How can we determine the economically optimal level of exploitation of sustainable fisheries systems?

Marine Theme Objective: Science for Integrated Marine Management

What's the issue?

Successfully achieving the economically optimal level of exploitation of a fisheries system is strongly influenced by a range of factors including the current status of the fish stocks, the influence of environmental variability (e.g. climate change), interactions with the wider ecosystem, the effects that fishing may have on the non-target elements of that system and the economic nature of fishermen's responses to management. Proposed management strategies should therefore be robust to the uncertainty introduced by all of those elements (Figure 1). The effectiveness of a management strategy is strongly dependent upon the identification and use of appropriate targets and indicators. Ideally, these indicators should consider all of the factors described above. This means that indicators should consider wider socio-economic measures (for example, the benefit for the wider group of stakeholders) as well as ecosystem changes and exploitation. To ensure sustainable levels of exploitation, impacts on non-target and susceptible fish species should also be considered.

What are the aims of the project?

DEFINEIT produced tools to determine the optimal economic level of exploitation of North European marine fish, combining knowledge on species interactions, recruitment processes, vulnerable species and socio-economics. Models were developed covering a wide geographic area including the Baltic, North, Barents and Icelandic Seas. Sharks, rays and skates as biologically sensitive species, were ranked according to key biological and fisheries susceptibility parameters. Their distribution and sensitivity to fisheries was investigated, and advice given on maximum sustainable levels of fishing effort. Species-fishery co-occurrence maps were produced to help identify areas of greatest bycatch risk for mammals and birds. Resource indicators combining economic, social and biological indicators to determine the optimal economic level of exploitation were developed, and used in several case studies including North Sea demersal fisheries and Norwegian Spring Spawning herring. Methods to obtain information from stakeholders were developed that capture uncertainty, and were used for Herring in the Barents Sea. The results have been disseminated through academic publications and impacted on fisheries management through input into ICES (http://www.ices.dk), ICCAT (http://www.iccat.int) and STECF (https://stecf.jrc.ec.europa.eu/) working groups.

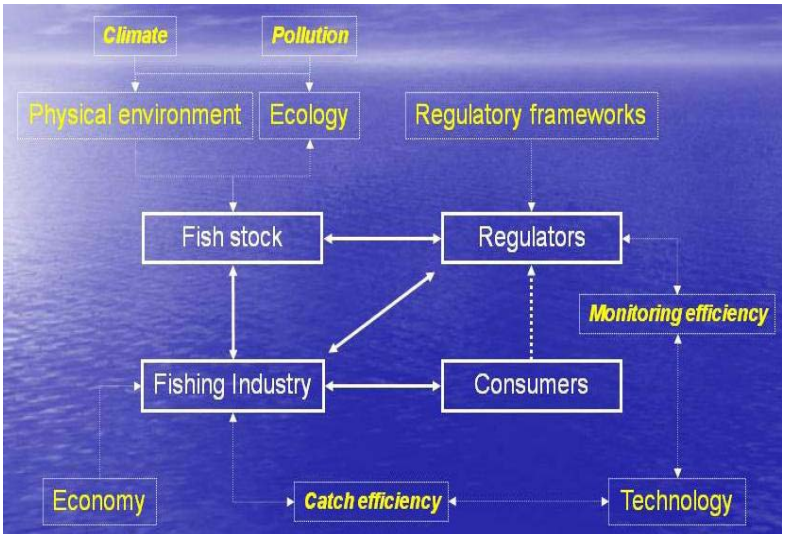

Figure 1: Wider influences on uncertainty affecting management indicators in fisheries. (Source: Crown Copyright Cefas)

Which policy areas will the research inform?

DEFINEIT provided better tools for fisheries management, supporting Defra's Fisheries 2027 vision by integrating ecosystem and environmental concerns, the protection of susceptible non-target species, and wider economic and socioeconomic issues. Outputs were also relevant to Defra's Shark, Skate and Ray Conservation Plan, and to the development of an EU seabird bycatch plan. It also helped focus EU member state responses to obligations under the Habitats Directive, and the elaboration of the Marine Strategy Framework Directive.

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How can we determine the economically optimal level of exploitation of fisheries systems while ensuring that the pressure exerted on both commercial stocks and susceptible fish species is biologically sustainable?

What are the results from the project and how will they be used?

The Defra project outlined here was part of a larger MARIFISH project consisting of 10 partners across Europe and led by DTU-AQUA (http://www.aqua.dtu.dk/) that finished in June 2012. The findings reported in this section relate to the work done by Defra funded partners and is split into three areas as described below.

1. Improving understanding of fish recruitment

Stock-recruitment and reproduction processes are a crucial component of the dynamics of fish stocks, so understanding them is vital for effective management. Approaches developed within DEFINEIT showed that stock-recruitment relationships can be generated from models that only include feeding interactions and that inclusion of stock structure is very important in effective fishery management. These results are being used to develop methods to achieve maximum sustainable yield (MSY) detailed in papers submitted to peer-review journals.

2. By-catch and non-target species

The susceptibility of bycatch and non-target species to fisheries is very important in the protection of these species. The overlap between sensitive species (elasmobranchs, seabirds and mammals) and fishing activity was assessed. In the North Sea, the most vulnerable species were elasmobranchs such as porbeagle shark (Figure 2), spurdog and tope, and three fish species were in the top 25% most vulnerable species (Norway redfish, wolffish and cod). For mammals and seabirds, 25 maps of species distribution have been developed to guide future monitoring and / or mitigation measures. These methods have been used to develop precautionary management methods and employed at ICES and ICCAT working groups.

3. Economic and socio-economic indicators

Resource indicators combining economic, social and biological indicators to determine the optimal economic level of exploitation were developed. Adding species interaction decreased estimates of Maximum Economic Yield (MEY), so models excluding species interactions are likely to overestimate the economic gains from a fishery moving to MEY. Constraints on levels of by-catch of sensitive species did not lead to large changes in profitability in the fleets studied. A stochastic approach to economic indicators showed that to maximise the total Net Present Value of the fishery, fishing levels slightly higher than current are needed. However, maximising overall economic benefits will come at a trade-off as some stocks are likely to end up outside biological constraints. An elicitation method was developed to derive estimates of indicator suitability from stakeholders that formalised the elicitation of uncertainties. This method has been extended to current ECOKNOWS and MYFISH EU FP7 projects.

Figure 2: A critically endangered porbeagle shark by-caught as a non-target species in the North Sea. (Source: Crown Copyright, Cefas)

Where can I find further information about this and related research?

More information is provided in the MARIFISH and Defra reports, and can be obtained from Defra's Marine and Fisheries Science Unit (marinescience@defra.gsi.gov.uk)

Defra Science – did you know?

At any one time Defra manages over 2000 research projects covering a wide range of topics. For more information on current research see **http://randd.defra.gov.uk** and to find out about future research proposals see the Defra Research and Analysis page at: **www.defra.gov.uk/evidence/index/htm**