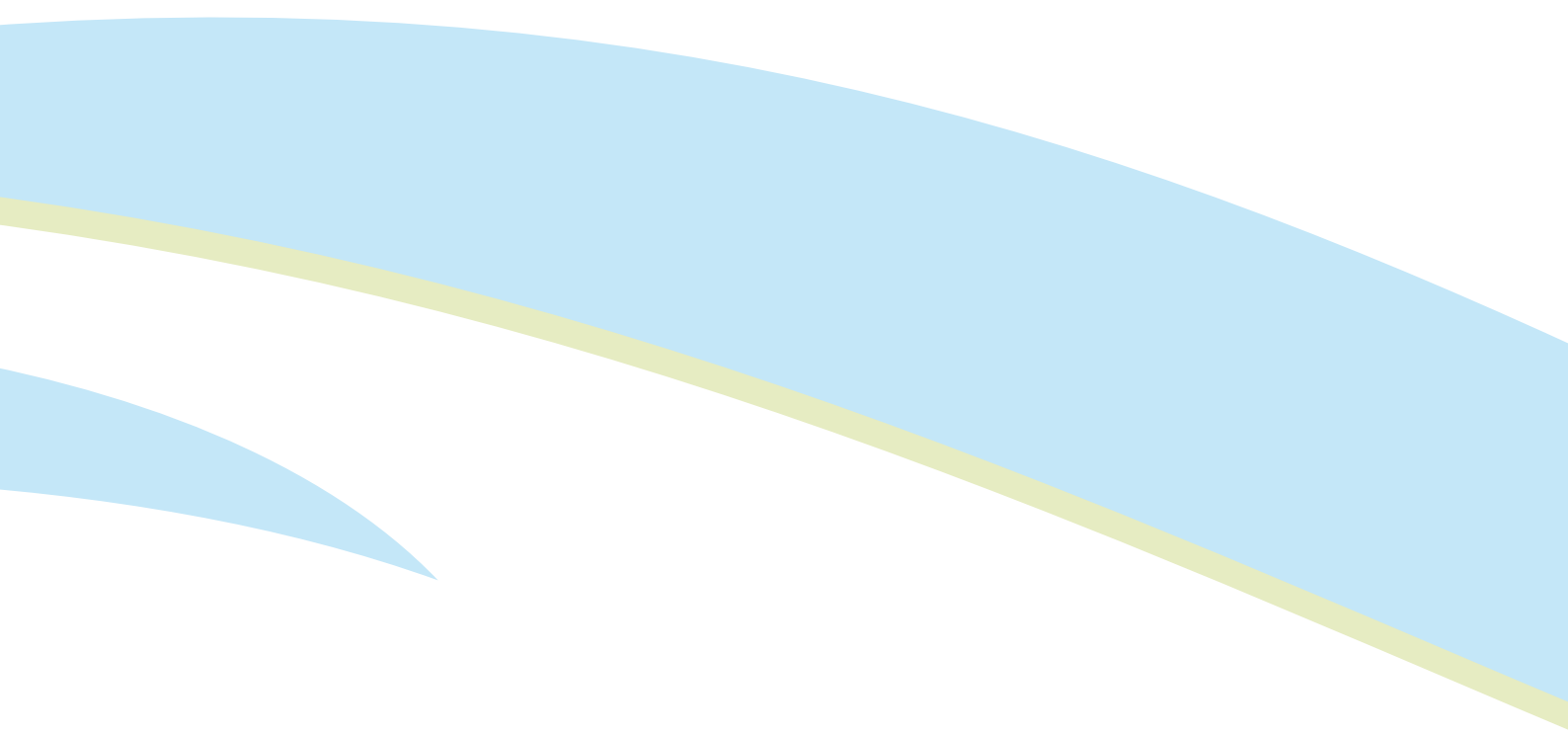


Fish and Shellfish Stocks 2012



marinescotland
science

FISH AND SHELLFISH STOCKS
2012 EDITION



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// INTRODUCTION TO FISHERIES MANAGEMENT IN SCOTLAND

Fisheries management involves a number of political and scientific processes that aim to provide a sustainable supply of fish. Each year Marine Scotland Science (MSS) carries out the scientific work to support fisheries management. Monitoring and research is undertaken at MSS to understand the biology and the state of commercially important fish stocks. Management is generally applied at the level of these biological units known as stocks. MSS investigates the life history of each stock, for example when the fish spawn, how long they live, and what they eat. Staff also research how changes in the marine environment may affect fish stocks.

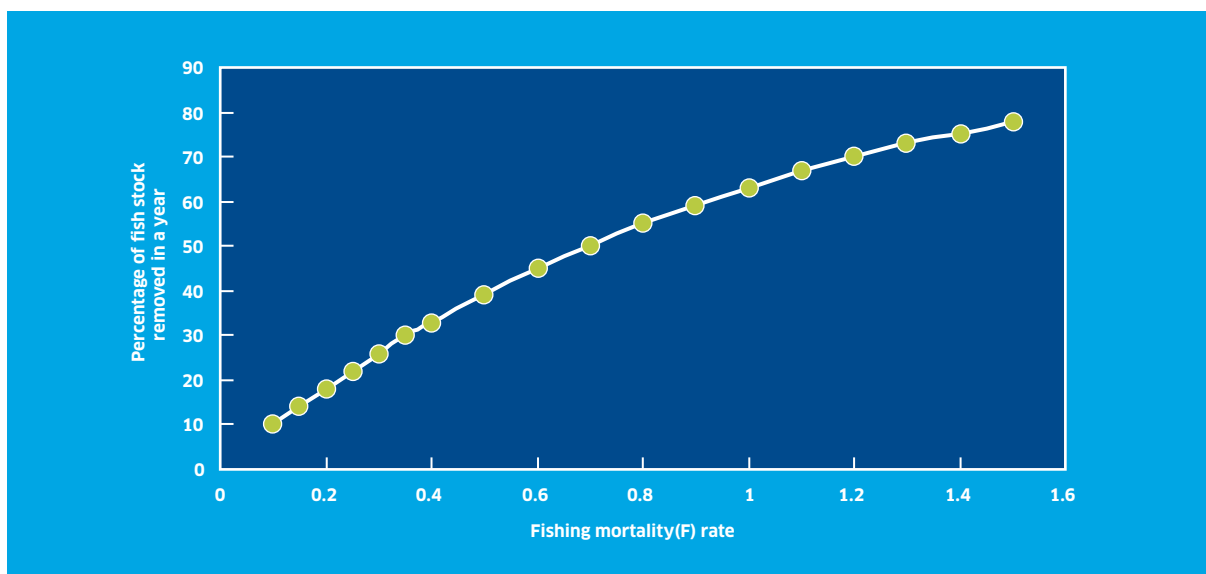
The state of the stock refers to the numbers of fish in the population or their total weight, known as the stock biomass. The aim is to provide fishery managers – the Government and the European Commission – with information on the state of stocks. They can then make decisions on exploitation rates to sustain the stocks and the management actions necessary to achieve them.

Many of the stocks of interest to Scotland are shared with other nations. In general, scientific advice is based on a pool of information provided by several European fishery nations.

In a process known as stock assessment, scientists estimate the past and current state of the stocks. Four main measures are considered in the determination of the health of exploited fish populations:

- **Fishing Mortality (F)** – A measure of the rate at which fish are removed from the stock. This can be related to the proportion of the stock taken out each year by fishing. The figure below illustrates this relationship
- **Spawning Stock Biomass (SSB)** – The total weight of mature fish (capable of spawning) in the population
- **Recruitment** – The number of young fish produced each year which survive from spawning to enter the adult stock and the fishery.
- **Landings** – The total annual tonnage of fish taken from the stock and landed by the fishing fleet.

Every year scientists at MSS, as well as other members of the International Council for the Exploration of the Sea (ICES), look at the changes in these characteristics and forecast what is likely to happen in the future. This information underpins the basis of fisheries advice and subsequent management action.



HOW FISHING MORTALITY RATES (F) TRANSLATE INTO ANNUAL REMOVAL RATES

// THE BASIS AND FORM OF ICES ADVICE

For some years ICES based its advice on a precautionary approach defining reference points related to fishing mortality rate (**F**) and spawning stock biomass (SSB). Where stocks were judged to be fished unsustainably (**F** above the reference points) or where recruitment was likely to be impaired (SSB below reference points) then restrictive advice could be expected. The rationale behind this approach is 'avoidance' of situations likely to lead to stock collapse. More recently there has been a shift in emphasis towards a 'target' based approach to management, where the emphasis is on fishing at a rate likely to lead to long term sustainability. This is exemplified in the concept of maximum sustainable yield (MSY).

The goal of achieving MSY has an international legal basis, and was stipulated in the United Nations Convention on the Law of the Sea (1982) and Johannesburg Declaration of the World Summit on Sustainable Development (2002). The European Commission for Fisheries, DG MARE, has emphasised the importance of the target that all European fisheries are to be exploited for MSY by 2015.

The MSY approach is now prominent as the basis of the ICES advice, but the form of that advice is largely dependent on the availability of data and the quality of the assessment for each stock. Advice types can be broadly categorised as follows. It should also be noted that the ICES advice for fisheries should take explicit cognisance of the ecosystem impacts and consequences of fishing, but this aspect is not yet well developed.

Management plans

For several stocks, international management plans and agreements exist that stipulate suitable harvest control rules (and hence exploitation rates and appropriate removals). In many cases the exploitation rates align closely with MSY principles. If these stocks also have accepted age-structured assessments based on catch and survey data, then these are used to determine the advice. Examples include North Sea haddock, herring and cod.

Maximum sustainable yield (MSY)

Where no agreed international management plan exists, the default ICES position for stocks with full accepted assessments is to base advice on a fishing mortality rate (known as **F_{MSY}**) that is expected to generate the MSY for the participating fleets: that is, the highest possible catch that can be maintained indefinitely. Examples include West of Scotland haddock.

This approach has superseded the precautionary approach (PA), although PA biomass reference points are still in use for some stocks and PA advice is still listed.

MSY (or, more specifically, **F_{MSY}**) can be very difficult to estimate, and proxies to it are often used. It may be different in single-species and multi-species contexts, but it is generally the case that **F_{MSY}** is less than the historical fishing mortality rate experienced by a stock. Hence a requirement to fish at or around **F_{MSY}** usually leads to a reduction in fishing mortality, and a concomitant increase in sustainability.

'Data-poor' stocks

For all other stocks, the form of the ICES advice is principally determined by the requirements of the advice customer, which for ICES is often the European Commission (EC). In an attempt to force member states to monitor and submit detailed data on all their fisheries, in 2011 the EC decided that only stocks with full, age-structured analytic assessments could be managed according to management plans or MSY considerations. All other stocks, including those with only (for example) research-vessel survey data, would be managed according to advice based on the following table. While the intention to improve data provision is laudable, questions need to be asked about whether a rigid approach to the type of assessments that are acceptable is appropriate. Robust assessments using different approaches also need to be considered. For now, the consequences of the consistent application of the table are that many stocks for which reasonable indicators of stock abundance exist are subject to quota cuts because these data do not fit a particular paradigm. Examples include Northern Shelf monkfish.

		No overfishing	Overfishing	Unknown exploitation status
Decreasing stock trend	or	Reduce catch at rate of stock decrease.	Reduce catch at rate greater than the rate of stock decrease.	Reduce catch at rate greater than the rate of stock decrease.
Stable stock trend		Do not allow catches to increase.	Reduce catch.	Reduce catch.
Increasing stock trend	or	Increase catch at rate of stock increase.	Do not allow catches to increase.	Do not allow catches to increase.
No trend information		Do not allow catches to increase.	Reduce catch.	Reduce catch.

The presentation of advice

However the advice is determined, the conclusions are presented in a consistent way for all stocks. The first element of the advice is a table summarising current stock status and, comparing this with the previous two years, for spawning stock biomass (SSB) and fishing mortality (F). The status relative to particular reference points is summarised using a simple system of icons:

- Appropriate (below **F** target, or above SSB target)
- At **F** or SSB targets
- Not appropriate (above **F** target, or below SSB target)
- Unknown
- Increasing trend
- Stable
- Decreasing trend

The example below is from the advice given in June 2011 for West of Scotland haddock (Division VIa)

F (Fishing Mortality)				
	2008	2009	2010	
MSY (F_{MSY})				Appropriate
Precautionary approach (F_{pa} , F_{lim})				Harvested sustainably

SSB (Spawning Stock Biomass)				
	2009	2010	2011	
MSY ($B_{trigger}$)				At trigger
Precautionary approach (B_{pa} , B_{lim})				Full reproductive capacity

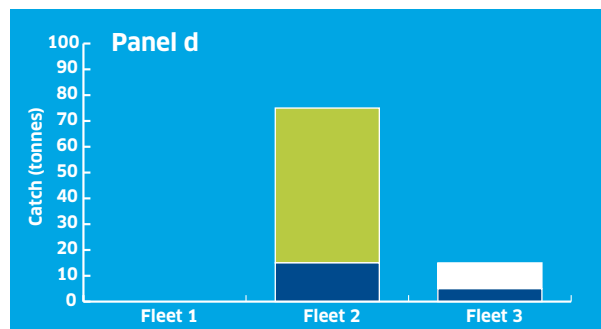
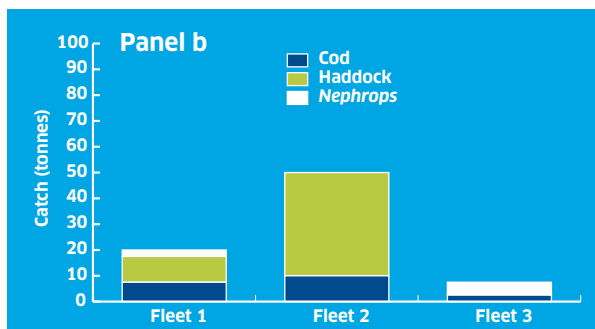
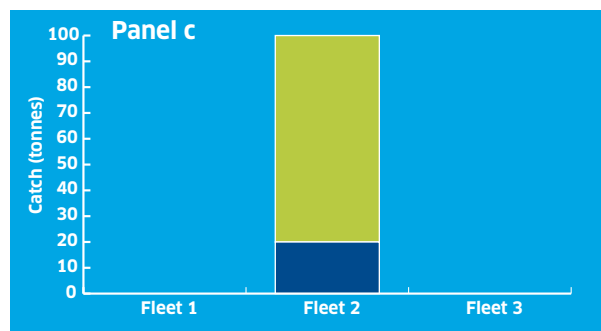
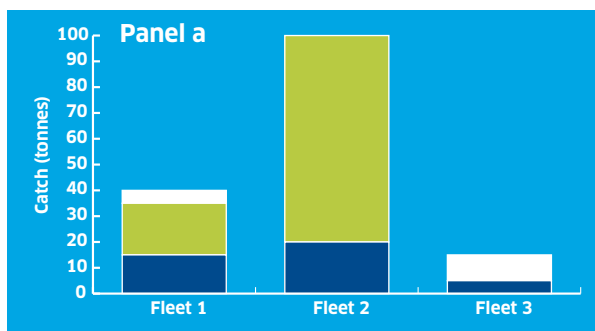
// MIXED SPECIES FISHERY ADVICE

Introduction

The International Council for the Exploration of the Sea (ICES) has traditionally given fishery management advice on an individual stock basis. For each assessed stock, catch options corresponding to the formal ICES advice are provided for the following year and form the basis of the Total Allowable Catch (TAC) for that stock. The TAC is the total landing allowed to be taken from that stock by all fleets. For demersal fisheries in particular this approach is deficient since it disregards the fact that mixtures of roundfish, flatfish and shellfish are often caught simultaneously within a single fishery. Moreover, fish stocks are targeted by different fleets, each catching different mixes of species. Ignoring the mixed-species aspect of fisheries can mean, for example, that the quota for one species may become exhausted, but due to the continued quota availability for other species, vessels continue to fish and inevitably catch the species whose quota is exhausted. The required constraints on fishing mortality for vulnerable species are not always therefore operative. Alternatively, early closure of a fishery because one species needs protection could result in the loss of fishing opportunities on other stocks.

Approaches investigated

Both ICES and the European Commission are investigating ways to advise on and manage mixed-species fisheries. One option is that advice is provided on a fleet or fishery basis. This requires evaluation of fisheries in a multi-fleet framework. Management under such a framework requires judgements from fishery managers on the relative species importance, since broadly equivalent outcomes for one species may be reached in a number of ways with very different restrictions on other species. A simple example of management options for three fleets catching three species (cod, haddock and *Nephrops*) is illustrated below. Panel 'a' shows the historic catch composition. Fleet one catches a mixture of all three species, fleet two catches cod and haddock, and fleet three cod and *Nephrops*. Now imagine that catches of haddock and *Nephrops* can be maintained but there is a need to protect cod and reduce catches of it by 50%. Panel 'b' shows the effect on the catches of all three species of reducing cod catches evenly across all fleets. Panel 'c' shows the option where priority is also given to maintaining haddock catches, and results in closing down fleets one and three. Panel 'd' shows the outcome of prioritising



cod, then *Nephrops* and finally haddock. This distributes the permissible cod catches firstly to the catch associated with *Nephrops* in fleet three and then to a significant but lesser extent to the catch associated with haddock in fleet two. Thus managers have complex decisions to take, but the mixed fisheries approach can help to maximise fishing opportunities.

Current practice and future possibilities

The European Commission's Scientific, Technical and Economic Committee for Fisheries (STECF) made initial attempts at mixed fisheries forecasts using the MTAC approach (after Mixed-species TAC), from 2004. Attempts to use MTAC in an advisory context led to the identification of a number of limitations with the approach and, as a result, ICES established a series of workshops between 2006 and 2009 to establish a simpler model in line with the availability and accessibility of data. Together with two EU-funded research projects this established the Fcube model (after Fleet and Fishery Forecast). Fcube was run within a mixed fisheries advice working group for the first time in 2010 and to date its application has been restricted to demersal fisheries and stocks within the North Sea, Skagerrak and Eastern Channel.

Two basic concepts of primary importance to Fcube are the Fleet (or Fleet segment), and the Métier defined as:

- **A Fleet segment** is a group of vessels with the same length class and predominant fishing gear during the year. Vessels may have different fishing activities during the reference period, but might be classified in only one Fleet segment.
- **A Métier** is a group of fishing operations targeting a similar (assemblage of) species, using similar gear, during the same period of the year and/or within the same area and which are characterized by a similar exploitation pattern.

The exploitation pattern of each species is the distribution of fishing mortality over the different ages of that species.

The species considered as part of the demersal mixed fisheries of the North Sea are cod, haddock, whiting, saithe, plaice, sole and *Nephrops norvegicus*. By 2011 all of these were subject to multi-annual management plans apart from *Nephrops*. These plans all consist of harvest rules evaluated and adopted on a

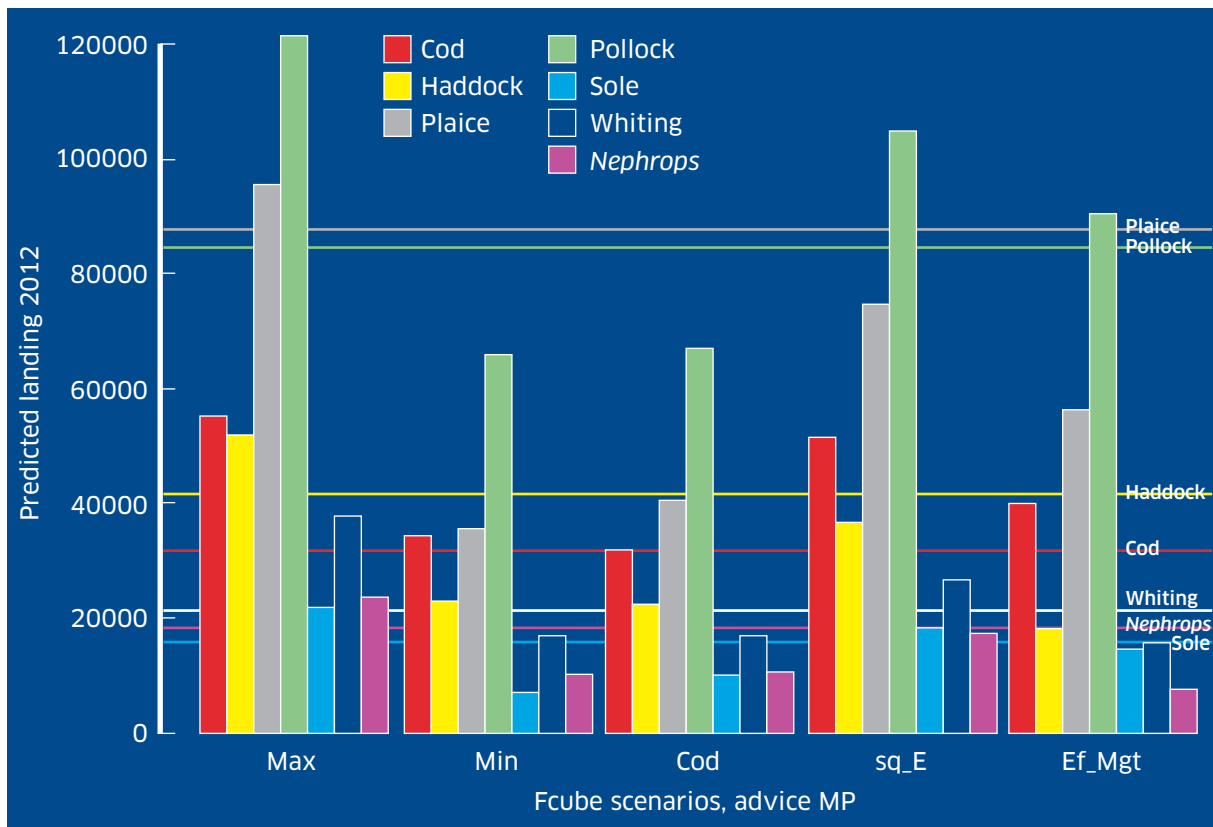
stock-by-stock basis, and derive the annual TACs depending on the biomass of the stock relative to biomass reference points and a target fishing mortality. The harvest rules also impose constraints on the annual percentage change in TAC. The basis of the Fcube model is to estimate the potential future levels of effort by fleet corresponding to the fishing opportunities based on:

- The results of the single species advice and management plans.
- The fleet's effort distribution across métiers.
- The catchability of each species by each métier.
- An assumption regarding the behaviour of each fleet in the forecast year.

Examples of assumptions of fishers' behaviour are the 'max' scenario: where a fleet continues fishing until all quotas are exhausted, the effort management scenario: where fleets are assumed to use the same effort as in the most recent year except those using gear subject to reduced effort ceilings under EU legislation or the 'cod' scenario: where fleets are assumed to stop fishing once their quota of cod is exhausted.

To date, no single assumption on fishers' behaviour (or even a single set of fleet specific assumptions varying across fleets) has been adopted and therefore no mixed fisheries advice as such has been produced. Instead several forecasts are made, each according to a scenario where the same assumption about fleet behaviour is made for all fleets. The resulting overall catches by species are presented to fisheries managers as a set of potential outcomes given all else remains as before.

These potential outcomes can be presented in the figure overleaf. The horizontal lines represent the TACs from the single species advice. Columns representing the potential 'landings' of each stock considered are grouped together by scenario. A column finishing under its associated horizontal line represents underutilised quota for that species. A column finishing above its associated horizontal line represents landings over and above the proposed TAC. In the latter case, if the scenario was to hold true and the TAC remained unchanged then the excess 'landings' would become discards or potentially unreported landings. The figure only shows the result of projecting the landings component of the fleets' catches. If one or more fleets already discard a proportion of the catch an amount representing discards would have to be added to the columns.



This form of mixed fisheries forecasting is in its infancy. The projection of status quo catchabilities is a weakness of the current approach and the scenarios considered by ICES so far are simple and uniform across fleets. Fishermen have demonstrated the ability to reduce by-catch through season, area or gear modifications, or changes in their short term fishing patterns. There is a danger that the allocation of fishing opportunities based on past catch compositions will lock fisheries into their historical pattern, providing no incentive to reduce by-catch. More complex models of behaviour could potentially be 'plugged in' to the mixed fisheries short term projections but modelling adaptive changes in

fishing behaviour is still in development. Another limitation is the availability of data. Any data to be used in a mixed fisheries context (e.g. running costs by fleet, so that the cost of utilising different quotas can be considered) has to be available across all fleets and/or stocks. For 2012 the mixed fisheries working group will move to May and its results will be available alongside the single species advice from ICES. Mixed fisheries advice should still only be seen as being in its early stages and it is not ecosystem management. Even so it can be seen as a means to bridge the gap between 'traditional' fisheries management and the development of an ecosystem approach to marine management.

// TOTAL ALLOWABLE CATCH (TAC) MANAGEMENT – HOW FISH QUOTAS ARE AGREED

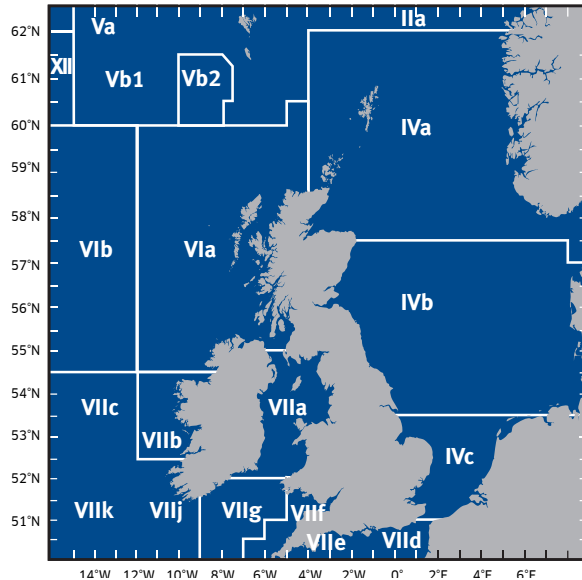
Many stocks exploited by Scottish fishermen are managed under the EU Common Fisheries Policy (CFP) – administered by the European Commission. An important part of the management procedure is the use of TACs. Most TACs are set on an annual basis and are the result of a cycle of events ending in the December Council of Fisheries Ministers, which decides on the final TACs for the following year. In the early days of the CFP, TACs were mainly used to provide a starting point for allocating fish resources (quotas) to different member states. Soon after, however, TACs were used to control the amount of fish removed each year from the sea.

Fixing the level of fish TACs that can be caught by EU member states is a complex process and EU fisheries ministers have the final say on the quotas to be allocated for the next twelve months. Sometimes scientific advice on how much of a certain species should be caught is followed to the letter. This is particularly the case where a long term management plan exists for the stock. It is not, however, unusual for ministers to agree on levels which are different from the European Commission's initial proposals.

Different TACs are applied in different areas for different species, the so called TAC areas (see map). These areas do not always correspond exactly with the areas of stock distribution used in the assessments. For example, the assessment area for North Sea haddock stock includes ICES Subarea IV and Division IIIa, the forecast catch for this stock is split up to provide a TAC for each of the constituent parts.

It is also important to remember that before the December Council of Fisheries Ministers meeting takes place, an agreement must be reached with Norway – not an EU member – on quota shares. This is because the main North Sea demersal and pelagic stocks are shared by Norway and the EU. For some widely distributed stocks, this process also occurs between the 'coastal states' (e.g. Faroes).

While TACs are strongly influenced by politics and have generally not been recommended by scientists as the appropriate management measure for demersal stocks, they are based



ICES DIVISIONS SHOWN ON THE BOUNDARIES OF THE FIGURE MAY COMPRISE PART AREA ONLY

on catch forecast advice from ICES using data from national research institutes. Each country collects basic biological data from fish landings, observer and research vessel surveys which are used to provide:

- An estimate of the historical trends in landings, spawning stock biomass, recruitment and fishing mortality rate
- A description of the 'state of the stock' in relation to historic levels
- The likely medium term development of the stock using different rates of fishing mortality
- A short term forecast of spawning stock biomass and catch

Assessments performed by these working groups are considered by the Advisory Committee (ACOM), an ICES Committee with representatives from each country. ACOM decides what the official ICES advice on the TAC management will be. For the purposes of TACs, ACOM provides a catch option table for managers consisting of expected catches under different fishing rates, and usually indicates which of the options corresponds most closely to its advice. The advice given is based upon what is likely to happen in the medium term if the stock is fished at a particular level. Recently, the advice has been to fish at a level likely to achieve MSY that gives good odds of avoiding dangerously low spawning stock size.

The Commission drafts its proposals for TACs applying in the following year using the ICES advice and any other factors that it considers appropriate. For example, the Commission may ask its own advisory body, the Scientific, Technical and Economic Committee on Fisheries (STECF), for guidance on the economic effects of the scientific advice. Between the time the ICES advice becomes available and the time of the December Council of Fisheries Ministers, the Commission consults with member states about the measures for managing fisheries in the coming year. At this time, member states have the opportunity to influence the Commission in the drafting of the TAC regulation. It is also at this time that the Commission negotiates TACs for jointly managed stocks with Norway. The joint stocks affecting Scotland in the North Sea are cod, haddock, saithe, herring and mackerel.

The Commission has unique responsibility to make formal proposals about the forthcoming TACs. No other body within the EU may do this, not even the Council or the presidency. The power to make policy proposals lies with the Commission. However, it is the Council of Ministers which makes the final decision. The Council can reject the Commission's proposals and ask for alternatives. Generally, the Commission tries to draft a proposal

which will be acceptable to all member states. There is a lengthy process of consultation up to and including the Council meeting to find a compromise.

Once a compromise has been agreed by the Council of Ministers, there is an automatic process of allocating shares of the total TACs to member states. This is done on the basis of a fixed allocation key which was established early in the history of the CFP. The key reflects fishing patterns in the early 1980s which raise problems for certain stocks, for example saithe. Historically, the UK had little interest in landing saithe and consequently it has only a small proportion of the TAC. In the present day more are being caught but the UK is unable to land them owing to the TAC constraint.

Following the allocation of the TACs to member states, the principle of subsidiarity operates. Each member state can administer its quota according to its own preferences provided the catch limits are adhered to and that all member state fishermen are treated equally. In the UK, the trend has been for Government to hand the management of quotas to the producer organisations (POs). These organisations, run by fishermen, decide how to manage the quotas during the course of the year and usually try to ensure that the fishery remains open for the whole year.

// MANAGEMENT MEASURES IN SCOTLAND

In addition to management measures designed to control the amount of fish removed from the sea (TACs), other measures are also applied. Technical measures to regulate the fishing gears in use influence the selectivity of fisheries. A number of mesh size regulations are in place to control size selection – larger mesh openings generally release more small fish. In the *Nephrops* fishery, smaller meshed trawls are required to use a panel composed of larger, square mesh netting to facilitate the release of small fish. Certain gear designs take this a stage further and influence the composition of species which are captured. Minimum landings sizes (MLS) are in place for many species. These are intended to support the mesh regulations and are frequently intended to allow the species to spawn at least once before capture. The utility of MLS regulation is particularly important in some of the shellfish fisheries.

Spatial management measures operate in a number of areas around Scotland and often involve closed areas operating permanently or at strategic times to restrict fishing activity at spawning times or when young fish are present in an area. Some closures, under the Inshore Fishing Scotland Act, operate so as to restrict the use of gears (e.g. deep suction dredges) in areas where the habitat and associated species are vulnerable.

More recently, difficulties with a number of cod stocks has led to the EU developing cod recovery plans which include an effort management regime. This regime identifies key gears responsible for cod mortality and

reduces their activity in a systematic way. In Scottish waters the two main trawl gear categories (targeting whitefish and *Nephrops* respectively) fall into this category.

Provisions in the EU cod plan regulation allow for Member States to develop alternative measures to deliver reductions in fishing mortality and the Scottish fleet have employed various measures under the Conservation Credits Scheme to buy-back fishing effort. One of the principle tools has been the use of Real Time Closures (RTCs), a system involving short term closures identified in real time from examination of landings and VMS (vessel monitoring system) data as areas of highest abundance of cod. Results suggest some reduction in cod catches although the scale of reduction has so far not delivered a sufficiently large reduction in mortality.

New proposals from the European Commission as part of the upcoming review of the Common Fisheries Policy (CFP) include a ban on discards – unwanted fish thrown back into the sea. It has long been recognised that the current system of TAC management, which in fact deals with Total Allowable Landings (TAL), does not adequately control the fishing mortality on fish and that discarding can result from this. It is widely acknowledged that it would be better if the full catch were to be regulated. Scotland has been involved in trialling an initiative to operate 'Catch Quotas' – in which all the catch is accounted for and reported. Assurance that the whole catch is fully documented is provided by an accompanying system of CCTV on board the trial vessels.

// ASSESSING THE STATE OF FISH STOCKS

To carry out a stock assessment, it is necessary to build up a picture of how the fish populations change over time and examine the historical trends. The information required comes from market sampling, discard sampling and research vessel surveys. Attention is also given to information available from fishermen's surveys.

Market sampling

Throughout the year, landings at Scottish fish markets are sampled regularly by staff from MSS. Information on length and age are collected for a range of species along with details of the landings made by the fishing fleets.

The most common method used to age fish is to examine the ear stone (otolith) which is found in the head of the fish. These bony structures give an accurate picture of the life history of the individual fish. They consist of layers that are built up like the rings on a tree. Each year can be identified by a dark and light band corresponding to winter and summer growth. The age of the fish can be determined by counting the number of bands on the otolith. By counting the ages of a large number of fish, the age structure of the whole population can be estimated. This gives a good indication of how the stock is standing up to the effects of fishing. If there are not many young fish, then recruitment has been poor and this could mean problems for the future. If there are no old fish present in the stock, this could be an indicator of over-fishing. If the stock is in a healthy state, fish of a wide range of ages are present. Each year MSS staff take around 900 samples of landings across a range of 18 species. Over 305,000 fish are measured and around 24,000 are aged.

Observer sampling

Sampling the landings is very important, but it gives no information about those fish which are caught that never reach the market. Many of the fish and shellfish caught at sea are unwanted and thrown away for a variety of reasons, either to comply with the quota limits, because they have limited commercial value or because they are below the legal minimum landing size. With the co-operation of the fishing industry, MSS staff make around 100 trips per year, collecting information on the amount of fish discarded, as well as details of their length and age composition. Each year around 290,000 discarded fish and shellfish are measured and around 18,000 are aged. This information is then combined with the landings data to give a complete picture of the effects of fishing on the stocks.

Research vessel surveys

Research vessel surveys give information on the numbers of young fish 'recruits' which are too small to be caught and landed by commercial vessels. They also provide information on changes in the distribution and abundance of the adult stock. Bottom trawling surveys are used for cod, haddock and whiting, whereas acoustic surveys are used for herring. Shoals of herring show up on echo-sounders as 'marks'. Analysis of the strength of the echo-soundings gives an estimate of the total biomass. For mackerel, surveys are carried out to estimate the total number of eggs produced during the spawning season. This is used in combination with information on the numbers of eggs produced by female mackerel of different lengths to estimate the size of the population. Surveys employing underwater television techniques are used for estimating *Nephrops* abundance.

Summary

The Main Characteristics

By collecting information each year from the fish landings, observer trips and research vessel surveys, scientists build up a picture of how the stocks change over a long period of time.

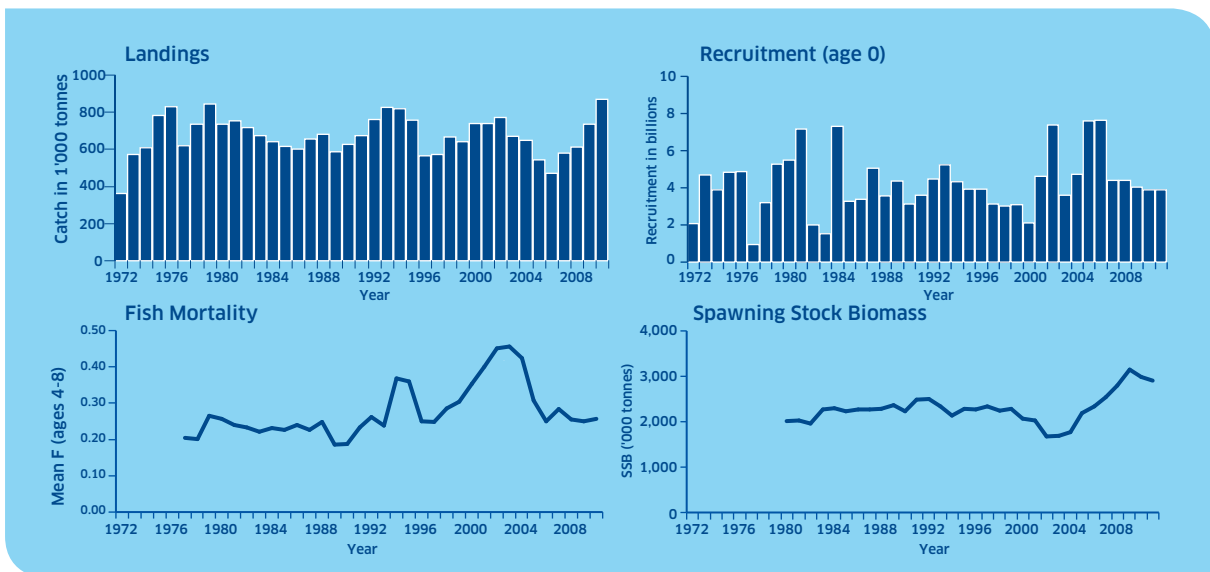
Each year when they carry out stock assessments, scientists plot out the important characteristics of the population. They look at the trends over time and decide on the 'state of the stock'. They also try to predict what will happen to the stock in the future.

Trends in landings, recruitment, fishing mortality and spawning stock biomass, for an example fish stock for the period 1972 to

2010 are shown below. These can be used to answer questions such as:

- Are landings increasing or decreasing?
- Is recruitment high or low in recent years?
- Is spawning stock biomass as a high or low level?
- Is fishing mortality rising or falling?

This example shows that while the landings have remained fairly consistent over the time period, the rate of fishing mortality gradually increased over the same period, reaching a peak in 2004, before decreasing in recent years. This decrease corresponds with an increase in spawning stock biomass, which was boosted by several above average recruitments into the stock.



// SCOTTISH FISH STOCKS



// NORTHEAST ATLANTIC MACKEREL STOCKS

Mackerel (*Scomber scombrus*) is the most important pelagic species for the Scottish fishing industry. It is caught predominantly with pelagic trawl mainly in western waters and the North Sea.

2012 position : UK share 152,368 tonnes
Last Year : 189,694 tonnes
Landed into
Scotland in 2010: 95,180 tonnes
Value for 2010 : £78 million

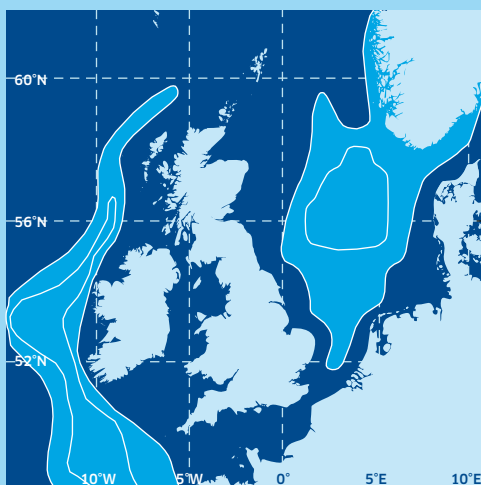
Biology

The mackerel (*Scomber scombrus*) caught by the Scottish pelagic fleet belong to two different stocks – the North Sea and the western. This separation is based on differences in the timing and the areas used for spawning. North Sea mackerel overwinter in the deep water, to the east and north of Shetland and on the edge of the Norwegian Deep. In the springtime, they migrate south to spawn in the central part of the North Sea from May until July. The western mackerel stock is found near to the continental slope, over a vast area. These fish spawn between March and July, mainly to the south and west of the UK and Ireland. When spawning is finished, most of the spent fish move to the feeding grounds in the Norwegian Sea and the northern North Sea where they mix with the North Sea stock. Some

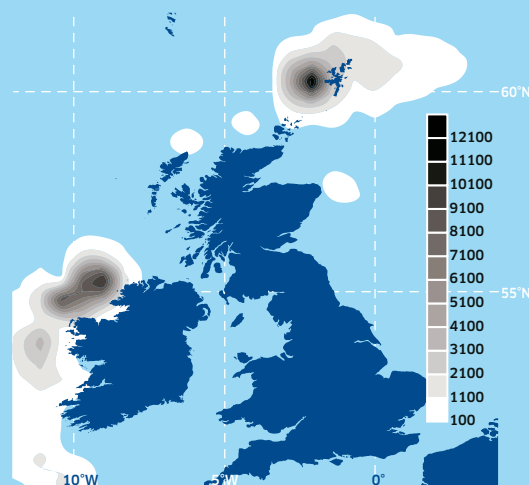
western stock mackerel, predominantly small individuals, also enter the North Sea through the English Channel. The western stock mackerel travel long distances between the feeding grounds and the spawning areas. Over the past twenty years, the pattern of their southerly migration has changed dramatically in both timing and route. In the 1970s and 1980s this movement occurred in late summer and autumn with the fish passing through the relatively shallow waters of the Minch. Now the migration occurs gradually later in the year and is further offshore. The pattern of the return northerly journey, after spawning, has remained relatively constant. The boundaries of the spawning areas have also slowly changed, with an increase in spawning activity in the north of the area and to the west of the shelf edge.

By the time they reach three years old, most mackerel are mature. At one year old, only a small proportion of females are mature and able to spawn, while more than half can spawn at two years old. Female mackerel shed their eggs in about twenty separate batches over the course of a spawning season. An average-sized fish produces around 250,000 eggs. Juvenile mackerel grow quickly and can reach 22cm after one year and 30cm after two years.

The diet of mackerel can vary with the area and the season. By weight, almost half of the food consists of crustacea (shrimps). The remainder is made up of juvenile fish such as sandeel, herring and Norway pout.



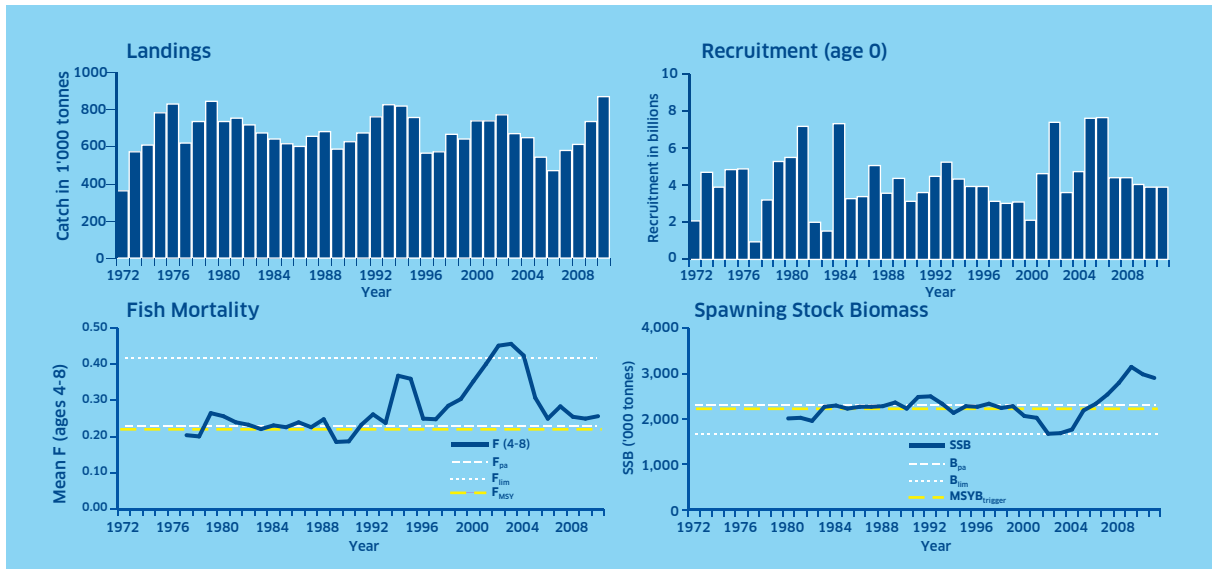
SPAWNING GROUNDS



2010 DISTRIBUTION OF LANDINGS BY SCOTTISH VESSELS (TONNES)

// ICES ADVICE ON MANAGEMENT

Information Source: ICES advice 2011 (<http://www.ices.dk/committe/acom/comwork/report/2011/2011/mac-nea.pdf>). Quoted text in italics



MSY and precautionary approach reference points

	Type	Value
Management plan	$SSB_{trigger}$	2.2 million t
	F_{target}	0.20-0.22
MSY Approach	$MSY B_{trigger}$	2.2 million t
	F_{msy}	0.22
Precautionary Approach	B_{lim}	1.67 million t
	B_{pa}	2.3 million t
	F_{lim}	0.42
	F_{pa}	0.23

The TAC should apply to all areas where mackerel is caught. Catches since 2008 have been considerably in excess of ICES advice which was based on the management plan. This situation continued in 2011. The absence of comprehensive international agreements on the exploitation of the stock remains a critical concern, and prevents control of the total exploitation rate. A projected fishing mortality of 0.31 for 2011 is above that stipulated in the management plan. If the level of catch associated with this fishing mortality were to be maintained in 2012 and onwards, then the spawning stock biomass is expected to decline rapidly to below B_{pa} within a few years.

State of stock and advice

- Fishing mortality in 2010 is estimated to be 0.26: this means that approximately 23%, by number, of all fish between 4 and 8 years of age were caught.
- Spawning stock biomass in 2011 is estimated to be well above B_{pa} and $MSY B_{trigger}$ at around 2.9 million tonnes.
- Fishing mortality and biomass are both above the precautionary limits and the level of F which is consistent with achieving maximum sustainable yield ($F_{2010} > F_{MSY}$).
- The advice is in accordance with the Norway, Faroe Islands and EU management plan which recommends that catches in 2012 should be between 586,000 tonnes and 639,000 for NEA mackerel.

Management outcomes for 2012

At the December 2011 meeting in Brussels, the Council of Ministers decided that the 2011 EU Total Allowable Catch for northeast Atlantic mackerel should be 278,948 tonnes. The UK quota was provisionally set at 152,368 tonnes.

Management of this stock continues to be complicated by unilateral action taken by Iceland and Faroes, and a failure to reach a political solution.

// HERRING STOCKS – NORTH SEA

Herring (*Clupea harengus*) is the second most important species landed by the Scottish pelagic fleet. It is mainly caught for human consumption by vessels towing large pelagic mid-water trawls, with very little by-catch of other fish.

2012 position : UK share 57,836 tonnes
Last Year : 29,832 tonnes
Landed into
Scotland in 2010 : 27,566 tonnes
Value for 2010 : £7.95 million

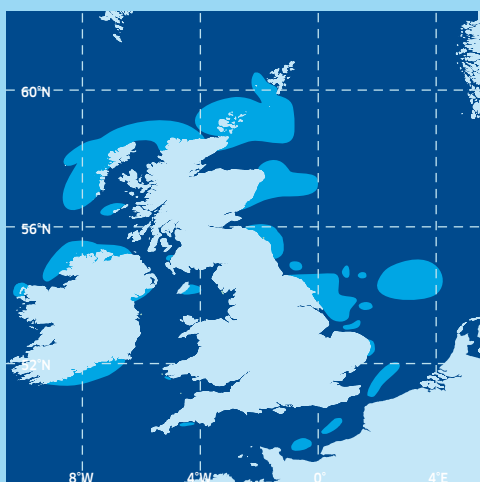
Biology

During daytime, herring shoals remain close to the sea bottom or in deep water. At dusk they move towards the surface and disperse over a wide area. Although most fish species have a single spawning season, herring is one of the exceptions. The sub-populations of North Sea herring spawn at different times and localised groups of herring can be found spawning in almost any month. The North Sea stock is dominated by autumn spawners. Currently, three major populations can be identified by differences in spawning time and area. These are: Buchan / Shetland herring, spawning off the Scottish and Shetland coasts during August and September; Banks or Dogger herring, spawning in the Central North Sea and off the English coast from August until October; and the Southern Bight or Downs herring, spawning in the English Channel from November

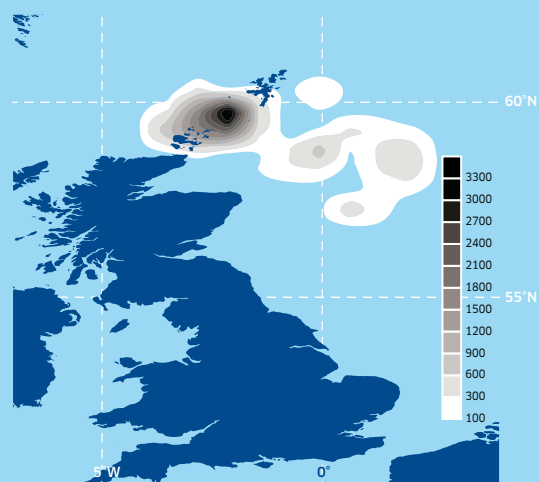
until January. For most of the year the different populations mix, but during the spawning season they migrate to their separate areas.

Some herring mature and spawn at two years of age, but most are three or four before they spawn. The number of eggs produced by an average-sized female varies between populations. A 28cm female from the Downs stock produces around 42,000 eggs per year whereas a similarly sized female from the Buchan stock can produce 67,000 eggs. Herring are demersal spawners, depositing their sticky eggs on coarse sand, gravel, small stones and rock. Shoals of herring gather on the spawning grounds and spawn more or less simultaneously. Females release eggs in a single batch and the resulting egg carpet may be several layers thick and cover a considerable area. The eggs take about three weeks to hatch depending on the sea temperature.

Many autumn hatched larvae spend their first winter drifting towards nursery areas on the eastern side of the North Sea, around the Moray Firth, the Firth of Forth and in the western North Sea. Their drift rate is variable and in some years many do not reach the nursery areas. As they grow, the juvenile herring move offshore, eventually joining the adult populations in the feeding and spawning migrations in the western areas of the North Sea. Some of the herring in the North Sea nurseries originate from the spawning grounds on the north and west coasts of Scotland.



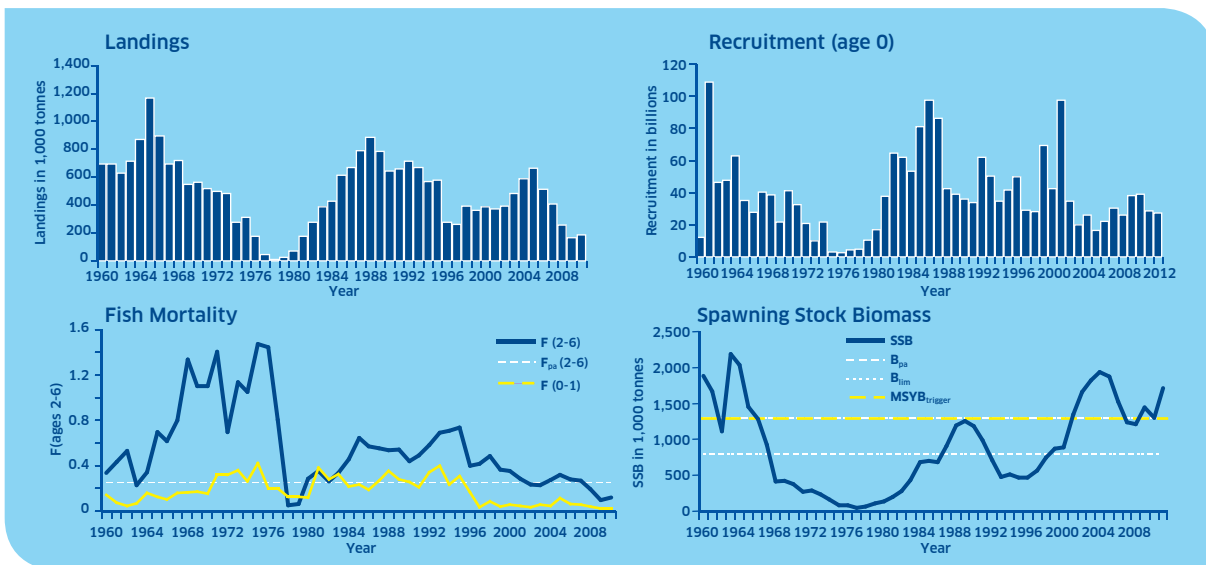
SPAWNING GROUNDS



2010 DISTRIBUTION OF LANDINGS BY SCOTTISH VESSELS (TONNES)

// ICES ADVICE ON MANAGEMENT

Information Source: ICES advice 2011 (<http://www.ices.dk/committe/acom/comwork/report/2011/2011/her-47d3.pdf>). Quoted text in italics.



MSY and precautionary approach reference points

		Type	Value
Management Plan	F _{MP}	>1.5 million tonnes	F ₀₋₁ = 0.05 F ₂₋₆ = 0.25
		<1.5 & >0.8 million tonnes	F ₀₋₁ = 0.05 F ₂₋₆ = 0.25 - (0.15*(1500000 - SSB)/700000)
		<0.8 million tonnes	F ₀₋₁ = 0.04 F ₂₋₆ = 0.10
MSY Approach	MSY B _{trigger}		Not defined
	F _{msy}		0.25
Precautionary Approach	B _{lim}		800,000 t
	B _{pa}		1.3 million t
	F _{lim}		Not defined
	F _{pa}		F ₀₋₁ = 0.12 F ₂₋₆ = 0.25

State of stock and advice

- Fishing mortality in 2010 was estimated at 0.025 for juvenile fish (aged 0-1 year) and 0.118 for adult fish (aged 2-6 year): this means that 2.5%, by number, of juvenile (aged 0-1 year) fish and approximately 11%, by number, of adult (aged 2-6 year) fish were caught. This stock is, therefore, classified as being harvested sustainably.
- Spawning stock biomass was predicted to be around 1.7 million tonnes in 2011, which is above B_{pa} and classified as being at full reproductive capacity.
- Fishing mortality and spawning stock biomass are below and above, respectively, the precautionary limits. Fishing mortality is below the level which is consistent with achieving maximum sustainable yield (F₂₀₁₀ > F_{MSY}).
- The advice, in accordance with the multi-annual management plan, recommends that landings in 2012 should be 230,000

tonnes for the main North Sea fleet and 17,900 tonnes for the small mesh industrial fleet.

In early 2011 the EU-Norway management plan was reassessed by ICES, and was found to operate well in relation to the objectives of consistency with the precautionary approach and a rational exploitation pattern. However, in late 2011, a joint EU-Norway request led to an evaluation of the harvest control rule (HCR) within the management plan to determine if it is compatible with the precautionary approach if the 15% TAC constraint rule is not applied. Several options were tested, based on the assumption that the current low productivity regime for North Sea herring (observed since 2002) will continue. All options were found to be compatible. ICES concluded that the current HCR, i.e., without a 15% TAC constraint, is compatible with the precautionary approach as the risk of SSB falling below B_{lim} is low.

Although the estimates for the 2008 and 2009 year classes are above the geometric mean of the time-series, and the year classes of 2007 and 2008 have been revised upwards, ICES still considers the stock to be in a low productivity phase. The management plan has proved to be an effective tool for maintaining sustainable exploitation and conserving the North Sea herring stock in this lower productivity regime.

Management outcomes for 2012

At the December 2011 meeting in Brussels, the Council of Ministers decided that the international Total Allowable Catch for North Sea herring (north of 53° 30' N) in 2012 should be 405,000 tonnes. The UK quota has been set at 57,836 tonnes.

Evaluations and discussions prior to the Council resulted in a potential modification to the herring management plan which may be considered in the future. The plan, which provided a less stringent catch restraint rule, was applied giving rise to a substantial increase in TAC but still keeping the stock within the acceptable boundaries.

// HERRING STOCKS — WEST OF SCOTLAND

West coast herring (*Clupea harengus*) is mainly prosecuted by large pelagic trawlers to the north and north-west of Scotland, with some small landings being taken in the Clyde by pair trawlers. Very little by-catch of other fish occurs within this fishery.

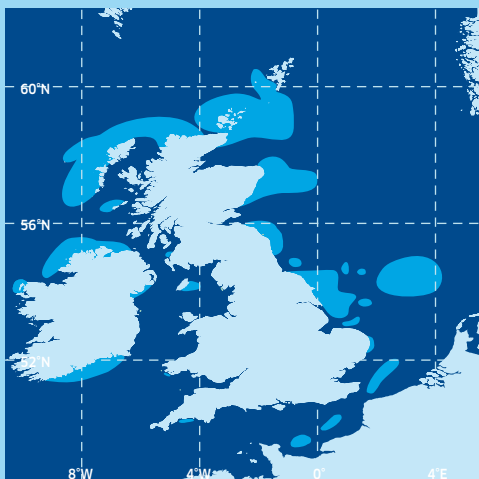
2012 position : UK share 13,438 tonnes¹
Last Year : 13,865 tonnes²
Landed into
Scotland in 2010 : 6,400 tonnes³
Value for 2010 : £1.96 million

Biology

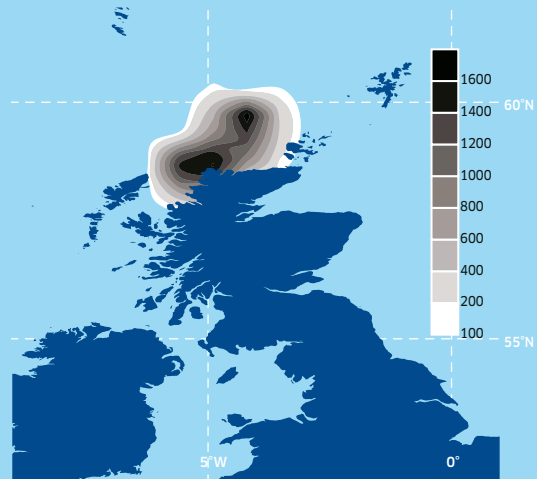
Herring is widely distributed throughout the north-east Atlantic, ranging from the Arctic Ocean in the north to the English Channel in the south. During daytime, the shoals remain close to the sea bottom or in deep water but at dusk they move towards the surface and disperse over a wide area. On the west of Scotland, the herring stock is composed of two groups of fish – one spawning in spring and the other in autumn. The majority of the population is made up of the latter group. Some herring are mature and able to spawn at two years old but most herring reach maturity by around four years. Autumn spawning takes place from late August until October, to the west and north of the Outer Hebrides and off Cape Wrath, in depths up to 100m.

Herring are demersal spawners, depositing their sticky eggs on coarse sand, gravel, small stones and rock. The shoals of herring gather on the spawning grounds and spawn more or less simultaneously. Each female releases her eggs in a single batch and the resulting egg carpet may be several layers thick and cover a considerable area. The eggs take about three weeks to hatch depending on the sea temperature; the warmer the water, the shorter the period of incubation. The newly hatched larvae follow the current systems and drift to the north and east. Some are retained on the west of Scotland but a large proportion are carried through the Fair Isle channel and travel well into the North Sea. In spring the larvae reach the nursery areas where they develop into juveniles. Young herring spend some time in the inshore areas and sea lochs before migrating offshore to join the adult population. There is some evidence from tagging experiments and from using biological markers, to suggest that as herring mature, some of those that moved as juveniles to the east coast population make the return journey back to the west of Scotland spawning areas.

Herring feed mainly on crustaceans (shrimps and copepods) and young sandeels. There are no marked differences between the diets of large and small herring, only the proportions of different food items change with size.



SPAWNING GROUNDS



2010 DISTRIBUTION OF LANDINGS BY SCOTTISH VESSELS (TONNES)

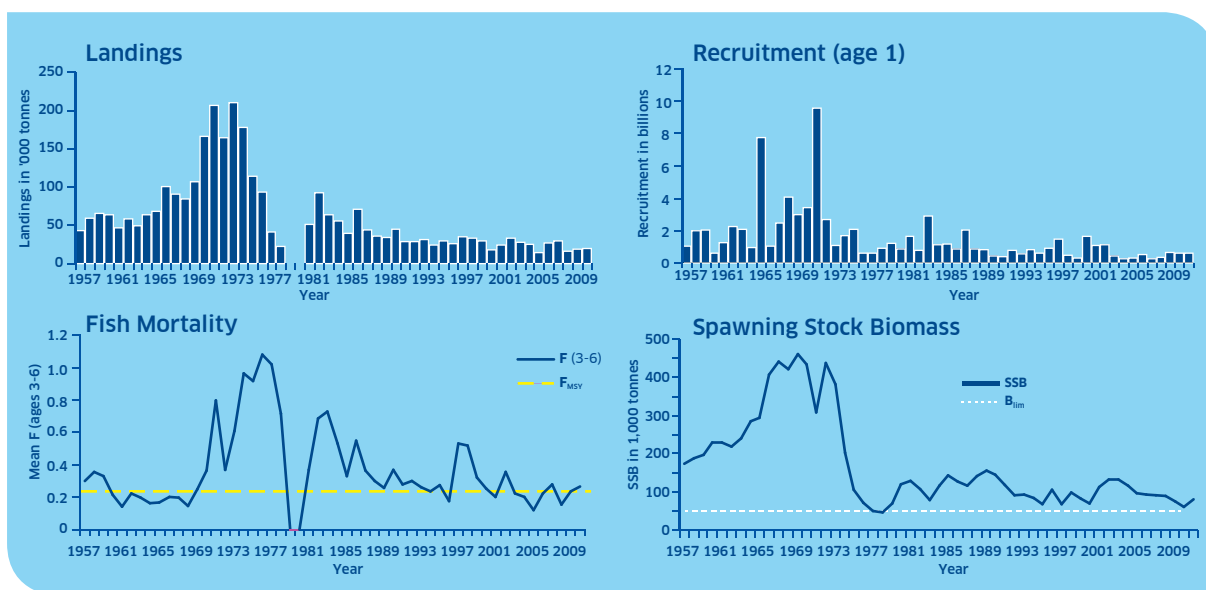
¹This excludes Clyde herring. Management now controlled by UK

²This included Clyde herring.

³Landings by Scottish based vessels only

// ICES ADVICE ON MANAGEMENT

Information Source: ICES advice 2011 (<http://www.ices.dk/committe/acom/comwork/report/2011/2011/her-vian.pdf>). Quoted text in italics.



MSY and precautionary approach reference points

		Type	Value
Management Plan		SSB_{MGT}	Not defined
	F_{MGT}	$SSB \geq 75$ kt	$F_{3-6} = 0.25$
		$SSB < 75$ kt & ≥ 50 kt	$F_{3-6} = 0.20$
	$SSB < 50$ kt	$F_{3-6} = 0.00$	
MSY Approach		$MSY B_{trigger}$	Not defined
		F_{msy}	0.25
Precautionary Approach		B_{lim}	50,000 t
		B_{pa}	Not defined
		F_{lim}	Not defined
		F_{pa}	Not defined

State of stock and advice

- Fishing mortality for 2010 was estimated to be 0.27: this means that approximately 23%, by number, of all fish aged between 3 and 6 years were caught.
- The spawning stock biomass for 2011 was predicted to be around 81,000 tonnes. This is above the precautionary approach reference limit (B_{lim}).
- Fishing mortality cannot be determined in relation to the precautionary approach. The spawning stock biomass is above the precautionary limit. However, it cannot be determined in relation to any of the other reference points. Fishing mortality is above the level which is consistent with achieving maximum sustainable yield ($F_{2010} > F_{MSY}$).
- The advice is in accordance with the

management plan which recommends that the TAC for 2012 should be set at 22,900 tonnes.

The stock identity of herring to the west of the British Isles was reviewed by the EU-funded project WESTHER. This identified Division VIa (N) as an area where catches comprise a mixture of fish from Divisions VIa (N), VIa (S), and VIIa (N). In 2008, ICES convened the study group SGHERWAY to evaluate management for herring in these areas. In 2010, SGHERWAY concluded that, where single species/stock approaches give a distorted view on individual populations and catch characteristics do not reflect population dynamics, there is a need for metapopulation management. It also determined that managing the VIa (N) and VIa (S) / VIIb,c ICES stocks sustainably under different mixing scenarios and misidentification levels is possible but only with detailed information on fisheries independent data. These data are now being collected. However, it will be a number of years before ICES can provide a fully operational integrated strategy for these units. In this context HAWG recommends that the management plan for Division VIa (N) should be continued.

Management outcomes for 2012

At the December 2011 meeting in Brussels, the Council of Ministers decided that the 2012 Total Allowable Catch for west of Scotland (Vb, VIa North and VIb) herring should be 22,900 tonnes. The 2012 UK quota has been set at 13,438 tonnes.

This quota decision was in line with scientific advice and results in a small increase in fishing opportunity.

// HADDOCK STOCKS — NORTH SEA

Haddock (*Melanogrammus aeglefinus*) is one of the most important fish for Scottish fishermen. With varying abundance throughout the year it is caught both inshore and offshore by a variety of gears.

2012 position : UK share 25,386 tonnes
Last Year : 22,250 tonnes
Landed into
Scotland in 2010 : 17,701 tonnes
Value for 2010 : £19.8 million

Biology

In the North Sea, haddock occur mainly in the northern and central areas, but can be found as far south as the Humber Estuary. At the beginning of the 20th century they were also abundant in the southern North Sea.

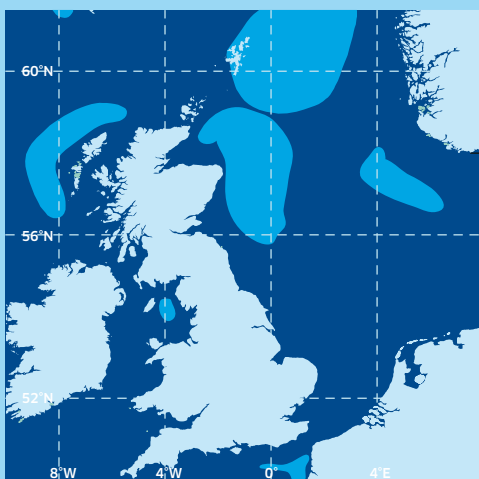
Virtually all three year old fish are mature and in some years over 80% of two year olds may be mature. A three year old female of average size is able to produce around 300,000 eggs in a season. Haddock release their eggs over several weeks. Spawning runs from February until early May and occurs in almost any area of the North Sea from the Scottish coast to the Norwegian Deep. There are differences in the length of the spawning season, associated with the size and age of the local population, with age two fish spawning later. The spawning fish on inshore grounds are usually

smaller and younger fish than those found in offshore areas. As a result the spawning period of inshore fish can be around half of the time of that found offshore.

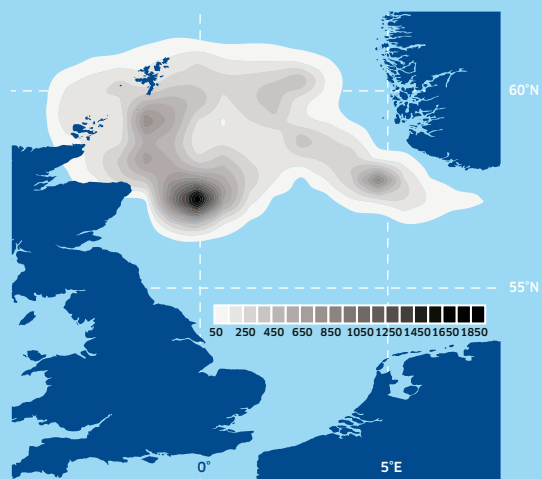
In the northern North Sea most of the larvae do not travel far from the spawning grounds. Some larvae from the west coast spawning grounds can be transported to the North Sea, which they enter through the Fair Isle/Shetland Gap or to the north east of Shetland. Young haddock spend the first few months of life in the upper water layers before moving to the seabed.

Tag recapture studies suggest that whilst adult shoals spread out after spawning, many do not inter-mix with haddock from distant spawning areas. Results from early genetic studies on haddock have suggested there could be different populations within the North Sea. However, whilst there are regional differences in maturity between these proposed populations, tagging, parasite and more recent genetic studies have questioned the proposed differences.

The diet of haddock varies with the size of the fish, the time of year, and with the area. In the winter months haddock of all sizes feed mainly on worms, small molluscs, sea urchins and brittle stars. In the spring and summer fish prey are important, particularly for the larger haddock. The type of fish prey reflects the local availability, with Norway pout being the most common fish eaten in the more northerly areas, whereas sandeels are more important in the central North Sea.



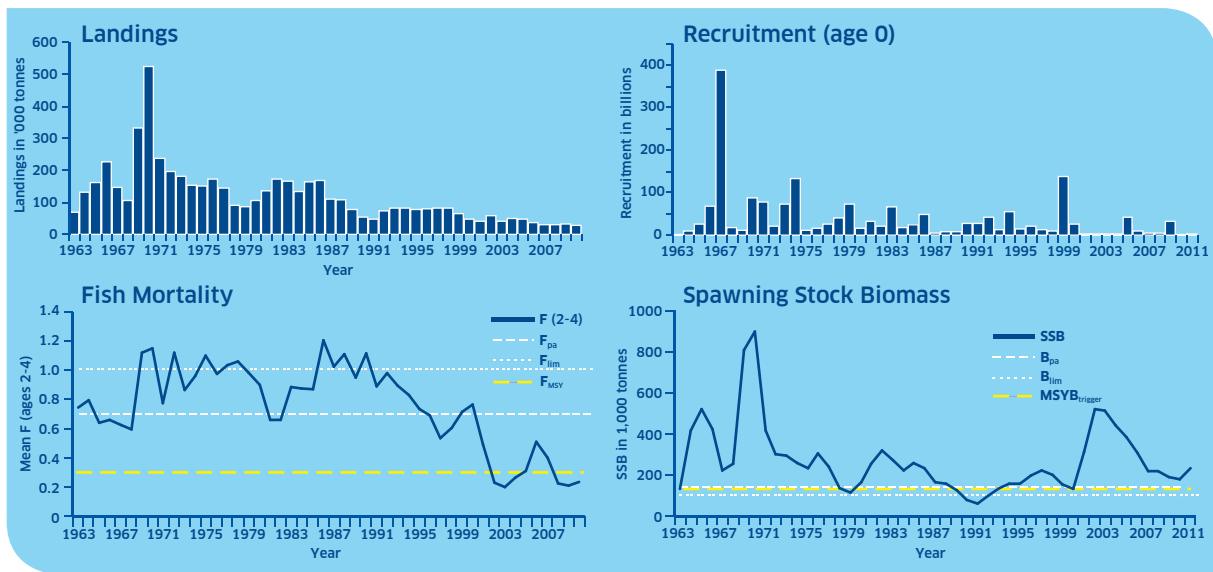
SPAWNING GROUNDS



2010 DISTRIBUTION OF LANDINGS BY SCOTTISH VESSELS (TONNES)

// ICES ADVICE ON MANAGEMENT

Information Source: ICES advice 2011 (<http://www.ices.dk/committe/acom/comwork/report/2011/2011/had-34.pdf>). Quoted text in italics.



MSY and precautionary approach reference points

	Type	Value
Management Plan	FMP	0.3
	SSB _{MP}	100,000 t
MSY Approach	MSY B _{trigger}	140,000 t
	F _{msy}	0.3
Precautionary Approach	B _{lim}	100,000 t
	B _{pa}	140,000 t
	F _{lim}	1.0
	F _{pa}	0.7

Adherence to the EU-Norway management plan has contributed to lower fishing mortality levels, increased yield and greatly improved stability of yield.

ICES evaluated the original management plan in 2007 and then the revised plan in 2008 (which allowed for interannual catch variation, or “banking and borrowing” of quota), and concluded that this plan could be accepted as precautionary and could be used as the basis for advice.

The industry’s perception is of increasing haddock abundance in all areas of the North Sea in 2011. This is in line with scientific surveys, except for the southern North Sea where research vessel survey data do not show an increase.

State of stock and advice

- Fishing mortality in 2010 is estimated to be 0.23: this means that approximately 20%, by number, of all fish between 2 and 4 years of age were caught.
- Spawning Stock Biomass is estimated to be above both B_{pa} and the MSY B_{trigger} in 2011 at around 235,000 tonnes.
- Fishing mortality and biomass are below and above, respectively, the precautionary limits and the level which is consistent with achieving maximum sustainable yield (F₂₀₁₀ < F_{MSY}).
- The advice is in accordance with the long-term management plan which recommends human consumption landings in 2012 of 41,575 tonnes for areas IIIa (Skagerrak) and IV.

Management outcomes for 2012

At the December 2011 Council of Ministers meeting in Brussels, the EU Total Allowable Catch for North Sea (IIIa & IV) haddock was set at 30,132 tonnes, with the UK quota for 2012 at 25,386 tonnes.

This quota decision was in line with the haddock long term management plan agreed between the EU and Norway. Hague preference was invoked which adjusted the final outcome in the UK’s favour.

// HADDOCK STOCKS — WEST OF SCOTLAND

Haddock (*Melanogrammus aeglefinus*) to the west of Scotland is, by weight, one of the most important demersal species landed from this area. It is caught mainly by bottom trawlers which target mixed demersal fish assemblages. Discarding is still quite high in this area, with nearly 51% of the catch estimated to be thrown back.

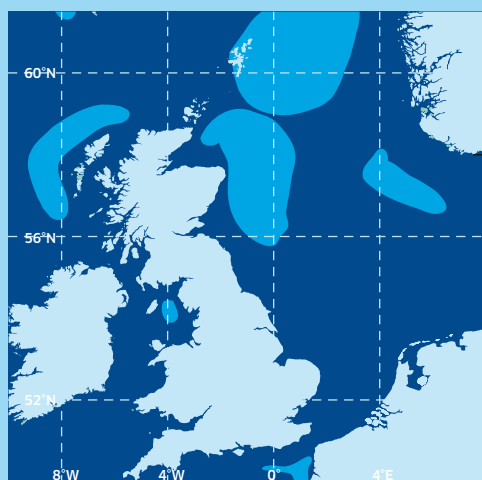
2012 position : UK share 4,683 tonnes
Last Year : 1,561 tonnes
Landed into
Scotland in 2010 : 2,407 tonnes
Value for 2010 : £2.9 million

Biology

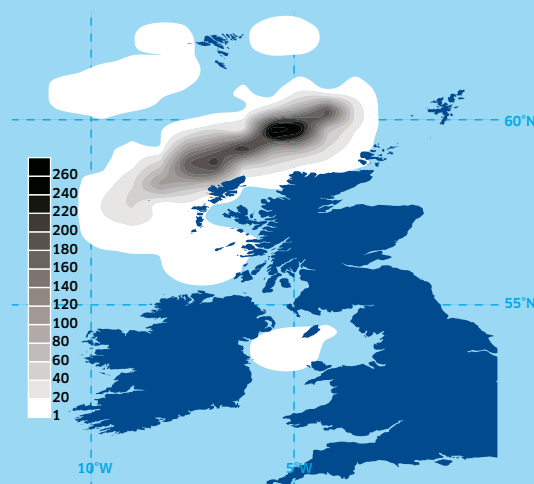
The haddock is widely distributed around the west coast of Scotland and can be caught in most areas within the 200 m depth contour. The stocks occurring off the north-west coast of Scotland are usually identified according to the regions which support a fishery, but genetic and biological marker studies suggest the possibility of different populations of haddock. A continuous population of haddock is thought to extend from the west coast around to the north of Scotland. Results from tagging experiments and larval transport studies suggest that there may be links between west coast haddock and those in the North Sea.

The majority of haddock now mature at age two with usually all mature by age three. However, mature age two haddock spawn fewer eggs for a given size than an age three haddock. A three year old female of good size is able to produce around 300,000 eggs in a season and releases her eggs in a number of batches over many weeks. Spawning usually occurs in February and March and occurs in almost any area. There is major spawning between the Butt of Lewis and Shetland. Some larvae from the west coast spawning grounds can be transported to the North Sea, which they enter through the Fair Isle/Shetland Gap or to the north east of Shetland. Young haddock then spend the first few months of life in the upper water layers before adopting the demersal way of life. The survival rate of young haddock is very variable from year to year.

The diet of haddock varies with the size of the fish, the time of year, and with the locality. In the winter months haddock of all sizes feed mainly on worms, small molluscs, sea urchins and brittle stars. In the spring and summer, fish prey, especially sandeels, are important, particularly for the larger haddock. At other times Norway pout is the most common fish eaten. During the herring spawning season haddock will feed heavily on their eggs.



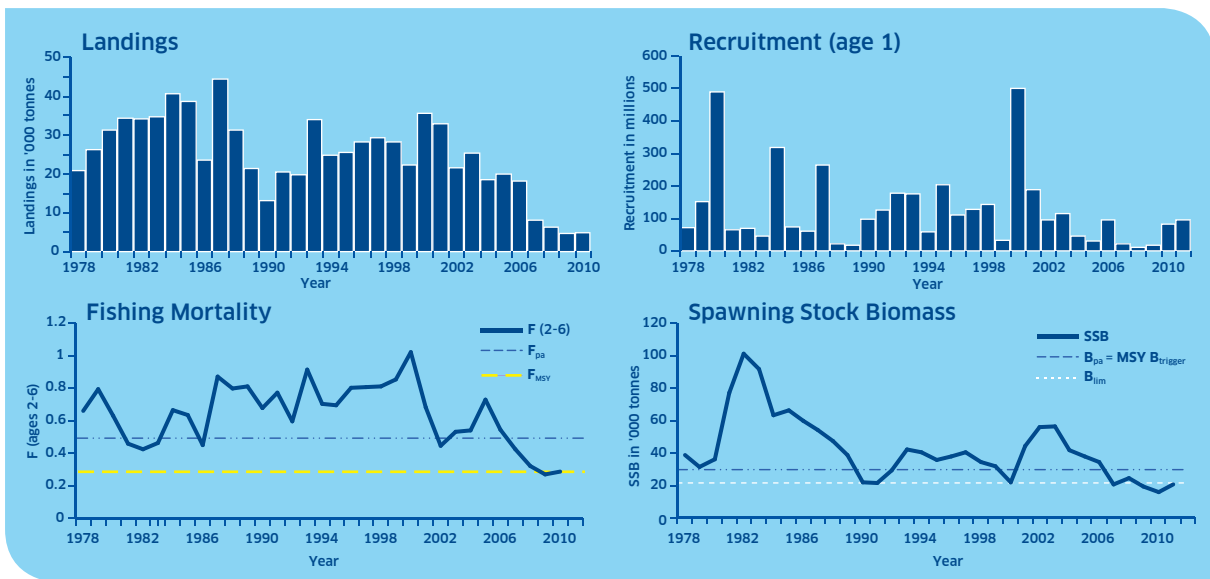
SPAWNING GROUNDS



2010 DISTRIBUTION OF LANDINGS BY SCOTTISH VESSELS (TONNES)

// ICES ADVICE ON MANAGEMENT

Information Source: ICES advice 2011 (<http://www.ices.dk/committe/acom/comwork/report/2011/2011/had-scov.pdf>). Quoted text in italics.



MSY and precautionary approach reference points

	Type	Value
MSY Approach	MSY B _{trigger}	30,000 t
	F _{MSY}	0.3
Precautionary Approach	B _{lim}	22,000 t
	B _{pa}	30,000 t
	F _{lim}	Not defined
	F _{pa}	0.5

State of stock and advice

- Fishing mortality in 2010 has been estimated at about 0.29: this means that approximately 20%, by number, of all fish between 2 and 6 years of age were caught.
- The relatively strong 2006 and 2009 year classes have contributed to the rise of the spawning stock biomass in 2011, which is estimated to just be below B_{lim} at 20,800 tonnes.
- Fishing mortality and biomass are both below their precautionary limits. However, fishing mortality is just below the level which is consistent with achieving maximum sustainable yield (F₂₀₁₀ ≈ F_{MSY}).
- The advice is in accordance with the MSY approach which recommends human consumption landings in 2012 of 10,200 tonnes for haddock in Division VIa.

A management plan is under development. It is not yet in operation and has still to be fully evaluated by ICES, therefore stock advice is not yet based on this plan.

The management plan should offer maximum protection to the haddock while recognising that they are caught in a mixed fishery. Attention should be given to the sporadic nature of recruitment in to the stock and how to manage the periods of poor recruitment interspersed with the larger, occasional pulses. *In recent years around 50% of the total catch in weight has been discarded, so restricting landings alone may not achieve the necessary increase in SSB.*

Discarding of haddock remains stubbornly high, with the majority of these fish discarded being one year olds. In 2010 the *Nephrops* fleet is estimated to have discarded approximately seven times that of the demersal fish fleet. The advice explicitly states that: "The selection pattern should be improved in the *Nephrops* (TR2) fleet to reduce its high proportion of discards." Any measure to reduce discarding and to improve the fishing pattern should be actively encouraged. Such measures should include the adoption of a sorting grid as well as appropriately located square-meshed panels.

Management outcomes for 2012

At the December 2011 meeting in Brussels, the Council of Ministers decided that the international Total Allowable Catch for West of Scotland (VIa and Vb) haddock should be 6,015 tonnes, which is in line with the proposed management plan. The UK quota for 2012 is set at 4,683 tonnes.

To realise the TAC, adjustments to the existing bycatch regulations affecting haddock in previous years have been applied by the Commission. There are requirements to manage the haddock TAC uptake spatially in order to avoid increases in mortality on cod.

// HADDOCK STOCKS — ROCKALL

Rockall haddock (*Melanogrammus aeglefinus*), by weight, is the most abundant demersal species landed from this area. It is exploited by two main fleets: Russian vessels deploying small mesh nets (40-70 mm), and the European fleet using demersal trawl gear with a cod-end mesh of 120 mm and above.

2012 position : UK share 2,660 tonnes
Last Year : 3,022 tonnes
Landed into
Scotland in 2010 : 2,931 tonnes
Value for 2010 : £3.8 million

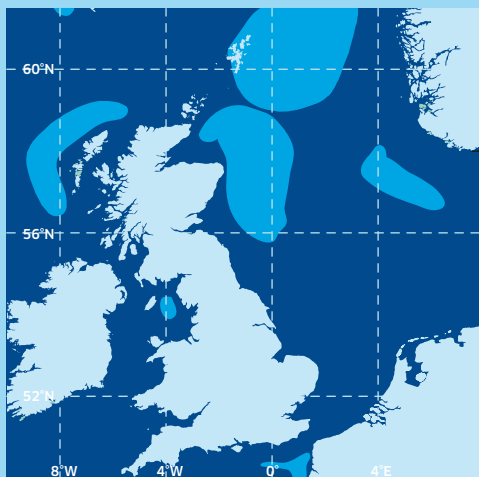
Biology

Haddock are distributed throughout the Rockall Bank area and can be found at depths down to 600m, although they are mainly concentrated in the 150 to 300m depth range. Juvenile haddock are mainly found in the shallower waters of the central Bank, at depths less than 180m. There is strong evidence to suggest that Rockall haddock form a separate stock from those found on the continental shelf of the British Isles. The northward flowing surface current between

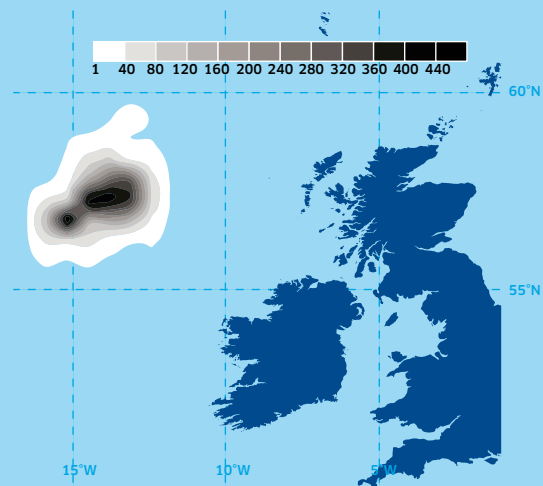
Rockall and the Hebrides may act as a barrier preventing eggs and larvae reaching Rockall from the east or southeast. This hypothesis is supported by tagging studies showing that no haddock tagged from other stocks have been recovered from Rockall.

The haddock found on the Bank have much slower growth rates and a smaller size at age than haddock from other areas. Sampling information by MSS observers has also shown that over 80% of Rockall haddock are sexually mature at age 2. The first spawning of a newly matured female produces around 80,000 eggs, with this number increasing as the fish gets older. Spawning takes place between March and May, with the eggs being released in batches. The eggs and larvae are distributed in the upper water column, and drift north-easterly. Once the juveniles reach 5-10 cm in length they gradually migrate and settle on the sea bottom.

Rockall haddock eat a variety of foods, preferring benthic organisms, with fish and detritus becoming an increasing part of the diet during periods of large stock size. The fish feed preferentially during the summer and autumn, putting on weight until the spawning period when the intensity of feeding significantly decreases.



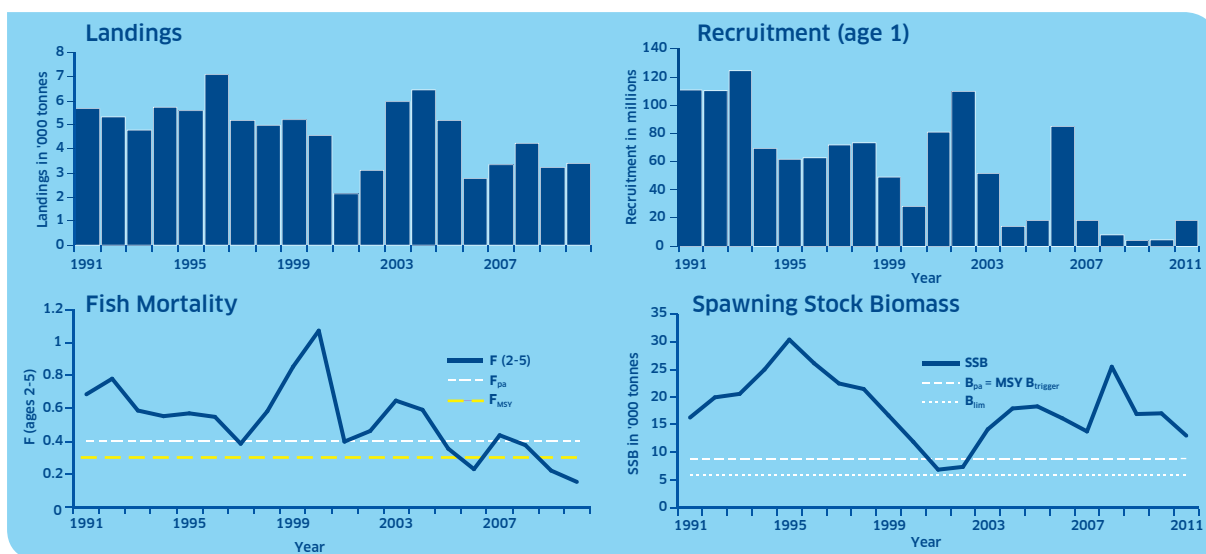
SPAWNING GROUNDS



2010 DISTRIBUTION OF LANDINGS BY SCOTTISH VESSELS (TONNES)

// ICES ADVICE ON MANAGEMENT

Information Source: ICES advice 2011 (<http://www.ices.dk/committe/acom/comwork/report/2011/2011/had-rock.pdf>). Quoted text in italics.



MSY and precautionary approach reference points

	Type	Value
MSY Approach	$MSY B_{trigger}$	9,000 t
	F_{msy}	0.3
Precautionary Approach	B_{lim}	6,000 t
	B_{pa}	9,000 t
	F_{lim}	Not defined
	F_{pa}	0.4

State of stock and advice

- Fishing mortality has decreased over time and for 2010 was estimated at 0.15: this means that nearly 14%, by number, of all fish between 2 and 5 years of age were caught
- The spawning stock biomass has increased in recent years and has been above B_{pa} since 2003. For 2011 it was estimated to be around 13,000 tonnes.
- Fishing mortality and biomass are below and above, respectively, the precautionary approach limits and the level which is consistent with achieving maximum sustainable yield ($F_{2010} < F_{MSY}$).
- The advice is in accordance with the MSY approach which recommends human consumption landings in 2012 of 3,300 tonnes from Division VIb.

The EU and the Russian Federation have developed a management plan for this stock that is currently being evaluated by ICES. For the time being, the Russian fleet is not limited by any quota regulation, although in recent years very few Russian vessels have fished at Rockall.

To increase the chance that the spawning stock remains above B_{pa} in 2013 ICES has recommended that the precautionary approach rate of fishing mortality (0.36) not be used, but the MSY framework rate (0.30) be utilised.

For 2012 the spawning stock biomass is estimated to be at B_{pa} but the incoming recruitment over the last five years has been low, leading to a high probability that the spawning stock biomass will decrease to levels below B_{pa} in the near future.

Management outcomes for 2012

At the December 2011 meeting in Brussels, the Council of Ministers decided that the international Total Allowable Catch for Rockall (VIb, XII and XIV) haddock should be 3,300 tonnes. The UK quota for 2012 is set at 2,660 tonnes.

This quota decision was in line with scientific advice advising a reduction in catch. The final quota was adjusted by Hague preference.

// COD STOCKS — NORTH SEA (IV, VIID AND IIIA)

Cod (*Gadus morhua*), by weight, is the third most important demersal species landed from the North Sea by Scottish fishermen. Like many North Sea stocks, cod is overfished with a high percentage of removals from the stock unaccounted for.

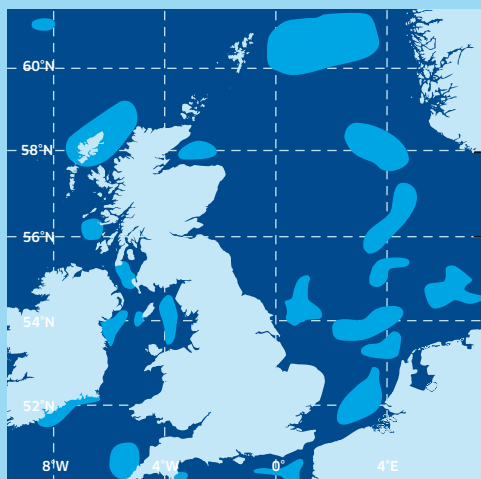
2012 position : UK share 10,311 tonnes
Last Year : 10,455 tonnes
Landed into Scotland in 2010 : 10,911 tonnes
Value for 2010 : £21.5 million

Biology

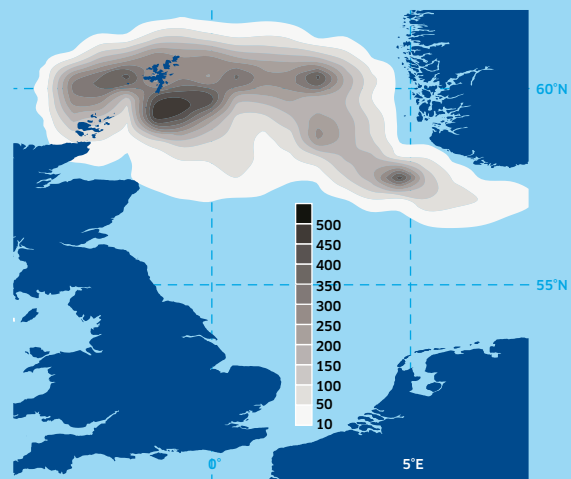
Cod occur mainly in the northern and central areas. New born cod are distributed over a large part of this area, with high concentrations off the Jutland coast. One and two year old cod tend to overwinter in shallow coastal areas, but eventually disperse into deeper water. Whilst some cod tend to reside all year around in coastal areas, the larger offshore congregations of cod tend to be migratory. Many cod now reach maturity at two years old, with 50% mature by three years old. By the time they reach five years, all cod are mature. An adult

female of around 80 cm can produce around four million eggs in a season. Most spawning takes place between February and March with the largest spawning areas in the northern North Sea and around Dogger bank. Young cod live in the upper water layers for a period before moving to the seabed in July and August. They grow quickly and can reach 20cm after one year, 50cm after two years and 80cm by the time they are four years old. By the time they reach two years old, young cod are fully exploited by the commercial fishery as the minimum landing size for cod is 35cm. Many fish are caught long before they have the chance to spawn, and less than one twentieth of one year olds will survive to the age of four.

Cod do not usually browse for food on the bottom but are active feeders. By weight, around three quarters of the food of all sizes of cod consists of fish and crustaceans. The rest is made up of small quantities of molluscs and worms. As they grow, cod eat an increasing amount of fish. Sandeel, Norway pout, whiting, herring, dab and cod themselves are the main fish species eaten.



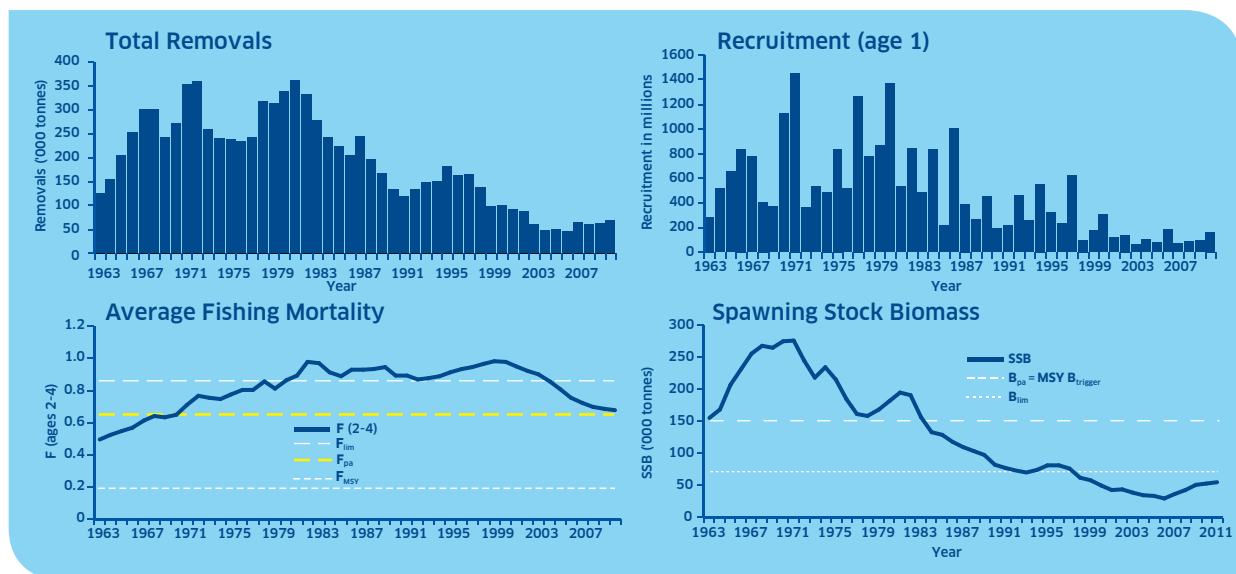
SPAWNING GROUNDS



2010 DISTRIBUTION OF LANDINGS BY SCOTTISH VESSELS (TONNES)

// ICES ADVICE ON MANAGEMENT

Information Source: ICES advice 2011 (<http://www.ices.dk/committe/acom/comwork/report/2011/2011/cod-347.pdf>). Quoted text in italics.



MSY and precautionary approach reference points

	Type	Value
Management Plan	SSB_{MP}	150,000 t
	F_{MP}	0.4
MSY Approach	$MSY B_{trigger}$	150,000 t
	F_{msy}	0.19
Precautionary Approach	B_{lim}	70,000 t
	B_{pa}	150,000 t
	F_{lim}	0.86
	F_{pa}	0.65

State of stock and advice

- Fishing mortality in 2010 was estimated to be 0.676: this means that approximately 49%, by number, of all fish between 2 and 4 years of age were caught.
- Spawning stock biomass has increased since its historical low in 2006, but is estimated still to be below B_{lim} in 2011 at 54,700 tonnes.
- Fishing mortality and biomass are between and below, respectively, the precautionary approach limits. However fishing mortality is well above the level which is consistent with achieving maximum sustainable yield ($F_{2010} > F_{MSY}$).
- The advice is in accordance with the long-term management plan and recommends a TAC in 2012 of 31,800 tonnes for areas IIa, IIIa Skagerrak, IV and VIId combined.

In February 2008 Scotland implemented a national scheme known as the 'Conservation Credits Scheme'. The principle of this two-part scheme involves additional time at sea in return for the adoption of measures which aim to reduce mortality on cod and lead to a reduction in discard numbers. ICES notes that from the initial year of operation (2008) cod discarding rates in Scotland have decreased from 62% to 36%

in 2010. In 2010 there were 165 closures, and from July 2010 the area of each closure increased (from 50 square nautical miles to 225 square nautical miles). Recent work tracking Scottish vessels in 2009 has concluded that vessels did indeed move from areas of higher to lower cod concentration following real-time closures during the first and third quarters (there was no significant effect during the second and fourth quarters).

In previous years, comparison between the fishers' North Sea stock survey and the IBTS survey data has shown that the time-series are broadly in agreement in recording a stable overall stock abundance until 2003–2005, followed by a more recent increase. Because of the inherent spatial variation, the IBTS surveys have more variability, but exhibit similar trends in the same areas as the fishers' survey, showing significant increases in stock abundance in the north and west, and less in the south.

Management outcomes for 2012

At the December 2011 meeting in Brussels, the Council of Ministers decided that the EU Total Allowable Catch for cod in Subarea IV and Division IIa should be 21,974 tonnes. The UK quota for 2012 was set at 10,311 tonnes.

This quota decision is consistent with the existing cod long term management plan. This plan (affecting a number of cod stocks) includes an effort management scheme which limits the effort available to the main cod catching gears. The Council Regulation covering the plan also includes provision for applying management measures to reduce cod mortality without reducing effort. The UK interpretation of permissible effort 'buy back' under the Conservation Credits Scheme (effort levels can be reinstated up to the level of the baseline established at the start of the scheme) was upheld. In accordance with the cod LTMP a further 10% cut in effort (before buy back) from the baseline applies in 2012. To justify existing and future effort buy back the UK is committed to the introduction of highly selective gears in both finfish and *Nephrops* targeted fleets.

// COD STOCKS — WEST OF SCOTLAND

West of Scotland cod (*Gadus morhua*) is mainly taken in a mixed demersal fishery by bottom trawl gears with mesh size 100 mm and greater and is now regarded as a by-catch species. Discarding remained high for this species, approximately 83% caught in 2010 was discarded.

2012 position : UK share zero tonnes
Last Year : 110 tonnes
Landed into
Scotland in 2010 : 114 tonnes
Value for 2010 : £225,000

Biology

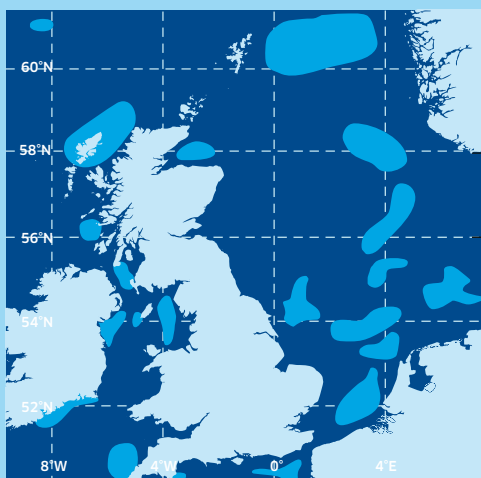
Cod are distributed throughout the west coast but occur mainly in the northern area. Tagging experiments have shown that cod from this region inter-mix with those in IVa, west of Shetland. In contrast, further south in areas such as the Clyde, cod appear to be largely resident all year round.

Many cod reach maturity by two years old and by the time they reach four years, all cod are mature. An average three year old female can produce around four million eggs in a season. Spawning on the west coast takes place between January and April with a peak in March and occurs in most offshore areas. The major spawning area

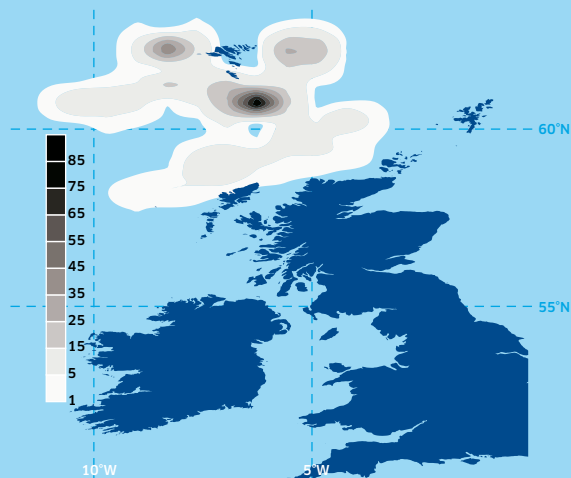
extends offshore from the Outer Hebrides although there are other important areas such as the Clyde. During the spawning season, there is a continuous distribution of cod eggs and larvae around the west and north coasts of Scotland. It is possible that these drifting eggs and larvae could contribute in some small way to the North Sea stocks. Although cod can live for many years, they are big enough to be caught as early as age one. By the time they reach two years old, young cod are fully exploited by the commercial fishery. Many fish are therefore caught before they have the chance to spawn and less than one twentieth of fish aged one will survive to the age of four. This means the stock is particularly vulnerable to an on-going reduction of the spawning component.

Young cod produced in springtime live in the upper water layers until about July before adopting the demersal way of life. They grow quickly and can reach 20cm after one year, 50cm after two years and 80cm by the time they are four years old. On the west coast, juvenile cod during the first year of life are often found close inshore or around the entrances to sea lochs. As they grow older they move offshore, although they appear to recruit to nearby adult areas.

Cod are active feeders and around three quarters of the food of all cod consists of fish and crustaceans. Unusual food items are sometimes eaten: small birds, stones, coal and the occasional salmon smolt.



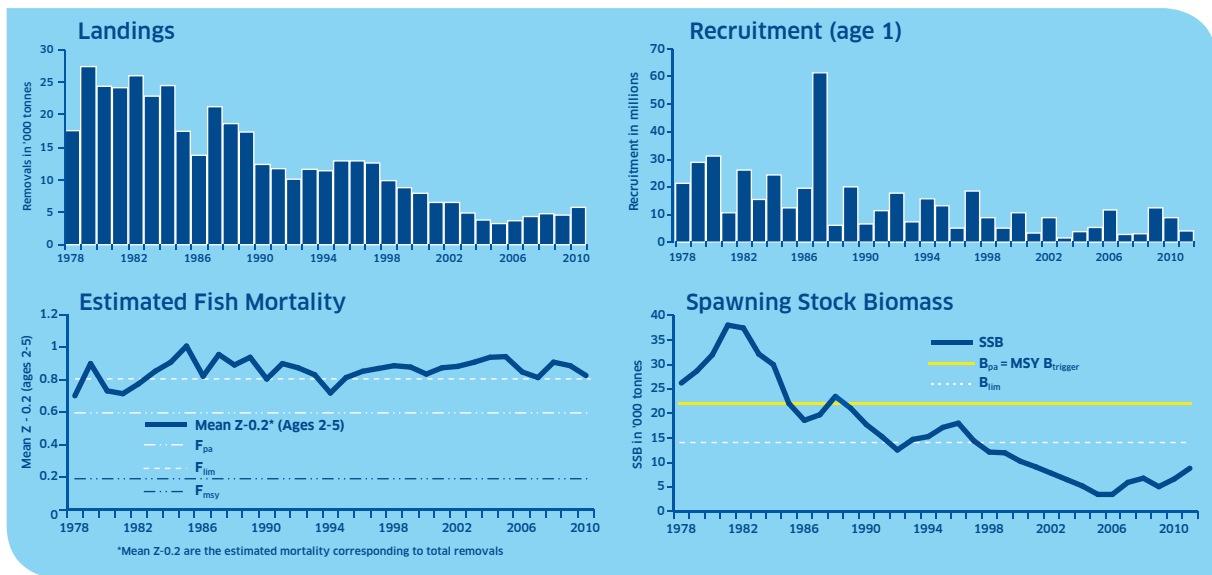
SPAWNING GROUNDS



2010 DISTRIBUTION OF LANDINGS BY SCOTTISH VESSELS (TONNES)

// ICES ADVICE ON MANAGEMENT

Information Source: ICES advice 2011 (<http://www.ices.dk/committe/acom/comwork/report/2011/2011/cod-scow.pdf>). Quoted text in italics.



MSY and precautionary approach reference points

	Type	Value
MSY Approach	$MSY B_{trigger}$	22,000 t
	F_{msy}	0.19
Precautionary Approach	B_{lim}	14,000 t
	B_{pa}	22,000 t
	F_{lim}	0.8
	F_{pa}	0.6

State of stock and advice

- Total mortality (**Z**) in 2010 was estimated to be high (1.024) and cannot be accurately partitioned into fishing mortality (**F**) and natural mortality (**M**).
- Spawning stock biomass for 2011 was estimated to be just over 8,700 tonnes.
- Fishing mortality cannot be determined in relation to any of the reference points. The stock biomass is well below both the Precautionary approach reference limit (B_{lim}) and the level set for achieving maximum sustainable yield ($MSY B_{trigger}$).
- Due to the decline of the spawning stock biomass to very low levels only a zero catch of cod would be compatible with the precautionary approach.
- Fishing advice following the MSY approach calls for catches (mainly discards) to be reduced to the lowest possible level.

The stock is suffering impaired recruitment. SSB is very low. It is necessary to reduce all sources of fishing mortality to recover the stock above B_{pa} as quickly as possible. Management measures taken thus far have not recovered the stock. The 2008 year class is estimated to be more abundant and consequently additional measures (such as real-time closures) to protect it are essential to ensure that it contributes to the rebuilding of the stock.

Following the management plan would give a TAC of less than 137 tonnes in 2012. This could be made lower at the Council's discretion if advised that the stock is failing to recover properly. As it is not possible to assess unaccounted mortality accurately, ICES cannot yet evaluate if the management plan is in accordance with the precautionary approach.

Given the low SSB and low recruitments in recent years, it is not possible to identify any non-zero catch which would be compatible with the precautionary approach. Bycatches, including discards of cod in all fisheries in Division VIa, should be reduced to the lowest possible level.

Management outcomes for 2012

At the December 2011 meeting in Brussels, the Council of Ministers decided that the international Total Allowable Catch for west of Scotland cod should be zero Tonnes with a consequent UK quota for 2012 of zero tonnes. A 1.5% bycatch allowance has however been introduced for EU fleets fishing this stock.

This quota decision was reached in response to the recommendation that only catches reduced to the lowest possible levels are compatible with the MSY and precautionary approaches and in light of difficulties in separating fishing mortality from natural mortality.

The UK interpretation of permissible effort 'buy back' under the Conservation Credits Scheme (effort levels can be reinstated up to the level of the baseline established at the start of the scheme) was upheld. In accordance with the cod LTMP a 25% cut in effort (before buy back) from the level in 2011 was enforced. To justify existing and future effort buy back, the UK is committed to the introduction of highly selective gears in both finfish and *Nephrops* targeted fleets. For the West of Scotland the UK also committed to introducing spatial measures to separate catches of cod and other gadoids from 1st January 2012.

// WHITING STOCKS — NORTH SEA

Whiting (*Merlangius merlangus*) is caught all year round, mainly in mixed demersal fisheries with some bycatch taken in the industrial fisheries. It's found throughout the North Sea, but is known to occur exclusively in some localised areas. Discarding of this species is still quite high.

2012 position : UK share 10,539 tonnes
Last Year : 8,933 tonnes
Landed into
Scotland in 2010 : 6,291 tonnes
Value for 2010 : £8 million

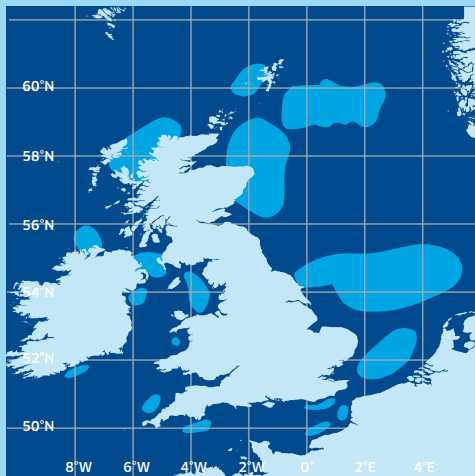
Biology

Whiting is one of the most numerous and widespread species found in the North Sea. High numbers of immature fish occur off the Scottish coast, in the German Bight and along the coast of the Netherlands. Tagging experiments, and the use of a number of fish parasites as markers, show that the whiting found to the north and south of the Dogger Bank form two virtually separate populations. It is also likely that the whiting in the northern North Sea may contain populations including 'inshore' and 'offshore' groups.

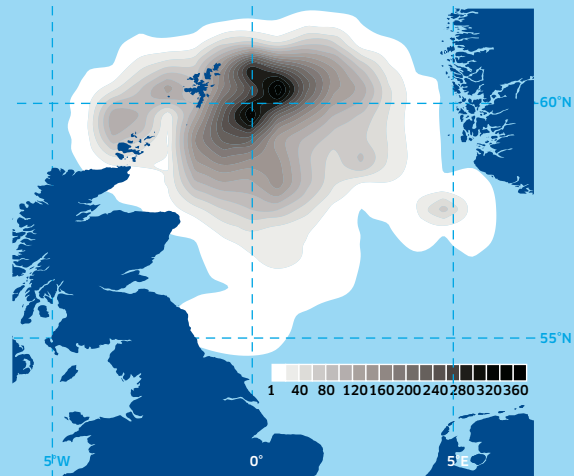
At four years old, a single female fish of reasonable size produces more than 400,000 eggs. By two years old, however, most whiting are mature and able to spawn. The spawning season lasts from late January until June. The spawning season of an individual female lasts at least ten weeks, during which time she releases many batches of eggs.

Like many other fish, whiting spend their first few months of life in the upper water layers before moving to the seabed. They grow very quickly for the first year, after which the growth rate becomes much slower. There are large differences between the growth rates of individual fish and a 30 cm fish can be as young as one year or as old as six. The whiting in the northern North Sea usually grow faster than their more southern counterparts.

Adult whiting feed mainly on juvenile fish and crustaceans (shrimps and crabs). The exact composition of the diet depends on the size of the fish, the area and the time of the year. In the North Sea, whiting is one of the main predators of other commercially important species of fish. Norway pout, sandeel, haddock, cod and even whiting themselves are frequently eaten. It has been estimated that each year the North Sea whiting population consumes several hundred thousand tonnes of these species.



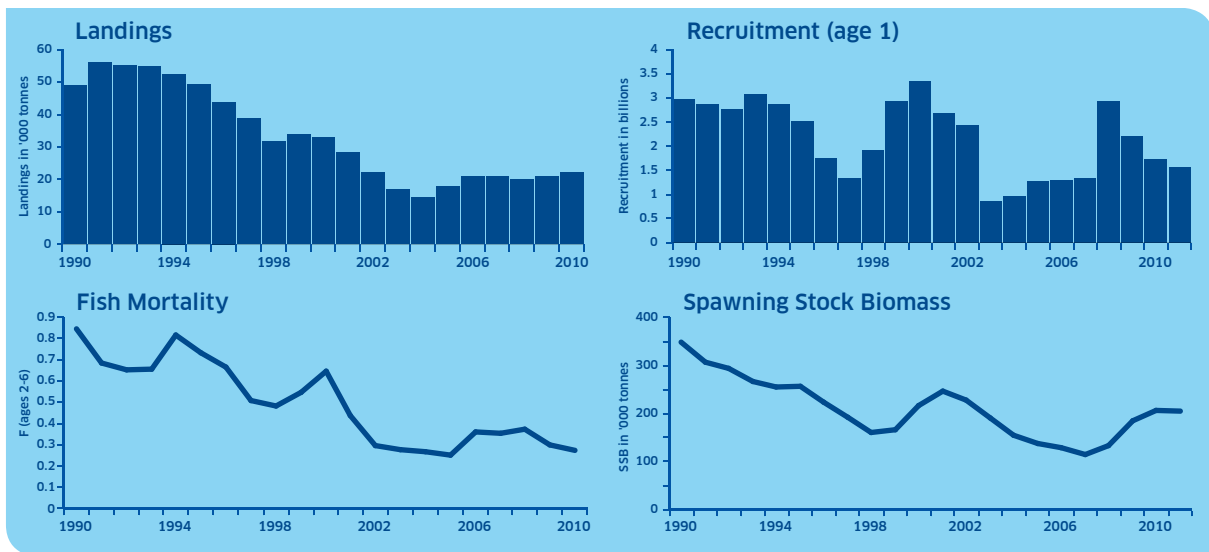
SPAWNING GROUNDS



2010 DISTRIBUTION OF LANDINGS BY SCOTTISH VESSELS (TONNES)

// ICES ADVICE ON MANAGEMENT

Information Source: ICES advice 2011 (<http://www.ices.dk/committe/acom/comwork/report/2011/2011/whg-47d.pdf>). Quoted text in italics.



MSY and precautionary approach reference points

	Type	Value
Management Plan	SSB_{MP}	Undefined
	F_{MP}	0.3
MSY Approach	$MSY B_{trigger}$	Undefined
	F_{msy}	Undefined
Precautionary Approach	B_{lim}	Undefined
	B_{pa}	Undefined
	F_{lim}	Undefined
	F_{pa}	Undefined

State of stock and advice

- Fishing mortality in 2010 was estimated to be 0.27: this means that approximately 24%, by number, of all fish aged between 2 and 6 years were caught.
- Spawning stock biomass in 2011 was estimated to be approximately 205,000 tonnes.
- Fishing mortality and biomass cannot be determined in relation to the precautionary approach, as reference points have not been defined for this stock
- The advice is in accordance with the EU-Norway interim management plan, recommending a human consumption TAC in 2012 of 21,300 tonnes for Subarea IV and Division VIIId.

ICES considers that maintaining the level of fishing mortality at 0.3 would be consistent with long-term stability as long as recruitment is not poor. The EU and Norway adopted this level of fishing mortality for the interim management of the stock for 2011. ICES are in the process of developing and evaluating the management plan.

There are no reference points to give advice on TACs for the MSY or precautionary approaches.

Whiting abundance estimations from surveys suggest that the northern component is declining, whereas the southern component is increasing or stable. The increase in the southern component is broadly in line with the industry's perception of the stock. However, their perception of increasing abundance of whiting in the northern North Sea is at odds with the evidence gathered from the surveys.

Management outcomes for 2012

At the December 2011 meeting in Brussels, the Council of Ministers decided that the EU Total Allowable Catch for North Sea (IV and IIa) whiting should be 15,750 tonnes. The UK quota for 2012 was set at 10,539 tonnes.

This quota decision reached was in line with the scientific advice based on an interim EU Norway management plan. Hague preference was invoked which adjusted the final outcome.

// WHITING STOCKS — WEST OF SCOTLAND

Whiting (*Merlangius merlangus*) has not been a particularly valuable species and is primarily taken as a bycatch with other species. They are mainly caught by trawlers using gear with mesh size between 80 mm and 120 mm. Discarding of this stock remains high, particularly within the *Nephrops* fishery.

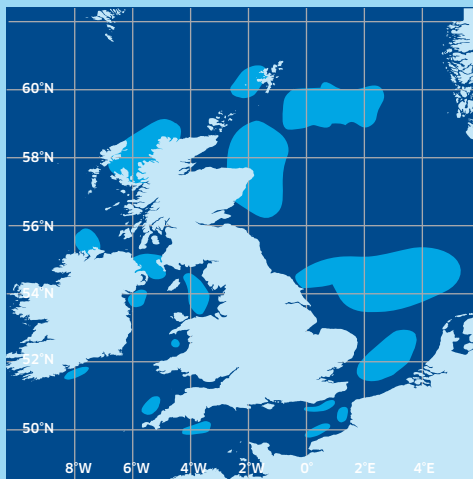
2012 position : UK share 176 tonnes
 Last Year : 185 tonnes
 Landed into
 Scotland in 2010 : 245 tonnes
 Value for 2010 : £270,000

Biology

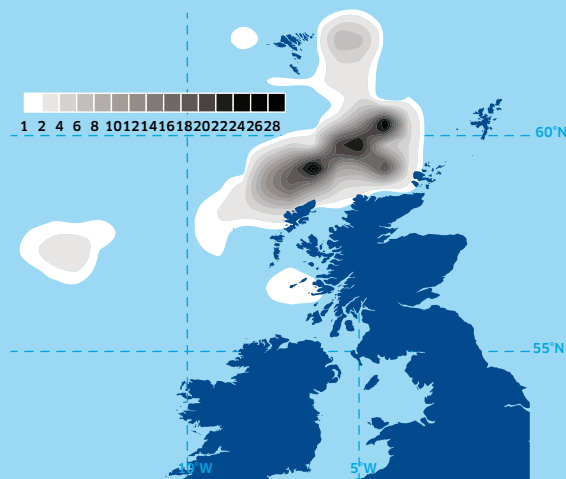
Whiting is widely distributed throughout the west coast of Scotland and high numbers of immature fish can be found in most sea lochs and inshore areas. The offshore stock is composed of older and larger fish which are recruited from the inshore shoals. Tagging experiments, and the use of fish parasites as markers, show that the whiting found to the south of 56°N and to the west of Ireland are separate from those in the Minches, the Clyde and the Irish Sea. The whiting population that overwinters in the Stanton Bank area moves to the Irish coast and the Clyde to spawn in spring. Some individuals may even move to the west of the Hebrides. There is no evidence to suggest movement between the west coast and the North Sea grounds.

Unlike some species, whiting do not form distinct spawning shoals, and both ripe and immature fish are often found together. As the latitude increases spawning of whiting occurs progressively later. This is closely associated with temperature changes, but spawning activity generally peaks in springtime, just as sea temperatures begin to rise. On the west coast of Scotland whiting spawn between January and June. Within this period, the spawning season of an individual female lasts around fourteen weeks, during which time she releases many batches of eggs. At two years old most whiting are mature and able to spawn. By the time it reaches four years old, a single female fish of reasonable size can produce more than 400,000 eggs. Like many other fish, whiting spend their first few months of life in the upper water layers before moving to the seabed. Male and female whiting grow very quickly reaching around 19 cm in their first year. After this the growth rate becomes much slower. There are large differences between the growth rates of individual fish and a 30cm fish can be as young as one year or as old as six.

Whiting are active predators. Juvenile fish eat mainly crustaceans (shrimps and crabs) but as whiting grow, the amount of fish in their diet increases. The exact composition of the diet depends on the size of the fish, the area and the time of the year. Whiting is one of the main predators of other commercially important species of fish. Norway pout, sandeels, haddock, cod and even whiting themselves are frequently eaten. It has been estimated that each year the whiting population consumes several hundred thousand tonnes of these species.



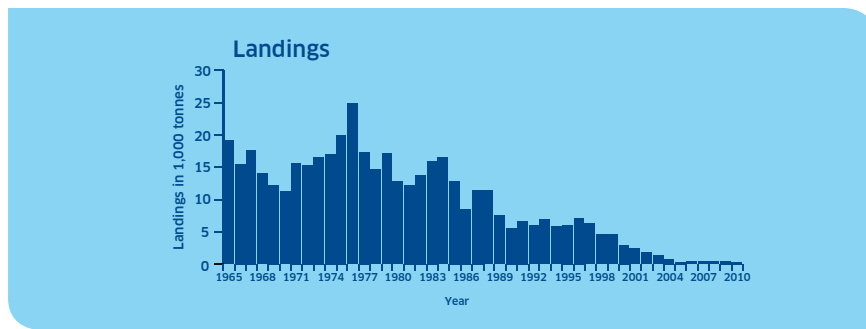
SPAWNING GROUNDS



2010 DISTRIBUTION OF LANDINGS BY SCOTTISH VESSELS (TONNES)

// ICES ADVICE ON MANAGEMENT

Information Source: ICES advice 2011 (<http://www.ices.dk/committe/acom/comwork/report/2011/2011/whg-scov.pdf>). Quoted text in italics.



MSY and precautionary approach Reference Points

	Type	Value
MSY Approach	MSY $B_{trigger}$	Undefined
	F_{MSY}	Undefined
Precautionary Approach	B_{lim}	16,000t
	B_{pa}	22,000t
	F_{lim}	1.0
	F_{pa}	0.6

State of stock and advice

- Fishing mortality is uncertain. But estimates show it to have declined since 2005.
- The spawning stock biomass for 2011 is uncertain. But is estimated to be very low, although there are indications that recruitment increased in 2010.
- Fishing mortality and biomass cannot be determined with regard to either the Precautionary Approach or the transition to MSY Approach.
- The advice is based on the Precautionary Approach recommending that catches in 2012 should be reduced and that the selection pattern used by the *Nephrops* fleet be improved.

There is currently no specific management plan for this stock.

No reliable assessment can be presented for this stock. The main cause of this is due to historic uncertainties in the reported landings. However, based on the recent decline in trends of fishing

mortality and the increased abundance of the 2009 year class, the stock would be expected to increase if the 2009 year class does not continue to be discarded at the rate observed in 2010.

*There are strong indications that management control is not effective in limiting the catch. The proportion of fish discarded is very high and appears to have increased in recent years. More than half of the annual catch weight comprises undersized or low-value whiting which are discarded. 83% of these discards come from the *Nephrops* fishery. Measures to reduce discards and to improve the exploitation pattern would be beneficial to the stock and to the fishery, particularly when there are indications that the 2009 year class is relatively strong. Such measures should include the adoption of a sorting grid as well as appropriately located square-meshed panels.*

Management outcomes for 2012

At the December 2011 meeting in Brussels, the Council of Ministers decided that the international Total Allowable Catch for west of Scotland (VI, EC waters of Vb and international waters of XII and XIV) whiting should be 307 tonnes. The UK quota for 2012 was set at 176 tonnes.

This quota decision was in line with the ICES advice to reduce catches.

// SAI THE STOCKS

Saithe (*Pollachius virens*) is mainly taken by demersal trawl as part of a directed fishery along the Northern Shelf edge and Norwegian Trench. Saithe are also taken as part of the mixed demersal fishery. They are, by weight, the second most landed roundfish species caught by Scottish fishermen.

2012 position : UK share 9,472 tonnes
Last Year : 10,650 tonnes
Landed into
Scotland in 2010 : 13,519 tonnes
Value for 2010 : £12.3 million

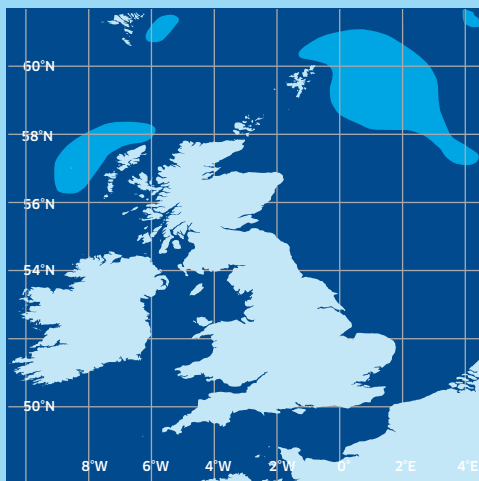
Biology

Adult saithe can be caught in almost any sea area but occur mainly around the 200m depth contour. In late summer and autumn young saithe are found in large numbers within Scottish and Norwegian coastal waters, usually on grounds which are unsuitable for commercial fishing. The adult stock can occur in dense

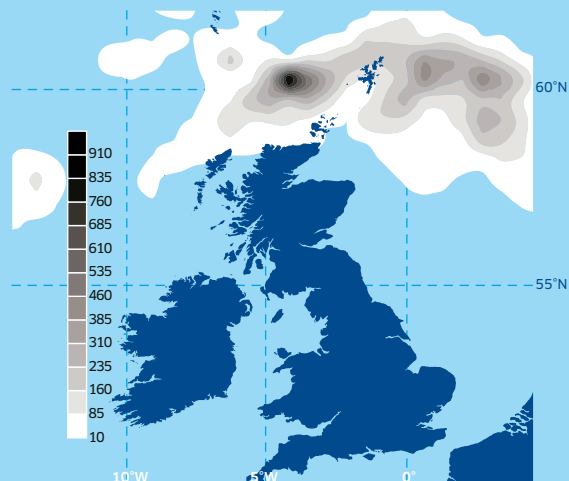
shoals which move around the water column and are often caught hundreds of metres above the seabed.

Saithe reach maturity between the ages of four and six years. A medium sized adult female can produce about 2.5 million eggs during a spawning season. Spawning takes place between January and April near to the edge of the continental shelf to the north and west of the Outer Hebrides. Initially the young fish live near to the surface but by mid-summer they can be found close inshore, in bays and harbours. In their second year they live along the shoreline before eventually moving to deeper water. This offshore migration usually occurs in springtime. Saithe grow quickly, averaging around 15cm per year for the first three years and 10cm for the next three, reaching 100cm by the time they are eleven years old.

Saithe are active predators, feeding on the bottom and in mid-water. By weight, fish prey dominate their diet at all times of the year. Herring, Norway pout and sandeel are the main fish species eaten.



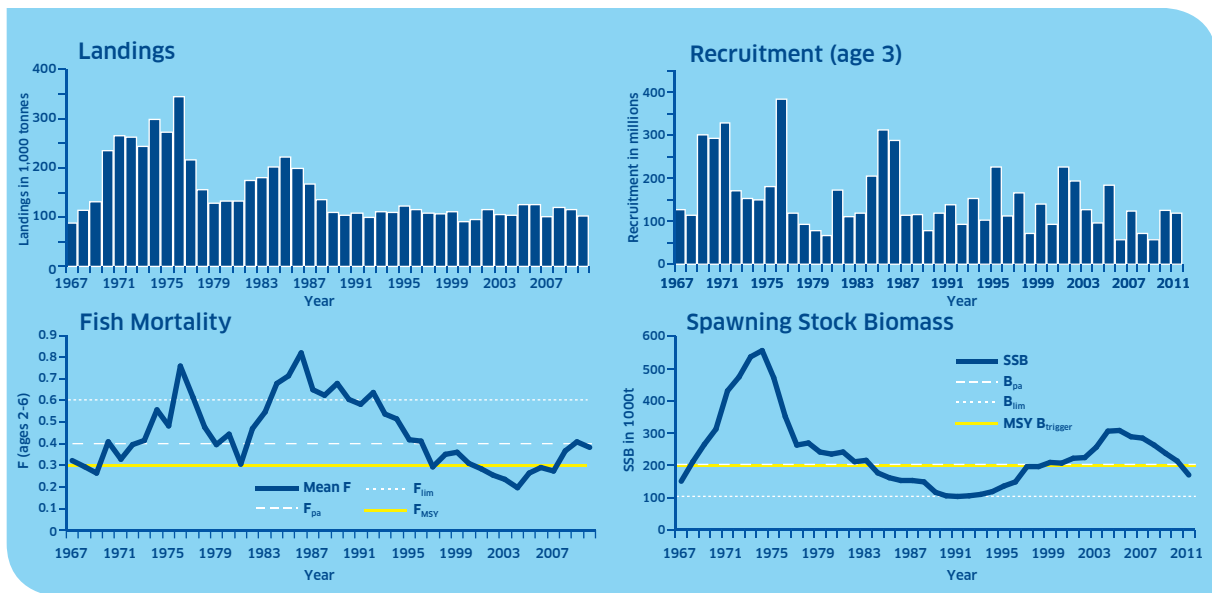
SPAWNING GROUNDS



2010 DISTRIBUTION OF LANDINGS BY SCOTTISH VESSELS (TONNES)

// ICES ADVICE ON MANAGEMENT

Information Source: ICES advice 2011 (<http://www.ices.dk/committe/acom/comwork/report/2011/2011/sai-3a46.pdf>). Quoted text in italics.



MSY and precautionary approach reference points

	Type	Value
Management Plan	SSB _{MP}	200,000 t
	F _{MP}	0.3
MSY Approach	MSY B _{trigger}	200,000 t
	F _{msy}	0.3
Precautionary Approach	B _{lim}	106,000t
	B _{pa}	200,000t
	F _{lim}	0.6
	F _{pa}	0.4

constraint imposed, resulting in an advised TAC of 87,550 tonnes in 2012 for the whole assessment area.

There has been a southern shift in geographical distribution in fishing pattern, at least for the German fleet. This is probably due to EU fleets coming under the effort regime of the EU cod management plan, and may shift the distribution of catches toward younger fish. Due to these changes in fishery distribution and stock productivity (lower growth and recruitment) a re-evaluation of the management plan for saithe stocks is needed. The re-evaluation is envisaged for 2012.

State of stock and advice

- Fishing mortality, F , has generally increased since 2004 and is currently just below F_{pa} .
- The status of the stock has deteriorated in the last few years. The spawning stock is estimated to have been above B_{pa} from 2001–2008 but has since declined to below B_{pa} .
- Fishing mortality and biomass are both below their precautionary limits. However fishing mortality is above the level which is consistent with achieving maximum sustainable yield ($F_{2010} < F_{MSY}$).
- This year's advice is in accordance with the EU-Norway management plan, with the 15% TAC

Management outcomes for 2012

At the December 2011 meeting in Brussels, the Council of Ministers decided that the international Total Allowable Catch for North Sea and west of Scotland saithe should be 87,550 tonnes. The UK quota for 2012 was set at 9,472 tonnes.

This quota decision was reached in accordance with ICES advice and the saithe long term management plan.

// MONKFISH STOCKS

Monkfish (*Lophius piscatorius* and *Lophius budegassa*) also known as anglerfish.

Although, only fourth by weight, they were the second most valuable fish species landed into Scotland in 2010. It's caught mainly by bottom trawl gear in the northern North Sea, to the north and west of Scotland close to the shelf edge.

2012 position : UK share 9,319 tonnes
 Last Year : 9,794 tonnes
 Landed into
 Scotland in 2010 : 8,209 tonnes
 Value for 2010 : £28 million

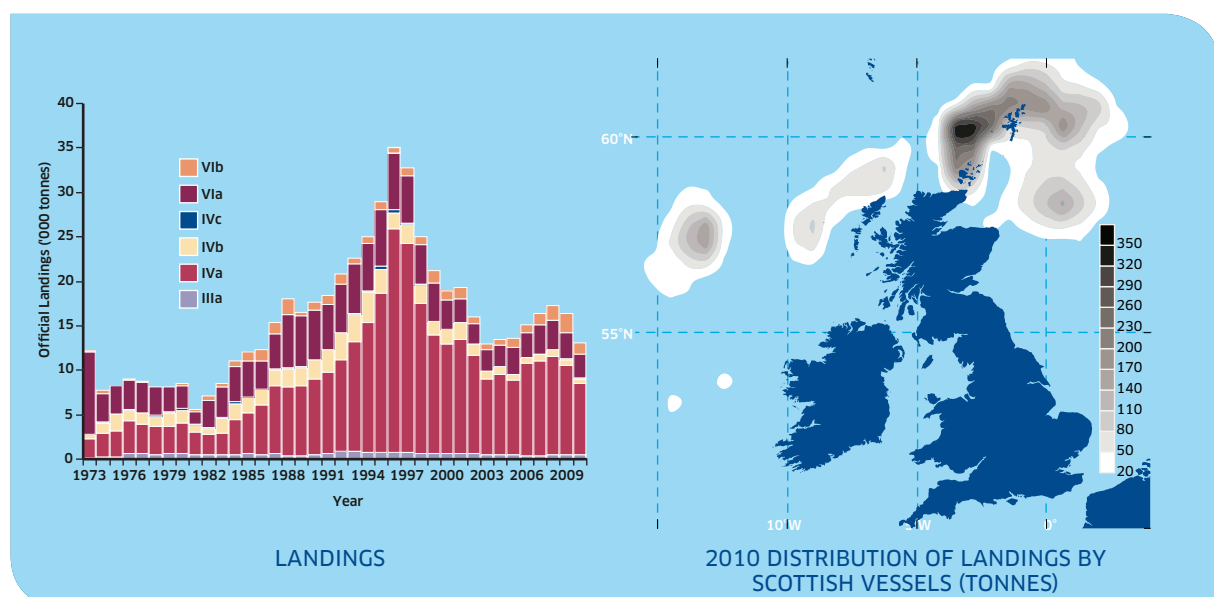
Biology

There are two species of anglerfish, also called monkfish, in Scottish waters. The black-bellied monkfish, *Lophius budegassa*, is much less common than the 'white' monkfish, *Lophius piscatorius*. The basic biology of the two species is very similar.

Monkfish occur in an unusually wide range of depths, extending from very shallow inshore waters down to at least 1,100m. Small monkfish can be caught over most of the northern North Sea and west coast grounds, down to about 150m. Large fish, the potential spawners, used to be found at all depths, including inshore waters, but are now scarce in water shallower than 100-150 m.

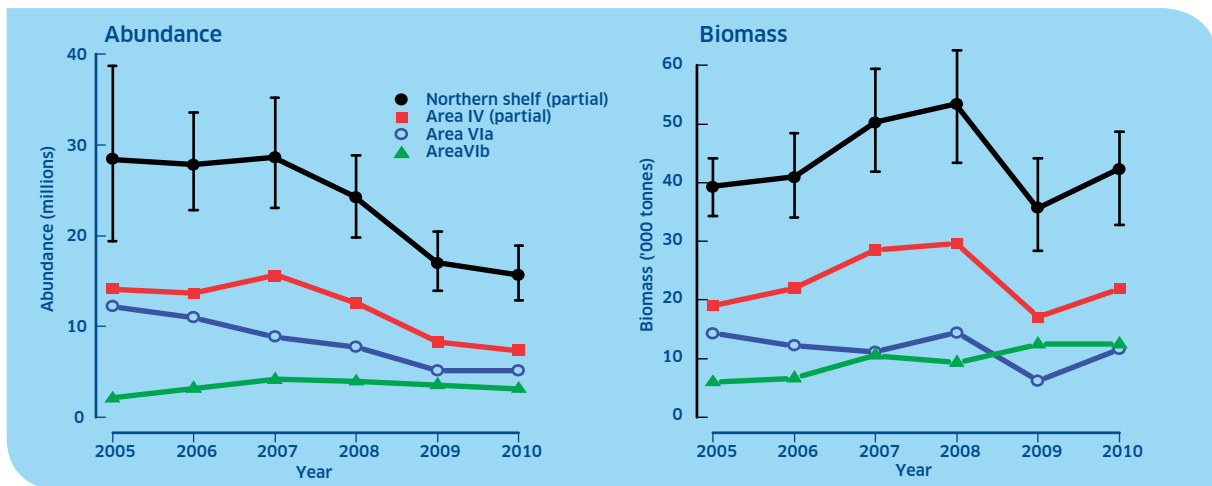
Spawning takes place mainly during the first six months of the year and is believed to occur in relatively deep water. Although monkfish have a long spawning season, each female probably produces only one batch of eggs, unlike cod, haddock and whiting, which spawn many times during a single spawning season. Female monkfish only begin to reach maturity around the age of seven years when they have grown to a length of about 70cm. The majority of females do not spawn until they are even older and are therefore likely to be caught long before they reach full maturity. Monkfish have very unusual spawning habits. The eggs are released in a huge ribbon of jelly that floats to the surface and drifts with the currents. A single egg ribbon can be more than 10 metres long and can contain well over 1 million eggs. After hatching, the young monkfish spend three or four months in mid-water, before settling on the bottom at a size of 5-12cm. During their time in mid-water the young fish may drift a very long way from the spawning grounds.

Monkfish feed mainly on fish, although shellfish and even seabirds are sometimes found in their stomachs. They lie on the seabed and attract prey to within range of their enormous mouths by twitching a 'fishing rod', or lure, that extends from the top of the head, in front of the eyes.



// ICES ADVICE ON MANAGEMENT

Information Source: ICES advice 2011 (<http://www.ices.dk/committe/acom/comwork/report/2011/2011/ang-ivvi.pdf>). Quoted text in italics.



ANGLERFISH (*L. PISCATORIUS* AND *L. BUDEGASSA*). ESTIMATES OF TOTAL ABUNDANCE AND BIOMASS FROM THE SCOTTISH AND IRISH ANGLERFISH INDUSTRY/SCIENCE SURVEY, FOR NORTHERN SHELF (black filled circles with 95% confidence limits), WITH BREAKDOWN BY AREA: ICES SUBAREA IV (red filled squares), DIVISION VIa (blue open circles) AND DIVISION VIb (green filled triangles).

MSY and precautionary approach reference points

	Type	Value
MSY Approach	MSY $B_{trigger}$	Not defined
	F_{msy}	Not defined
Precautionary Approach	B_{lim}	Not defined
	B_{pa}	Not defined
	F_{lim}	Not defined
	F_{pa}	Not defined

State of stock and advice

- *No accepted analytical assessment can be presented for this stock.*
- *Recent dedicated anglerfish surveys carried out by Marine Scotland Science in Division IVa and Subarea VI indicate a decline in abundance in 2007- 2009 and stable biomass in recent years.*
- No reference points have been defined for

these stocks. Previous reference points are no longer considered to be valid. The available information is insufficient to evaluate exploitation status. Therefore, catches should be reduced.

- No management objectives are known to ICES.

Genetic and particle-tracking studies have determined that the monkfish caught in the North Sea and those caught to the west of Scotland come from the same biological stock.

Management outcomes for 2012

At the December 2011 meeting in Brussels, the Council of Ministers decided that the EU Total Allowable Catch for the northern shelf (IV and VI, EC waters of IIa and Vb, and international waters of XII and XIV) monkfish should be 15,844 tonnes. The UK quota for 2012 was set at 9,319 tonnes, this includes 269 tonnes from Norwegian waters of IV.

// 2012 DEEPWATER ECOSYSTEM AND FISHERIES WEST OF SCOTLAND



DEEPWATER CORALS

Introduction

Although 90% of global marine habitat is 'deepwater' (deeper than 500 m), we still know relatively little about life down there. To the northwest of Scotland lies a remarkable deepwater ecosystem. It was not until near the end of the 20th century that dwindling inshore fish stocks and advances in fishing technology made it profitable to target the deeper waters. French and German trawlers were the first to exploit species such as orange roughy and blue ling. Interest and effort increased, but there were signs early on that some deepwater species could not withstand heavy exploitation and were on the verge of collapse. Consequently TACs were introduced in 2003. This forced a number of UK vessels out of the fishery, leaving only a few to prosecute the deepwater. Thus the deepwater's economic significance to the UK fishing industry as a whole was much reduced. The ICES scientific consensus is that many of the deepwater fish stocks have declined and are now outside safe biological limits. Since the introduction of the management plan, TACs and effort generally decreased. Recently data from Marine Scotland's deepwater surveys suggests that over the past decade stocks of some species, such as the grenadiers, have stabilised. Although this suggests that stock declines may have been halted, there is no sign yet of recovery.

This deepwater area contains some of the most extensive and diverse coldwater coral reef ecosystems in the North Atlantic. There is little

doubt that bottom contact fishing operations cause long-lasting damage to such habitats and that they need conservation measures. Marine Scotland is therefore involved in a programme to catalogue, monitor and research Scotland's deepwater ecosystem as well as its fish stocks.

Deepwater environment

The deepwater to the west of Scotland is divided by a massive underwater feature south of the Faroes - the Wyville-Thomson Ridge - which runs southeast to northwest. The area north of this ridge, known as the Faroe-Shetland Channel, is dominated at 500-600m by cold Arctic waters where temperatures can be below 0°C. Relatively few species are able to survive there. South of the ridge is the area known as the Rockall Trough. The water there comes from the Atlantic, and is considerably warmer than that found north of the ridge. Consequently there is a much greater diversity of life, and it is there that the major deepwater fisheries take place. The continental shelf slope descends steeply into the Rockall Trough and runs approximately north-south, descending to around 1200 m in the north and to over 3000 m in the south of the trough. The flat plain of the trough is punctuated by the Anton Dohrn and Hebridean Terrace Seamounts and Rosemary bank. These massive extinct volcanoes rise over 1000 m from the seafloor and are characterised by steep sides, hard substrate, strong currents and enhanced biological productivity.

The shelf slope is home to a diverse assemblage of fish that differs markedly from that found on the adjacent shelf. Very little sunlight penetrates to 500 m and beyond 900 m it is perpetually dark. The temperature



BATHYMETRIC MAP OF UK WATERS

drops from around 9°C at 500 m to just 3°C at 1800 m. Species of commercial interest found on the upper slopes (500 m) include hake, torsk, ling, angler fish, deepwater redfish and greater argentine. At 1000 m the residents include blue ling, roundnose grenadier, orange roughy, black-scabbard fish and a number of deepwater sharks, e.g. the leaf-scale gulper shark. The biomass of fish peaks at 1500 m but at depths beyond this there is little of commercial interest. A host of other weird and wonderful species such as chimaeras, smooth-heads, fang-tooth and cut-throat eels make up the rest of the catch. Well over 200 species have been recorded from the slope.

The ecosystem approach and multidisciplinary surveys

In the last few years deepwater research has become multidisciplinary with the aim of bringing the data together under the framework of the ecosystem approach to marine management. In addition to trawl surveys, underwater TV surveys are undertaken to map the seabed and verify the presence of vulnerable habitats such as coral reefs. This research is now coming to fruition, and published results suggest that over the past 10 years biodiversity of the deepwater slope fish community has not declined or changed significantly. This is encouraging for conservation and suggests current levels of fishing are not having major impacts on biodiversity. With the advent of a network of marine protected areas (MPAs), this is especially pertinent as there are

several deepwater sites, including the seamounts, that are being considered as MPAs.

Scottish interest in the deepwater fishery for 2012

The latest (2010) official information for deepwater species landed into Scotland by UK vessels shows that total landings of roundnose grenadier, blue ling, black scabbardfish, Greenland halibut and Portuguese dogfish amounted to 942 tonnes at a value of approximately £1.7 million. Species like hake, ling and tusk, which are also found in the shallower shelf waters, contributed 8,937 tonnes to the 2009 Scottish fishery at a value of nearly £14.5 million. There were no landings of orange roughy by Scottish vessels in 2010.

For the 2012 fishery, no quota has been set for either orange roughy or the deep-sea sharks in all ICES areas. Since 2007, directed fisheries for deep-sea sharks in the northeast Atlantic have not been permitted. Subsequent TACs have reflected the amount that was allowed to be landed as a by-catch from the deepwater mixed fishery. For 2012, a zero TAC for deep-sea sharks has been set, with no quota for by-catch being available from the start of this year. TACs for other deepwater species have either remained the same as last year or have been reduced, with the exceptions of west of UK blue ling, where there was an increase in quota, and northeast Atlantic ling with a more modest increase.

Species	Area	2012 UK Quota (t)
Black scabbardfish	Community waters of V, VI, VII & XII	124
Roundnose grenadier	Community waters of Vb, VI & VII	123
Blue ling	Community waters of II, IV & V	15
Blue ling	community and international waters of VI & VII	362
Greenland Halibut	Community waters of IIa & IV; community and international waters of Vb & VI	123
Hake	Community waters of IIa & IV	348
Hake	Community waters of VI, VII; community and international waters of Vb; international waters of XII, XIV	5,553
Ling	Community waters of IV	1,869
Ling	Community and international waters of VI, VII, VIII, IX, X, XII, XIV	2,647
Tusk	Community waters of IV	80
Tusk	Community waters of V, VI & VII	83



// NEPHROPS STOCKS — BIOLOGY AND ASSESSMENT

Latin name : *Nephrops norvegicus*
Common names : Norway lobster,
scampi, Dublin Bay
prawn, langoustine

Introduction

The fishery for *Nephrops* in Scottish waters has developed from landings of a few tonnes in the early 1960s to almost 30,000 tonnes in 2010. Landings valued at £79.6 million made *Nephrops* the second most valuable species landed into Scotland in 2010. There are *Nephrops* fisheries on various grounds around Scotland, the largest being the Fladen Ground in the North Sea. Most *Nephrops* are caught by trawlers, but creel fisheries are also important, particularly on the west coast of Scotland. Scotland is allocated the majority of the Total Allowable Catch (TAC) in both the North Sea and on the Scottish west coast and takes over one third of the landings worldwide.

Biology and life cycle

Nephrops distribution is limited by the extent of suitable muddy sediment in which animals construct burrows. There are populations in the North Sea and waters to the west of Scotland, in open waters and sea lochs, at depths ranging from a few metres down to over 500 m on the shelf edge, west of the Hebrides.

Nephrops spend most of their time in burrows, only coming out to feed and look for a mate. They are opportunistic predators, feeding primarily on crustaceans, molluscs and polychaete worms. Female *Nephrops* usually mature at three years of age and reproduce each year thereafter. Mating takes place in early summer. Females spawn in September, and carry eggs under their tails (described as being 'berried') until they hatch in April or May. The larvae develop in the plankton before settling to the seabed six to eight weeks later. Reproductive timing may be slightly delayed in the deeper areas of the Fladen Ground.

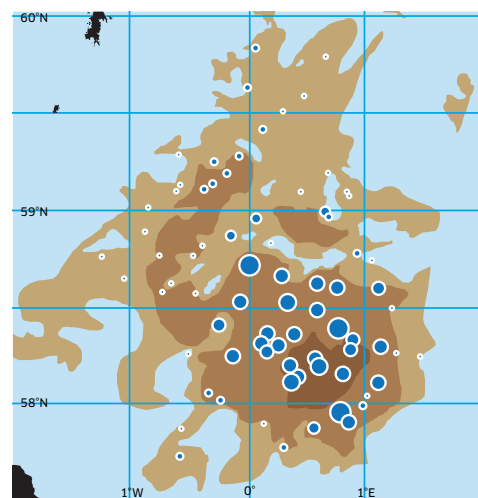
Nephrops in different areas grow at different rates and mature at different sizes. This variation is related to the density of animals and sediment type. On the softest mud, *Nephrops* densities are low, but the animals grow relatively fast and reach a larger maximum size. The largest animals are colloquially referred to as clonkers. On

sandier mud, *Nephrops* density is much higher, but the animals grow relatively slowly and are smaller ('beetles'). In the North Sea there are differences in growth between stocks, while on the west coast there are also differences between areas within the same stock.

Since most *Nephrops* fishing is by trawling, and animals are protected from trawls when in burrows, the emergence patterns affect catch rates. The timing of emergence to feed appears related to light level, and greatest catches are often taken at dawn and dusk, although this may vary with water depth and clarity. As 'berried' females rarely come out of the burrow, they are naturally protected from trawlers. Males dominate trawl catches for most of the year, and are more heavily exploited than females.

Assessments

For the purposes of stock assessment, *Nephrops* around Scotland are split into a number of stocks or 'functional units' (FUs) based on the discrete patches of mud which they inhabit. Unlike fish, *Nephrops* cannot be aged directly and therefore the assessments make use of size composition data from catches, combined with information on stock abundance obtained from underwater television (UWTV) surveys. UWTV cameras are used on research vessel surveys to estimate *Nephrops* burrow density on the seabed. The information gathered provides an index of stock abundance for each FU which is independent of the fishery and burrow emergence patterns. By applying a number of 'correction' factors to the index, an estimate of the absolute abundance of *Nephrops* is obtained.



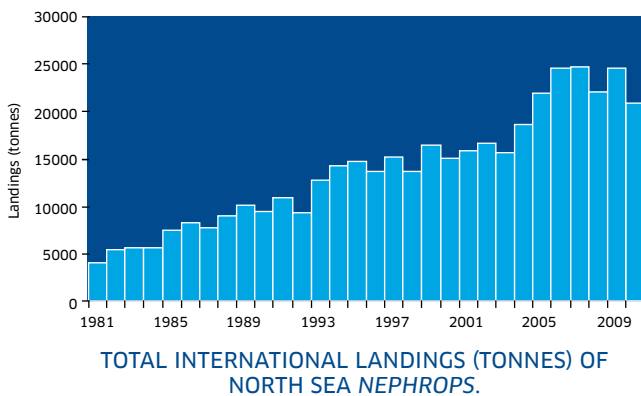
RELATIVE DENSITY OF NEPHROPS BURROWS ON A RECENT UWTV SURVEY OF THE FLADEN GROUND (■ MUDDY SAND, ■ SANDY MUD, ■ SOFT MUD).

// NORTH SEA : ICES ADVICE ON MANAGEMENT

2012 position	:	TAC 21,929 tonnes; UK share 18,994 tonnes
2010 Landings	:	20,800 tonnes
Stock Health	:	Most stocks appear to be stable and fished at around F_{MSY}
Importance	:	Key shellfish species
Location	:	Widespread on muddy grounds
Latest Assessment	:	May 2011

North Sea stocks

In the North Sea, Scottish fishermen exploit *Nephrops* in the **Farn Deeps**, **Firth of Forth**, **Moray Firth**, **Fladen Ground** and to a lesser extent at the Noup and Devil's Hole. Most are caught by trawlers targeting *Nephrops*. In some areas, particularly the Fladen Ground, they are also caught by whitefish trawlers. The Fladen Ground is by far the largest FU and accounts for more than 50 % of the total North Sea landings.



State of the stocks

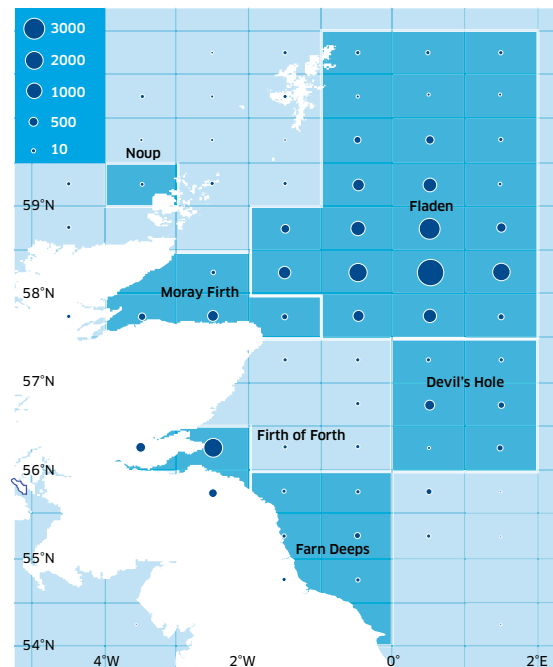
In 2011, ICES conclusions about *Nephrops* stock status were based on trends in the UWTV survey, fishery and catch size composition data.

Farn Deeps: the UWTV survey indicates that the stock status has been fluctuating around $MSY B_{trigger}$ since 2007. Changes in survey methodology in 2007 make comparison with the preceding series difficult.

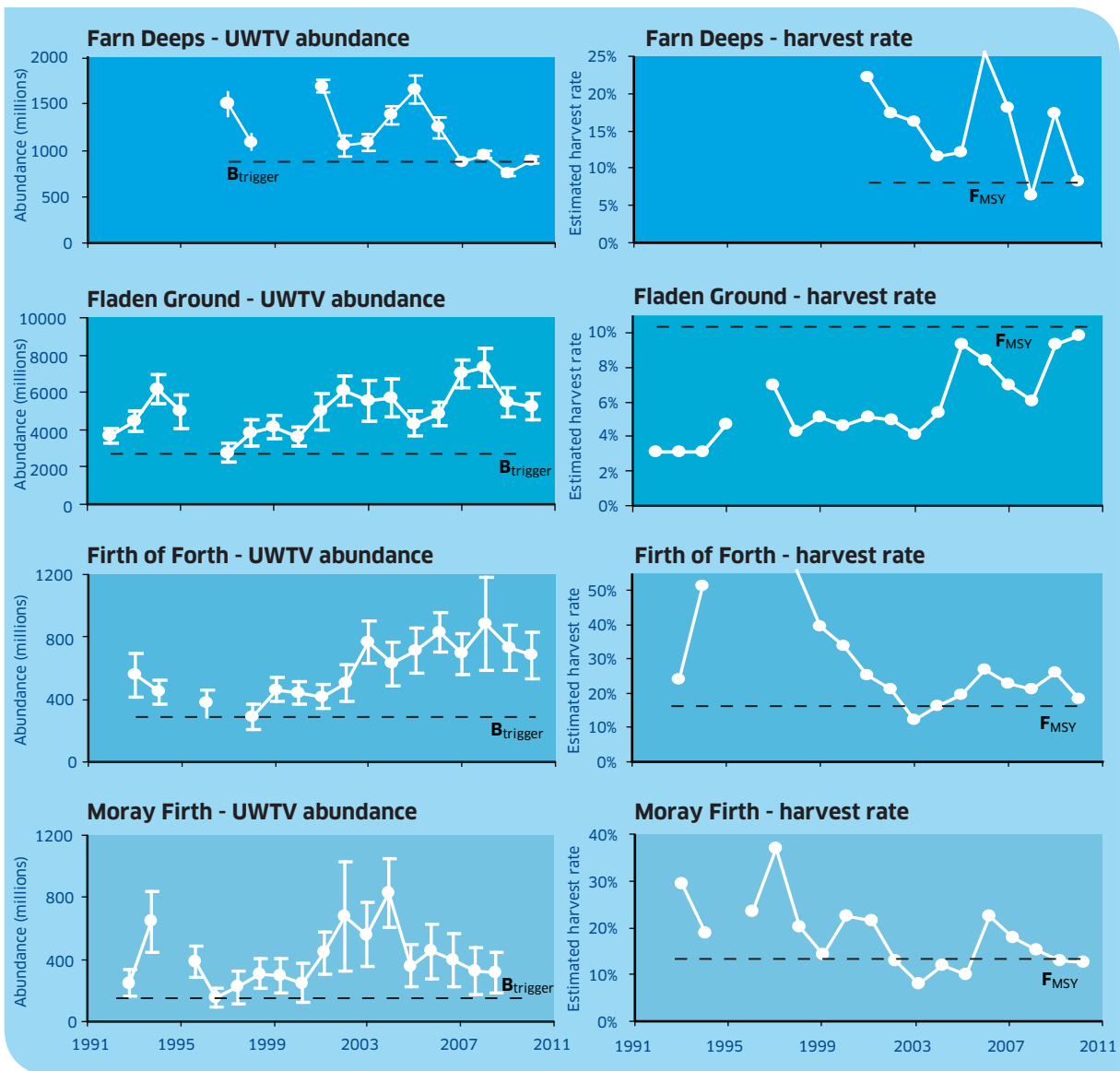
Fladen Ground: the stock remains at a high level, well above $MSY B_{trigger}$. The harvest rate (removals/TV abundance) has been increasing but is still below F_{MSY} .

Firth of Forth: the stock remains at a high level, well above $MSY B_{trigger}$. The harvest rate (removals/TV abundance) remains slightly above F_{MSY} .

Moray Firth: the stock remains above $MSY B_{trigger}$. The harvest rate has declined since 2006 and is now at F_{MSY} .



DISTRIBUTION OF SCOTTISH *NEPHROPS* LANDINGS (TONNES) IN THE NORTH SEA IN 2010 (UK VESSELS INTO SCOTLAND)



Management advice

The ICES advice on future landings is provided on the basis of a fixed proportion ('harvest rate') of the UWTV abundance estimate. ICES advised that this 'harvest rate' should be at a level which is consistent with high long term yield and low risk of depletion of production potential (F_{MSY}). Target harvest rates corresponding to fishing at $F_{0.1}$ to F_{MAX} (proxies for F_{MSY}) were recommended. Where the advice implies a reduction in harvest rate, ICES has advised on the basis of incremental reductions in fishing mortality towards the target (transition to F_{MSY}).

Management action

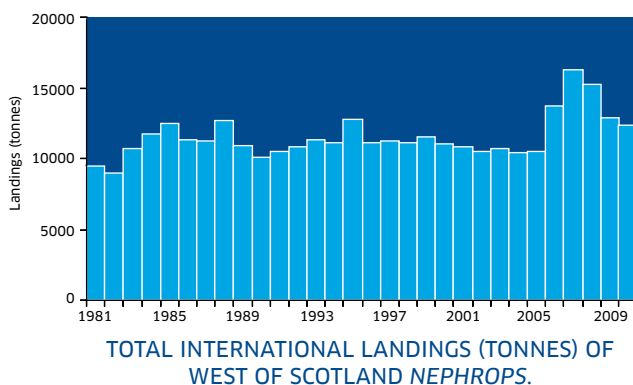
ICES management advice is formulated for *Nephrops* FUs, whereas management has continued to be applied to the larger ICES finfish areas. STECF supports the ICES ACOM advice for management at a smaller scale and has emphasised the need for whitefish by-catch mitigation measures in *Nephrops* fisheries.

// WEST COAST : ICES ADVICE ON MANAGEMENT

2012 position	: TAC 14,091 tonnes; UK share 13,758 tonnes
2010 Landings	: 12, 200 tonnes
Stock Health	: Stocks appear to be stable and fished at around F_{MSY}
Importance	: Key shellfish species
Location	: Widespread on muddy grounds
Latest Assessment	: May 2011

West of Scotland Stocks

On the west coast of Scotland, there are *Nephrops* fisheries in the North Minch, South Minch, the Clyde and to a lesser extent at Stanton Bank and in more offshore areas on the shelf edge. Most of the catch is taken by small inshore trawlers targeting *Nephrops*, but some are caught by larger twin-rig vessels. Creel fishing accounted for 24% of landings in both the North and South Minch in 2010. Creel-caught *Nephrops* are generally larger and in better condition than those caught by trawling. They attract high prices in the live export market and provide an important source of income for small local boats. Creels are used mainly in inshore areas and sea lochs, where access by trawlers may be limited by the seabed or legislation. In some areas both fishing methods are used and gear conflicts sometimes occur.



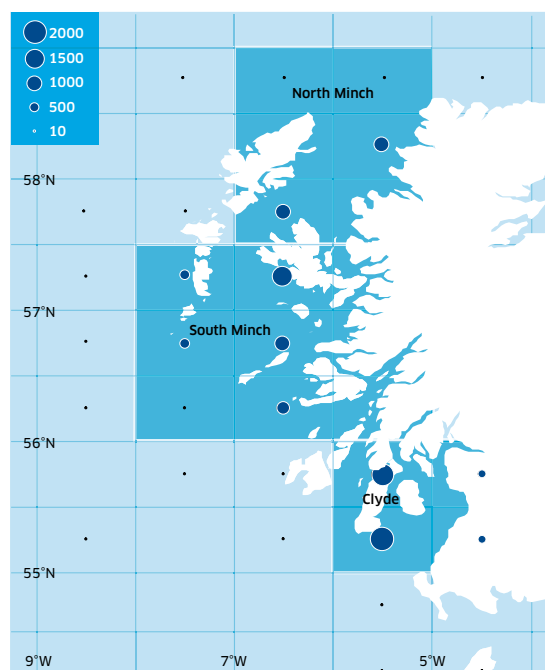
State of stocks

In 2011, ICES conclusions about *Nephrops* stock status were based on trends in the UWTV survey, fishery and catch size composition data.

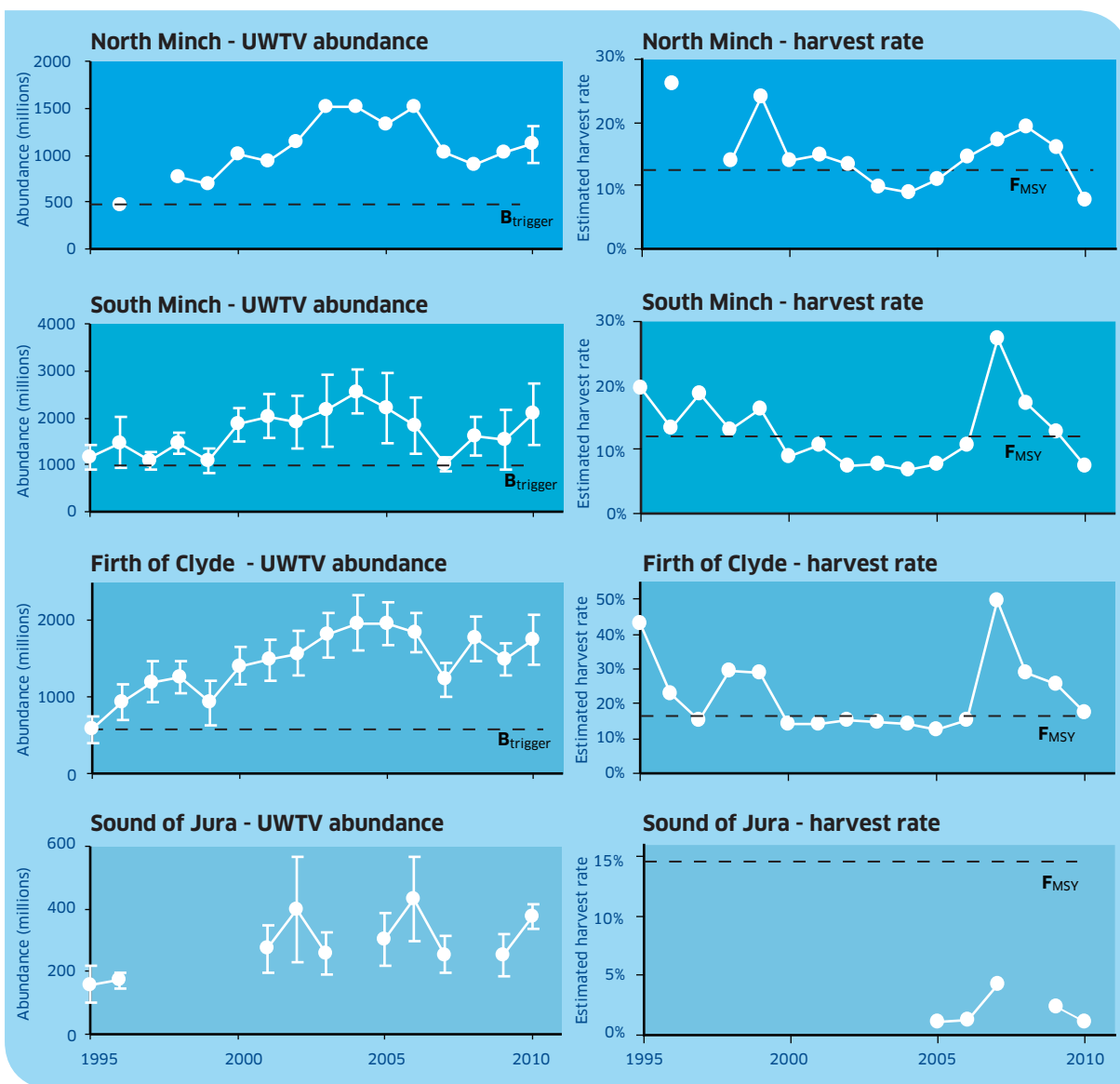
North Minch: The harvest ratio (dead removals/ UWTV abundance) has fluctuated around the F_{MSY} proxy. The stock has been above $MSY B_{trigger}$ for more than 10 years. (Both $MSY B_{trigger}$ and historical abundance estimates were rescaled in 2011 to account for revisions to the estimated area of population distribution based on VMS data).

South Minch: The harvest ratio (dead removals/ UWTV abundance) has fluctuated around the F_{MSY} proxy. The stock is above $MSY B_{trigger}$.

Clyde: Harvest rates in the Firth of Clyde have been above the proposed F_{MSY} proxy since 2007. UWTV abundance remains well above the $B_{trigger}$. Harvest rates in the Sound of Jura have been well below the proposed F_{MSY} proxy in recent years. UWTV abundance remains higher than observed at the start of the series, but the series is too short and patchy to propose an $MSY B_{trigger}$.



DISTRIBUTION OF SCOTTISH WEST COAST NEPHROPS LANDINGS (TONNES) IN 2008 (UK VESSELS INTO SCOTLAND)



Management advice

The ICES advice on future landings is provided on the basis of a fixed proportion ('harvest rate') of the UWTV abundance estimate. ICES advised that this harvest rate should be at a level which is consistent with high long term yield and low risk of depletion of production potential (equivalent to fishing at F_{MSY} . Target harvest rates corresponding to fishing at $F_{0.1}$ to F_{MAX} were recommended (proxies for F_{MSY}). Where the advised harvest rate implies a significant reduction in catch, ICES has advised on the basis of incremental reductions in fishing mortality towards the target (transition to F_{MSY}).

Management action

ICES management advice is formulated for *Nephrops* FUs, whereas management continues to be applied to the larger ICES finfish areas. STECF supports the ICES ACOM advice for management at FU level and has emphasised the need for whitefish by-catch mitigation measures in *Nephrops* fisheries.

// BROWN CRAB

Latin name : *Cancer pagurus*
Common names : Edible crab, Brown

Introduction

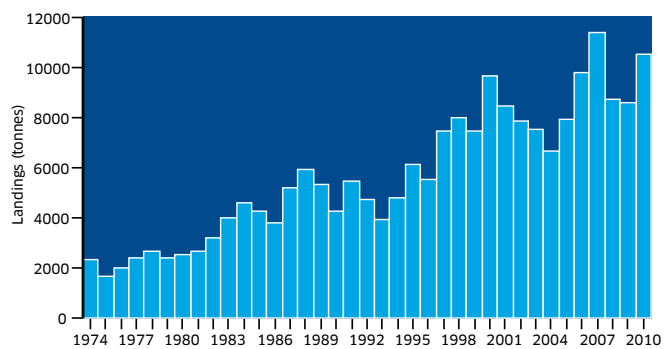
The brown crab fishery is economically a very important fishery for Scotland with total landings in 2010 of around 10,600 tonnes and a value of £13.3 million. The fishery is long established and landings, although variable, have increased significantly over the last thirty years. Previously, most brown crab was caught inshore in mixed species creel fisheries. From the mid 1980s, technological advances allowed the fishery to expand to offshore areas to the west and north of Scotland, which nowadays account for almost a third of total landings. Landings from the five principal brown crab assessment units: the Hebrides, Sule, Papa, South Minch and Orkney, made up 72 % of the total in 2010. The majority of crabs are landed in the third and fourth quarters of the year and a large proportion are exported live to markets in southern Europe.

Biology and life cycle

The brown crab is found all around the Scottish coast from the shallow sub-littoral into offshore waters to depths exceeding 100 m. It inhabits rocky reefs, mixed coarse grounds and soft sediments (muddy sand) particularly on the offshore grounds. Brown crabs eat mainly benthic invertebrates, particularly bivalves, small decapods and barnacles; although their capture in baited traps indicates that they will also scavenge for food. In common with other crustaceans, brown crab grow by casting (moulting) their shell and then hardening a new larger shell. Growth rate varies between areas, and animals will typically reach minimum landing size, (140 mm carapace width CW) at four to six years old. Small animals may moult several times in a year, but at larger sizes growth slows down and the inter-moult period can be as long as four years. Female brown crabs in Scottish waters typically mature between 130-150 mm CW. During courtship the mature female is guarded by a male. Mating takes place post moult while the shell is still soft. Females produce up to three million eggs. Fertilised eggs are carried under the female's

'tail' for up to nine months, over the winter, until they hatch. The larvae are pelagic and drift with water movements until they settle to the seabed as miniature adults (about 2.5 mm in size) in summer or autumn depending on latitude and water temperature. Juvenile crabs are more commonly found in shallow inshore waters.

Adult crabs, especially females, can undertake extensive seasonal migrations (100s km), behaviour thought to be associated with reproduction. Migration of adults and the dispersal of larvae will both influence how connected stocks are. The structure of brown crab populations around Scotland is poorly understood.



LANDINGS (TONNES) OF BROWN CRAB INTO SCOTLAND BY SCOTTISH VESSELS, 1974 TO 2010.

The brown crab fishery is not subject to EU TAC regulations or national quotas although there are EU measures in place to restrict the fishing effort (kW days) of all vessels > 15 m (including creel boats) in ICES Subarea VI. In Scotland, vessels landing brown crabs are required to hold a licence with a shellfish entitlement. Vessels without this entitlement are only allowed to land limited amounts (25 crabs per day). The main regulatory mechanism is a minimum landing size of 140 mm CW to the north of 56°N and 130 mm CW to the south of 56°N (except for the Firth of Forth).

Assessment

Age determination is generally not possible for animals which moult and application of age-structured assessment methods to crustacean stocks is problematic. Length Cohort Analysis (LCA) is the method used for assessing brown crab stocks. It uses official landings and length frequency data collected as part of the Marine Scotland Science market sampling programme.

LCA results are calculated in terms of yield-per-recruit and biomass-per-recruit relative to changes in fishing mortality, providing a framework for evaluation of management measures. Assuming a direct relationship between fishing mortality and effort, generally, lower levels of fishing effort will result in an increase in stock size and a reduction in landings. A higher level of fishing effort will reduce total stock biomass but landings may also fall, as animals are caught before they have had time to grow to a size that would contribute much weight to the yield (growth overfishing). In between these lies F_{MAX} the fishing mortality rate that maximizes yield per recruit. The changes that the LCA predicts are long term (equilibrium). The method does not provide any indication of short-term stock dynamics or recruitment over-fishing. Assessments are performed on a regional basis for males and females separately.

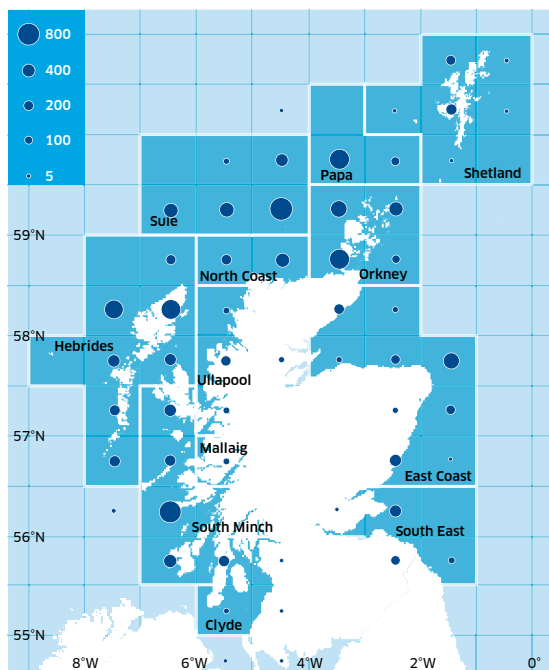
State of the stocks

Results of assessments based on LCAs for the period 2006-2008 for nine of the twelve assessment units, summarising estimates of fishing mortality in relation to the reference

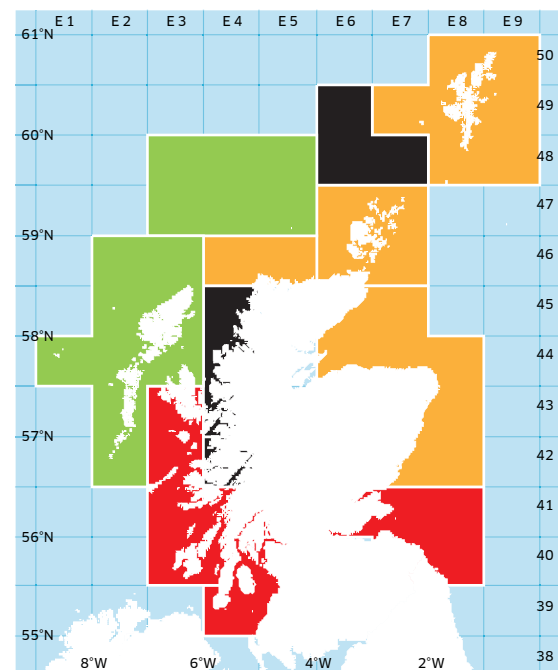
point F_{MAX} are shown on the map. There were insufficient sampling data from the Mallaig, Ullapool and Papa areas to conduct LCAs. Of the assessed areas, the majority were growth overfished to some extent, particularly male crabs. In the areas of major importance for brown crab landings, fishing mortality was estimated to be significantly above F_{MAX} for both males and females in Clyde, South Minch and South East whilst in the Hebrides and Sule, current fishing mortality was approximately F_{MAX} . In Shetland, Orkney, North Coast and East Coast, the fishing mortality for females was close to F_{MAX} while males were fished above F_{MAX} . The stock assessment for brown crab in Scottish waters will be updated in 2012.

Management advice

Overall, assessments for the period 2006-2008 showed that most brown crab assessment units in Scotland were fished close to or above F_{MAX} , which is above the optimum level to achieve the maximum yield per recruit. In many of the assessment units, a higher yield and biomass per recruit in the long term could potentially be obtained by reducing the level of fishing mortality (effort).



CREEL FISHERY ASSESSMENT AREAS AND SCOTTISH BROWN CRAB LANDINGS (TONNES) IN 2010.



CREEL FISHERY ASSESSMENT AREAS AND ESTIMATED FISHING MORTALITY, 2006 -2010.

- Fishing mortality at or around F_{MAX} .
- Fishing mortality significantly above F_{MAX} for either males or females
- Fishing mortality significantly above F_{MAX} for both males and females
- Not assessed

// VELVET CRAB

Latin name : *Necora puber*
Common names : Velvet swimming crab,
devil crab

Introduction

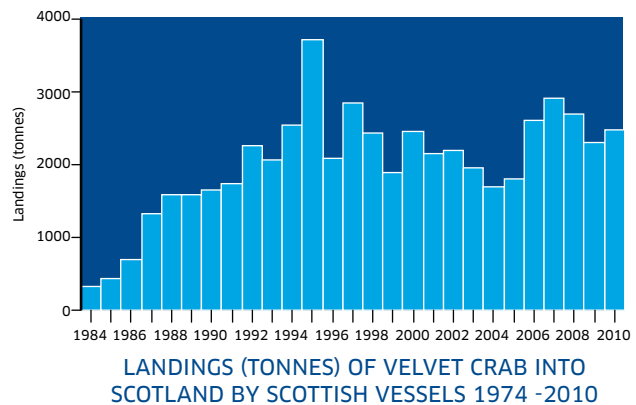
The velvet crab fishery in Scottish waters is a relatively recent development; velvet crabs were once considered a 'pest' species, and only taken in a small scale fishery for a few months in the winter. With the collapse of the Spanish fishery in the early 1980s, the Scottish fishery expanded rapidly to supply southern European markets and became the largest velvet crab fishery in Europe. In 2010, the fishery landed 2,500 tonnes of velvet crab into Scotland with a value of £6.4 million. Velvet crabs are caught in the inshore creel fishery along with lobster and brown crab. Very few fishermen fish solely for 'velvets'. Previously the fishery was associated mainly with the west coast (Hebrides and South Minch assessment units) and Orkney, but since 2002 landings on the east coast of Scotland have increased substantially. It is not clear whether this is due to an increase in the velvet crab population in this area or to more specific targeting of the species. In 2010, the majority of landings came from Orkney, South Minch, Shetland, East Coast, Hebrides and Clyde. Most velvet crabs are landed between July and November.

Biology and life cycle

The velvet crab is a member of the family *Portunidae* (swimming crabs) and is found in waters all around the British Isles. It is a fast moving and aggressive species, most commonly found on rocky substrates down to depths of about 25 m. Velvet crabs feed on both animal and algal material, with brown algae being the dominant item found in gut content analysis.

Females grow more slowly and to a smaller maximum size than males, differences which are likely to be due to reduced growth during the females' egg bearing phase. Growth is highly seasonal and males and females moult at different times of the year; the main moult for males is between April and July whereas females moult between May and

August. Velvet crabs typically live for four to six years and recruit to the fishery at around age 3 (65 mm carapace width (CW)). They reach maturity at a carapace width of approximately 40 mm (approximately 1.5 years), although size at maturity varies according to location. This variation may be due to differences in water temperature or other factors such as population density, genetic makeup and fishing pressure. Mating occurs after females have moulted, when the shell is still soft. Studies carried out in Orkney and Shetland provide fecundity estimates of between 5,000 and 278,000 eggs per female. In contrast to brown crabs, there is no evidence that velvet crabs undertake extensive migrations. Their movements are thought to be restricted to a few hundred metres.



Management advice

The velvet crab fishery is not subject to EU TAC regulations or national quotas. In Scotland, vessels landing velvet crabs are required to hold a licence with a shellfish entitlement. Vessels without this entitlement are only allowed to land limited amounts (25 crabs per day). The main regulatory mechanism is a minimum landing size of 65 mm CW in all areas except Shetland (70 mm CW, under the Shetland Regulating Order)

Assessment

Age determination is generally not possible for animals which moult, and application of age-structured assessment methods to crustacean stocks is problematic. Length Cohort Analysis (LCA) is the method used for assessing velvet crab stocks. It uses official landings and length frequency data collected as part of the Marine Scotland Science market sampling programme¹. LCA results are calculated in terms of yield-

per-recruit and biomass-per-recruit relative to changes in fishing mortality, providing a framework for evaluation of management measures. Assuming a direct relationship between fishing mortality and effort, generally, lower levels of fishing effort will result in an increase in stock size and a reduction in landings. A higher level of fishing effort will reduce total stock biomass but landings may also fall, as animals are caught before they have had time to grow to a size that would contribute much weight to the yield (growth overfishing). In between these lies F_{MAX} , the fishing mortality rate that maximizes yield per recruit. The changes that the LCA predicts are long term (equilibrium). The method does not provide any indication of short-term stock dynamics or recruitment over-fishing. Assessments are performed on a regional basis for males and females separately.

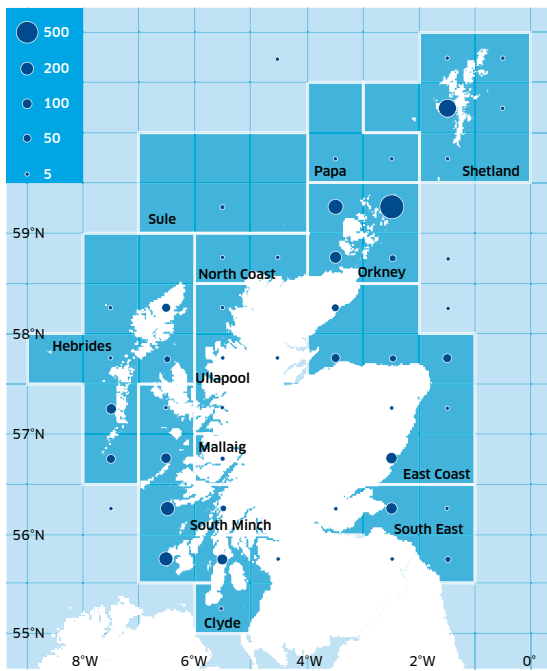
State of the stocks

Results of assessments based on LCAs for the period 2006-2008 for seven of the twelve

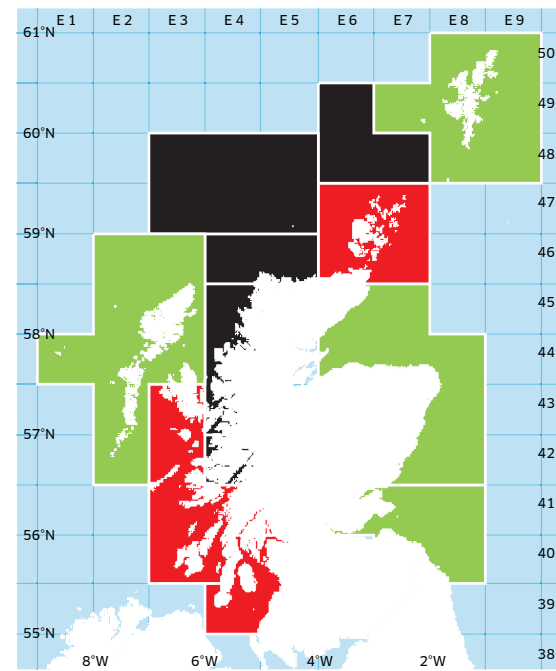
assessment units, summarising estimates of fishing mortality in relation to the reference point F_{MAX} , are shown on the map (below). There were insufficient sampling data from the Mallaig, Ullapool, North Coast, Sule and Papa areas to conduct LCAs. Of the assessed areas, velvet crabs in the Hebrides, Shetland, East Coast, and South East were fished at approximately F_{MAX} whilst both males and females in Clyde, Orkney and South Minch were fished at levels significantly above F_{MAX} . The stock assessment for velvet crab in Scottish waters will be updated in 2012.

Management advice

Overall, assessments for the period 2006-2008 showed that most velvet crab assessment units in Scotland were being fished close to or above F_{MAX} , which is above the optimum level to achieve the maximum yield-per-recruit. In some assessment units, a higher yield and biomass per recruit in the long term could potentially be obtained by reducing the level of fishing mortality (effort).



CREEL FISHERY ASSESSMENT AREAS AND SCOTTISH VELVET CRAB LANDINGS (TONNES) IN 2010.



CREEL FISHERY ASSESSMENT AREAS AND ESTIMATED FISHING MORTALITY, 2006 -2008.

- Fishing mortality at or around F_{MAX} .
- Fishing mortality significantly above F_{MAX} for either males or females
- Fishing mortality significantly above F_{MAX} for both males and females
- Not assessed

¹Size frequency data used in the assessment for the Shetland area were provided by the NAFC Marine Centre with the permission of the Shetland Shellfish Management Organisation.

// LOBSTER

Scientific name : *Hommarus gammarus*
Common names : Clawed lobster

Introduction

The earliest records of lobster fishing in Scotland date back to the 12th century when lobster was caught by hand using 'crooks' and hoop nets. With the introduction of baited traps (creels), exploitation on a more commercial basis developed, and today there are important creel fisheries for the European lobster in many areas around the Scottish coast. Landings by Scottish vessels have increased substantially in recent years, from 290 tonnes in 2001 to about 1,100 tonnes with a value of over £11.7 million in 2010. In recent years, the majority of lobster landings have come from the South East, East Coast, Orkney, Hebrides and South Minch assessment units.

Biology and life cycle

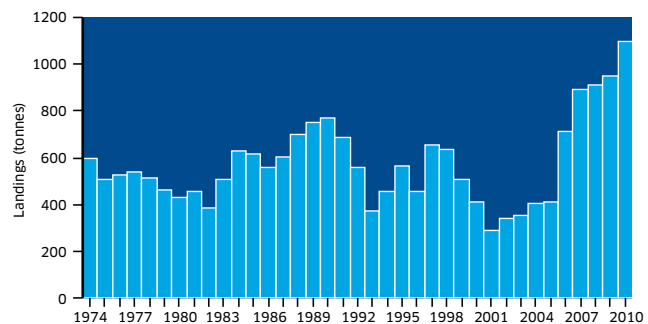
The European lobster is found all around the coast of Scotland, typically on hard ground in relatively shallow waters and on the fringes of kelp beds. The diet of the adults consists mainly of benthic invertebrates such as crabs, molluscs, sea urchins, polychaete worms and starfish, but may also include fish and plants. The majority of lobsters are caught in waters shallower than 30 m but they may be found as deep as 150 m. Substrate and suitable shelter are thought to affect the size and population density, with larger lobsters being found on more exposed grounds. Lobsters do not undertake extensive migrations and will only move a few miles along the shore. Despite this, a recent study on the genetic variation of lobsters reported very low levels of genetic variation amongst lobster populations in Europe.

The growth rate of lobster is highly variable. Individuals recruiting into the fishery at the minimum landing size of 87 mm carapace length (CL) can be anywhere between 4 and 12 years old. In common with other crustaceans, lobster shed their shell (moult) in order to grow. The main moulting period is in June-July. Juveniles moult more frequently and grow faster than older animals. Mating occurs just after moulting while the female's shell is still

soft. Size at maturity in females varies across Scotland; for example, females mature at smaller sizes in the South East than in the Hebrides.

Female lobsters produce between 10 and 15 thousand eggs. Once fertilised the eggs develop internally for up to a year after which they are carried under the 'tail' for 9 to 11 months until they hatch. 'Berried' female lobsters have much reduced feeding and growth rates and low catchability during the egg bearing phase.

Lobsters can grow to a very old age and the potential reproductive life span of a female lobster is in excess of 40 years. Amongst the largest reported lobsters in the UK are a female of 157 mm CL, thought to be about 72 years old, and an 11 lb (5 kg) lobster from the Hebrides estimated 190 mm CL.



LANDINGS (TONNES) OF LOBSTER INTO SCOTLAND BY SCOTTISH VESSELS, 1974-2010

Management

The lobster fishery is not subject to EU TAC regulations or national quotas. In Scotland, vessels landing lobsters are required to have a licence with a shellfish entitlement. Vessels without this entitlement are only allowed to land a limited amount (5 lobsters per day). The main regulatory mechanism is a minimum landing size of 87 mm CL in all areas except Shetland (90 mm CL, under the Shetland Regulating Order). There is a maximum landing size of 155 mm CL for females.

Assessment

Age determination is generally not possible for animals which moult and application of age-structured assessment methods to crustacean stocks is problematic. Length Cohort Analysis (LCA) is the method used for assessing lobster stocks. It uses official landings and length frequency data collected as part of the Marine

Scotland Science market sampling programme¹. LCA results are calculated in terms of yield-per-recruit and biomass-per-recruit relative to changes in fishing mortality, providing a framework for evaluation of management measures. Assuming a direct relationship between fishing mortality and effort, generally, lower levels of fishing effort will result in an increase in stock size and a reduction in landings. A higher level of fishing effort will reduce total stock biomass but landings may also fall, as animals are caught before they have had time to grow to a size that would contribute much weight to the yield (growth overfishing). In between these lies F_{MAX} , the fishing mortality rate that maximizes yield per recruit. The changes that the LCA predicts are long term (equilibrium). The method does not provide any indication of short-term stock dynamics or recruitment over-fishing. Assessments are performed on a regional basis for males and females separately.

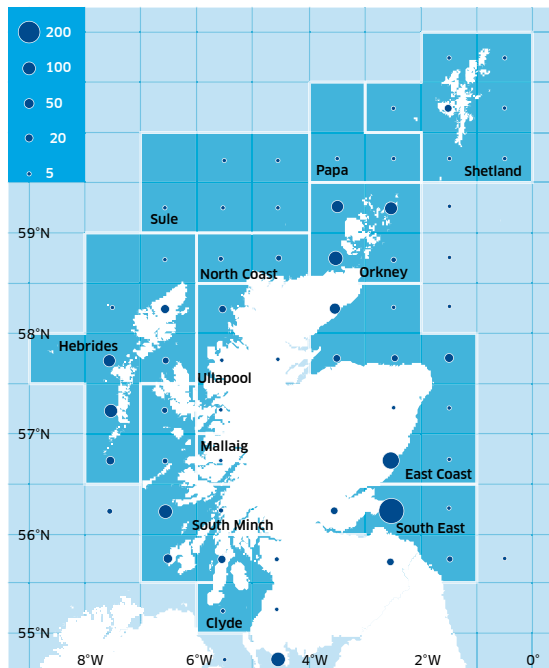
State of the stocks

Results of assessments based on LCAs for the period 2006-2008 for seven of the twelve

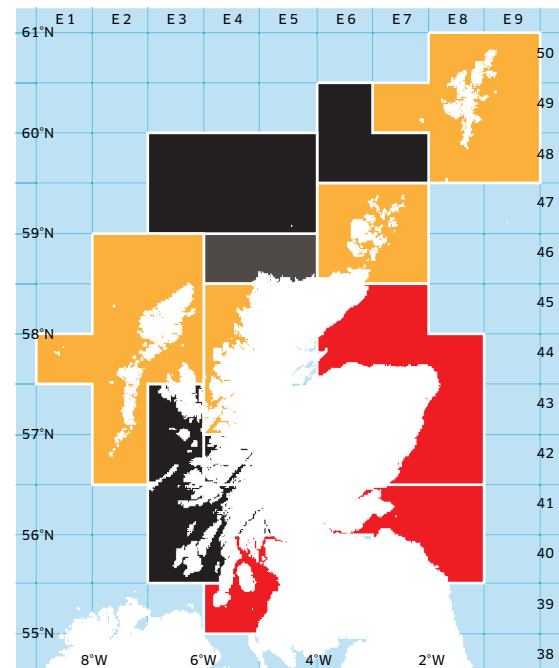
assessment units, summarising estimates of fishing mortality in relation to the reference point F_{MAX} , are shown on the map (below). There were insufficient sampling data from the South Minch, Mallaig, North Coast, Sule and Papa areas to conduct LCAs. Lobsters in all the assessed areas were growth overfished to some extent, particularly males. In the areas of major importance for lobster landings, fishing mortality was estimated to be significantly above F_{MAX} for both males and females in Clyde, East Coast and South East whilst in Shetland, Orkney, Hebrides and Ullapool, fishing mortality for females was close to F_{MAX} while males were fished above F_{MAX} . The stock assessment for lobster in Scottish waters will be updated in 2012.

Management advice

Overall, assessments for the period 2006-2008 show that most lobster assessment units in Scotland were fished close to or above F_{MAX} , which is above the optimum level to achieve the maximum yield-per-recruit. A higher yield and biomass per recruit in the long term could potentially be obtained in all assessment units by reducing the level of fishing mortality (effort).



CREEL FISHERY ASSESSMENT AREAS AND SCOTTISH LOBSTER LANDINGS IN 2010 (TONNES)



CREEL FISHERY ASSESSMENT AREAS AND ESTIMATED FISHING MORTALITY, 2006 -2008.

- Fishing mortality at or around F_{MAX} .
- Fishing mortality significantly above F_{MAX} for either males or females
- Fishing mortality significantly above F_{MAX} for both males and females
- Not assessed

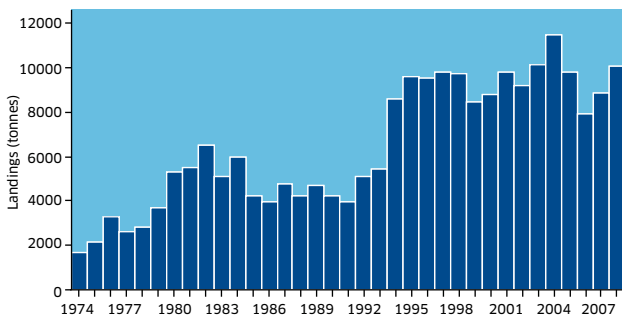
¹Size frequency data used in the assessment for the Shetland area were provided by the NAFC Marine Centre with the permission of the Shetland Shellfish Management Organisation.

// SCALLOP

Latin name : *Pecten maximus*
Common names : Great scallop,
King scallop, Clam,
Coquille St. Jacques

Introduction

The King scallop is the second most valuable shellfish species in Scotland. Landings into Scottish ports in 2010 of 9,000 tonnes were worth £17.6 million and made up just under a third of the UK total. The commercial fishery for scallops in Scotland started as a seasonal fishery in the Clyde during the early 1930s, and developed rapidly during the late 1960s and early 1970s, expanding to other west coast grounds. Fisheries around Shetland and in the Moray Firth also developed over this period, followed by fisheries off the east coast of the Scotland in the 1980s. Nowadays, fishing takes place all year round. Most scallops are caught using arrays of specialized dredges attached to bars towed from either side of the vessel. The scallop fleet comprises small vessels that tend to work locally in inshore waters and some larger vessels, up to about 30 m in length, which are capable of fishing grounds around Scotland and the rest of the UK. Scallops are also fished commercially by divers; dive caught scallops accounted for about 5 % of the landings in 2010.



SCALLOP LANDINGS (TONNES) BY UK VESSELS INTO SCOTLAND, 1974 -2010

Biology and life cycle

Scallops are bivalve molluscs that live in the waters around Scotland and the wider northeast Atlantic coast. They can be found on the sea bed anywhere from just below the low water mark to depths exceeding 100 m, preferring sediments comprised of sand, gravel and mud, sometimes interspersed with stones, rocks or boulders. They are active suspension

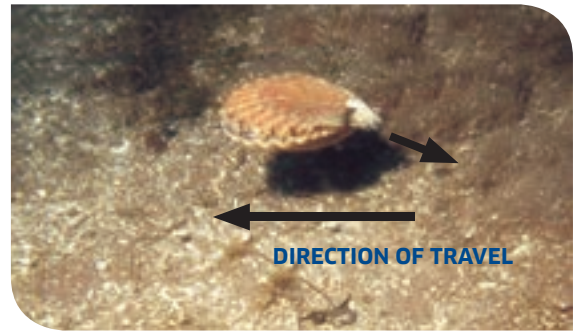
feeders, which rely on phytoplankton and suspended detrital material as their food source. If undisturbed, scallops usually lie recessed into the sediments with their flat valve uppermost, often covered by a layer of sediment with only their eyes and tentacles visible when the valves are open. They have numerous eyes around the shell margin. Each eye is capable of forming an image which, along with other well developed sense organs, make scallops highly sensitive to changes in their immediate surroundings. Although considered sedentary, scallops are able to swim limited distances propelled by jets of water. The jets are produced by rapid closure of the valves and can be redirected to aid recessing. Scallops are hermaphrodites and release male and female gametes separately into the surrounding water. Spawning is synchronized with scallops nearby which improves the chances of successful cross-fertilization. Fertilised eggs develop over a period of 24 to 48 hours into free-swimming larvae that migrate towards the sea surface, spending three weeks or more in the water column. Larvae eventually settle on to the seabed, often becoming attached to the substrate, before undergoing final metamorphosis into the adult form. Larvae are affected by water circulation, tides and wind driven currents when they are near the surface. This makes it very difficult to predict where they eventually settle, which may be some distance from the parent population. In Scottish waters, scallops spawn for the first time in the autumn of their second year, and subsequently each year in the spring or autumn. After settlement, scallops grow until their first winter during which growth usually ceases. Thereafter, growth resumes in spring and ceases in winter causing distinct rings to be formed on the external surface of the shell. These annual growth rings can be used to determine the age and growth rate of scallops. In biological terms, the length of a scallop is the maximum dimension parallel to the hinge. In Scottish waters, scallops grow to lengths exceeding 175 mm, and can live for 20 years or more. Environmental factors such as water temperature and food availability affect growth rates, which vary between areas.

Management

For scallops current EU legislation specifies a minimum landing size of 100 mm length except in the Irish Sea where the limit is 110 mm. There are no limits on landings in the form of TACs or quotas.



RECESSED SCALLOP



SCALLOP SWIMMING BEHAVIOUR

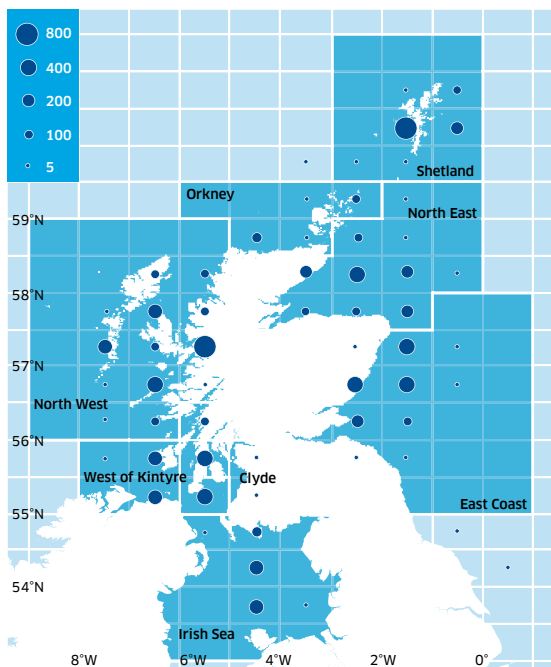
Under the Western Waters effort regime (which applies to all UK waters except the North Sea), effort limits are applicable to all vessels 15 m and over in length, including those fishing for scallops. The limits for UK scallop vessels are 1,974,425 KW days for Sub-areas V and VI and 3,315,619 KW days for Sub-area VII.

the UK territorial sea adjacent to Scotland (out to 12 nautical miles); and 14 per side in any other part of the Scottish zone (out to 200 nautical miles). Additionally, the use of “French” dredges (a design incorporating water deflecting plates and rigid fixed teeth) is prohibited in Scottish inshore waters.

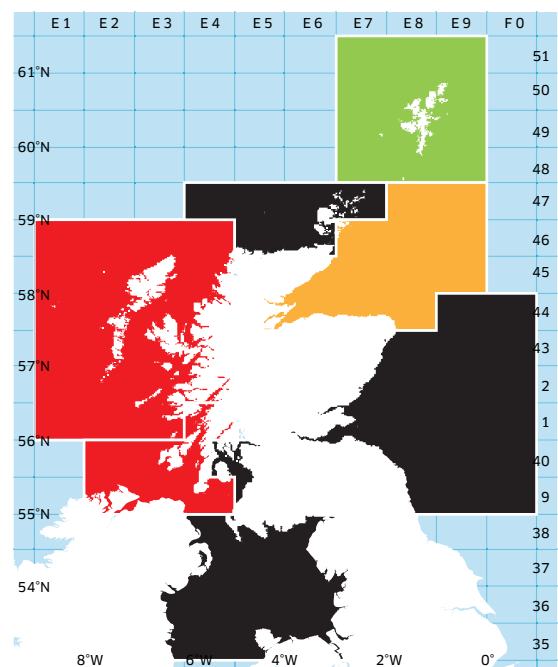
In Scotland, additional management measures specific to the scallop fishery have been introduced to support sustainable exploitation. In 1999, a restricted scallop licensing scheme was introduced in response to concerns about the expansion of scallop fishing effort. The scheme was strengthened in 2003 by gear restrictions that vary according to where fishing takes place: a maximum of 8 dredges per side can be towed in Scottish inshore waters (out to 6 nautical miles); a maximum of 10 per side in any other part of

Assessment

For the stocks in the main scallop assessment areas: West of Kintyre, North West, Shetland, and North East, an aged structured method, Time Series Analysis (TSA) is used. The TSA uses reported landings data, age and length frequency data collected as part of the Marine Scotland Science (MSS) market sampling programme and catch at age data from the annual MSS scallop dredge surveys which



SCALLOP ASSESSMENT AREAS AND LANDINGS (TONNES) IN 2010



ASSESSMENT AREAS AND SSB / RECRUITMENT LEVELS, 2005-2007

- SSB and recruitment relatively stable
- SSB/recruitment fluctuating
- SSB and recruitment declining
- Not assessed

are conducted around the coast of mainland Scotland and Shetland. The approach is an improvement on methods previously used to assess scallop stocks and is considered more robust in that it makes use of multiple data sources and can cope with the omission of poor quality or missing data. It provides annual estimates (with confidence intervals) of yield, fishing mortality, spawning stock biomass and recruitment. For the East Coast assessment area the survey catch rate data are the main source of information on stock dynamics. Stocks in the Irish Sea, Orkney, and the Clyde are not routinely surveyed and there are insufficient data for TSA - official landings and market sampling data are monitored.

State of the stocks

The latest assessments were conducted in 2011, using data collected up to and including 2010. For those stocks with analytical assessments, the summaries below show catch (data and model estimates) and spawning stock biomass (SSB) in thousand tonnes of scallop muscle, recruitment at age three in millions and annual fishing mortality averaged over ages four to six, as estimated by the TSA model. For the East Coast, the summary shows mean standardised trends in SSB and recruitment at age three as estimated from the dredge survey data.

West of Kintyre: The continued high catches and only moderate recruitment during the mid 2000s have resulted in a declining SSB which in 2010 reached the lowest level estimated over the 30 year time series. Estimated fishing

mortality (F) more than doubled between 2006 and 2010, although the estimates of F in the most recent years are relatively uncertain.

North West: Following a period of high recruitment in the late 1990s and early 2000s, recruitment has declined and has been below the long term average since 2006. As a result SSB has also declined from the relatively high levels of 10 years ago. Catches have been low in recent years and this is reflected by the low fishing mortality.

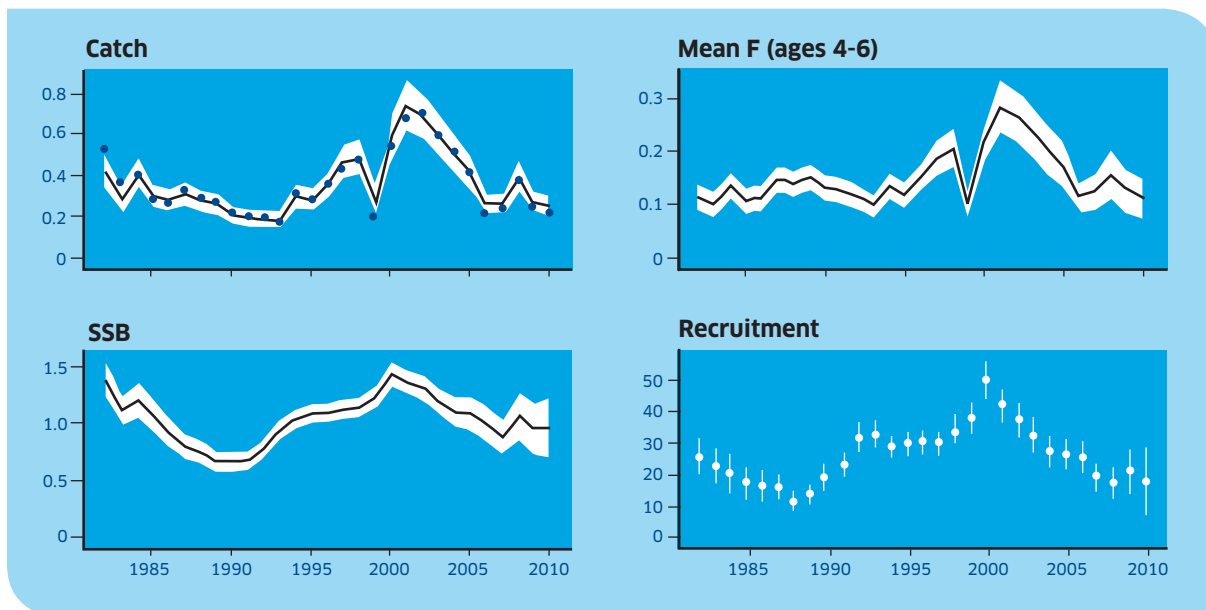
North East: Fishing mortality in this area increased rapidly during the late 1980s and early 1990s. In the last five years it has been more stable, but with significant uncertainty surrounding the estimates throughout the time period. SSB has declined slightly in recent years after a period of relatively stable/increasing SSB since the mid 1990s.

Shetland: Fishing mortality on the stock around Shetland is estimated to have increased substantially in 2010 to the highest value in the time series. Recruitment has been fairly stable in recent years at around the long term average for the time series. SSB has been stable since the mid 2000s at above average levels.

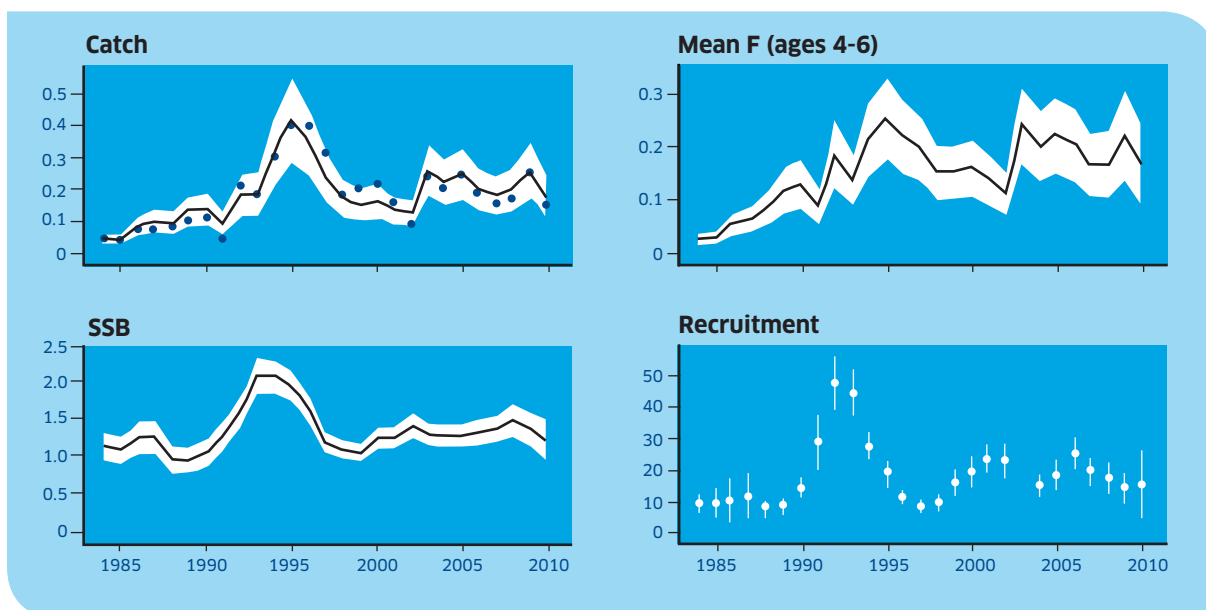
East Coast: Stock trends as estimated from the dredge survey data suggest that SSB increased during the 2000s as a result of a number of strong year classes. However, recruitment in the last four years appears to have been low and SSB has been declining since 2008.



WEST OF KINTYRE STOCK SUMMARY SHOWING CATCH AND SSB OF SCALLOP MUSCLE (000 T), RECRUITMENT AT AGE THREE (MILLIONS) AND ANNUAL FISHING MORTALITY AVERAGED OVER AGES FOUR TO SIX.



NORTH WEST STOCK SUMMARY SHOWING CATCH AND SSB OF SCALLOP MUSCLE (000 T), RECRUITMENT AT AGE THREE (MILLIONS) AND ANNUAL FISHING MORTALITY AVERAGED OVER AGES FOUR TO SIX.



NORTH EAST STOCK SUMMARY SHOWING CATCH AND SSB OF SCALLOP MUSCLE (000 T), RECRUITMENT AT AGE THREE (MILLIONS) AND ANNUAL FISHING MORTALITY AVERAGED OVER AGES FOUR TO SIX.

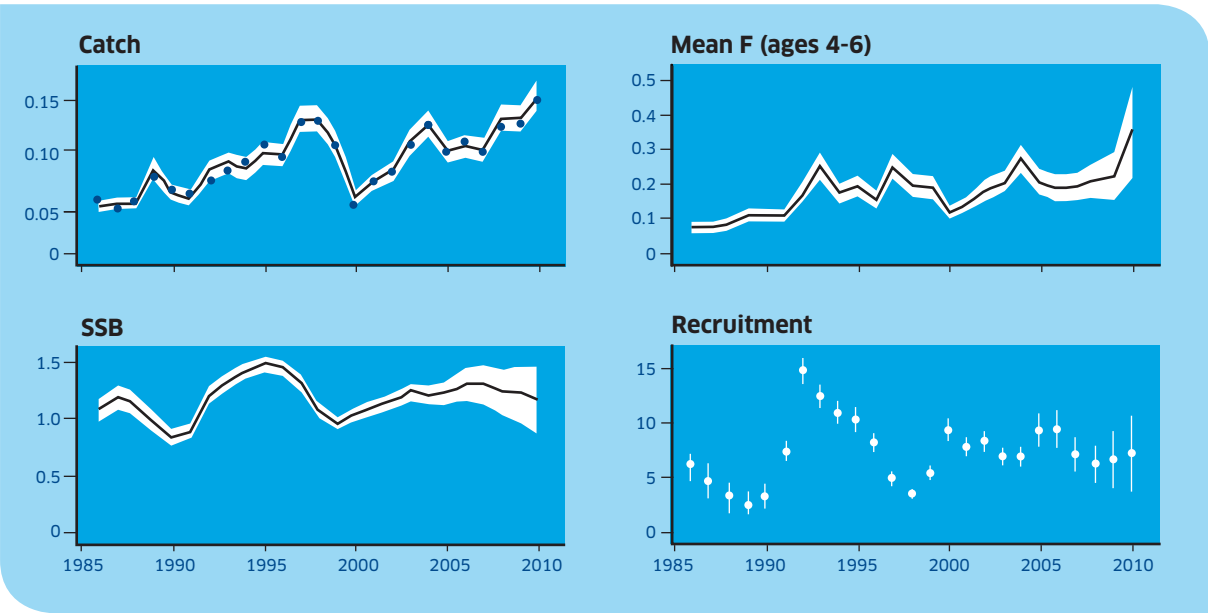
Management considerations

There are currently no agreed biomass or fishing mortality reference points for scallop stocks. MSS assessments indicate differences in stock dynamics in different assessment areas. In some areas increases in catches are associated with increased recruitment.

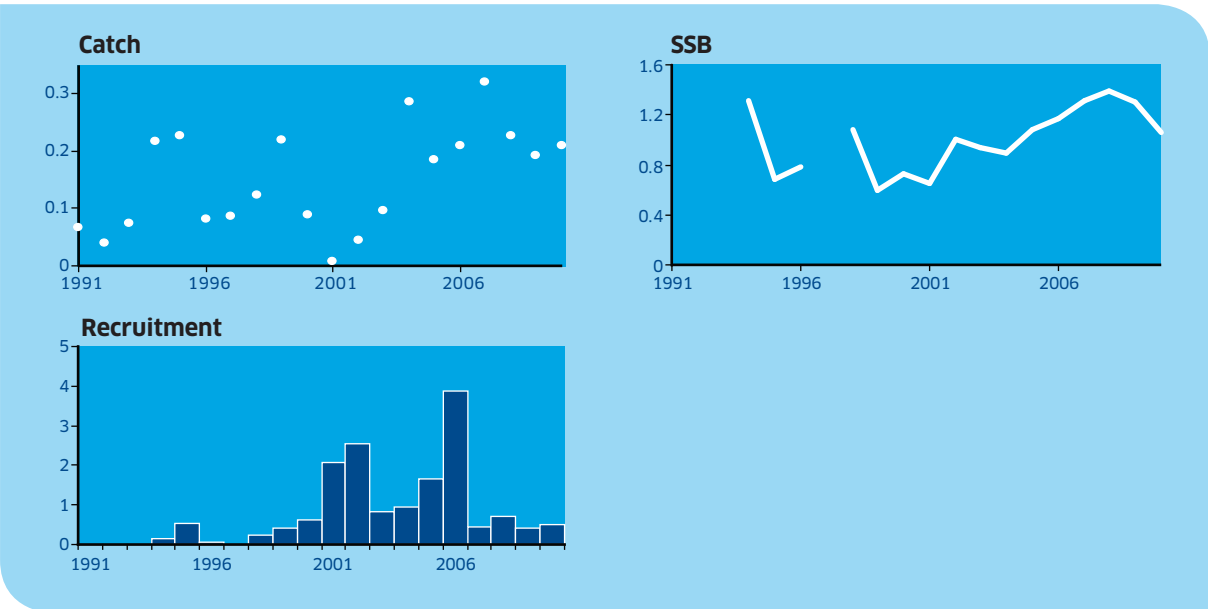
To the west of Scotland, SSB has declined markedly in the last ten years and recent estimates of fishing mortality for the West of Kintyre assessment area are high. Under these circumstances advice is for a reduction in fishing effort. Measures to increase spawning stock biomass should be considered. An increase in the minimum landing size has been

proposed as a possible management measure for Scottish scallop fisheries. The survival of discarded scallops is high and therefore most undersized scallops returned to the sea have the potential to grow. This measure therefore has the potential to increase the reproductive capacity of the stock, provided that there is no associated increase in fishing effort.

In the North East and Shetland assessment areas, both SSB and recruitment appear relatively stable in recent years. Fishing mortality has been above the long term average. In such circumstances advice is for no increase in effort.



SHETLAND STOCK SUMMARY SHOWING CATCH AND SSB OF SCALLOP MUSCLE (000 T), RECRUITMENT AT AGE THREE (MILLIONS) AND ANNUAL FISHING MORTALITY AVERAGED OVER AGES FOUR TO SIX.



EAST COAST STOCK SUMMARY SHOWING CATCH (000 T OF SCALLOP MUSCLE) AND TRENDS IN SSB AND RECRUITMENT AT AGE THREE (BOTH MEAN STANDARDISED) FROM THE DREDGE SURVEY.

// FISH STOCK SUMMARY TABLE 2012

Stock	ICES Reference Points						Current Assessment			Outcomes for EU Fisheries ¹	
	B _{lim} (t)	B _{pa} (t)	F _{lim}	F _{pa}	MSY B _{trigger} (t)	F _{MSY}	F 2010	SSB (t) 2011	TAC (t)	UK Quota (t)	
Mackerel - Northeast Atlantic	1,670,000	2,300,000	0.42	0.23	2,200,000	0.22	0.258	2,907,519	278,948	152,368	
Herring - North Sea	800,000	1,300,000	ND	0.12 ¹ 0.25 ²	ND	0.25	0.025 ¹ 0.118 ²	1,714,498	405,000	57,836	
Herring - West of Scotland	50,000	ND	ND	ND	ND	0.25	0.266	80,998	22,900 ³	13,438 ³	
Haddock - North Sea	100,000	140,000	1.0	0.70	140,000	0.3	0.233	235,072	30,132	25,386	
Haddock - West of Scotland	22,000	30,000	ND	0.50	30,000	0.3	0.288	42,182	6,015	4,683	
Haddock - Rockall	6,000	9,000	ND	0.40	9,000	0.3	0.153	13,036	3,300	2,660	
Cod - North Sea	70,000	150,000	0.86	0.65	150,000	0.19	0.676	54,721	21,974	10,311	
Cod - West of Scotland	14,000	22,000	0.80	0.60	22,000	0.19	0.824*	8,720	0	0	
Whiting - North Sea	ND	ND	ND	ND	Undefined	Undefined	0.272	205,282	15,750	10,539	
Whiting - West of Scotland	16,000	22,000	1.0	0.60	Undefined	Undefined	Uncertain	Uncertain	307	176	
Saithe - Northern shelf	106,000	200,000	0.60	0.40	200,000	0.3	0.383	169,000	87,550	9,472	
Monkfish - Northern shelf	ND	ND	ND	ND	Undefined	Undefined	Uncertain	Uncertain	15,844	9,319	

¹Provisional values at time of going to press subject to change

*Total mortality (Z)

²For juvenile North Sea herring - ages 0-1

²For adult North Sea herring - ages 2-6

³Not including Clyde fishery

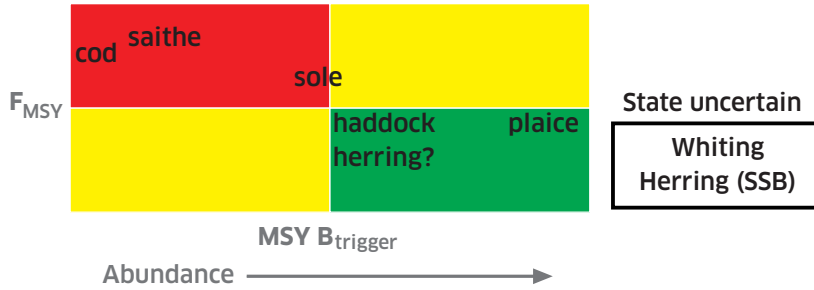
ND = not defined

(t) = metric tonnes

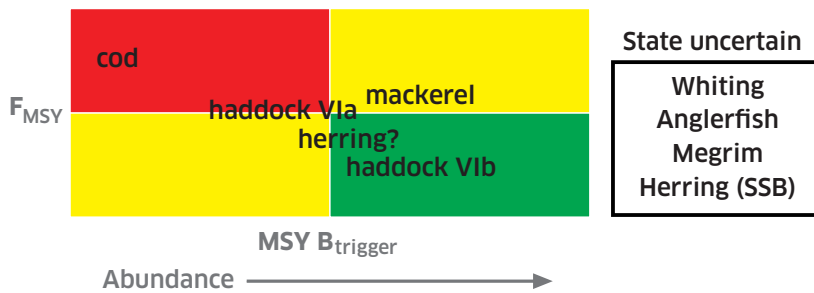
// STATE OF STOCK SUMMARY TABLE

MSY approach

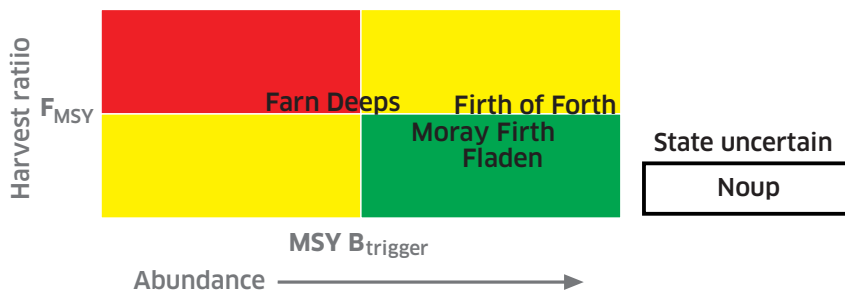
North Sea Fish Stocks Summary



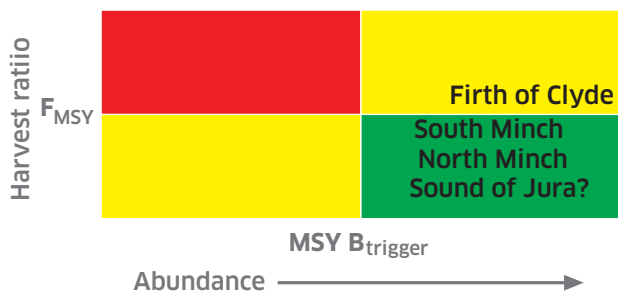
West of Scotland Fish Stocks Summary



North Sea Nephrops Summary



West of Scotland Nephrops Summary





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