to the experiment : total area ratio. With habitat map data, more sophisticated approaches might be used. In any event, bearing in mind that there will be some immigration and emigration unaccounted for and that the experiment only provides a snapshot of the stock at best, it is likely that the experiment data will allow uncertainty to be more narrowly bracketed rather than provide accurate parameter estimates.

## Tag and Return

Tagging can be used to protect a proportion for the stock. Voluntary V-notch programmes are used to identify spawning females in lobster fisheries that have been returned to the sea after capture, for example. Releasing females should reduce effective fishing mortality on the spawning stock at the obvious cost of having to return valuable catch to the sea.

Tagging experiments can also provide information on growth, movement and mortality, making them potentially very useful. Fishers can carry out their own tagging experiments: recording, tagging and then releasing individual animals. An advantage of a fisher-run programme is that recaptures are very likely to be reported. The disadvantage of tagging is the cost of this sort of programme.

The effectiveness of any tagging programme designed to protect the stock needs to be assessed. This also requires recording and reporting tag returns and recaptures.

Marking animals with an individual number is preferable. This provides more information on growth and mortality than techniques like V-notch which do not identify individuals. Nevertheless, the practicalities and costs limit what might be done, and non-identifying marking is still informative.

## Closed seasons

Closed seasons serve three purposes: to reduce or limit fishing effort, to protect spawners or juveniles from exploitation or to introduce contrast in monitoring data series. The main problem with closed seasons is they enforce a period when fishers are unable to earn money.

Closed seasons are sometimes useful for enforcing current practice. Many Sussex fisheries are seasonal in nature, so enforcing a closed season when fishing on a particularly stock does not much occur anyway would seem to serve no purpose. However setting a closure sets a precedent that could be extended into the fishing season (as for cuttlefish for example) and puts in place a control that might limit expansion in the fishery to unsustainable levels, if for example, prices for the product increased.

## Closed areas (Marine Protected Areas)

Closed areas can be used to protect a section of the population and thereby prevent overfishing. They also may provide an indication of what an unexploited stock might be like, which is important for developing good reference points. Very often, data collection only starts when the management authority becomes concerned that overfishing might be occurring and the fishery has been fishing for many years. Fishery data from this point can only be used to estimate the condition of the unexploited stock through extrapolation, which may not be reliable. Closed areas in contrast may provide actual observations on a population not subject to fishing, which should be much more reliable.

The disadvantage of closed areas is that they require understanding of the spatial distribution and movement of the population. Given the difficulties of working with one dimension, time, in stock assessment, the addition of 3 more dimensions is usually beyond the capacity of the assessment to provide advice on. Closed areas are therefore proposed on limited often non-quantitative information and therefore their performance will be uncertain. Nevertheless, they are an important tool in applying the precautionary approach, limiting impact on bycatch and the habitat as well as potentially providing information for decision-making.

## A2.6 Administration and monitoring performance

### Establishing feedback and control

Responsibilities need to be allocated among stakeholders. Ideally, a single group would not be responsible for the entire process, but responsibilities would be split into at least two areas so each group might oversee the other. However, for small scale fisheries, it may not be appropriate to have more than a single meeting where the two independent groups, managers/scientists and producers for example, might come together. The responsibilities and tasks are:

1. Converting data into information. This is primarily estimating the appropriate indicators and reviewing the data and calculations to ensure that they are correct. This task can be conducted by a designated technical staff who should also be a member of the management authority.
2. Deciding upon the level of control, abiding by policy decisions. If there are no extenuating circumstances, this should be a simple case of applying the harvest control rule. This can be carried out either by a group or, if the harvest control rule is to be applied, through review then dissemination of the result. If there is a meeting, the results and recommended control should be reported and enough information provided so that the meeting can ensure the calculations and results are correct. Unless there is clear evidence to set an alternative control, the agreed harvest control rule should be applied. If the harvest control rule is broken, it implies a review of the policy and rule is required.

3. Enforcing the decision. This should consist of, at the very least, dissemination of the decision so that all stakeholders are made aware of their responsibilities for the coming season. It may also involve a third party to ensure the quotas are adhered to. As long as a general agreement has been reached, most stakeholders should keep to their quota.

Regular meetings of decision-makers are required commensurate with the likely rate of change of the stock. In most cases, meetings would be annual, but where a transparent rule is being applied, meetings may only be rarely required to review the performance of the controls and other matters pertaining to the management of the fishery. Furthermore, the management of several fisheries might be reviewed at the same meeting, making the system relatively efficient.

The management authority will need to initiate the process by making the following decisions:

- The harvest control rule which determines the overall quota;
- An agreed division of the quota among the stakeholders;
- Various other static management controls to limit fishing mortality and decrease risk to the target and bycatch fish populations.
- A research plan to inform the management process.

## Evaluating management performance

It is important that the management performance undergoes periodic review. This need not necessarily be frequent (every 3 to 5 years, for example), but ensures management performance is maintained at a high level, that the management authority is undertaking its basic tasks correctly. To aid the review, the vision, goals, objectives, outputs and tasks of the management authority, together with the terms of reference and results of meetings need to be documented. The review can also be used to identify possible improvements.

A scientific “working group” could be established to oversee any research activities, review the indicator calculations, the reference points and harvest control rule. They can also develop and mark the progress on the research plan. Working groups made up primarily of scientists are used to provide scientific advice to managers in most fisheries management systems. A group of local scientists could perhaps be brought together periodically to cover all stocks under this management system tasked with scientific review of the relevant aspects of the management strategy and to provide general technology support to the management process.

## Appendix 3 – Information on stock status, by species

### A3.1 Note on the Overall Approach and MSC Principle 1

An important consideration of Principle 1<sup>3</sup> is stock structure. Many of the stocks managed within Sussex waters may be shared not only with other English fleets, but with other countries. The aim of this preliminary report is to consider management within this context. This would require two approaches

- If there is a good overall management plan, ensure these management requirements are fully implemented locally. This might include minimum landing size, limits on fishing effort and catch.
- If there is no overall management plan, implement a local plan which will prevent local depletion (i.e. if it was applied globally, overall depletion would not occur) and/or if the stock overall were depleted would not hinder its recovery.

Even if it is decided that Sussex management alone cannot meet the requirements of MSC, it is assumed that good principles still need to be developed and applied consistent with the intent of the MSC.

The objective of this report was to consider the general options for local management of the fish population. All management would require a harvest strategy, harvest control rule (implying a measure of stock status) and some form of monitoring. This needs to be achieved based on local resources, being inexpensive to implement and maintain, but effective in limiting and reducing harvest as the population is reduced in size.

While local management has a significant disadvantage in that it can only rarely be applied to a whole stock, it has a number of advantages:

- There are often local attributes and conditions which can be used to meet overall objectives with high effectiveness and low cost. Generic controls, such as a minimum size, often require high enforcement (catch inspection at landing sites) costs to achieve their objective. Local controls, for example avoiding times or areas where specific sizes are caught, may be as effective, but simpler and have lower associated cost.
- Local management can develop better co-operation from the fishing community. Agreed management actions and rules, as exemplified by the RACs for the larger fisheries, lead to better enforcement and more effective management.

Developing co-operation with and among the fishing community and identifying local circumstance which can be taken advantage of forms part of the on-going development of the harvest strategy, particularly for the smaller stocks which otherwise have attracted little attention.

An important part of the harvest strategy is the harvest control rule. This consists of a “target” defining where management and by extension, the fishing community would like the fishery to be, and a defined harvest reduction procedure that prevents the stock being depleted to the point where recruitment is put at risk. To implement a harvest control rule, indicators are required that relate to the state of the fishery. A number of indicators might be developed measuring the social, economic as well as ecological state of the fishery. In this case, we are only concerned with biological state of the stock, although in further development, other types of indicators should also be considered particularly where there is low cost in collecting the additional information.

The key indicators for the stock status are an index of abundance and an index of the exploitation rate. Two simple indicators for these are catch-per-unit-effort (CPUE) and mean size respectively. These data are

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<sup>3</sup> Principle 1 states that “A fishery must be conducted in a manner that does not lead to over-fishing or depletion of the exploited populations and, for those populations that are depleted, the fishery must be conducted in a manner that demonstrably leads to their recovery.” This can at least partially be met by a local management authority and in some special cases may be entirely met even where the stock is fished outside the area.

available from the market/processors and potentially more accurate information may be obtained from fishers. Some information was obtained from a market/processor for preliminary review. In addition, data were identified as potentially collectable by fishers.

The aim would be to carry out the following for each species:

- Identify a harvest strategy that is able to make use of any local or global attributes of the stock or fishery.
- Identify data that might be usefully collected by fishers and/or market/processors for the purpose of monitoring the stock. Indicators derived from these data would form the basis for evaluating the harvest strategy and implementing a harvest control rule.
- Define robust harvest control rules based on available monitoring data which protect the stock from depletion both locally and potentially over the whole stock range.
- Identify the most appropriate harvest control rule and provide evidence that it is robust across a range of alternative scenarios using management strategy evaluation approach. This would need to be done for each species/stock.

## A3.2 Stocks

### Sea Bass

Sea bass is assessed by ICES and currently the spawning is thought to have increased. The stock is shared and therefore this defines overall status. The ICES working group has not developed a harvest strategy or harvest control rule for this stock. This would need to be done by one of the fisheries science institutions (e.g. CEFAS) and presented to the working group. If endorsed, this could form the basis for management advice and increases the chance that it would be adopted stock wide.

Local management is also possible. Sea bass locally are predominantly line caught. The CPUE and size composition seem consistent year by year, although it also shows a slight negative trend. The stock assessment reported in ICES (2008) [ICES (2008) Report of the Working Group on Assessment of New MoU Species (WGNEW) ICES CM 2008/ACOM:25] ends in 2005 (when the current CPUE series starts), and reports the highest spawning stock size in the available time series. The slight decline in CPUE since 2005 is therefore not a cause for concern. It is possible that Sussex CPUE could be developed as a useful biomass index for use in the English channel stock assessment. Other official data are likely to be available for this stock, primarily random sampling of lengths. This needs to be obtained from CEFAS and/or DEFRA.

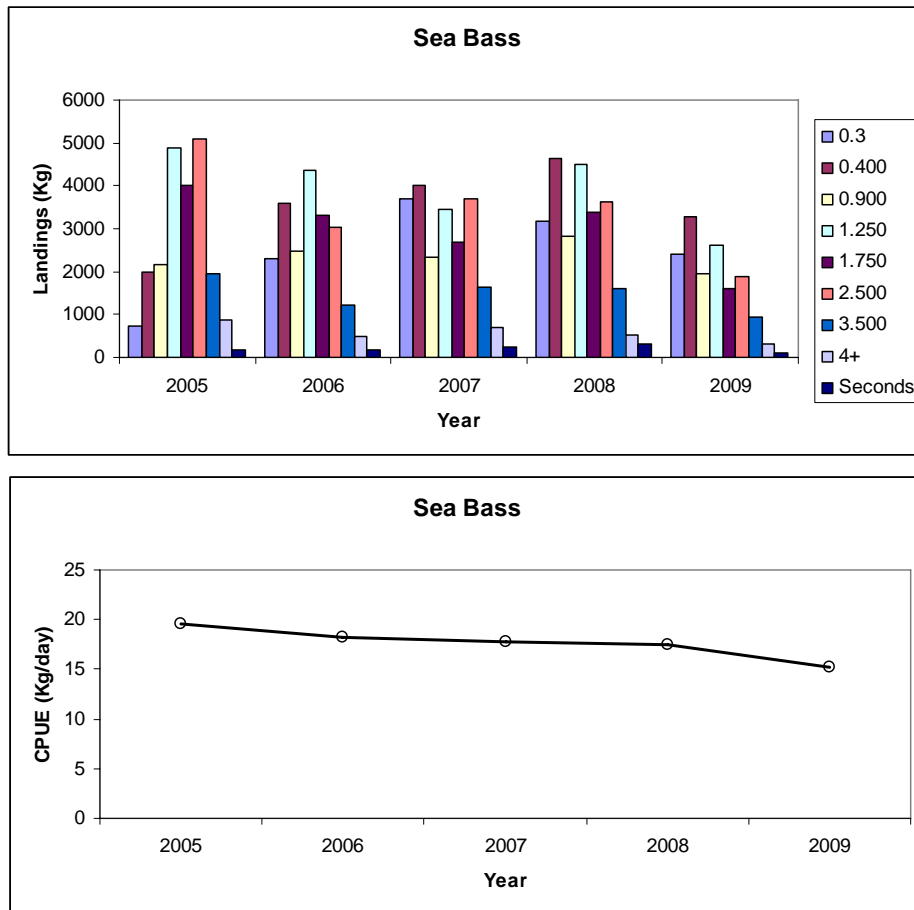


Figure 5 Sea bass line caught size composition and CPUE. Both data series show characteristic consistent with the stock assessment and state of the stock, with a relatively high proportion of larger fish. Current CPUE and size composition could be used as the basis for setting a reference point for future monitoring of these indicators.

## Turbot

Turbot is a fairly long lived (25 years) large flatfish, which unfortunately has no life history peculiarities useful for management. Eggs and larvae are pelagic and adults are likely to move around, so the stock is likely shared outside the management area.

The size composition shows some similarity to brill and the pattern is likely to be due to selectivity characteristics of the gear. It may be that a ratio between the modal catch sizes provides a reasonable estimate of the relative exploitation rate. There is some evidence of strong periodic recruitments which may be amenable to modal progression analysis (e.g. ELEFAN). However, as the CPUE only covers a small area of the stock, this may be a local abundance only. However, a local size composition pattern not realised elsewhere would suggest adults are relatively site attached making local management easier and justified as a management unit. The higher proportion of "seconds" when the CPUE is high also requires explanation.

The CPUE index shows some variation, although standardisation would be required. The higher CPUE in 2006 may reflect the high recruitment to the fishery in this year.

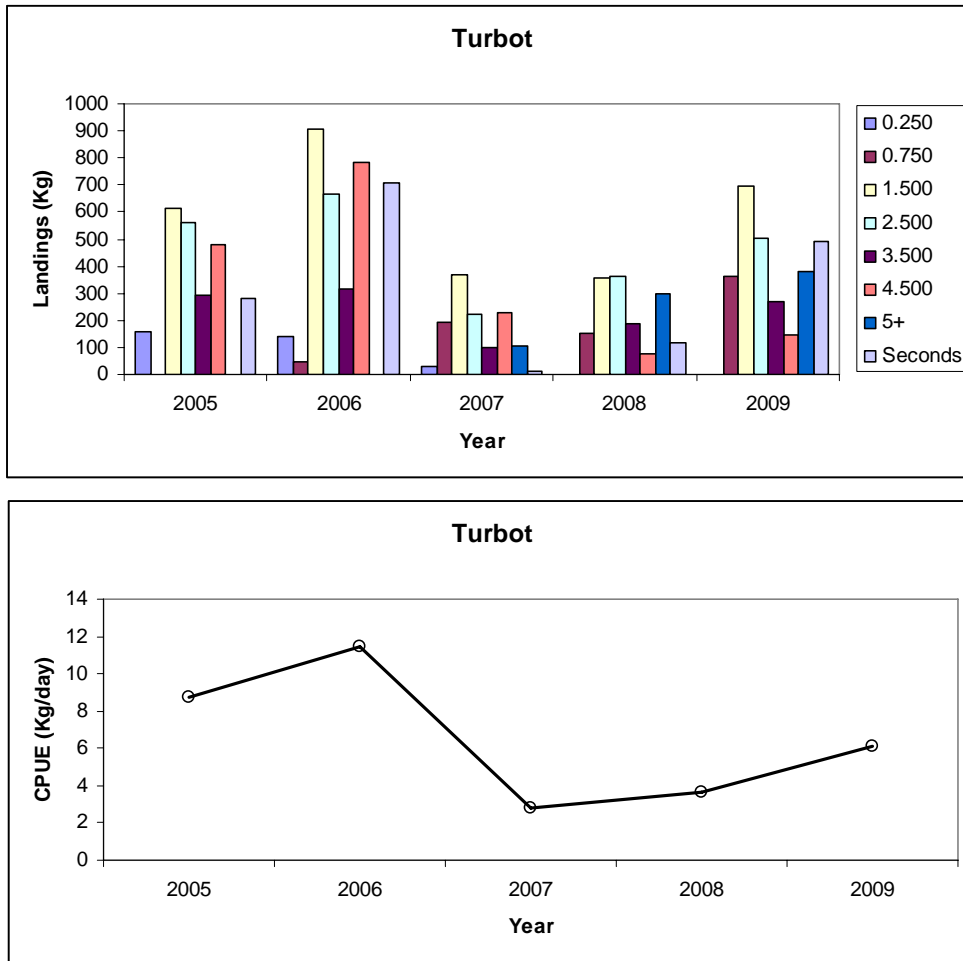


Figure 4 Turbot size composition shows a fairly consistent pattern, but there is also evidence of one or more large year classes moving through the population as the 5+ kilo sizes form an increasing part of the population. The high CPUE in 2006 may reflect large recruitment to the fishery, suggesting that turbot CPUE could form the basis for a useful abundance index, although selectivity will need to be accounted for.

## Brill

The stock is clearly shared. There do not appear to be any specific characteristics of the species which can be used for management. The aim would be to show that management of the target species (turbot) would also protect brill (catchability of turbot > catch of brill and/or life history robustness of turbot < life history robustness of brill).

Brill is primarily caught as bycatch in set nets of the inshore fleet. The catch size composition has varied with the absence of 1-2kg sizes suggest the observed sizes may primarily be due to selectivity of the gear rather than sizes in population. The CPUE index seems well behaved, however, showing some but not excessive variation. Standardisation will be required, but it could provide an index for local abundance.

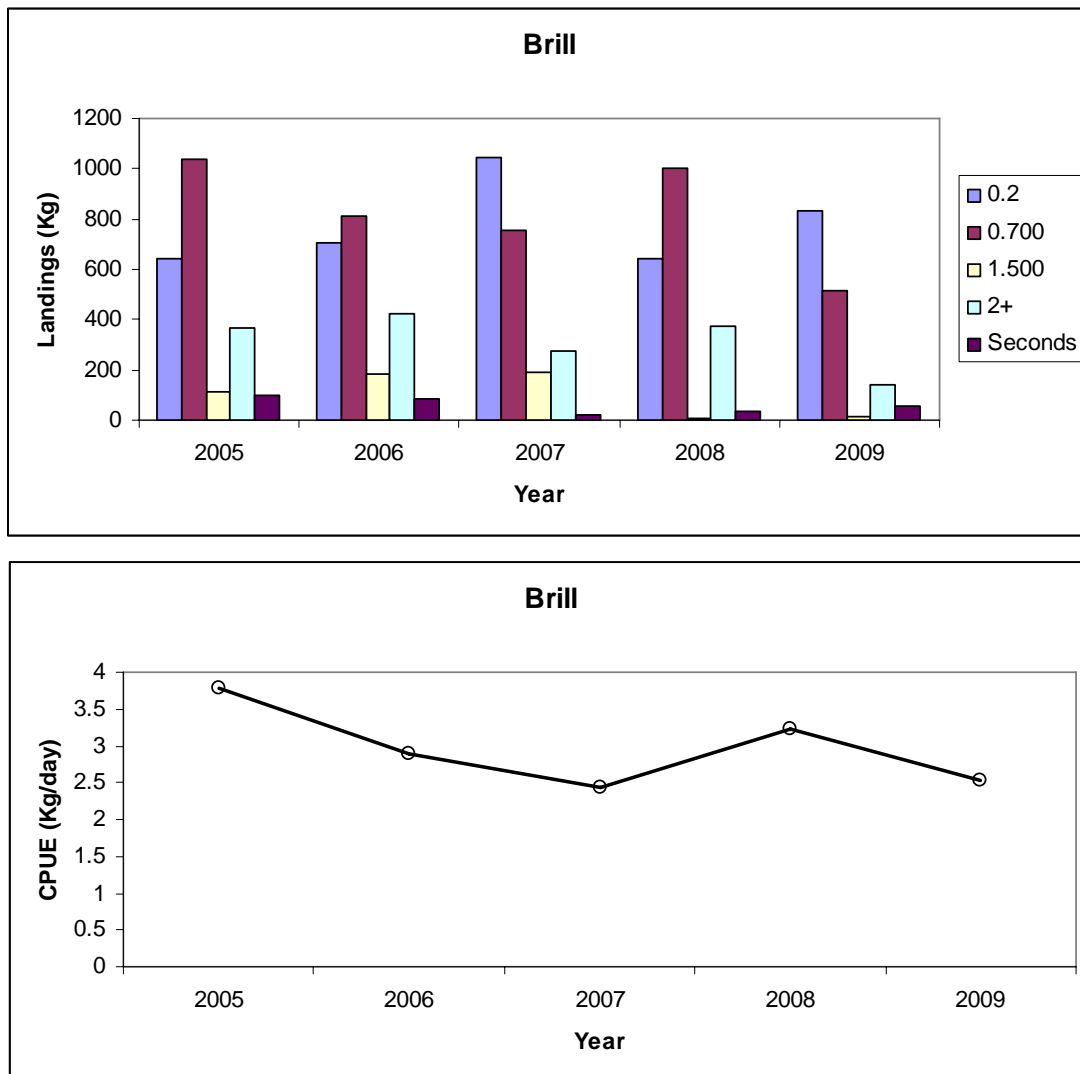


Figure 3 Brill catch composition and catch rates. Brill are netted by the inshore fleet as by-catch alongside turbot, and also caught by the beam trawl fleet.

## Black Seabream

Black seabream is a demersal spawner and protogynic hermaphrodite. Eggs are hidden in nests on sandy bottoms. Black seabream is caught by the inshore vessels, represented in the index below, primarily as a bycatch. Lack of targeting sometimes helps the index as the catchability remains largely unchanged over time. There appears to be some consistency in the data, particularly 2007-2009, which suggests that a reliable index may be obtained from the landings data for this species. Standardisation of the index would be required.

A fishery independent may also be useful for this species. Spawning sites in April/May are well-defined. These sites provide a location for monitoring stock through a survey. They also provide a way to protect a proportion of the spawning stock by seasonal area closure, which may prove to be a robust inexpensive way to manage the stock. Alternatively, if a method for minimising fishing mortality of smaller fish can be identified, males may preferentially be taken which would allow the stock to withstand a higher fishing mortality. In any case, due to the sex change, the stock may be able to withstand higher mortalities than would otherwise be the case, making it a good subject for simple harvest control rules.

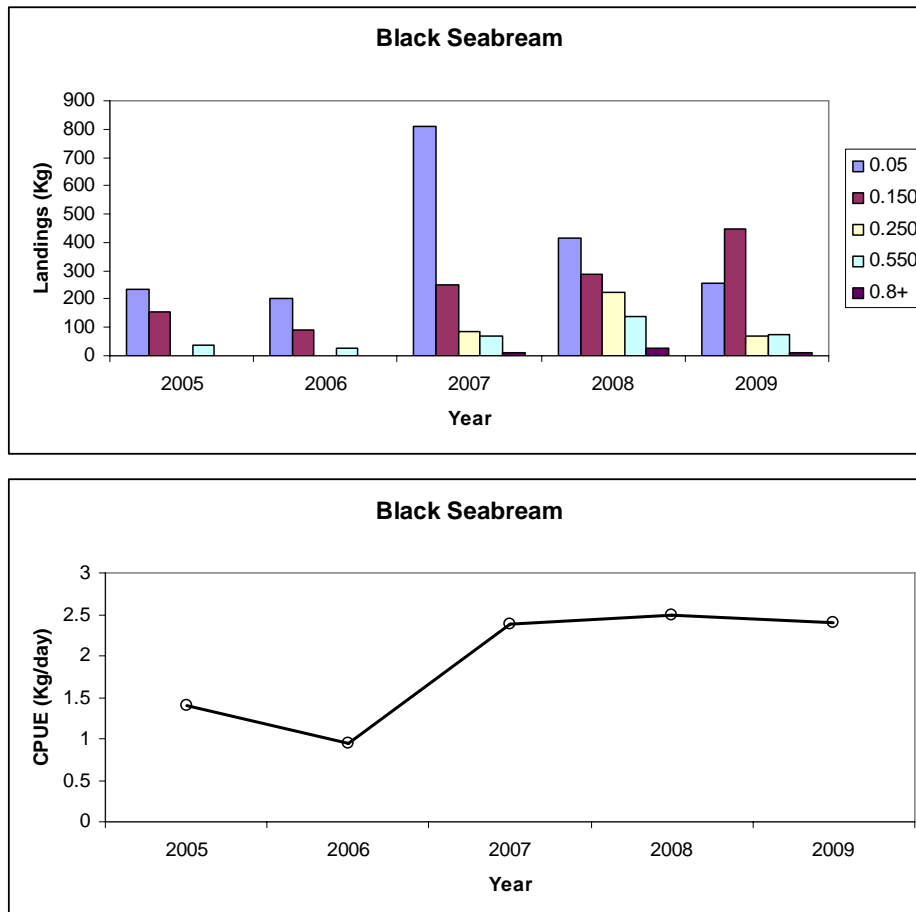


Figure 2 Inshore landings showing fairly constant CPUE 2007-2009. The size composition is also fairly consistent across all years, excepting 2009. The 2009 are incomplete running only up to July. It is possible that within-season patterns of sizes may be used to improve the exploitation of this stock, although such controls may be only applied to a directed fishery.

## Red Mullet

The eggs and larvae are pelagic so that it is likely that the recruitment is shared over a wide area. The adult are not necessarily site attached and migration is possible. Local management may only prevent local depletion and be consistent with requirements of management over the stock range.

Like most of the fisheries, red mullet is highly seasonal. It also appears to be susceptible to variable weather conditions that affect its capture (see Figure 1). CPUE on red mullet is not a good candidate to monitor stock size. Even with standardisation, the high variability in catch is likely to make the index susceptible to high error rates and therefore cannot be reliably interpreted. Size composition is similarly subject to high variability, much of which will not be due changes in the underlying population. If the landings data are to be useful, further research on interpretation is required. In particular, changes in catchability need to be explained.

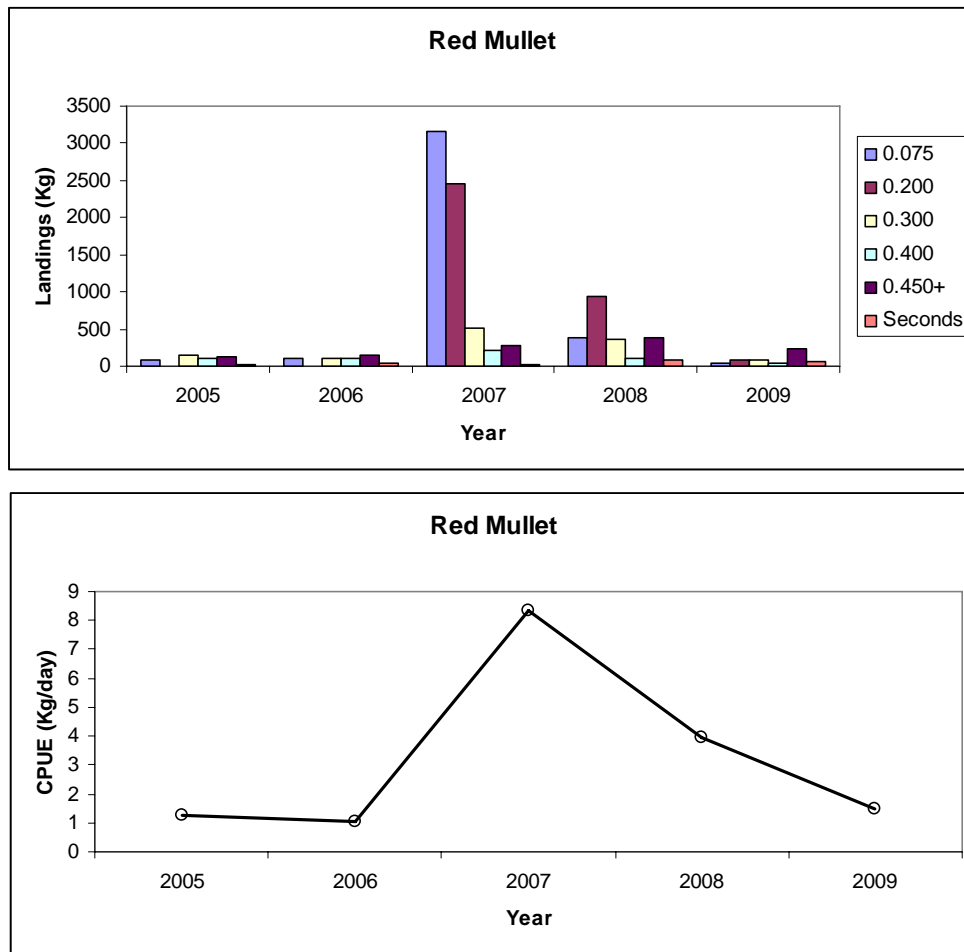


Figure 1 Red mullet catch size composition and catch per unit effort illustrating the low consistency of landings among years.

## Lobster

While lobster recruitment is likely shared over a wider area, adult movement is probably localised making managing the local population very possible. Although recruitment may be shared, the lack of a stock-recruitment relationship in most populations results in managing the spawning stock size to reduce risks of overfishing rather than managing the recruitment itself. This same principle can be applied just as well for a local adult population as for the stock as a whole.

The spatial nature of the stock and fishery lends itself to spatial management. Co-operative exploitation of lobster habitat should allow good protection for the stock. Harvest control rules in this context are likely to apply to specific areas rather than the whole stock at once.

Area based management on the face of it requires greater complexity, but also can result in more co-operation from the fishers due to a greater sense of ownership of the grounds. It would be necessary to be able to limit the number of traps in particular areas, and possibly allocating management of areas to groups of fishers, but providing technical support in terms of the strategy, monitoring and harvest control rule.

A big advantage of spatial based management is the ability to apply adaptive management. This would consist of trying alternative strategies in different areas and use monitoring information to provide information on the success or failure. Adaptive management should involve fishers in determining the trials that would be conducted to inform them as to the best management actions. Adaptive management can be used to estimate reference points and develop robust harvest control rules which should be able to stand up to external review (e.g. MSC certification).

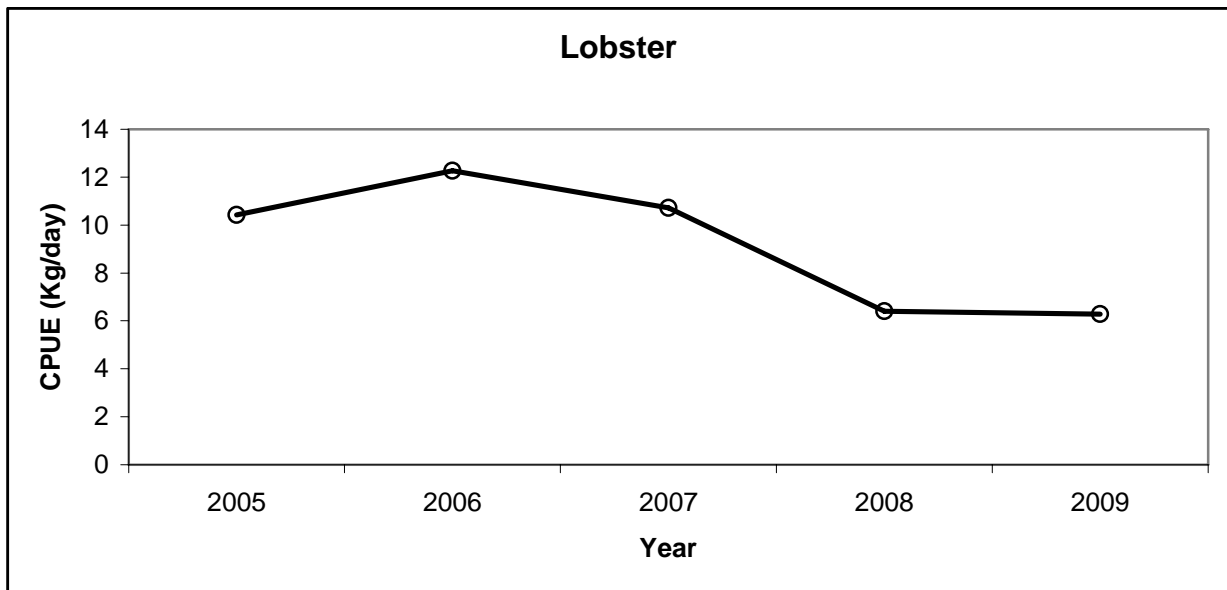


Figure 7 Reported CPUE for lobster. The index is smooth and well-behaved suggesting underlying low variance. However, the effort measure is poor, since catches may be accumulated over several days before landing. Much better effort data may be available from fishers. In addition, management should be area based, so area-specific data are likely to be required.

## Cuttlefish

The English Channel cuttlefish fishery provides one of the highest cephalopod yields in the north-east Atlantic, with catches by many interacting fishing gears. Some catches are taken in Sussex waters, primarily traps in inshore areas. Importantly, females may be used as bait, so the sex ratio of the catches may be an important determinant in developing a robust harvest control rule.

Royer et al. (2006) [Royer, J. Pierce, G.J. Foucher, E., Robin, J.P. (2006) The English Channel stock of *Sepia officinalis*: Modelling variability in abundance and impact of the fishery. *Fisheries Research* 78: 96–106] carried out CPUE standardization and used a simulation model to look at the interaction among gears. The aim of the study was to show that population modelling can be developed for this stock and that model estimates are useful to address practical issues such as diagnostics of fishing pressure and interactions between fishing fleets. The general result was there is no evidence of an overall decline in recruitment over the period for which data were available (1996-2002) and that gears fishing older cuttlefish could be affected by those fishing younger cuttlefish (mainly trawls). The authors conclude that “management in the coastal zone alone is not sufficient to ensure sustainable exploitation in a migrating species.”

The results suggest that it would be possible to fit an age structured model to the available data, but with only 2 year life span, the predictive capability of this approach would be very limited. Given much of the stock is captured outside Sussex waters, it would not be possible for Sussex alone to carry out such an assessment.

While Royer et al. (2006) do attempt to determine status of the stock to a limited degree, there was no attempt to determine reference points for their standardized CPUE or a harvest control rule. The obvious approach would be to apply a constant proportional escapement policy, but this would have to apply to French and English trawls upstream of the migration route. However, simulation model approach would allow Sussex to explore local management which might contribute to better overall management of the stock.

The simulation model used by Royer et al. (2006) could be used as the basis for a management strategy evaluation. An important weakness of the simulation, which would need to be addressed, was the population model did not separate the sexes.

While it may not be possible for local management implement a harvest strategy for the whole stock, it may well be possible to develop a strategy for the local population which would not hinder recovery should it be

required. This is a “MSC Principle 2” argument for the retained and discarded bycatch, but should arguably hold for small scale fisheries and their target stocks, perhaps under the risk based assessment.

A suggested robust harvest control rule, based on local abundance index (probably a CPUE proxy), which would reduce harvest as the stock declines below some level. This would require the determination of:

1. The indicator with the appropriate target, limit and trigger reference points. This would require at the very least the study of the behaviour of the chosen indicators as a random variable.
2. A control rule, which would probably require an increasing reduction in harvest of female cuttlefish and/or both males and females. Several control rules of varying levels of severity would be required for testing.
3. The tools to achieve the reduction harvest which must be verifiable would need to be determined.
4. A management strategy evaluation to test whether the controls would work to protect the stock and allow management to choose between them.

Given the sex differences, it may well be possible to develop a harvest control rule that would also provide some socio-economic buffering against activity conducted outside the local management area.

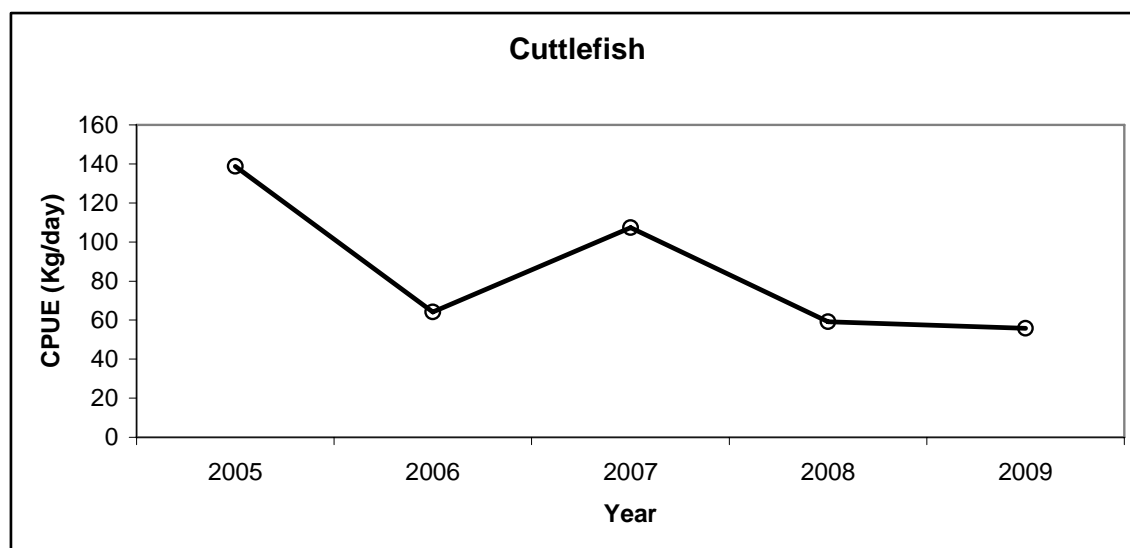


Figure 6 Variations in cuttlefish CPUE imply a problem in the index. They may be the result in landings from a mixture of gears. Trapping for cuttlefish might be of greatest interest in developing an index, although bycatch in other gears (trawls and nets) may be useful but more variable. Standardisation of local CPUE would address this problem and could therefore provide an index of the local spawning stock and the basis for decision making.

## Cod, Herring, Mackerel, Oyster, Scallop, Crab and Spider Crab

These species have not been dealt with here and further explorations will be made to develop a local management strategy.

Although there are similarities with lobster, the crab resource is treated more as a shared stock and management approaches may need to be implemented as part of a wider management plan, including, but not limited to, a minimum landing size.

Cod is an ICES assessed species and a local management strategy would need to take account of this. Cod is currently a major problem for local fleets as the TAC is set so low it can limit fishing opportunities where it is taken as retained bycatch. The main local management strategy might be to minimise local catches at least until the stocks are recovered and the TAC has been increased.

Herring and mackerel are quota species and as long as local fisheries do not exceed their quota, management requirements will be met.

Oyster and scallop represent a problem for Principle 2 as well as Principle 1. The primary management would depend on determining the dredge footprint in relation to estimates of biomass and habitat types, and as a result controlling the spatial distribution of the dredge activity. Habitat and biomass mapping and detailed spatial mapping of dredge activity is likely to be a pre-requisite to managing this fishery. Closed areas in different habitat types could be used to obtain reference points and adaptive management techniques would be very valuable in developing a robust harvest strategy. However, the principle of closed area and area rotation would need to be accepted by the fishers to allow these approaches to proceed.

## Appendix 4 – CITES listing of species found in UK waters

Those CITES listed species of most relevance to the Sussex SFC area are possible interaction with:

- species of dolphin and porpoise
- species of sea turtle
- species of seahorse
- basking shark
- sturgeon
- european eel
- species of soft and hard coral.

Under Criterion 2.3 there is a requirement to draw up a strategy for the management of interactions with all of these – including details of the likelihood of such interaction, and the level of damage or mortality associated with such interaction that would be deemed unacceptable.

In addition to these ETP species, there will also be a requirement (under MSC Criteria 2.2 and 2.4) for the development of strategies and plans for the management of interactions with other susceptible species – such as slow breeding sharks and rays, locally protected species such as shad and sea lamprey, and a range of seabed species and communities that are the subject of protection under various international, European, national and local legislation.

Phylum : CHORDATA

Class : MAMMALIA

Order : CETACEA

Family : ZIPHIIDAE

*Hyperoodon ampullatus* (Forster, 1770) northern bottlenose whale

*Mesoplodon bidens* (Sowerby, 1804) Sowerby's beaked whale

*Mesoplodon densirostris* (de Blainville, 1817) Blainville's beaked whale

*Mesoplodon europaeus* (Gervais, 1855) Gervais' Beaked Whale

*Mesoplodon mirus* True, 1913 True's beaked whale

*Ziphius cavirostris* G. Cuvier, 1823 Cuvier's beaked whale

Family : PHYSETERIDAE

*Kogia breviceps* (Blainville, 1838) pygmy sperm whale

*Physeter catodon* Linnaeus, 1758 sperm whale

Family : MONODONTIDAE

*Delphinapterus leucas* (Pallas, white whale, beluga

		1776)	
		Monodon monoceros Linnaeus, 1758	narwhal
Family :	DELPHINIDAE		
		Delphinus delphis Linnaeus, 1758	common dolphin
		Globicephala melas (Traill, 1809)	long-finned pilot whale
		Grampus griseus (G. Cuvier, 1812)	Risso's dolphin
		Lagenodelphis hosei Fraser, 1956	Fraser's dolphin
		Lagenorhynchus acutus (Gray, 1828)	Atlantic white-sided dolphin
		Lagenorhynchus albirostris (Gray, 1846)	white-beaked dolphin
		Orcinus orca (Linnaeus, 1758)	killer whale
		Peponocephala electra (Gray, 1846)	melon-headed Whale
		Pseudorca crassidens (Owen, 1846)	false killer whale
		Stenella coeruleoalba (Meyen, 1833)	striped dolphin
		Tursiops truncatus (Montagu, 1821)	bottlenose dolphin
Family :	PHOCOENIDAE		
		Phocoena phocoena (Linnaeus, 1758)	harbour porpoise
Family :	BALAENOPTERIDAE		
		Balaenoptera acutorostrata Lacépède, 1804	common minke whale or northern minke whale
		Balaenoptera borealis Lesson, 1828	sei whale
		Balaenoptera musculus (Linnaeus, 1758)	blue whale
		Balaenoptera physalus (Linnaeus, 1758)	fin whale
		Megaptera novaeangliae (Borowski, 1781)	humpback whale
Family :	BALAENIDAE		
		Eubalaena glacialis (P. L. S. Müller, 1776)	North Atlantic right whale
Class :	REPTILIA		
Order :	TESTUDINES		
Family :	CHELONIIDAE		
		Caretta caretta (Linnaeus, 1758)	loggerhead sea turtle

		<i>Chelonia mydas</i> (Linnaeus, 1758)	green turtle
		<i>Lepidochelys kempii</i> (Garman, 1880)	Kemp's Ridley sea turtle
Family :	DERMOCHELYIDAE		
		<i>Dermochelys coriacea</i> (Vandelli, 1761)	leatherback turtle
Class :	ELASMOBRANCHII		
Order :	LAMNIFORMES		
Family :	CETORHINIDAE		
		<i>Cetorhinus maximus</i> (Gunnerus, 1765)	basking shark
Class :	ACTINOPTERYGII		
Order :	ACIPENSERIFORMES		
Family :	ACIPENSERIDAE		
		<i>Acipenser sturio</i> Linnaeus, 1758	European sea sturgeon
Order :	ANGUILLIFORMES		
Family :	ANGUILLIDAE		
		<i>Anguilla anguilla</i> (Linnaeus, 1758)	European eel
Order :	SYNGNATHIFORMES		
Family :	SYNGNATHIDAE		
		<i>Hippocampus guttulatus</i> Cuvier, 1829	long-snouted seahorse
		<i>Hippocampus hippocampus</i> (Linnaeus, 1758)	short-snouted seahorse
Phylum :	CNIDARIA		
Class :	ANTHOZOA		
Order :	ANTIPATHARIA		
Family :	MYRIOPATHIDAE		
		<i>Antipathella subpinnata</i> (Ellis & Solander, 1786)	
Order :	SCLERACTINIA		stony corals
Family :	FUNGIACYATHIDAE		
		<i>Fungiacyathus marenzelleri</i> (Vaughan, 1906)	deep sea coral
Family :	OCULINIDAE		
		<i>Madrepora oculata</i> Linnaeus, 1758	zizag coral
Family :	CARYOPHYLLIIDAE		stony corals



Family : STYLASTERIDAE

*Stylaster erubescens* Pourtalès, 1868      athecate calcareous hydroid

*Stylaster gemmascens* (Esper, 1790)      athecate calcareous hydroid

*Stylaster norvegicus* (Gunnerus, 1768)      athecate calcareous hydroid

There may also be some coastal and marine bird species that need to be included in any management strategy.

## Annex 1 – Example of Harvest Control Rule testing: Suriname Seabob

### Annex 1.1 Summary

The harvest control rule (HCR) used for the Suriname seabob fishery is tested using Monte Carlo simulation. The rule is shown to be robust to all uncertainties, but identifies changes that could occur which will require monitoring to update the rule and ensure it remains valid. The possible uncertainties that could create a problem are changes to the productivity of the stock (e.g. recruitment), hyper-stability in the index, sample or process error swamping information in the index and changes in catchability. The HCR is shown to be robust to all these, or they appear not to be a problem from the available evidence, except for possible changes in catchability. Significant changes in catchability will invalidate the abundance index and the HCR. Therefore potential changes to the catching efficiency, including the improvement of BRDs, will need to be controlled and monitored carefully so that the HCR can be updated as necessary.

This harvest control rule is generic and a similar rule with parameters adjusted as appropriate could be used for all fisheries where CPUE provides a reasonable indication of the abundance of the stock. The simulations testing the robustness of this rule would equally well apply in all these cases.

### Annex 1.2 Harvest Control Rule Derivation

The harvest control rule was agreed among stakeholders, represented by the two fishing companies involved in the seabob fishery, the Suriname government and other members of the Fisheries Advisory Committee. The rationale and background behind their choice of harvest control rule is described below.

A stock assessment was completed in 2009 (Derrell *et al.* 2009), which forms the basis for the harvest control rule. The harvest control rule needs to be based upon the reference points from the stock assessment, which will depend upon the estimated maximum sustainable yield and the level of risk which the fishery stakeholders are willing to accept.

The criteria for choosing the harvest control rule were as follows:

1. The target level of fishing must be set at MSY or below. Fishing beyond MSY could not be justified on either economic or ecological grounds and would not meet the MSC standard.
2. The HCR should be based on constant effort rather than a constant catch. This allows some automatic adjustment in the catch in response to changes in abundance without management intervention.
3. The HCR should be simple and easy to understand. This is beneficial not just to the stakeholders, who can immediately see the implications of the different controls, but also the scientists who can design and test the control rule more easily to achieve the management objectives.

For these reasons, the harvest control rule is based upon easily measurable variables: days-at-sea, representing fishing mortality, and catch per day-at-sea representing abundance. Based on the stock assessment, all variables of interest including the reference points can be translated into these proxies (Table 1). CPUE also has the additional value of being directly measured with estimable characteristics of a random variable. This allows the rule to take full account of the estimable part of uncertainty (sample and process error) and be adjusted to take account of a defined acceptable risk.

Suriname Seabob Harvest Control Rule (see Figure 1)
The Total Allowable Days-at-sea (TAD) shall be set at: <ul style="list-style-type: none"><li>• 5100 days-at-sea when the current catch rate is <u>at or above</u> the trigger catch rate.</li></ul>

- a linearly declining value when the current catch rate is below the trigger catch rate according to the calculation:

$$\text{TAD} = (\text{Current Catch Rate} - \text{Limit Catch Rate}) * 8625$$

- zero (the fishery is closed) if the current catch rate is at or below the limit catch rate.

The trigger catch rate shall be set at 1.48 tonnes per day-at-sea.

The current catch rate for each year shall be calculated as the average between the previous year's current catch rate and catch rate of the current year. The catch rate is calculated as the total landings of seabob divided by the total number of days-at-sea for the fleet.

The target catch rate shall be set at 1.65 tonnes per day-at-sea and the limit catch rate shall be set at 0.89 tonnes per day-at-sea.

**Table 1 Summary of Reference Points for standard and proxy indicators. The MSY represents the minimum allowable target/limit biomass and the SGWG target/limit is a precautionary biomass recommended by the SGWG. The Stakeholder reference points were actually implemented in the management plan.**

Reference Point	Standard Indicators		Proxy Indicators	
	Biomass (t)	Fishing Mortality	Days at sea	CPUE
MSY (Lowest B Target)	43679	0.22	5662	1.48
50% MSY (Lowest B Limit)	21840	0.36	8624	0.74
SGWG Target (120% MSY)	52415	0.18	4599	1.77
SGWG Limit (60% MSY)	26208	0.33	8049	0.89
Stakeholder Target	48697	0.19	5100	1.65
Stakeholder Limit	26267	na	na	0.89
Stakeholder Trigger	43679	na	na	1.48

In further developing the HCR, various configurations were tested using a simulation approach (see Simulation Method). These considered the alternative reference points, the way the CPUE was calculated, the placement of the trigger between the limit and target reference points, the type of control and the minimum effort applied to the fishery (Table 2). Not only were the individual effects considered, but all combinations were tested so that any interactions could be observed.

The plenary of the Fifth CRFM Scientific Meeting in 2009 recommended precautionary reference points be used to manage the seabob stock. These were used in providing management advice provided by the Shrimp and Groundfish Working Group (SGWG; Derrell *et al.* 2009). However, industry, while recognising the significant risks with targeting MSY, preferred to apply a principle of risk, that the stock would have 10% chance or less of (or spend 10% of years) being below the MSY level. This principle, which was felt to be precautionary in this case, led to setting the maximum level of effort at 5100 days-at-sea. This target is less

precautionary than that suggested by the Shrimp and Groundfish Working Group (4700 DaS), but more precautionary than the MSY estimate (5660 DaS) and consistent with the MSC definition of “high unlikely” to cause overfishing. The more precautionary lower exploitation level suggested by the SGWG resulted in higher average stock level, but lower catches (Table 2). Nevertheless, while it was accepted that an MSY target level of fishing was too risky, the stakeholders thought that a defined risk level was better than the arbitrary precaution suggested by the Shrimp and Groundfish Working Group (SGWG). The stakeholders however accepted the precautionary limit reference point suggested by SGWG.

The way the CPUE is calculated was found to be important. The sample/process error is important in making the right or wrong decision from the HCR, but its effect could be reduced by applying a simple moving average calculation that smoothes out the index and reduces its jumping around randomly from year to year. A simple method was applied in this case, but alternative approaches could be tested in future to optimise the method.

The placement of the trigger between the limit and target reference point was found to have little impact. The position chosen was the MSY point. This implies that the main focus of the management plan is to maintain the stock above the MSY point, so additional reduction in exploitation is applied to the effort level should the stock fall below MSY.

The type of control applied could be either catch or effort. Although in theory catches may be less stable, they were allowed to fluctuate based on the estimated CPUE and a fixed effort. The net effect was that applying either a fixed effort or fluctuating catch produced the same result, with fixed effort being only slightly more stable. The choice is therefore reduced to which is easier to enforce, which was the fixed effort control in this case.

The minimum effort level had surprising little effect over the values tested. It was also pointed out by the stakeholders that CPUE levels below 10t per trip were probably economically unviable making the minimum effort of academic interest only. This remains a distinct possibility (Figure 2), and could result in further target effort reductions in future for purely economic reasons. It was decided to keep a lower limit of zero effort, so that the fishery would be closed should the recruitment be threatened. However, although it was not considered here, the main information is obtained from CPUE, so without at least some fishing effort, no information is obtained on the state of the stock. This needs to be considered on reviewing the HCR.

**Table 2 Alternative HCR configurations tested and their general results. No significant interaction effects were identified between the various configurations**

Configuration	Options	Result
Reference Point	Precautionary target proposed by SGWG or MSY target	The SGWG target was more precautionary than the MSY target, but there were fewer higher catches.
CPUE calculation	Moving average Independent annual estimate	The moving average calculation was more stable, with much less chance of overfishing.
Trigger Placement	Close to target Close to limit	There was no perceptible difference between the options. A trigger was chosen at the MSY level as an appropriate point to apply management intervention.
Type of quota	Effort (days at sea) Catch (kg landed)	There was not much difference as long as catch quota is estimated from the target effort. The fixed effort control gave a slightly better performance, with more stability and higher catches.
Minimum effort below limit	Fishery closed 20% maximum effort applied	There was not much difference between 20% and zero effort at the minimum. It is also likely that it will make little material difference. However, the principle on continuing collecting information for the HCR needs to be considered.

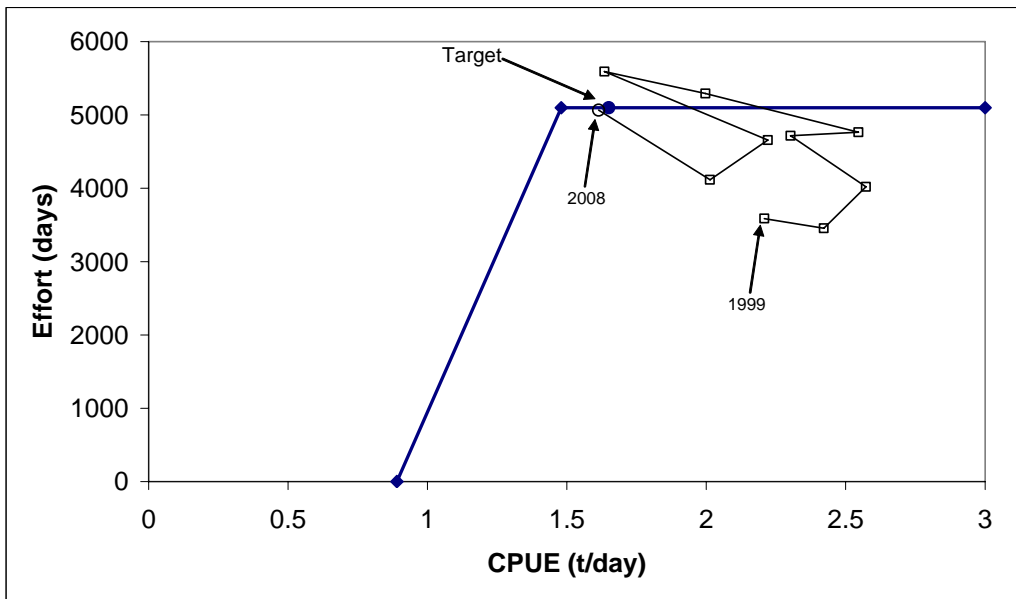


Figure 1 Harvest control rule as agreed for Seabob in the management plan. The recorded total fishing effort and CPUE for years 1999 – 2008 are also plotted. Historically, reduced effort below the target level would never have been applied using this plan. Furthermore, the HCR uses a moving average of CPUE which would dampen the fluctuations. If assumptions are met and target fishing effort has been set at the correct level, it is hoped that reduced effort need never be applied.

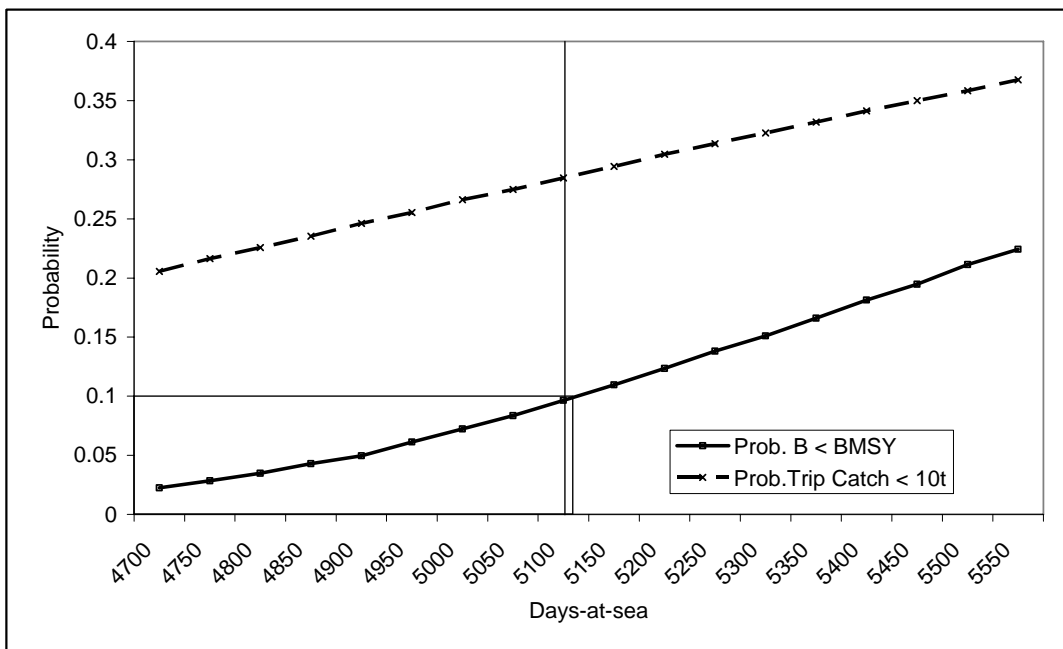


Figure 2 The target level of effort was derived based on a level of risk so that there is only a 10% chance that the level of effort would result in the stock being below MSY. This placed the target, rounded down to the nearest 100 days, at 5100 days-at-sea (centre vertical line). The risk that the catch of a trip is on average less than 10t (break-even point suggested by stakeholders) remains quite high at 5100 days-at-sea, but only declines slowly with effort reduction.

## Annex 1.3 Robustness of the HCR

### Overview

The species life history suggests that seabob will be robust to exploitation as long as there is some on-going monitoring. The monitoring is carried out using CPUE, so it is important to consider whether CPUE is a reasonable index of abundance and how robust it will be when considering various random and other errors, particularly errors in the model structure.

The following is the summary of the evidence that CPUE is a reasonable index of abundance in this case:

- The government catch and effort data were compared to an index based on raw data extracted from Guiana Seafoods N.V. plant and fleet reports which are used internally. The indices matched showing the same trend. This demonstrated that the CPUE index based on the official Government data was valid and was not corrupted by incorrect treatment or recording mistakes.
- CPUE index observation error needs to be relatively low compared to the information on the abundance. The sampling error can be estimated by random changes year to year in the index, although how this variance divides between sampling and process error is not known.
- The CPUE index shows a downward trend consistent with the increasing catches, suggesting that it is following an abundance trend. This trend would probably not be detectable against background noise if the series was hyper-stable.
- There is a strong correlation between CPUE and river outflow in the previous year in Guyana (Derrell *et al.* 2009). Guyana uses the same gear and fishing operations as Suriname, although they may operate further inshore. If this was the result of changes in catchability an immediate effect would be expected (i.e. this year's river outflow would be correlated with this year's CPUE). This was not the case. A more likely explanation is that river outflow affects recruitment which would cause observed fluctuations in a species which has longevity of a year. Hence, the correlation is most likely explained as representing abundance changes rather than other causes.

Although the evidence suggests that CPUE is a good index, it is not overwhelming. In addition, the arguments above do not address concerns with the stock assessment that the population dynamics might change resulting in changing reference points. Ideally, we want a HCR which is robust to inaccuracies in the assessment and to changes which might reasonably occur in the future. This can only be tested at this stage using Monte Carlo simulation.

The harvest control rule is based upon a simple population model, the parameters of which were estimated from fitting the model to the available data. The model was fitted using Bayesian methods, so the results were obtained as the probability of parameter values rather than point estimates. This parameter uncertainty was taken into account, while assuming the model in all other respects was correct, when developing the HCR. It was shown to be robust in this respect (Table 2; Figure 2).

The stock assessment model structure is very simple, representing the main effect of depletion. While more complex models might more accurately capture changes in stock structure, they will always follow the same pattern: higher exploitation will lead to lower stock biomass, while conversely decreasing the amount of fishing will allow stock abundance to increase. The model has a fairly precautionary MSY reference point “hard-wired” into it, that is the MSY is reached when the stock size is at 50% of the unexploited state. It also assumes that CPUE is proportional to stock size. Finally, the model assumes that its structure and parameters remain constant over time, albeit there is a random error associated with CPUE which cannot be explained by the population size or its dynamics.

Given this, there are a number of particular assumptions in the HCR which, if not true, could lead to the HCR failing:

- Sampling and/or process error may lead to poor estimates of CPUE which bear little relation to stock size. In this case, the available evidence suggests that CPUE, while it is associated with a significant observation error, is not swamped by it. In addition, the HCR reduces the effect of error by using a simple

smoothing function (moving average). The design of the HCR therefore takes account of the estimated error and this has been assessed as part of its development (Figure 2).

- The CPUE index may be hyper-stable, in that it does not decline linearly with stock size, but at a lower rate (Figure 3). This could allow the stock to be depleted without an indication that this is happening and lead to a sharp, unexpected decrease in CPUE when the stock is close to extinction (i.e. a stock collapse). Hyper-stability is most likely to occur where the stock density remains relatively stable in relation to fishing, either because the seabob itself contracts in its distribution as the abundance decreases, or the fishery serially depletes the stock rather than exploiting it across its range.
- It is possible that the stock productivity changes through time. For example, a correlation between CPUE and river outflow was found in Guyana, which might indicate that production depends on rainfall, which is likely to change with fluctuations in climate. Changes in production invalidate reference points, implying that the biomass at MSY will either decrease or increase over time.
- Changes in catchability may occur with changes in catching efficiency brought about usually by improvements in technology or knowledge of the fishers.

The effects of hyper-stability, trends in the stock productivity and trends in catchability can be tested using simulation. The test is to show whether the HCR is robust to these effects in avoiding overfishing. Clearly, events which occur and are not accounted for the model will lead to inefficiencies. It is hoped that a robust HCR will protect the stock and the fishery long enough for these events to be detected and included in the stock assessment, so that appropriate adjustments can be made to the management system.

## Simulation Method

A stock assessment, completed in June 2009 (Derrell *et al.* 2009), determined the status of the stock by fitting a stock assessment model to the available catch and effort data. The model was fitted using a Bayesian method which provides parameters as frequencies drawn from the posterior probability density. These frequencies represent the information in the data and “priors” (i.e. the total information on the population dynamics). They account for the uncertainty associated with observation (and process) error in the time series which are manifested in parameter estimate uncertainty. However, while the stock assessment can explain the past, the future has greater uncertainty because many of the parameters which are assumed fixed may actually change.

For each set of parameters, the population based on the logistic model used in the stock assessment was projected forward 100 years applying the HCR. There are 5000 parameters randomly drawn from the posterior of the stock assessment model, so each simulation produced 500 000 observations. As well as the random parameters, an observation error, based on the estimated variance from the observed CPUE, was included in each year of the projection as a random error on the observed CPUE and therefore catch. The projections therefore allow for some process error as the stock size will be affected by this random catch. The projections were undertaken in Visual Basic for Applications within an MS Excel spreadsheet.

The simulation was used to provide three performance indicators, the state of the stock measured as a proportion of the unexploited biomass (can vary from 0.0 – 1.0), annual catch and mean CPUE. In each year of the simulation, the true state of the stock, the total catch and CPUE were recorded and accumulated into a frequency representing a probability density. This provides a convenient summary of the risks associated with applying the HCR under each simulation.

## Hyper-stability

Hyper-stability was represented as a power relationship between CPUE and stock biomass such that:

$$\text{CPUE} = q B^a$$

where  $q$  = catchability,  $B$  = population size (biomass) and  $a$  = the hyper-stability constant. If the hyper-stability constant is equal to one, the relationship would be linear as assumed, whereas values less than one imply the CPUE index will decline less quickly than the abundance until the stock size approaches zero (Figure 3). The

closer the value is to zero, the more extreme the effect, until  $a=0$  when the index does not respond to stock size at all.

Although the CPUE does appear to decline in a fashion consistent with a linear relationship between stock size and index (Derrell *et al.* 2009), it is also possible that this relationship is hyper-stable and linear only over the range which has been tested. For example, the index is approximately linear for the stock status 0.1 – 0.9 where the hyper-stability constant = 0.2, only exhibiting a strong decline when the stock status falls below 0.1 (Figure 3). While this is possible, it is likely that a low slope associated with hyper-stability is unlikely to be detected as a statistically significant decrease in the index against the observation error, and therefore a hyper-stability constant as low as 0.2 remains unlikely in this case.

Problems with the HCR and hyper-stability depend on the relationship between the CPUE index and abundance being shallow enough that the CPUE does not fall below the trigger point until collapse has occurred. Of the hyper-stability constants, only the lowest value (0.2) seemed to significantly increase the risk (Figure 4). Given this, the HCR does seem reasonably robust to this potential problem.

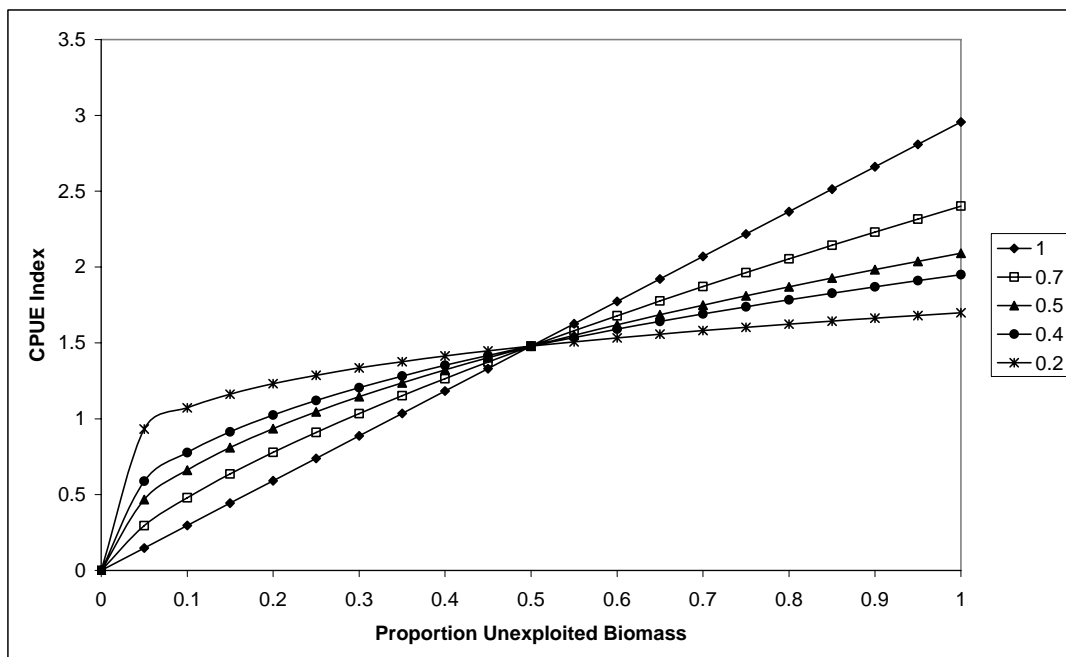


Figure 3 The power function used to represent different levels of hyper-stability in the CPUE index. While in all cases the index declines with abundance, the decline becomes sharper as the index approaches zero for the hyper-stable cases.

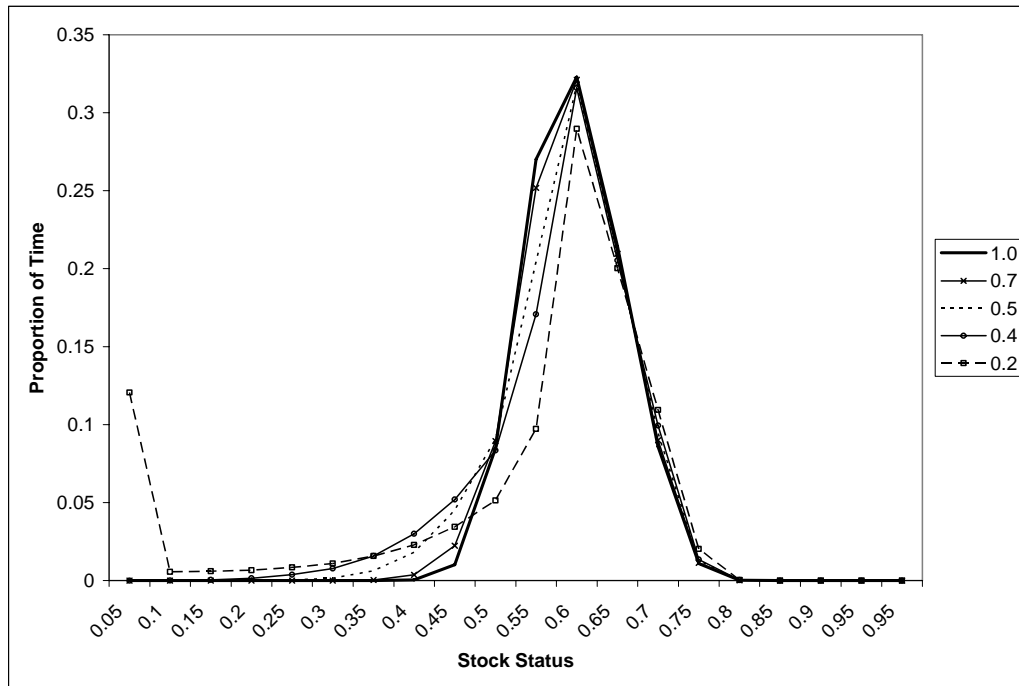


Figure 4 Risks from the CPUE index with different levels of hyper-stability.

### Trends in Productivity

The simulation was applied so that there was a proportion decline (to 0.95) or increase (to 1.05) in the unexploited biomass over time, which would represent a decreasing or increasing level of stock productivity. The harvest control rule was applied without taking notice of the MSY reference point changes which would be occurring with change in stock productivity.

It was found that if the stock declines in productivity and therefore size, the CPUE index would also decline and eventually the fishery closes resulting in the stock remaining at its unexploited size (Figure 5). Conversely, an increasing stock size would result in increasing CPUE, so that the rule reducing fishing effort would never be invoked. This would essentially become a fixed effort fishery with the associated risk that the stock may periodically be reduced below MSY (Figure 5).

A potential problem therefore only occurs if the unexploited stock size becomes larger (Proportional change >1.0). While the biomass is increasing, the MSY reference point, which depends on the unexploited stock size, will also increase so that the status of the stock will decline to around the target reference point, but with no safeguard should the stock fall lower. It is important to note that the biomass under this circumstance would still be very high compared to historical levels.

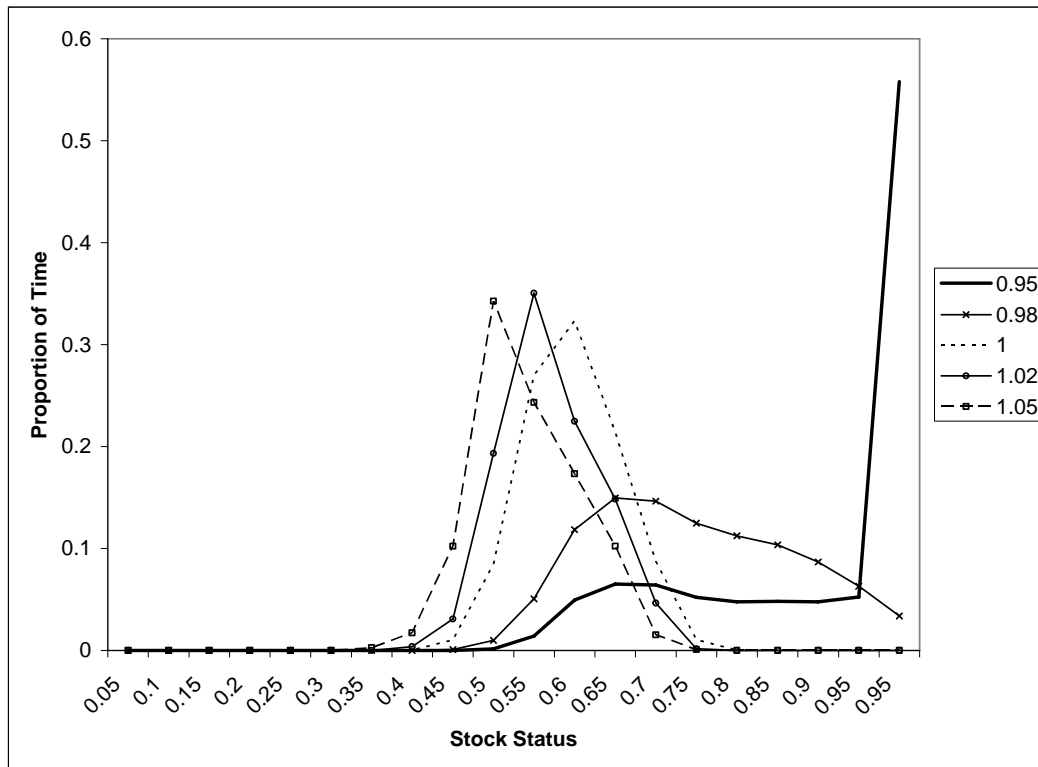


Figure 5 Stock status as a proportion of the unexploited stock biomass for different proportional changes in unexploited stock size (productivity).

### Changes in Catchability

Similarly to changes in stock productivity, changes in catchability were modelled as constant proportional decreases or increases over time. In this case however, results were highly sensitive and the HCR would clearly be invalidated should catchability change significantly. The most likely scenario is that catchability will increase over time with improvements in gear technology, which could lead to very poor performance of the HCR if the reference points are not adjusted as catchability increases (Figure 6). However the worst case, where proportional change in catchability = 1.05, is an extreme example. A constant 5% improvement in catching efficiency would lead to a catchability 131 times higher by the end of 100 years, which is not likely to go undetected.

It is quite clear that the HCR would need constant adjustment if catchability is likely to change. For this reason, monitoring has been added to the Seabob management plan to ensure any gear changes are recorded and reported.

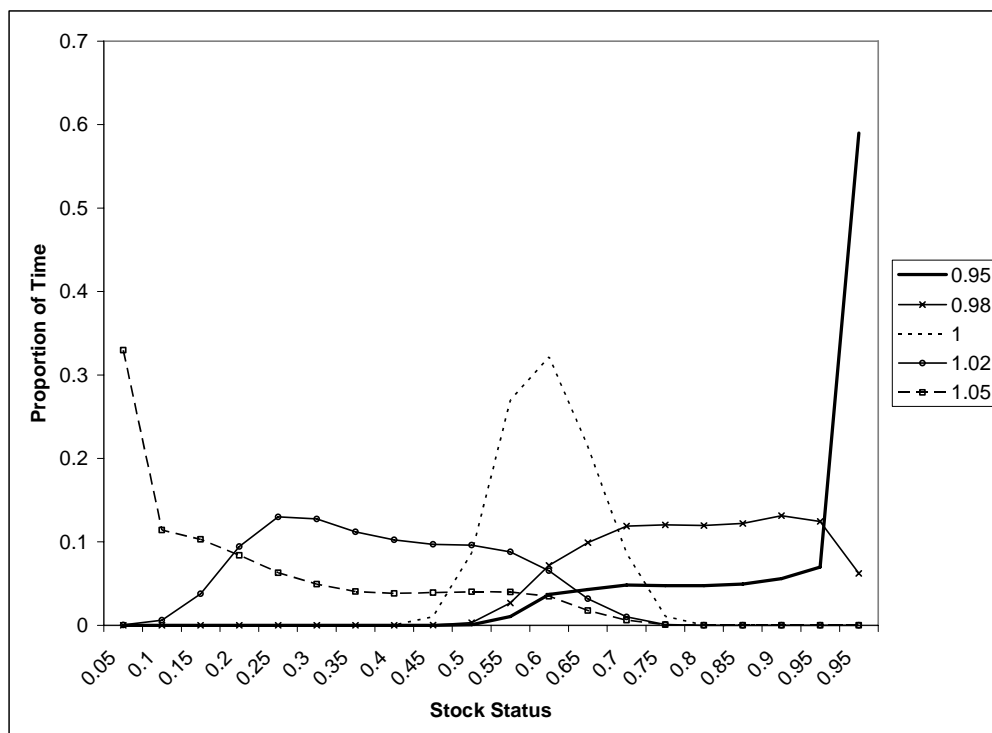


Figure 6 Stock status as a proportion of the unexploited stock biomass for different proportional changes in catchability.

## Annex 1.4 Discussion

As a result of the configuration testing, the maximum effort was set to a level between the biomass at MSY ( $B_{MSY}$ ) and the precautionary level suggested by the working group (120%  $B_{MSY}$ ). A level was chosen based on clear principles which were precautionary, but had some underlying justification and were acceptable to industry. This was that there was a 10% chance of the stock being below the MSY point for any year taken at random from the simulation (Figure 2). Finally, the limit reference point was defined as that recommended by the SGWG (60% MSY), which should be safe enough for this species.

The simulations applied so far are based on a very simple population model and fall short of a Management Strategy Evaluation (MSE), which would consider more complex population dynamics effects. However, it is likely that under all reasonable scenarios, the two most sensitive issues identified here are likely to remain the ones which will need to be monitored. Nevertheless, a model based on research of the life history could be used to better test the HCR through a MSE.

Under the simulations that have been conducted, the HCR has been shown to be robust, albeit on-going standard monitoring will be required to detect relevant changes to the fishery operations and the stock. The HCR will be most sensitive to changes in catching efficiency, and therefore this requires special attention in developing the monitoring programme. The recommendations are as follows:

- **Hyper-stability:** This should be detected through monitoring the spatial distribution of fishing effort based on the VMS output. Hyper-stability would require a contraction of fishing activities over the available area, which annual maps of relevant fishing areas would detect.
- **Catchability:** The most likely gear changes at least in the short term are introduction and changes to BRDs. These could lead to small decreases in catchability if seabob escape the net, or increases in catchability if more fishing is conducted each day as less sorting on deck is required. This requires monitoring and controlling which vessels have had changes to their gear or technology and when this occurred, together with seeking scientific advice before changes are rolled out across the entire fleet. More detailed information on fishing operations, such as VMS records, would also be necessary to monitor potential changes in catchability.

- Productivity: While the HCR is robust to changes in productivity, there is potential for improving the economic performance of the HCR if this is better understood. Further work will be undertaken on linking river outflow to recruitment. If a simple relationship is confirmed, this would increase the predictive capability of the stock assessment and allow the HCR to be adjusted should climate change affect the fishery.
- Observation and Process Error: The increasing sampling error with declining fishing effort may cause a problem for the HCR. This has not yet been considered. In the extreme case, if the fishery is closed, no information on the stock would be available. This may require reconsidering the HCR in terms of information which will be obtained from the CPUE index and identifying what minimum level of effort is required to protect the HCR.

## Annex 1.5 References

Derrell, C., Ferreira, L., Medley, P. Soekradj, R., (2009) Report of the Shrimp and Groundfish Resource Working Group (SGWG). In: CRFM (2009) CRFM Fishery Report -2009. Volume 1. Report of Fifth CRFM Scientific Meeting, Kingstown, St. Vincent and the Grenadines, 9-18 June 2009.



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**Project Funded by:**  
European Fisheries Fund



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