

Marine Scotland Science

Fish and Shellfish Stocks
2015 Edition



marinescotland
science

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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. Research on the effects of the marine environment are also carried out.

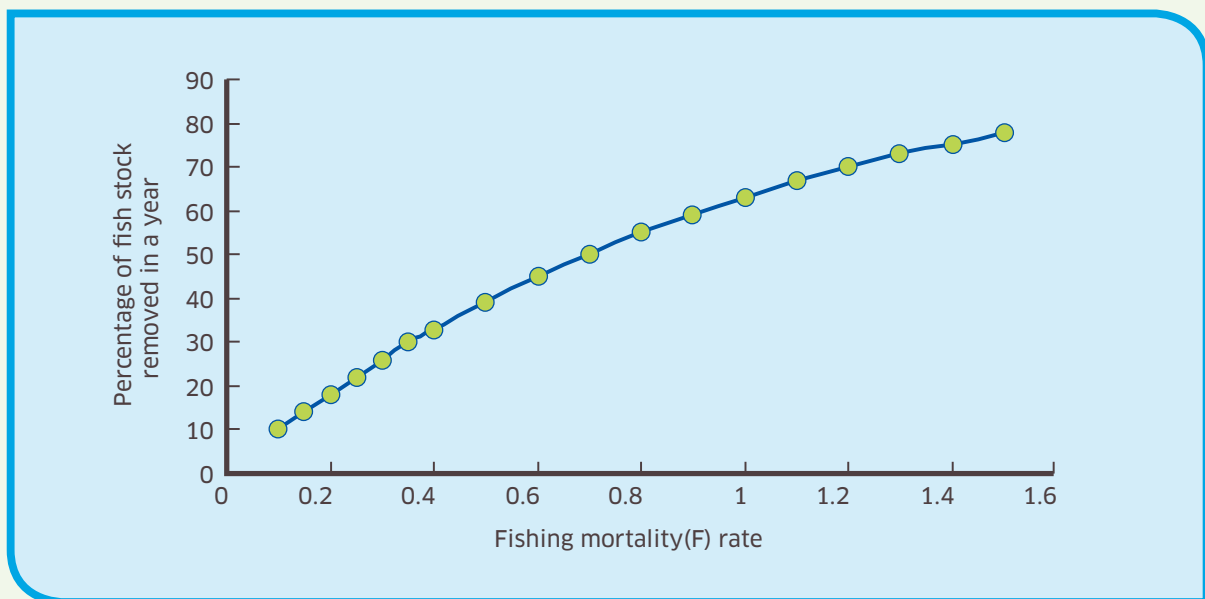
The state of the stock refers to the number of fish in the population or their total weight, known as the stock biomass, in relation to pre-defined reference values. The aim is to provide fishery managers – the Government and the European Commission – with information on the state of stocks. They can 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. Scientists estimate the past and current state of stocks in a process known as stock assessment. 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 that 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 into account 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 herring or saithe.

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 the haddock stock (IIIa, IV and VIa).

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. The biomass reference point is used as a 'trigger' - if the stock drops below this size, then F is adjusted downwards below F_{MSY} .

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

The example below is from the advice given in June 2014 for Saithe North Sea and West of Scotland (IIIa, IV and VI)

Fishing Pressure				
	2011	2012	2013	
MSY (F_{MSY})				Appropriate
Precautionary approach (F_{pa} , F_{lim})				Harvested sustainably
Management Plan (F_{MP})				At limit

Stock Size				
	2012	2013	2014	
MSY ($B_{trigger}$)				Below trigger
Precautionary approach (B_{pa} , B_{lim})				Increased risk

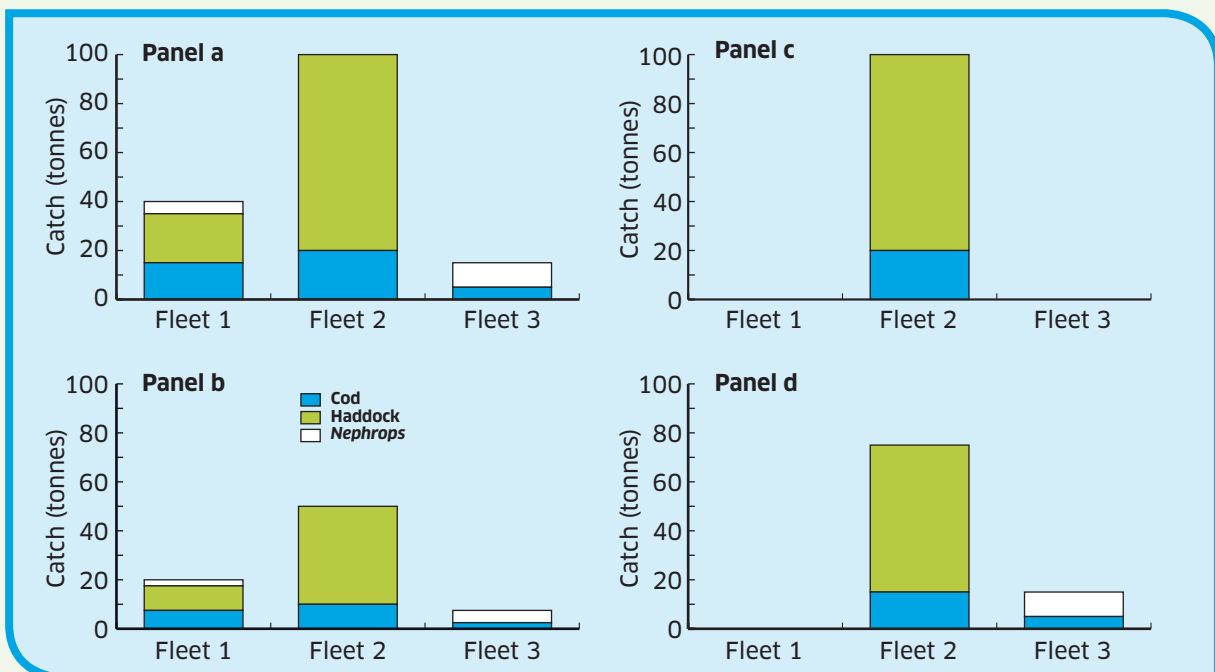
// MIXED SPECIES FISHERY ADVICE

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. Therefore, the required constraints on fishing mortality for vulnerable species are not always 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. 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. 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 that 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

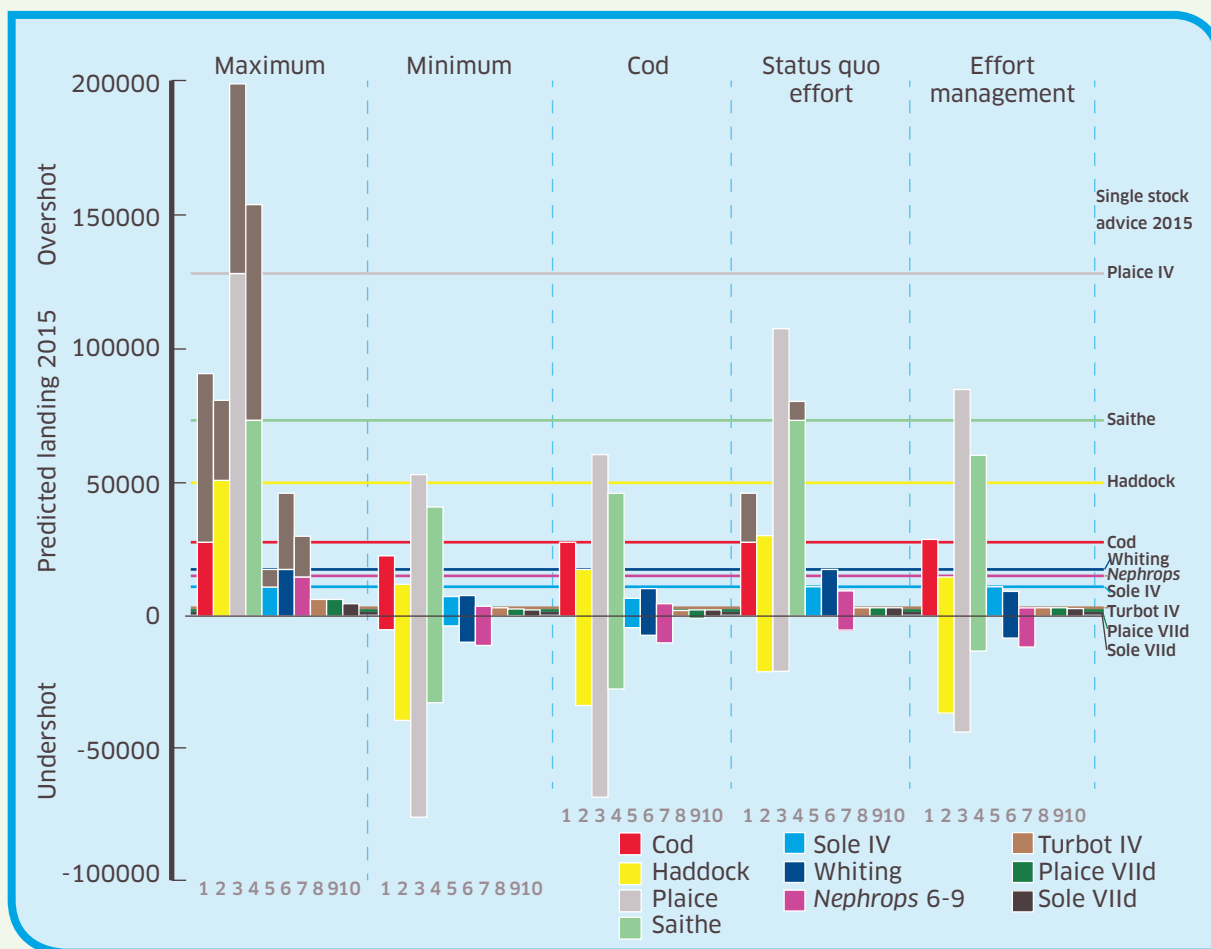
stock-by-stock basis, and derive the annual TACs depending on the biomass of the stock relative to biomass reference points and a target fishing mortality. The harvest rules also impose constraints on the annual percentage change in TAC. The basis of the Fcube model is to estimate the potential future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



NORTH SEA MIXED-FISHERIES PROJECTIONS. ESTIMATES OF POTENTIAL LANDINGS (IN TONNES) BY STOCK AND BY SCENARIO. DISCARDS ARE NOT SHOWN. HORIZONTAL LINES CORRESPOND TO THE SINGLE-STOCK LANDINGS ADVICE FOR 2015. BARS BELOW THE VALUE OF ZERO SHOW UNDERSHOOT (COMPARED TO SINGLE-STOCK ADVICE) WHERE LANDINGS ARE PREDICTED TO BE LOWER WHEN APPLYING THE SCENARIO. DARK GREY COLUMNS REPRESENT LANDINGS IN OVERSHOOT OF THE SINGLE-STOCK ADVICE.

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) have to be available across all fleets and/or stocks. The mixed fisheries working group results are now 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

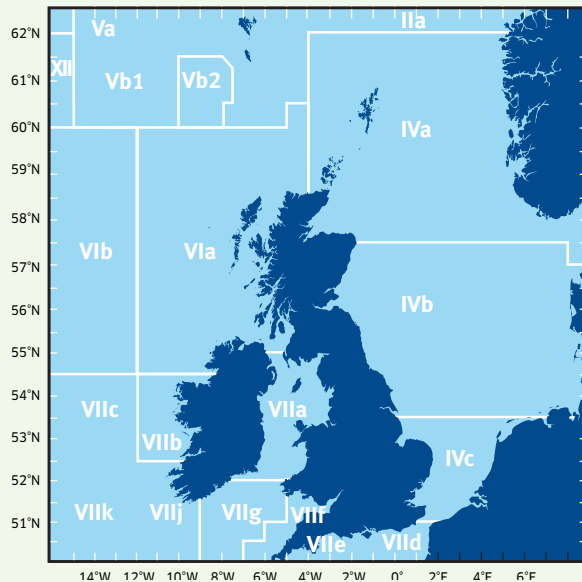
Many stocks exploited by Scottish fishermen are managed under the EU Common Fisheries Policy (CFP), administered by the European Commission. An important part of the management procedure is the use of TACs. Most TACs are set on an annual basis and are the result of a cycle of events ending in the December 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 haddock North Sea, Skagerrak and West of Scotland (now assessed as a single stock) includes ICES division IIIa, Subarea IV and Division VIa, so 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



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

measure for demersal stocks, they are based 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 a series of ICES 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 a 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 catch proposals lies with the Commission. However, it is the Council of Ministers that makes the final decision. The Council can reject the Commission's proposals and ask for alternatives. Generally,

the Commission tries to draft a proposal that 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 included 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 has 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.

Discard Ban

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. In an effort to better account for cod catches, Scotland has been involved in trialling an initiative to operate 'Catch Quotas', in which all the cod catch is landed and reported. Assurance that the whole catch is fully documented is provided by an accompanying system of CCTV on board the trial vessels.

As part of the reformed Common Fisheries Policy (CFP) an agreement was reached to include a landing obligation otherwise known as a discard ban. The unwanted fish may no longer be thrown back into the sea. Instead, all of the catch must be landed and counted against quota. The new CFP came into force on 1 January 2014 (EU Regulation 1830/2013).

The discard ban is being phased in over a number years, starting in 2015 with pelagic fisheries, being extended to target demersal fisheries in 2016 and being fully implemented across all TAC species by 2019.

The Scottish Government's overall aim is to ensure an effective landing obligation that is implemented in a proportionate and appropriate way. This will include a review of all legislative barriers that currently result in regulatory discarding. Progress is being made towards discard plans covering the regional areas affecting Scottish Fishermen. They will be agreed during 2015.

// 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 to 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 that 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. This may be 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.

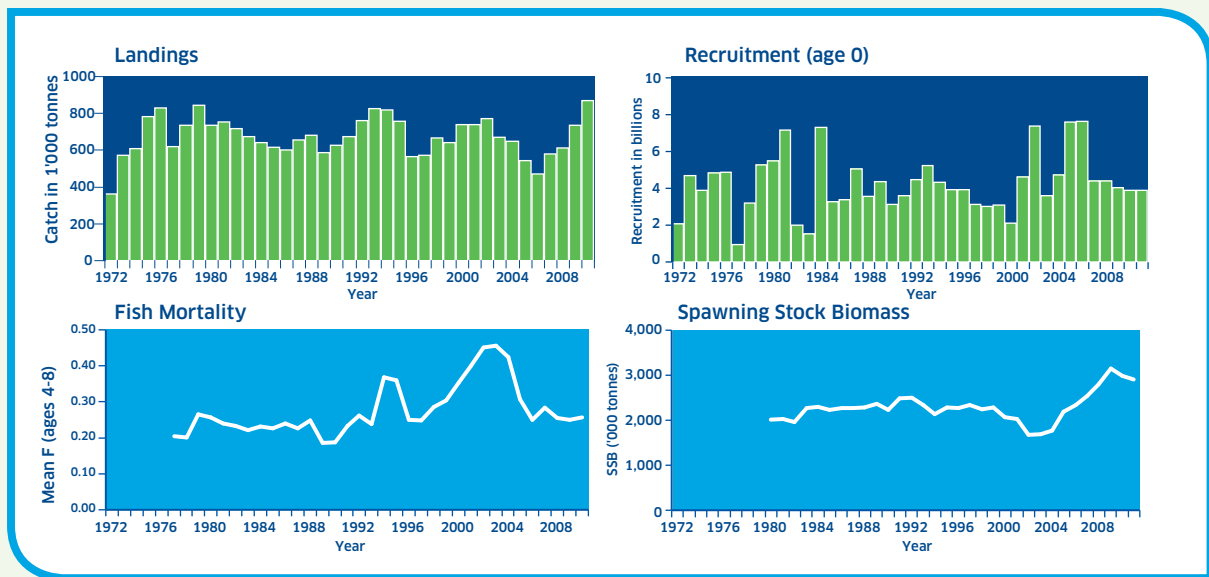
Each year when they carry out stock assessments, scientists plot out the important characteristics of the population. They look at the trends over time and decide on the 'state of the stock'. They also try to predict what will happen to the stock in the future.

Trends in landings, recruitment, fishing mortality and spawning stock biomass, for

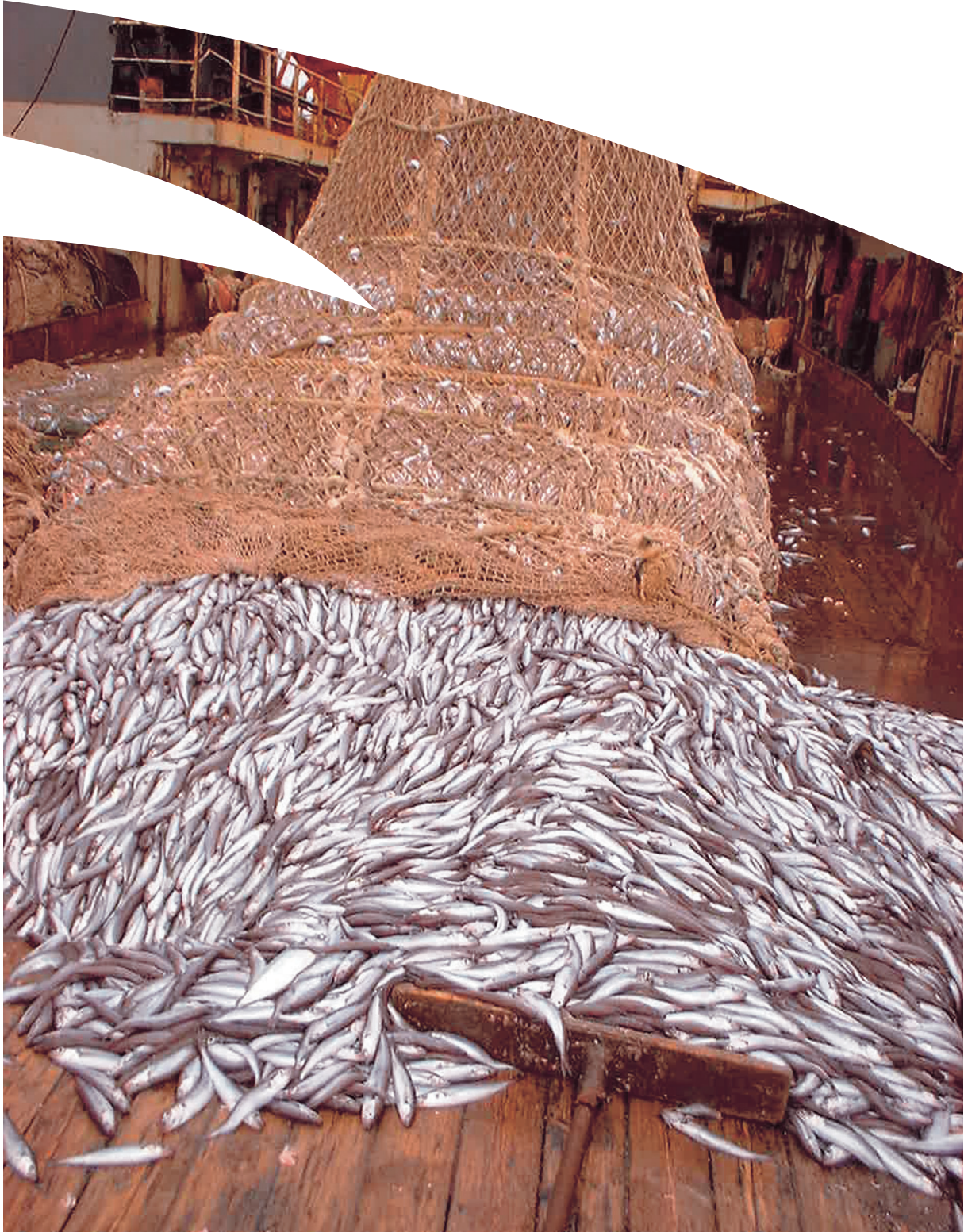
an example fish stock for the period 1972 to 2010 are shown below. These can be used to answer questions such as:

- 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 (COMBINED SOUTHERN, WESTERN AND NORTH SEA SPAWNING COMPONENTS)

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.

2015 position : UK share 247,296 tonnes

Last Year : 290,850 tonnes

Landed into

Scotland in 2013: 160,118 tonnes

Value for 2013 : £67 million

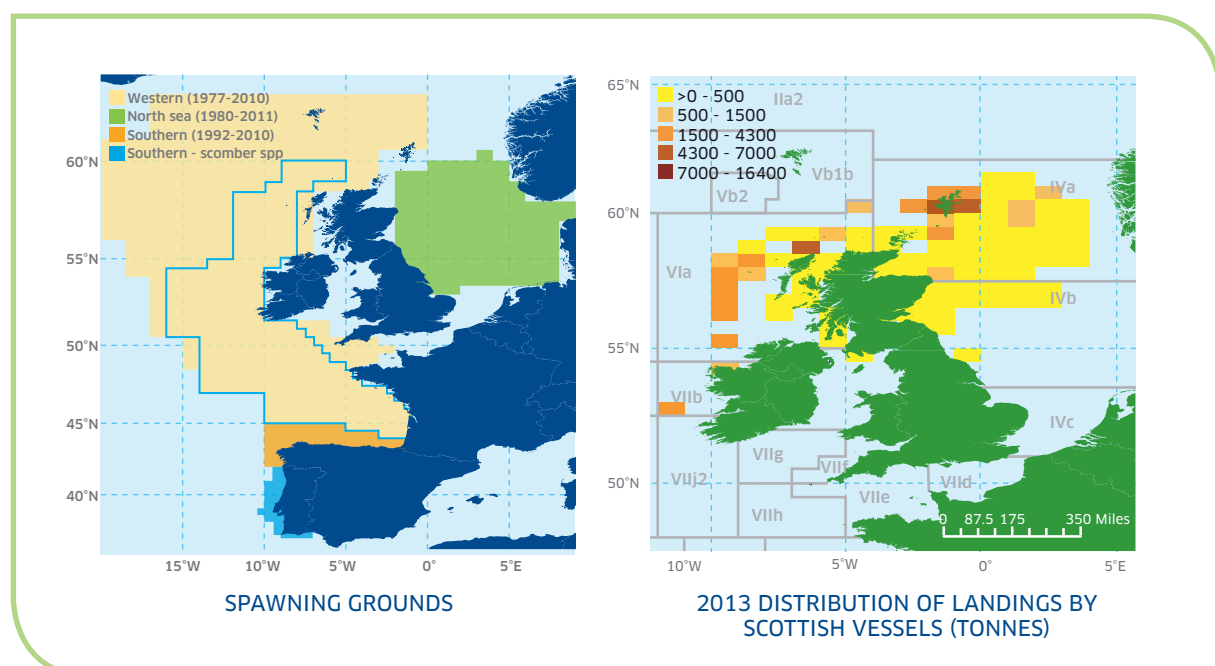
Biology

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.



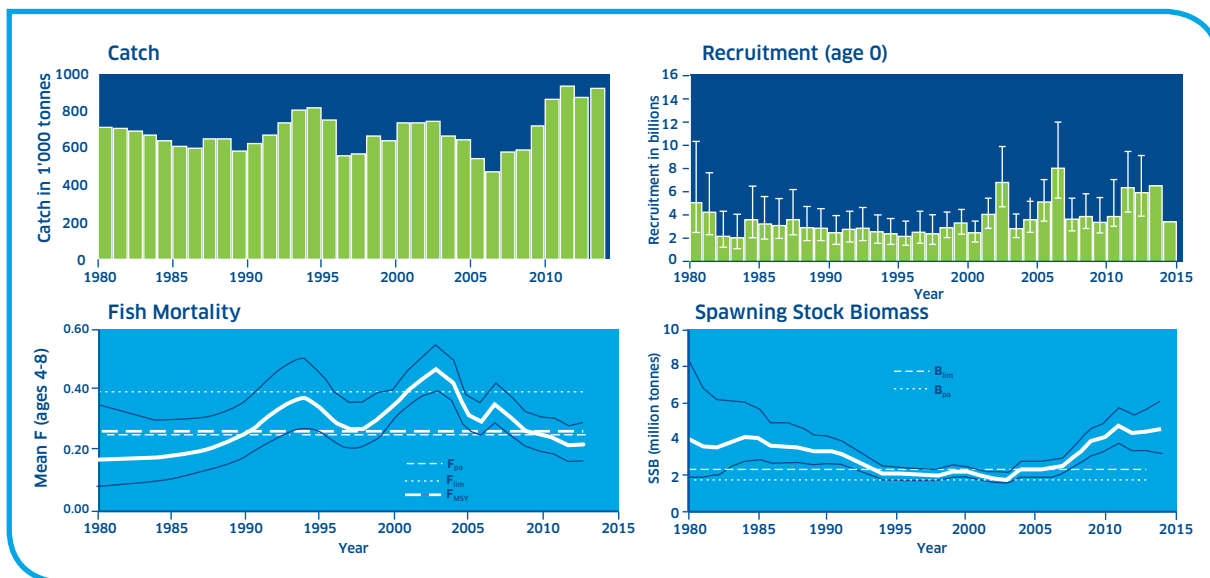
// ICES ADVICE ON MANAGEMENT

Information Source:

ICES advice September 2014

<http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/mac-nea.pdf>

Quoted text in italics



State of stock and advice

- Catches of mackerel have been increasing since 2005 and have been around 900kt since 2010.
- The mackerel egg survey index shows a doubling of the SSB since 2004 and a 30% increase from 2010 to 2013.
- Recent landings have been stable and the stock appears to have increased.

Advice is based on catch, assuming discards are negligible. The ICES assessment is based on a combination of landings and partial discard data, so the assessment does not represent only landings and cannot be used to give landings advice. Overall ICES considers the amount of discards to be negligible

- The benchmark assessment was carried out in February 2014 and considered alternative models. The assessment now uses an analytical age-based assessment model (SAM) including new tuning series in addition to the egg survey index which provides an index of SSB.

Note: ICES advises on the basis of the Norway, Faroe Islands, and EU management plan that catch in 2015 should be between 831,000 tonnes and 906,000 tonnes. EU, Norway, and the Faroes have approached ICES with a draft request on a revised long-term management plan evaluation. ICES is currently carrying out analyses to answer this request draft.

Management outcomes for 2015

After the negotiations between the EU, Norway, Iceland and Faroe Islands over Northeast Atlantic Mackerel, took place in November 2014, an international agreement was reached. The EU Total Allowable Catch 2015 for northeast mackerel was set at 521,689 tonnes. The UK quota was provisionally set at 247,296 tonnes.

MSY and precautionary approach reference points

(from advice released September 2014)

	Type	Value
Management plan	F _{target}	0.20-0.22
	SSB _{trigger}	2.2 million t
MSY Approach	MSY B _{trigger}	2.36 million t
	F _{MSY}	0.25
Precautionary Approach	B _{lim}	1.84 million t
	B _{pa}	2.36 million t
	F _{lim}	0.39
	F _{pa}	0.26

// HERRING STOCKS – NORTH SEA (North of 53°30'N)

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.

2015 position : UK share 62,292 tonnes

Last Year : 65,022 tonnes

Landed into

Scotland in 2013 : 28,762 tonnes

Value for 2013 : £10.8 million

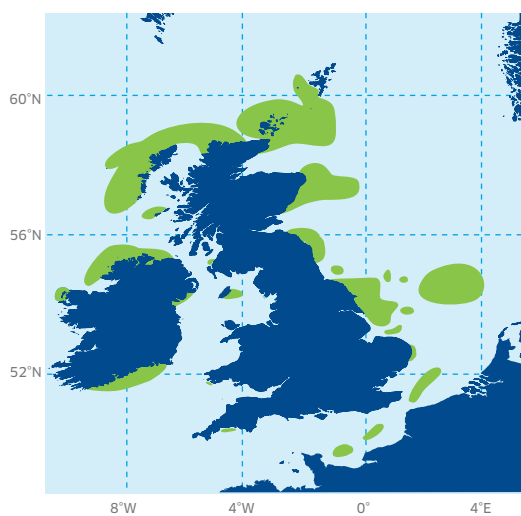
Biology

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

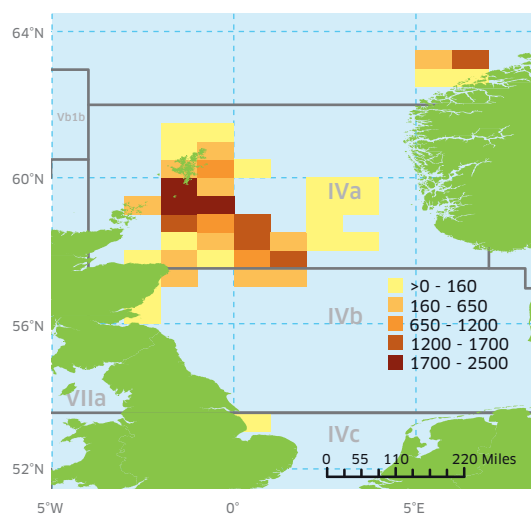
until January. For most of the year the different populations mix, but during the spawning season they migrate to their separate areas.

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

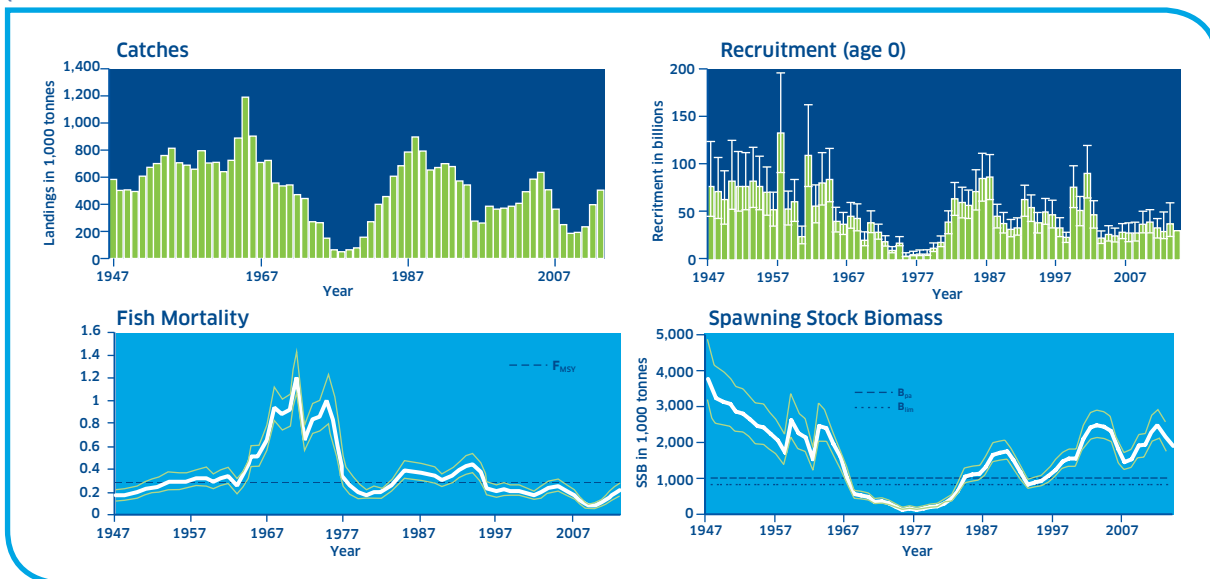


2013 DISTRIBUTION OF LANDINGS BY SCOTTISH VESSELS (TONNES)

// ICES ADVICE ON MANAGEMENT

Information Source: ICES advice 2014 <http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/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}		0.27
Precautionary Approach	B_{lim}		800,000 t
	B_{pa}		1.0 million t
	F_{lim}		Not defined
	F_{pa}		Not defined

State of stock and advice

- Fishing mortality in 2012 was estimated at 0.035 for juvenile fish (aged 0-1 year) and 0.168 for adult fish (aged 2-6 year): this means that 3.43 %, by number, of juvenile (aged 0-1 year) fish and approximately 15.4%, 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 1.99 million tonnes in 2013, 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 ($F_{2010} < F_{MSY}$).
- The advice, in accordance with the multi-annual management plan, recommends that landings in 2014 should be 470,037 tonnes for the main North Sea fleet and 12,440 tonnes for the small mesh industrial fleet.

a new assessment method was accepted which changed the perception of the stock. ICES classifies the stock as being at full reproductive capacity and as being harvested sustainably, below the current management plan and F_{MSY} targets. The current management plan agreed by EU and Norway in 2008 remains compatible with the precautionary MSY approaches.

In 2012, following the assessment benchmark and change in stock perception, the EU-Norway management plan was evaluated by ICES. Eight harvest control rule (HCR) options were examined for F_{MSY} targets at $F=0.24$ and $F=0.30$ and all were based on the assumption that the current low productivity regime for North Sea herring (observed since 2002) will continue. All eight HCR options tested included precautionary scenarios. Only five of the eight HCR options were considered to be appropriate candidates for a long term management plan. A decision on which scenario to adopt as the basis of a revised management plan has been postponed until additional scenarios have been evaluated.

A new management plan was agreed by EU-Norway in 2014. Until ICES evaluates this management plan as precautionary, the 2008 plan will be the advice basis.

The year classes from 2002 to 2007 are estimated to be the weakest since the 1970s. The year classes 2008 and 2009 are estimated to be around the long-term geometric mean of the time-series ICES considers that the stock is still 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 2015

In December 2014, the Council of Ministers decided that the international Total Allowable Catch for North Sea herring (north of 53° 30' N) in 2015 should be 267,197 tonnes. The UK quota has been set at 62,292 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 (Vb, V1a north and V1b)

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 bycatch of other fish occurs within this fishery.

2015 position : UK share 13,711 tonnes¹

Last Year : 16,959 tonnes²

Landed into

Scotland in 2013 : 10,233 tonnes³

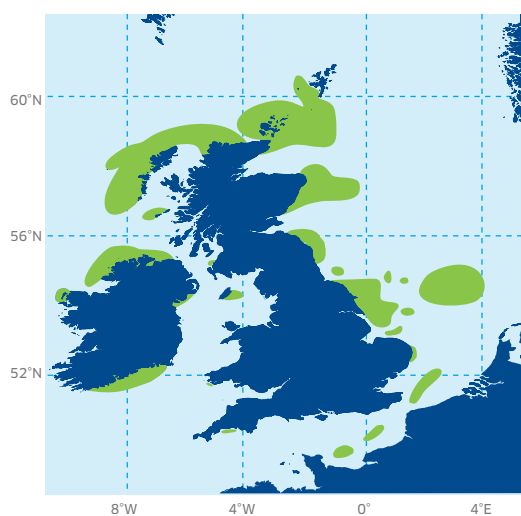
Value for 2013 : £3.5 million

Biology

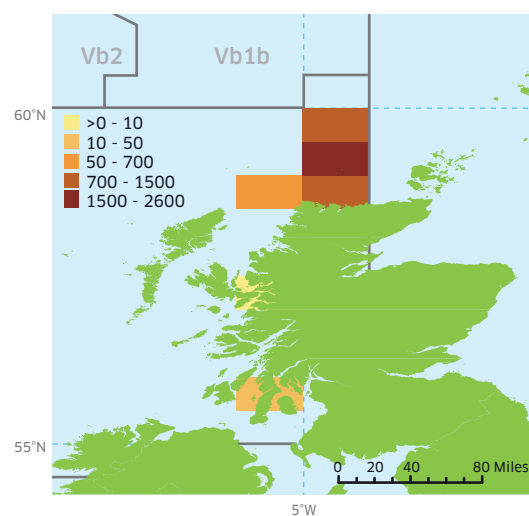
Herring is widely distributed throughout the north-east Atlantic, ranging from the Arctic Ocean in the north to the English Channel in the south. During daytime, the shoals remain close to the sea bottom or in deep water but at dusk they move towards the surface and disperse over a wide area. Off the 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 of 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



2013 DISTRIBUTION OF LANDINGS BY SCOTTISH VESSELS (TONNES)

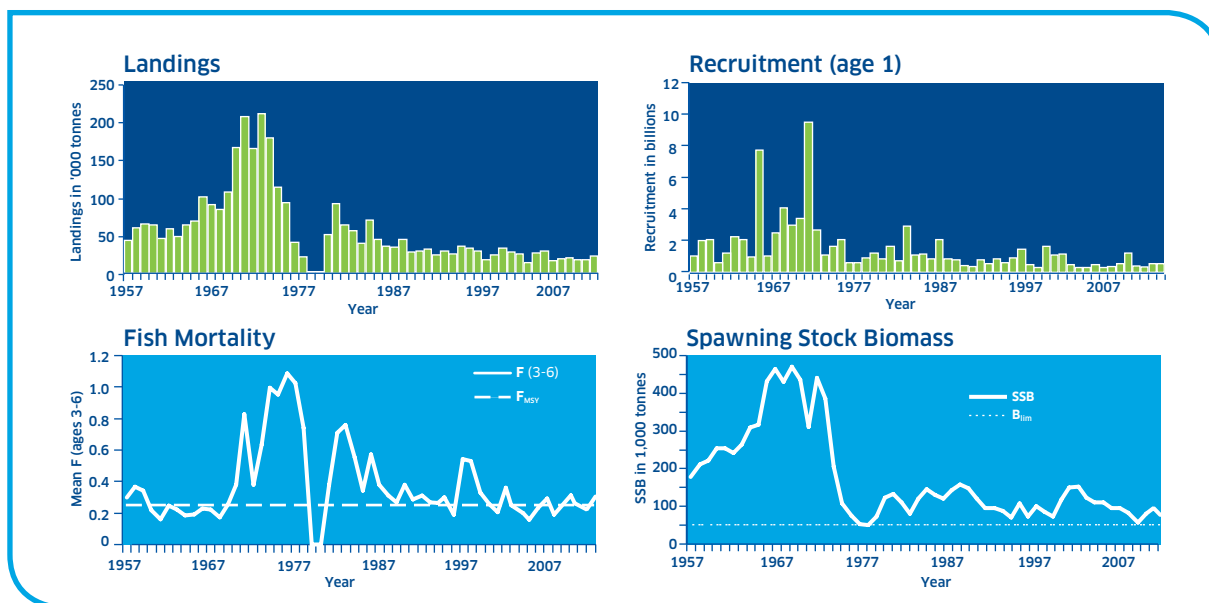
¹This excludes Clyde herring. Management now controlled by UK

²This included Clyde herring.

³Landings by Scottish based UK vessels

// ICES ADVICE ON MANAGEMENT

Information Source: ICES advice 2014 <http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/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 2013 was estimated to be 0.268: this means that approximately 23.51%, by number, of all fish aged between 3 and 6 years were caught.
- The spawning stock biomass for 2014 was predicted to be around 80,836 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 ($F_{2011} < F_{MSY}$).
- The advice is in accordance with the management plan which recommends that the TAC for 2015 should be set at 22,690 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.

ICES advises that activities that have a negative impact on the spawning habitat of herring, such as extraction of marine aggregates and marine construction on the spawning grounds, should not occur.

Management outcomes for 2015

In December 2014 the Council of Ministers decided that the 2015 Total Allowable Catch for west of Scotland (Vb, VIa North and VIb) herring should be 22,690 tonnes. The 2015 UK quota has been set at 13,711 tonnes.

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

// HADDOCK STOCKS — NORTH SEA, SKAGERRAK AND WEST OF SCOTLAND (IIIa, IV & VIa)

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. The Northern Shelf haddock stock was previously assessed as two separate stocks: Subarea IV and Division IIIaW (North Sea and Skagerrak), and Division VIa (West of Scotland).

2015 position : UK share of 32,108 tonnes

Last Year : 30,925 tonnes

Landed into Scotland in 2013 : 36,722 tonnes

Value for 2013 : £40.942 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.

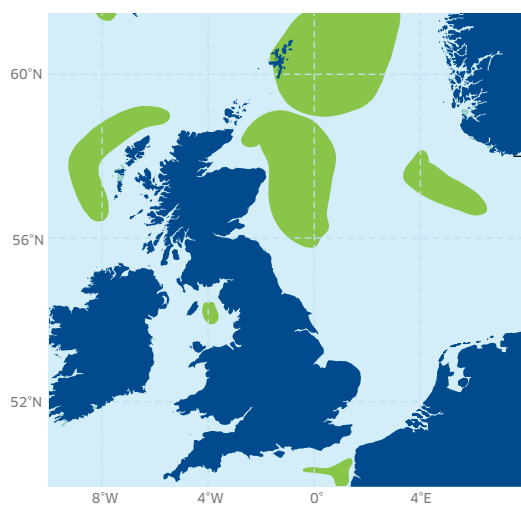
Virtually all three year old fish are mature and in some years over 80% of two year olds may be mature. A three year old female of average size is able to produce around 300,000 eggs in a season. Haddock release their eggs over several weeks. Spawning runs from February until early May and occurs in 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.

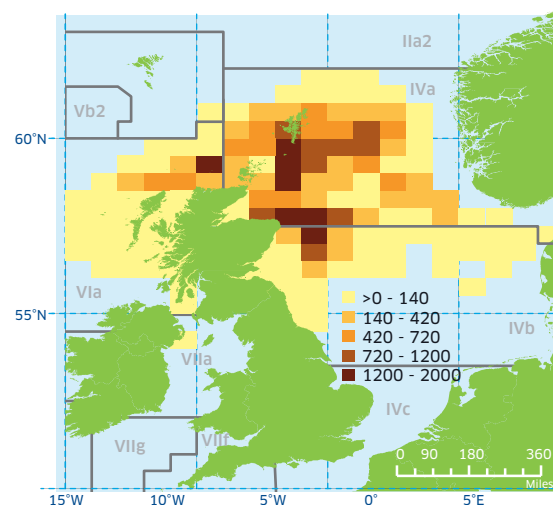
In the northern North Sea most of the larvae do not travel far from the spawning grounds. Some larvae from the west coast spawning grounds can be transported to the North Sea, which they enter through the Fair Isle/Shetland Gap or to the north east of Shetland. Young haddock spend the first few months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



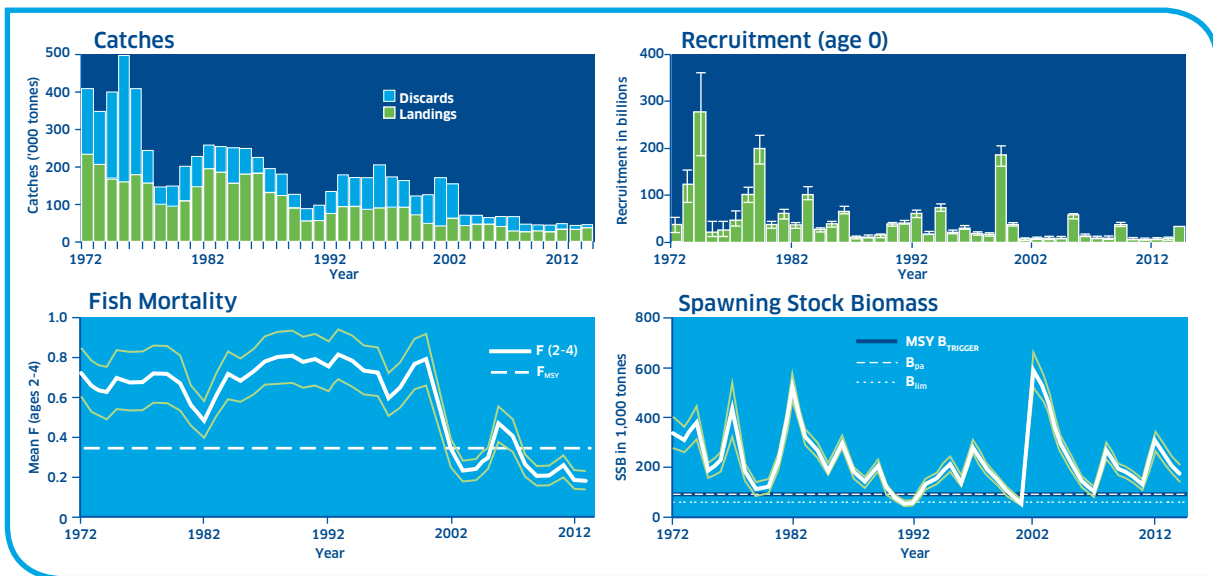
SPAWNING GROUNDS



2013 DISTRIBUTION OF LANDINGS BY SCOTTISH VESSELS (TONNES)

// ICES ADVICE ON MANAGEMENT

Information Source: ICES advice 2014 <http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/had-346a.pdf>
 Quoted text in italics.



MSY and precautionary approach reference points

	Type	Value
Management Plan (Subarea IV)	F _{MP}	0.3
	SSB _{MP}	100,000 t 140,000 t
MSY Approach (whole area)	MSY B _{trigger}	88,000 t
	F _{MSY}	0.35
Precautionary Approach (whole area)	B _{lim}	63,000t
	B _{pa}	88,000 t
	F _{lim}	Not defined
	F _{pa}	Not defined

State of stock and advice

- Fishing mortality in 2013 is estimated to be 0.183: this means that approximately 16.7%, 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 2014 at around 173,360 tonnes.
- Fishing mortality and biomass are below and above, respectively, the precautionary limits and the level which is consistent with achieving maximum sustainable yield.

ICES advises on the basis of the MSY approach that catches should be no more than 68 690 t for the whole assessment area. If rates of discards and industrial bycatch do not change from the average of the last three years (2011–2013), this implies human consumption landings of no more than 50 163 t. Measures to reduce discards should be taken in order to protect the incoming recruitment.

A management plan for the whole area needs to be developed, taking into account the need to protect local components of the stock.

A management plan for Subarea IV and Division IIIaW was agreed by EU and Norway in 2008. ICES has evaluated the plan and concludes that it can be accepted as precautionary. An EU management plan proposal for Division VIa was evaluated by ICES and is considered to be precautionary.

Adherence to the EU–Norway management plan in the North Sea and Skagerrak has contributed to lower fishing mortality levels and greatly improved stability of yield.

Discards are highly variable without obvious long-term trend but appear to have been declining in recent years. Discard rates in 2012 and 2013 are the lowest observed in the time-series and appear to be linked to low recruitment. The estimates of discards in the West of Scotland for 2013 are based primarily on sampling by Marine Scotland Science (MSS; covering around 16 trips), which indicates high discarding in the Scottish TR2 Nephrops fleet (both as a percentage of TR2 catches and as a percentage of total discards).

Management outcomes for 2015

The advice for this stock is given for Subarea IV (North Sea), Division IIIaW (Skagerrak), and Division VIa (West of Scotland), while the TACs for this stock are set for Division IIIa (EU waters) and Subarea IV, the whole of Subarea III, and Division VIa, respectively.

	IIIa	IV	VIa	Total
UK		28,576	3,532	32,108
Union	2,399	33,947	4,536	408,82

In December 2014 at the Council of Ministers meeting in Brussels, the EU Total Allowable Catch for the whole area (IIIa, IV & VI) haddock was set at 40,882 tonnes, with the UK quota for 2015 at 32,108 tonnes.

// HADDOCK STOCKS — ROCKALL (VIb, XII and XIV)

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.

2015 position : UK share 2,079 tonnes

Last Year : 976 tonnes

Landed into

Scotland in 2013 : 596 tonnes

Value for 2013 : £969,001

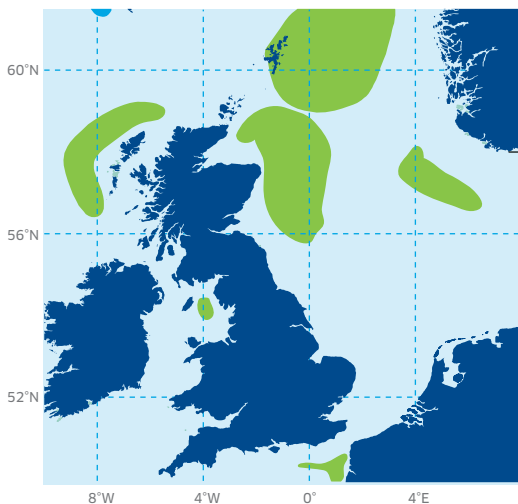
Biology

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

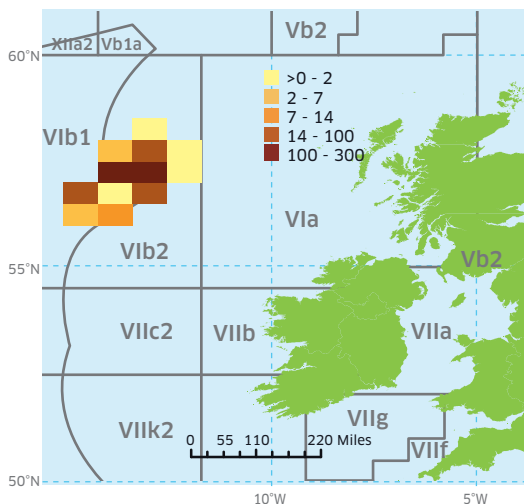
Rockall and the Hebrides may act as a barrier preventing eggs and larvae reaching Rockall from the east or southeast. This hypothesis is supported by tagging studies showing that no haddock tagged from other stocks have been recovered from Rockall.

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 two. 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.



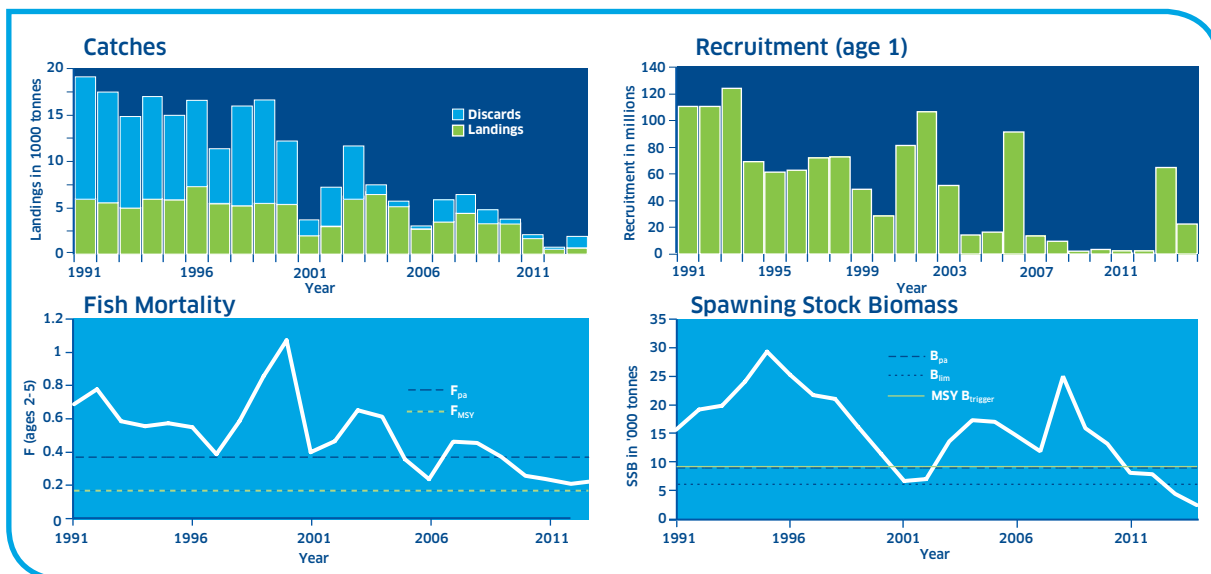
SPAWNING GROUNDS



2013 DISTRIBUTION OF LANDINGS BY SCOTTISH VESSELS (TONNES)

// ICES ADVICE ON MANAGEMENT

Information Source: ICES advice 2014 <http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/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}	0.2
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 2013 was estimated at 0.246 this means that nearly 21.8%, by number, of all fish between 2 and 5 years of age were caught.
- The spawning-stock biomass increased up to 2008 as a result of the 2001 and 2005 year classes but has decreased constantly since then. SSB in 2013 and 2014 is below B_{lim}. For 2014 it was estimated to be around 2,743 tonnes,
- Fishing mortality is below the precautionary approach limit and the level which is consistent with achieving maximum sustainable yield (F₂₀₁₃ < F_{MSY}).

ICES advises on the basis of the MSY approach that catches should be no more than 4310 t in 2015. If discard rates (at age) do not change from the average of the last eight years (2006–2013), this implies landings of no more than 2930 t. Further management measures should be introduced to reduce the discards, catches of small haddock, and to protect the incoming recruitment in 2013.

A management plan is under development and was evaluated by ICES in 2013. ICES concluded that a maximum F value of 0.2 in the HCR was required to ensure consistency with the precautionary approach under the low recruitment conditions observed since 2004.

Discards significantly increased in 2013 and are expected to remain high in 2014 as a consequence of the strong 2012 year class. Further technical measures to reduce bycatch discarding of the recruiting year classes should be considered. These might include increasing the mesh size in the square mesh panels and/or increasing the mesh size in gadoid fisheries catching haddock, as well as considerations on minimum landing size.

The basis for the assessment has not changed from last year: the MSY approach.

Management outcomes for 2015

In December 2014 at the Council of Ministers meeting in Brussels, the EU Total Allowable Catch for Rockall (VIb, XII and XIV) haddock was set at 2,580 tonnes, with the UK quota for 2015 at 2,079 tonnes.

// COD STOCKS — NORTH SEA (IIIa, IV and VIId)

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 are overfished with a high percentage of removals from the stock unaccounted for.

2015 position : UK share of 11,369 tonnes

Last Year : 10,827 tonnes

Landed into

Scotland in 2013 : 10,653 tonnes

Value for 2013 : £20.73 million

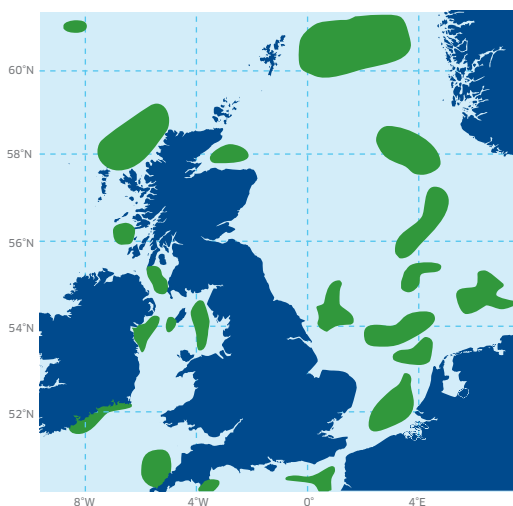
Biology

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.

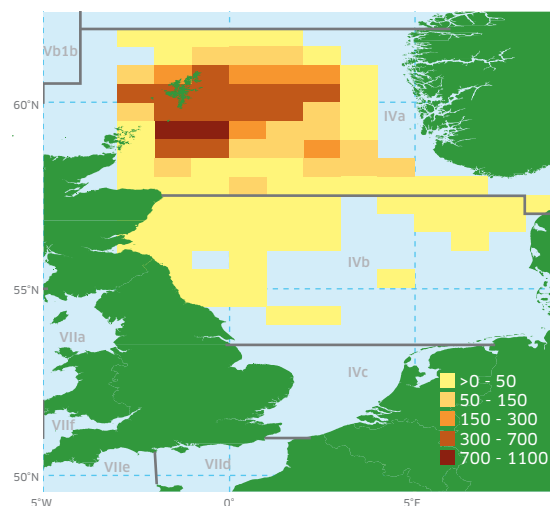
Many cod now reach maturity at two years old, with 50% mature by three years old. By the time they reach five years, all cod are mature.

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.



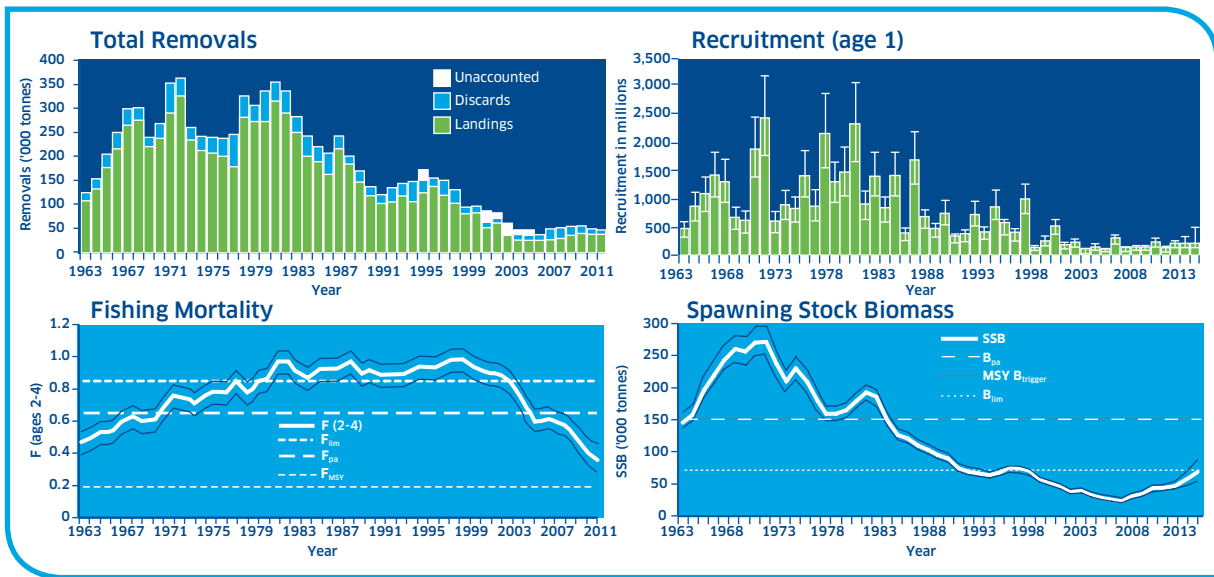
SPAWNING GROUNDS



2013 DISTRIBUTION OF LANDINGS BY SCOTTISH VESSELS (TONNES)

// ICES ADVICE ON MANAGEMENT

Information Source: ICES advice 2014 <http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/cod-347d.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 2013 was estimated to be 0.398: this means that approximately 32.8%, 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, and is estimated to be just below B_{lim} in 2014 at 68,528 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 ($F_{2013} > F_{MSY}$).
- The ICES advice is in accordance with the long-term management plan and recommends that landings in 2015 should be no more than 26,713 tonnes for areas IIa, IIIa Skagerrak, IV and VIId combined.

Scotland implemented in February 2008 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 at reducing mortality on cod and leading to a reduction in discard numbers. One measure was real-time closures. 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). During 2011 there were 185 of these larger closures, while there were 173 in 2012. ICES notes that from the initial year of operation (2008) cod discarding rates in Scotland have decreased from 62% in 2008 to 24% (in weights) in 2011 and 2012, but have increased again to 31% in 2013.

The introduction of closed-circuit TV (CCTV, 20% of landings in 2013) and fully documented fisheries (FDF) programmes starting in 2010 in Scotland, Denmark, Germany, the Netherlands, and England is expected to have contributed to the reduction of cod mortality. Under this scheme, UK vessels are not permitted to discard any cod, while Danish and German vessels are still permitted to discard undersized cod. For all vessels taking part, all cod caught are counted against the quota. Some of the fleets in this programme have shown a noticeable increase in smaller fish in the landings, which could imply that less highgrading occurs.

Management outcomes for 2015

In December 2014 the Council of Ministers decided that the EU Total Allowable Catch for cod in Subarea IV and Division IIa should be 24,227 tonnes. The UK quota for 2015 was set at 11,369 tonnes. This quota decision is consistent with the existing cod long term management plan (LTMP). This plan (affecting a number of cod stocks) includes an effort management scheme that 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 applied in 2014. To justify existing and future effort buy back the UK was committed to the introduction of highly selective gears and several gears were developed, tested and introduced.

// COD STOCKS – WEST OF SCOTLAND (VIa)

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 71% caught in 2012 was discarded.

2015 position : UK share zero tonnes

Last Year : zero tonnes

Landed into

Scotland in 2013 : 130 tonnes

Value for 2013 : £ 249,002

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.

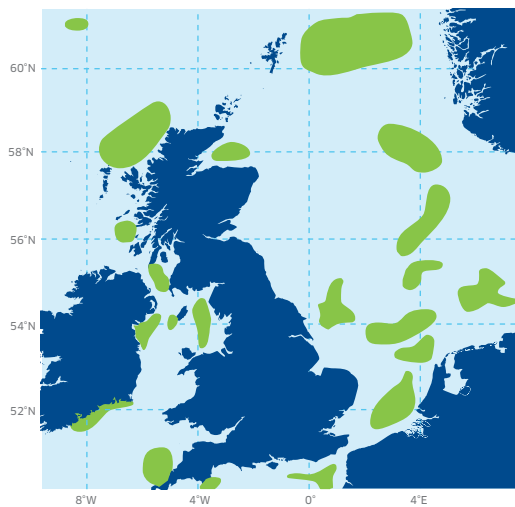
Biology

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 largely appear to be resident all year round.

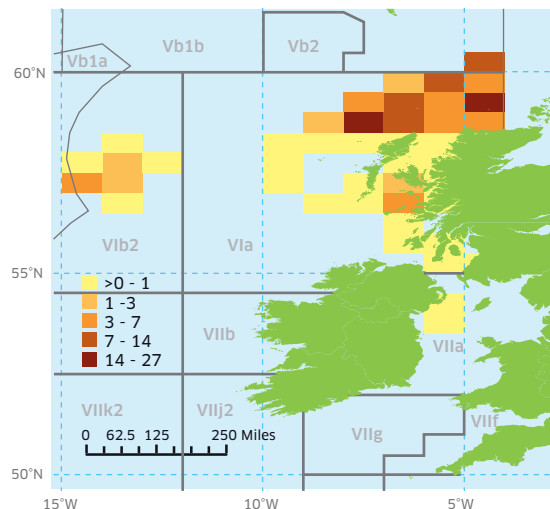
Many cod reach maturity by two years old and by the time they reach four years, all cod are mature. An average three year old female can produce around four million eggs in a season. Spawning on the west coast takes place between January and April with a peak in March and occurs in most offshore areas.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

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.



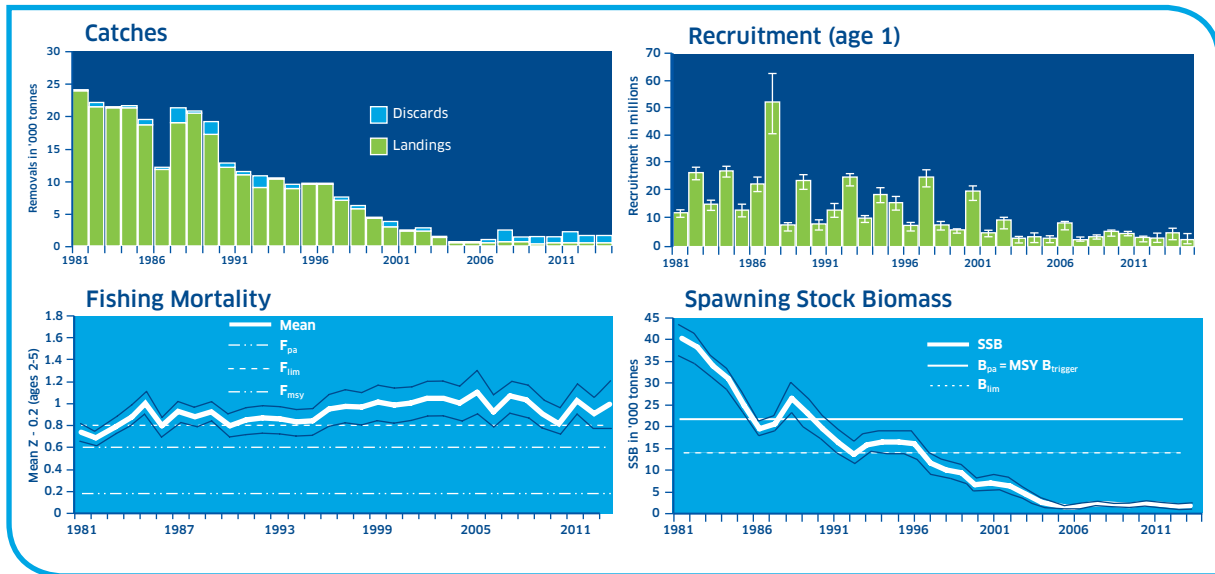
SPAWNING GROUNDS



2013 DISTRIBUTION OF LANDINGS BY SCOTTISH VESSELS (TONNES)

// ICES ADVICE ON MANAGEMENT

Information Source: ICES advice 2014 <http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/cod-scov.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 in 2013 was estimated to be high.
- Spawning stock biomass for 2014 was estimated to be just over 2,043 tonnes.
- Fishing mortality is currently higher than 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.
- ICES advises on the basis of the MSY and precautionary approach that there should be no directed fisheries and that bycatch and discards should be minimized in 2015.

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 - RTCs) to protect it are essential to ensure that it contributes to the rebuilding of the stock. The number of RTCs west of Scotland were four in 2008, twenty in 2009, nineteen in 2010, four in 2011, and nine in 2012, representing 27%, 14%, 12%, 2%, and 5% of the total RTCs in each year. RTCs are determined by *lpue*, based on fine-scale VMS data and daily logbook records, and also by on-board inspections. The low number of RTCs west of Scotland result from few instances of high *lpue* in the area. Estimates of continuing high discard rates in Division VIa indicate the scheme has not been effective west of Scotland.

The stock is managed under the cod long-term management plan (EC 1342/2008). Until the 2012 assessment benchmark ICES considered it not possible to assess unaccounted mortality accurately. As a consequence ICES has not yet evaluated if the management plan is in accordance with the precautionary approach.

However, management measures taken so far have not constrained catches and no increase in stock biomass has occurred.

Considering the low SSB and low recruitment over the last decade, it is not possible to identify any non-zero catch which would be compatible with the MSY approach. Also, bycatches including discards of cod in all fisheries in Division VIa should be reduced to the lowest possible level and further technical measures to reduce catches should be implemented. It is necessary to reduce all sources of fishing mortality to recover the stock above B_{pa} as quickly as possible.

Management outcomes for 2015

The fishery is managed by a combination of TAC, area closures, technical measures, and effort restrictions. TAC restrictions on landings and effort and spatial management of fisheries catching cod in Division VIa have not controlled mortality levels. Catch (landings + discards) is 9 times the reported landings.

In December 2014, 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 2015 of zero tonnes. A 1.5% bycatch allowance has however been introduced for EU fleets fishing this stock. This 1.5% rule applies to the retained part of the catches and does not constrain discards.

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.

The west of Scotland, UK also committed to evaluation of its demersal fish selectivity measures and to exploring further selectivity developments in the light of findings. Furthermore, additional surveys were conducted in 2014 and are planned to 2015.

// WHITING STOCKS – NORTH SEA (IV & VIId)

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.

2015 position : UK share 8,739 tonnes

Last Year : 10,193 tonnes

Landed into
Scotland in 2013 : 10,046 tonnes

Value for 2013 : £ 10.34 million

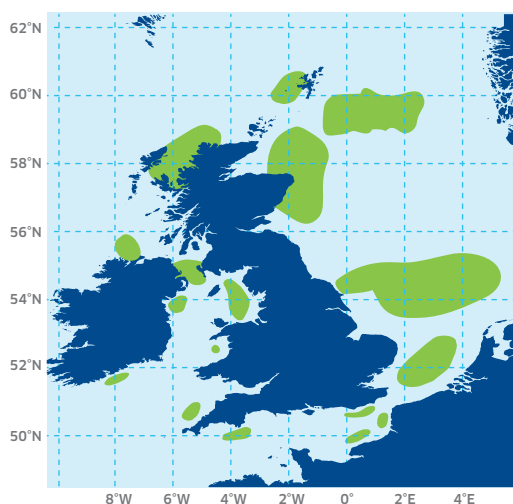
Biology

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.

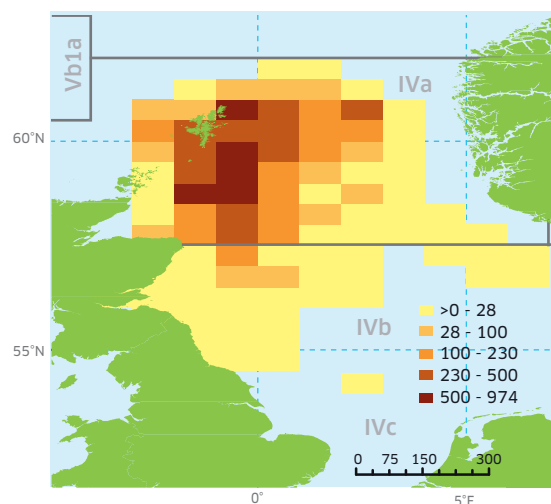
At four years old, a single female fish of reasonable size produces more than 400,000 eggs. By two years old, however, most whiting are mature and able to spawn. The spawning season lasts from late January until June. The spawning season of an individual female lasts at least ten weeks, during which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



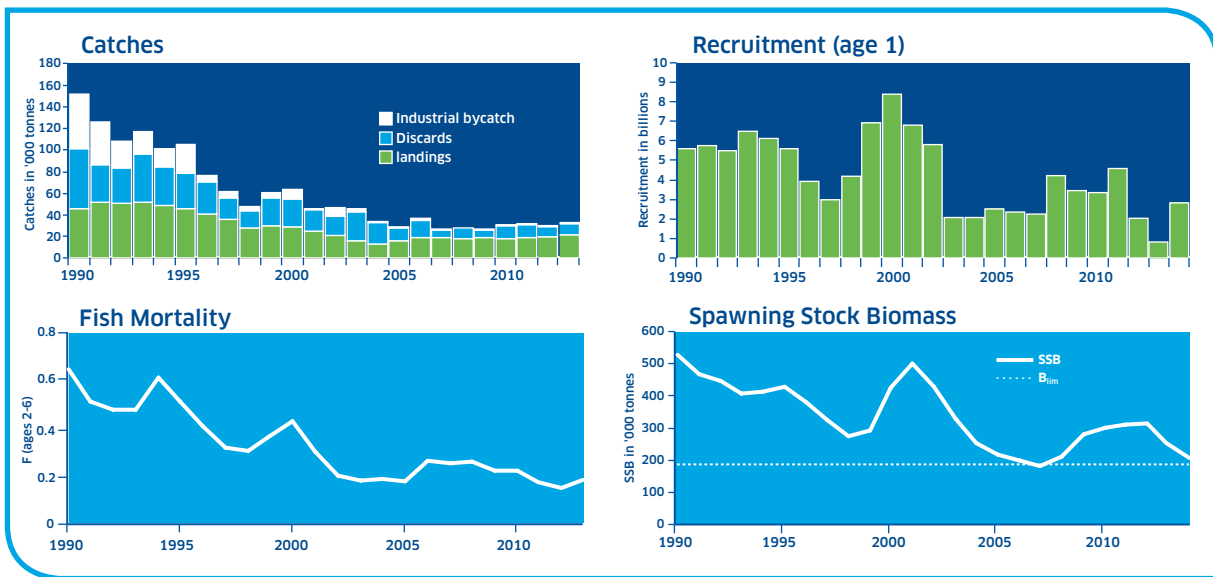
SPAWNING GROUNDS



2013 DISTRIBUTION OF LANDINGS BY SCOTTISH VESSELS (TONNES)

// ICES ADVICE ON MANAGEMENT

Information Source: ICES advice 2014 <http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/whg-47d.pdf>
 Quoted text in italics.



MSY and precautionary approach reference points

	Type	Value
Management Plan	SSB _{MP}	Undefined
	F _{MP}	0.15
MSY Approach	MSY B _{trigger}	Undefined
	F _{MSY}	Undefined
Precautionary Approach	B _{lim}	184,000 t
	B _{pa}	Undefined
	F _{lim}	Undefined
	F _{pa}	Undefined

State of stock and advice

- Fishing mortality in 2013 was estimated to be 0.186: this means that approximately 16, 9%, by number, of all fish aged between 2 and 6 years were caught.
- Spawning stock biomass in 2014 was estimated to be approximately 204,360 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 ICES advice is based on precautionary considerations, recommending a human consumption TAC in 2015 of 30, 579 tonnes for Subarea IV and Division VIId. Management for Division VIId should be separated from the rest of Subarea VII.

In 2011 ICES considered an F target of 0.3 (with a 15% TAC constraint) to be consistent with long-term stability even when recruitment is poor for several

consecutive years. Based on a considerable revision in the level of fishing mortality in 2012 (caused by new estimates in natural mortality), the target F is no longer considered applicable and the management target needs re-evaluation. The management plan agreed by EU and Norway in 2014 is based on the previous plan with an adjusted target F of 0.15. ICES evaluated this harvest control rule and considered this is precautionary.

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

The use of new natural mortality estimates has substantially increased estimates of recruitment and SSB, and decreased estimates of fishing mortality by approximately 25%, while the trends have remained similar.

The basis for the assessment has not changed from last year. The basis for the advice has changed from precautionary considerations to the EU-Norway management plan. The advice for 2015 was updated in November, based on new recruitment information from the IBTS Q3 survey. The November advice is also based on the EU-Norway management plan.

Management outcomes for 2015

In December 2014 at the Council of Ministers meeting in Brussels, the EU Total Allowable Catch for North Sea (IIIa & IV) whiting was set at 13,060 tonnes, with the UK quota for 2015 at 8,739 tonnes.

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

// WHITING STOCKS — WEST OF SCOTLAND

(VI, EC waters of Vb and international waters of XII and XIV)

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.

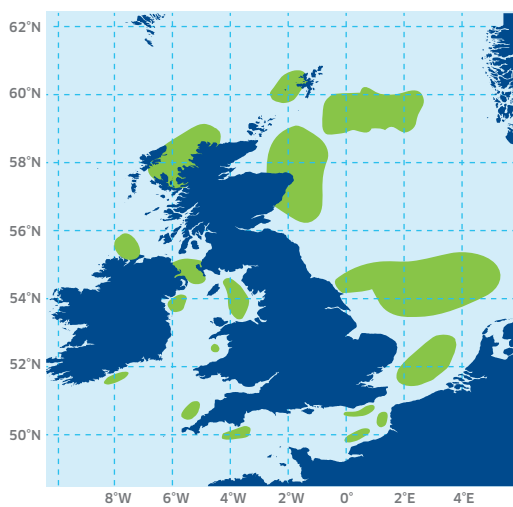
2015 position : UK share 150 tonnes
Last Year : 167 tonnes
Landed into
Scotland in 2013 : 117 tonnes
Value for 2013 : £108,000

Biology

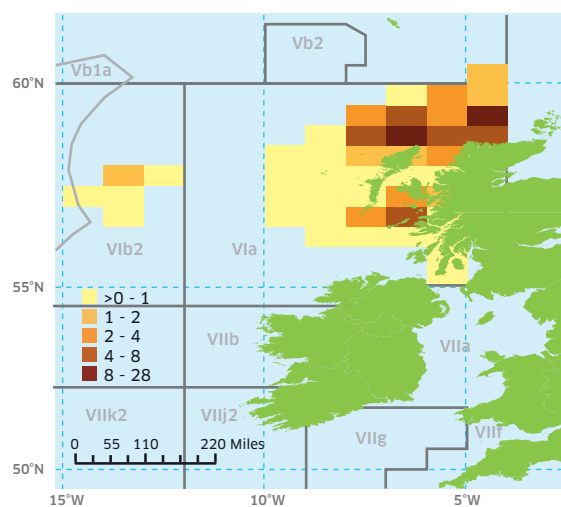
Whiting is widely distributed throughout the west coast of Scotland, and high numbers of immature fish can be found in most sea lochs and inshore areas. The offshore stock is composed of older and larger fish which are recruited from the inshore shoals. Tagging experiments, and the use of fish parasites 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.



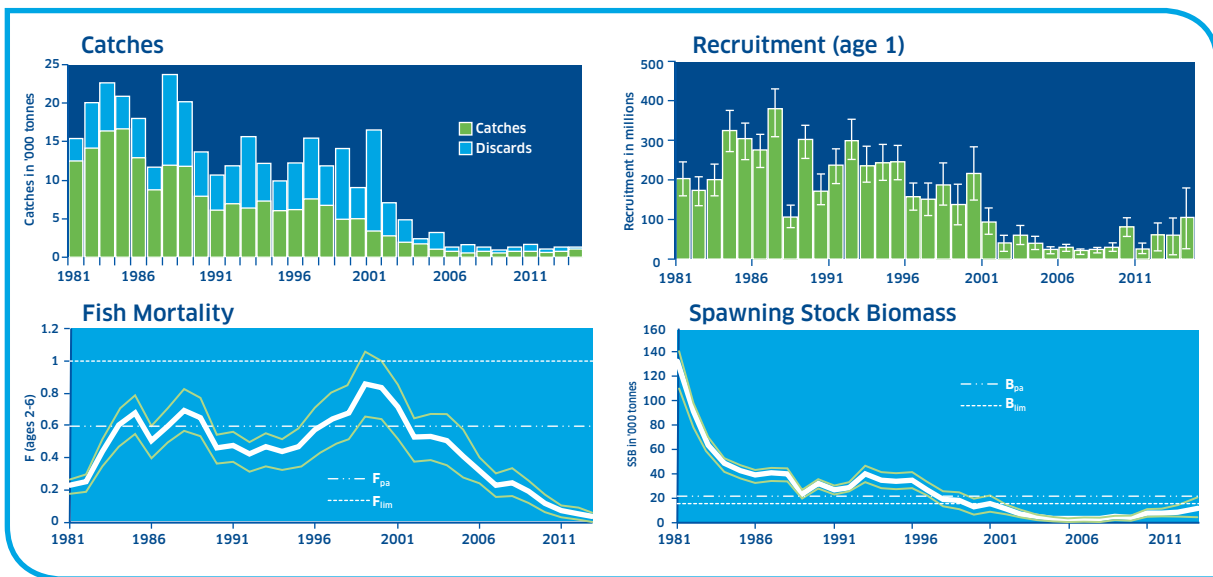
SPAWNING GROUNDS



2013 DISTRIBUTION OF LANDINGS BY SCOTTISH VESSELS (TONNES)

// ICES ADVICE ON MANAGEMENT

Information Source: ICES advice 2014 <http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/whg-scov.pdf>
 Quoted text in italics.



MSY and precautionary approach Reference Points

	Type	Value
MSY Approach	MSY $B_{trigger}$	Not defined
	F_{MSY}	Not defined
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 has increased slightly since an all-time low in 2005, but remains very low compared to the historical estimates (and well below B_{lim}).
- Fishing mortality and biomass cannot be determined with regard to either the Precautionary Approach or the transition to MSY Approach.
- ICES advises on the basis of the precautionary approach that catches in 2015 should be reduced to the lowest possible level – no directed fishery, and that effective technical measures should be implemented to reduce discards in the Nephrops (TR2) fleet.

There is currently no specific management plan for this stock.

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. Catches should be reduced to the lowest possible level.

There are strong indications that management control is not effective in limiting the catch. The proportion of discarded fish is very high and appears to have increased in recent years. More than half of the annual catch weight consists of undersized or low-value whiting which are discarded. Approximately 80% of these discards come from the Nephrops (TR2) 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 and 2011 year classes are relatively strong compared to other recent recruitments.

The basis of this year's advice is the same as last year, the precautionary approach.

Management outcomes for 2015

In December 2014 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 263 tonnes. The UK quota for 2015 was set at 150 tonnes.

This quota decision was in line with the ICES advice to reduce catches. The west of Scotland, UK also committed to evaluation of its demersal fish selectivity measures and to exploring further selectivity developments in the light of findings. Furthermore, additional surveys were conducted in 2014 and are planned to 2015.

// SAITHE STOCKS — NORTH SEA AND WEST OF SCOTLAND (IIIa, IV and VI)

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 third most landed roundfish species caught by Scottish fishermen.

2015 position : UK share 8,271 tonnes

Last Year : 9,303 tonnes

Landed into Scotland in 2013 : 10,468 tonnes

Value for 2013 : £8.718 million

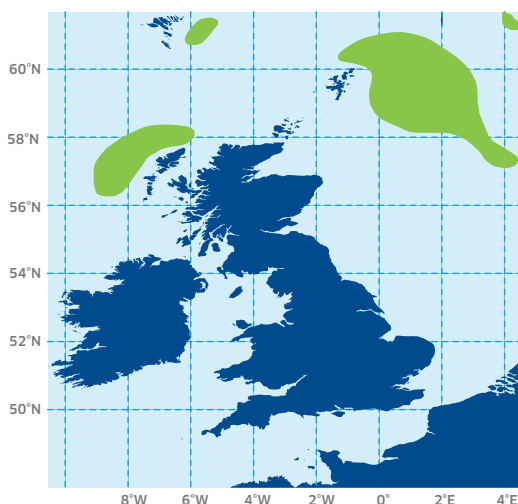
Biology

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

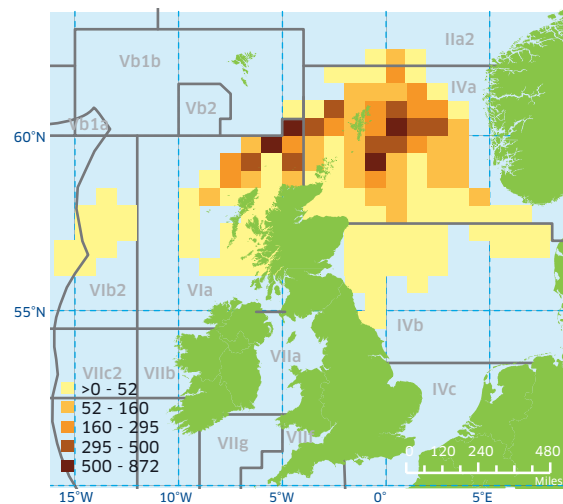
shoals which move around the water column and are often caught hundreds of metres above the seabed.

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.



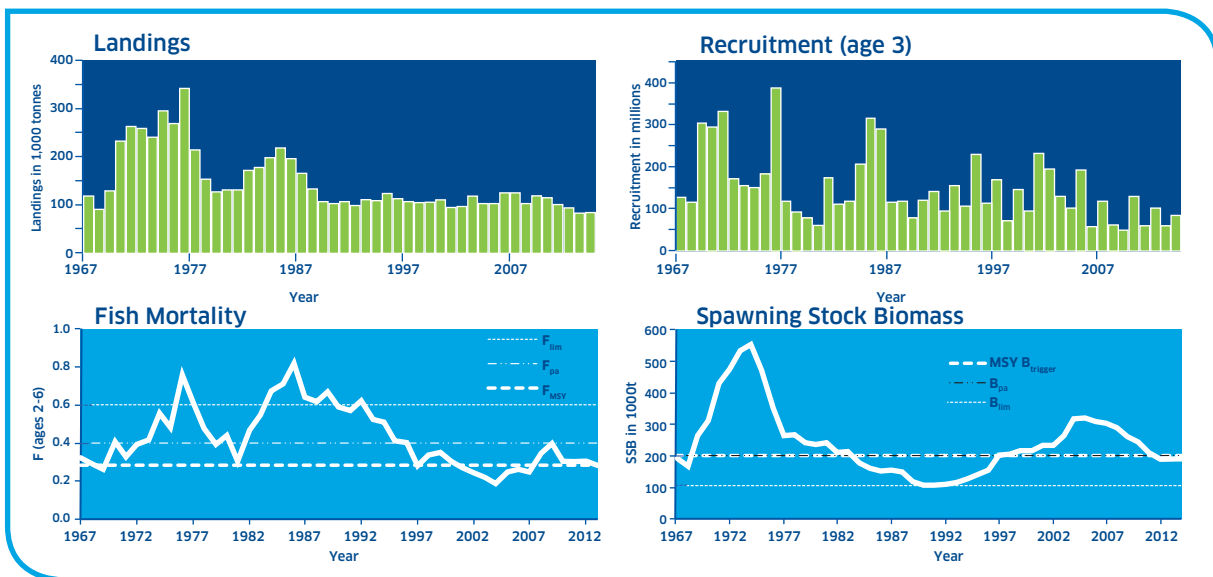
SPAWNING GROUNDS



2013 DISTRIBUTION OF LANDINGS BY SCOTTISH VESSELS (TONNES)

// ICES ADVICE ON MANAGEMENT

Information Source: <http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/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

State of stock and advice

- Fishing mortality, F , has generally increased since 2004. F in 2013 was estimated to be 0.301 which is just below F_{pa} and at around the same value for F_{MSY} .
- 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 just below B_{pa} .
- Fishing mortality and biomass are both below their precautionary limits. However fishing mortality is slightly above the level which is consistent with achieving maximum sustainable yield ($F_{2012} > F_{MSY}$).
- This year's advice is in accordance with the EU-Norway management plan, with the 15% TAC constraint imposed, resulting in an advised TAC of 80,097 tonnes in 2015 for the whole assessment area.

There has been a southern shift in geographical distribution in 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 aged fish.

The EU-Norway management plan was reconsidered in February 2013, but no

modification was implemented. It was previously evaluated by ICES in 2012 and considered to be consistent with the precautionary approach in the short term (< 4 years).

The current assessment estimates SSB in 2014 to be 13% higher than estimated in 2013, The basis for the advice is the same as last year: the management plan.

In contrast to single-species advice there is no single recommendation for mixed fisheries (ICES, 2013b), but rather a range of plausible scenarios, assuming fishing patterns and catchability in 2013 and 2014 are unchanged from those in 2012. Major differences between the outcomes of the various scenarios indicate potential undershoot or overshoot of the advised landings corresponding to the single-species advice. As a result, fleet dynamics may change, but cannot be determined.

Assuming fishing patterns and catchability in 2014 and 2015 are unchanged from those in 2013, cod and Nephrops in FU 6 are the limiting species (73% and 27%, respectively) for the fleets in the North Sea demersal fisheries in 2015.

Following the 'cod' scenario (full implementation of the cod management plan), and also the effort management scenario, the saithe management plan catch options could not be fully utilized.

Management outcomes for 2015

In December 2014 at the Council of Ministers meeting in Brussels, the EU Total Allowable Catch for North Sea and west of Scotland saithe was set at 37,732 tonnes, with the UK quota for 2015 at 8,271 tonnes.

This quota decision was reached in accordance with ICES advice and the saithe long term management plan and represents a reduction in fishing opportunity in 2015.

// MONKFISH STOCKS – NORTH SEA, CELTIC SEA AND WEST OF SCOTLAND (IIIa, IV and VI)

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

Although only seventh by weight, they were the fourth most valuable fish species landed into Scotland in 2013. Caught mainly by bottom trawl gear in the northern North Sea to the north and west of Scotland, close to the shelf edge.

2014 position : UK share 9,276 tonnes

Last Year : 7,739 tonnes

Landed into

Scotland in 2013 : 6,453 tonnes

Value for 2013 : £19.3 million

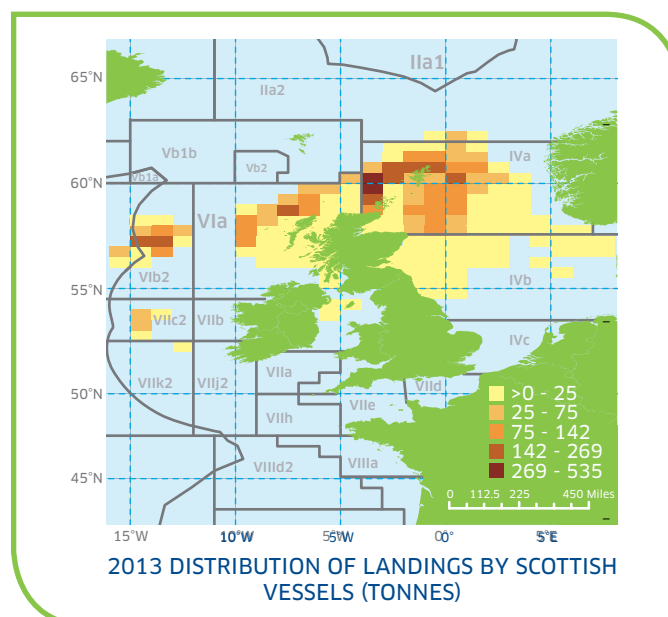
Biology

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.

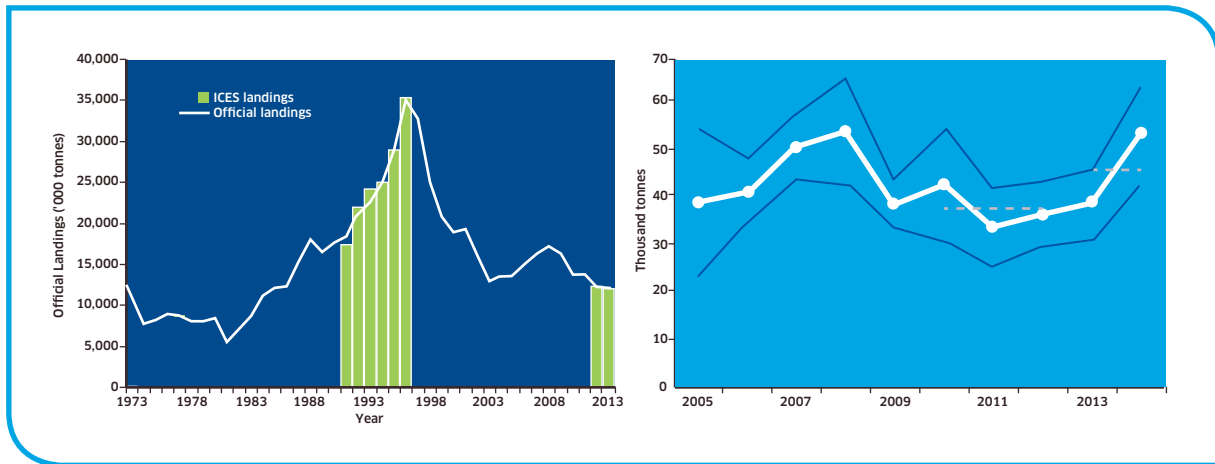
Spawning takes place mainly during the first six months of the year and is believed to occur in relatively deep water. Although monkfish have a long spawning season, each female probably produces only one batch of eggs, unlike cod, haddock and whiting, which spawn many times during a single spawning 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 2014 <http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/ang-ivvi.pdf>
 Quoted text in italics.




ANGLERFISH (*Lophius Piscatorius* AND *L. budegassa*).

LEFT: OFFICIAL AND ICES LANDINGS (THOUSAND TONNES) IN SUBAREAS IV AND VI AND DIVISION IIIA.

RIGHT: STOCK BIOMASS (THOUSAND TONNES) FROM SCO-IV-VI-AMISS-Q2. THE DASHED HORIZONTAL LINES INDICATE THE AVERAGE OF THE RESPECTIVE YEAR RANGE. DARK BLUE LINES MARK THE 95% CONFIDENCE INTERVAL.

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
Qualitative evaluation		Increasing

exploitation status. Therefore, catches should be reduced.

- *No management objectives are known to ICES.*

The basis for the advice this year is the same as last year, i.e. ICES approach to data-limited stocks. Previous concerns about underreporting of landings are no longer considered an issue, and therefore ICES is able to provide quantified advice this year.

ICES advises that catches should be increased by 20% in relation to the last two years' average landings (2012–2013), corresponding to landings of no more than 14 702 t. All catches are assumed to be landed.

State of stock and advice

- *No accepted analytical assessment can be presented for this stock.*
- *Recent dedicated anglerfish surveys, the Scottish and Irish anglerfish and megrim industry/science survey for the Northern shelf (SCO-IV-VI-AMISS-Q2) in Division IVa and Subarea VI, indicate a decline in abundance and biomass since 2008.*
- *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*

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 2015

In December 2014 at the Council of Ministers meeting in Brussels, 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 was set at 14,703 tonnes, with the UK quota for 2015 at 9,276 tonnes.

// 2015 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.

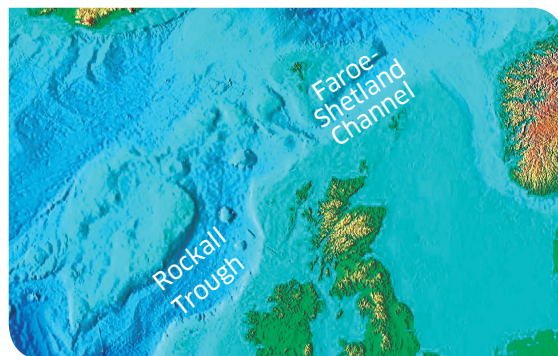
This deepwater area contains some of the most extensive and diverse coldwater coral reef ecosystems in the North Atlantic. There is little doubt that bottom contact fishing operations

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 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, anglerfish,



BATHYMETRIC MAP OF UK WATERS

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 2015 and 2016

The latest (2013) official information for deepwater species landed into Scotland by UK vessels shows that total landings of roundnose grenadier, blue ling, black scabbardfish and Greenland halibut amounted to 408 tonnes at a value of approximately £854,456. Species like hake and ling which are also found in the shallower shelf waters, contributed 9,230 tonnes to the 2013 Scottish fishery at a value of nearly £19.9million. There were no landings of orange roughy by Scottish vessels in 2013.

For the 2014 and 2015 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 by-catch from the deepwater mixed fishery. For 2015, a zero TAC for deep-sea sharks has been set, with no quota for by-catch being available from the start of this year. For deep-sea stocks the TACs are set every two years. In December 2014, the Council of Ministers meeting in Brussels, decided the quotas for the next 2 years – 2015 and 2016. See table below.

Species	Area	2014 UK Quota (t)
Black scabbardfish	Community waters of V, VI, VII & XII	208
Roundnose grenadier	Community waters of Vb, VI & VII	194
Blue ling	Community waters of II, IV & V	14
Blue ling	community and international waters of VI & VII	912
Greenland Halibut	Community waters of IIa & IV; community and international waters of Vb & VI	1,090
Hake	Community waters of IIa & IV	574
Hake	Community waters of VI, VII; community and international waters of Vb; international waters of XII, XIV	9,155
Ling	Community waters of IV	1,869
Ling	Community and international waters of VI, VII, VIII, IX, X, XII, XIV	2,869
Tusk	Community waters of IV	96
Tusk	Community waters of V, VI & VII	264

// SCOTTISH SHELLFISH STOCKS



// 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 over 30,000 tonnes in the mid 2000s. Landings in 2013 of just under 18,000 tonnes had a first sale value of £61.7 million making *Nephrops* the second most valuable species landed into Scotland. 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 Catches (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 meters 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 around 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.

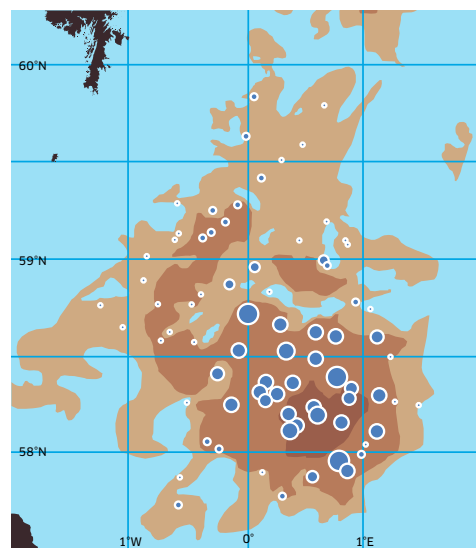
Nephrops in different areas grow at different rates and mature at different sizes. This variation is related to the density of animals and sediment type. On the softest mud, *Nephrops* densities are low, but the animals grow relatively fast, and reach a larger maximum size. The largest animals are colloquially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

Assessment

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 conversion factor to the relative abundance index, an estimate of the absolute abundance of *Nephrops* is obtained. A proxy for fishing mortality known as the 'harvest rate' is derived as the ratio of total catch to absolute abundance.



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

Information Source: ICES advice 2014
<http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/Neph-IV.pdf>

2015 Position	: TAC 17,843 tonnes UK share 15,456 tonnes
2013 Landings	: 10,800 tonnes
Stock Health	: In most stocks fishing mortality is at or below the F_{MSY} proxy
Importance	: Key shellfish species
Location	: Widespread on muddy grounds
Latest Assessment	: May 2014

State of the stocks

In 2014, ICES conclusions about *Nephrops* stock status were based on trends in the UWTV survey, fishery and catch size composition data.

Farn Deeps: the stock size has declined since 2005 and has been fluctuating near $MSY B_{trigger}$ since 2007. Harvest rates have been above F_{MSY} for all years except 2008.

Fladen Ground: the stock size has declined from the highest observed value in 2008 and is just above the $MSY B_{trigger}$. The harvest rate has declined in recent years, and fell to approximately 3 % in 2013 which is well below F_{MSY} .

Firth of Forth: the stock is well above the $MSY B_{trigger}$ level. The harvest rate decreased in 2013 to 15.6 % and is now below F_{MSY} .

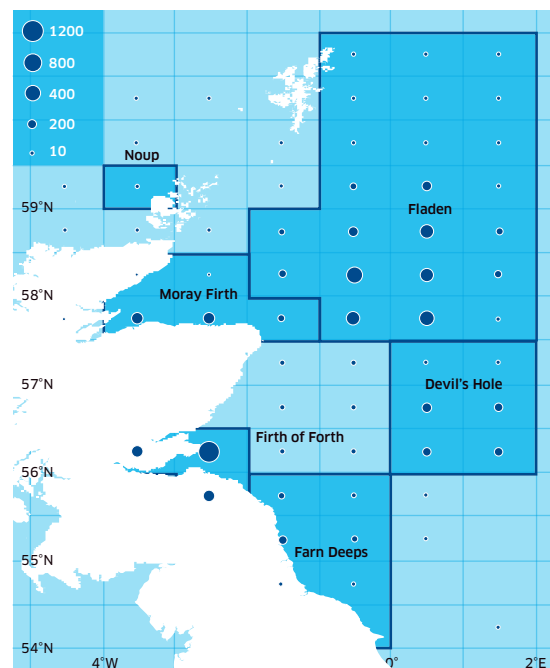
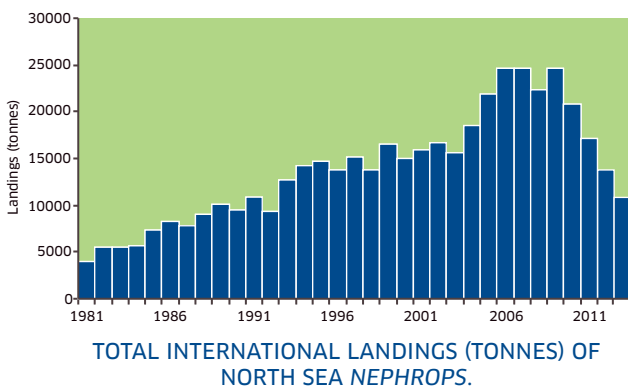
Moray Firth: the stock declined in 2007-2012 but increased again in 2013. The harvest rate decreased in 2013 to 5.8 % and is now below F_{MSY} .

North Sea stocks

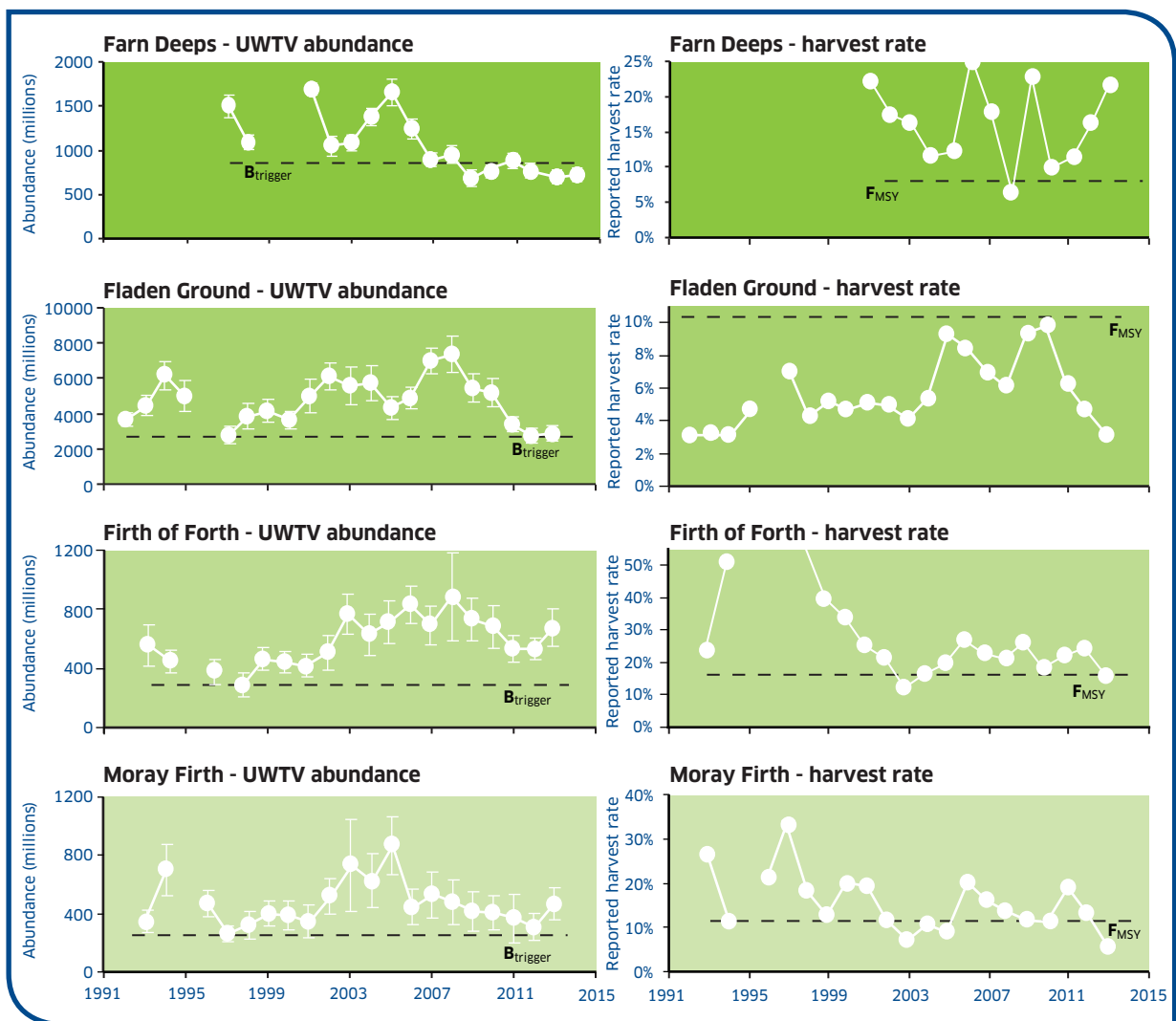
In the North Sea, Scottish fishermen exploit *Nephrops* in the Farn Deeps, Firth of Forth, Moray Firth, Fladen Ground and to a lesser extent at the Noup and Devil's Hole. Most are caught by trawlers targeting *Nephrops*. In some areas, particularly the Fladen Ground, they are also caught by whitefish trawlers.

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



DISTRIBUTION OF SCOTTISH NEPHROPS LANDINGS (TONNES) IN THE NORTH SEA IN 2013 (UK VESSELS INTO SCOTLAND)



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 between $F_{0.1}$ and F_{MAX} (proxies for F_{MSY}) were recommended.

On the basis of this approach, ICES has advised the following limits on landings (for the main FUs of Scottish interest) for 2015¹:

- Farn Deeps** Landings: 1,127 tonnes (Catch = 1,281 tonnes)
- Fladen** Landings: 10,759 tonnes (Catch = 10,759 tonnes, all catches are assumed to be landed)
- Firth of Forth** Landings: 1,769 tonnes (Catch = 2,050 tonnes)
- Moray Firth** Landings: 1,185 tonnes (Catch = 1,245 tonnes)

In order to provide information for implementation of the landing obligation, ICES has also given estimates of future catch (shown in brackets above) in addition to landings for 2015. These are based on the assumption that discard rates do not change from the average of the last three years (2011-2013). Note that the catch estimate includes *Nephrops* expected to survive the discarding process – assumed to be 25% of the total number discarded.

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 advice and considers that management of fishing mortality on *Nephrops* stocks would best be achieved if measures, including catch restrictions, were implemented at the level of the functional unit.

¹Advice for Farn Deeps *Nephrops* is based on 2014 UWTV survey data while other advice is based on survey data from 2013.

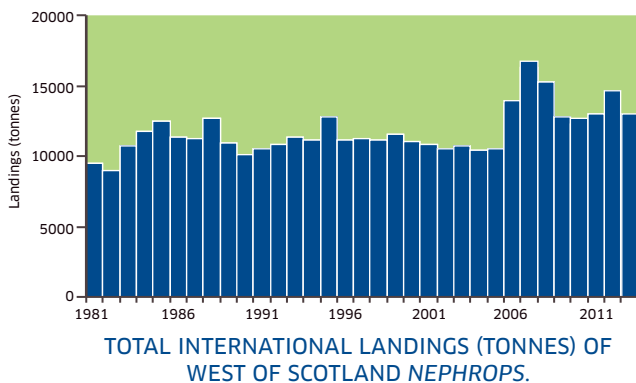
// WEST COAST : ICES ADVICE ON MANAGEMENT

Information Source: ICES advice 2014
<http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/Neph-VIa.pdf>

2015 Position	: TAC 14,190 tonnes UK share 13,854 tonnes
2013 Landings	: 12,700 tonnes
Stock Health	: Stocks above $B_{trigger}$ and fishing mortality fluctuating around the F_{MSY} proxy
Importance	: Key shellfish species
Location	: Widespread on muddy grounds
Latest Assessment	: May 2014 (advice released in autumn to account for 2014 surveys)

West of Scotland stocks

On the west coast of Scotland, there are *Nephrops* fisheries in the North Minch, South Minch, the Clyde and the the Sound of Jura and to a lesser extent at Stanton Bank. 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 17 % of landings in the North Minch and almost 20 % in the South Minch in 2013. 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 can 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.



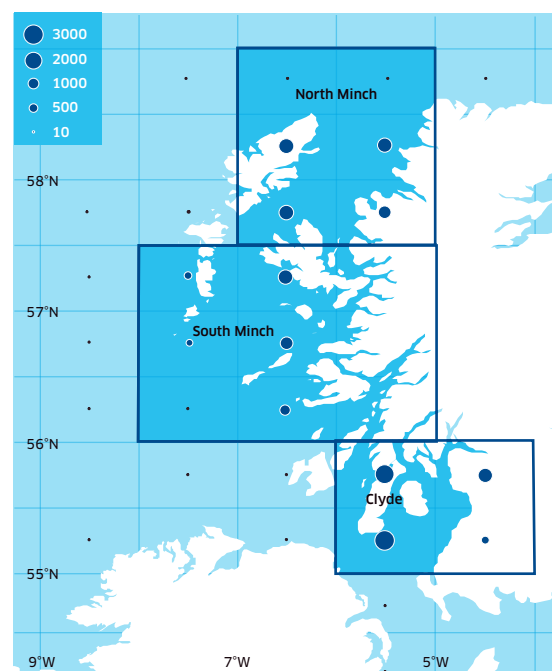
State of stocks

In 2014, ICES conclusions about *Nephrops* stock status were based on trends in the UWTV survey, fishery and catch size composition data.

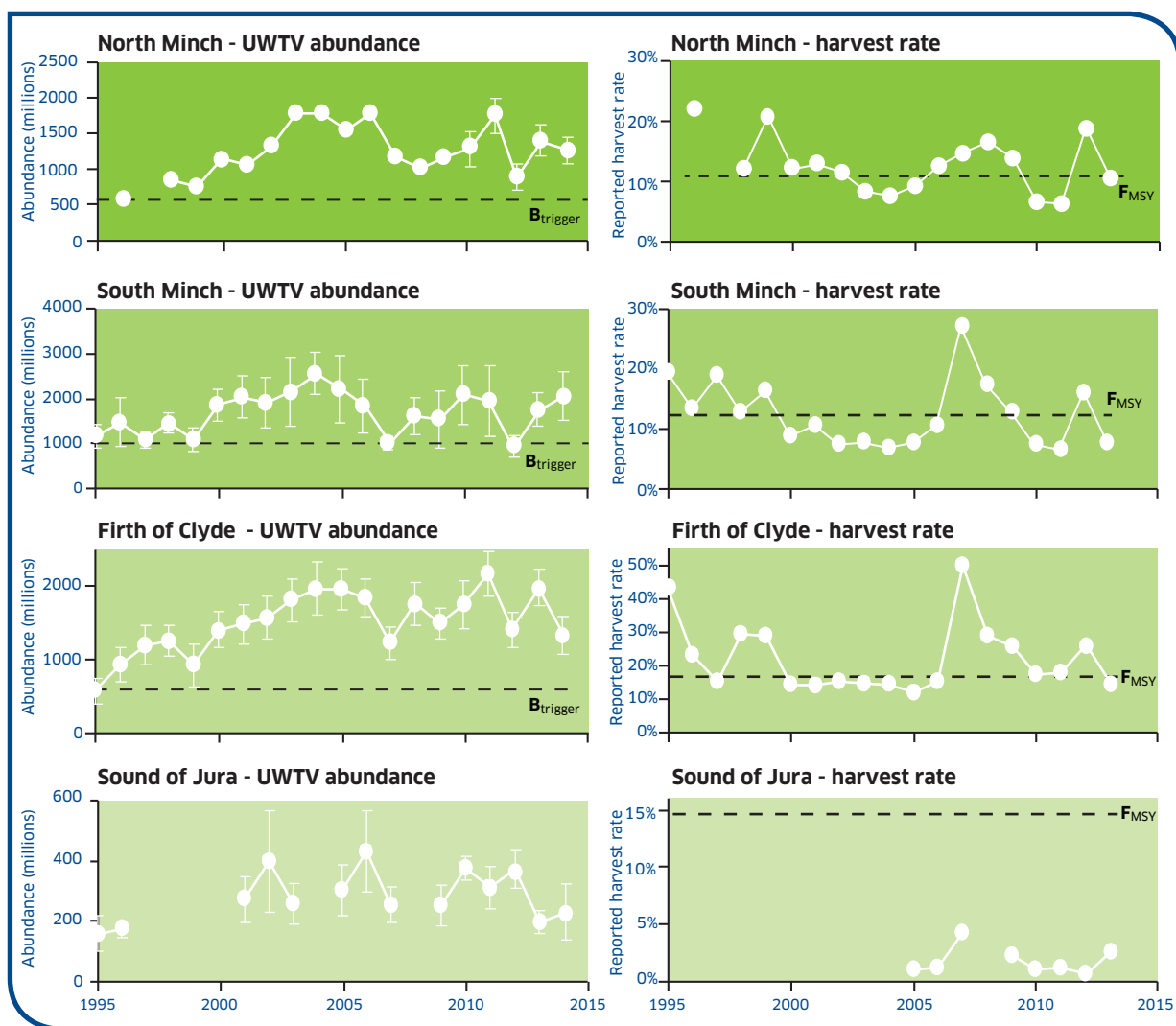
North Minch: The stock has been above $MSY B_{trigger}$ for more than 15 years. In 2014 estimated abundance has seen a small 11 % decrease in comparison to 2013. The historical harvest ratios (removals/UWTV abundance) have fluctuated around the F_{MSY} proxy. The harvest ratio in 2013 decreased to 10.0 % and is below the F_{MSY} proxy.

South Minch: The stock fell below $MSY B_{trigger}$ in 2012 but has increased since and is now above $MSY B_{trigger}$. The harvest ratio (removals/UWTV abundance) has decreased and is now below F_{MSY} proxy.

Clyde: UWTV abundance remains above the $MSY B_{trigger}$. The harvest rate (removals/UWTV abundance) for *Nephrops* in the Firth of Clyde decreased in 2013 and is now below the proposed F_{MSY} proxy. Harvest rates for *Nephrops* in the Sound of Jura have been well below the proposed F_{MSY} proxy in recent years. UWTV abundance in 2013 was at the lowest observed level since 2000, with 2014 showing only a slight increase. The UWTV series remains too short and patchy to propose an $MSY B_{trigger}$.



DISTRIBUTION OF SCOTTISH WEST COAST NEPHROPS LANDINGS (TONNES) IN 2013 (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} (proxies for F_{MSY}) were recommended. On the basis of this approach, ICES has advised the following limits on landings (by FU) for 2015:

North Minch	Landings: 3,092 tonnes (Catch = 3,312 tonnes)
South Minch	Landings: 6,382 tonnes (Catch = 6,567 tonnes)
Clyde	Landings: 4,390 tonnes (Catch = 4,861 tonnes)

In order to provide information for implementation of the landing obligation, ICES has also given estimates of future catch (shown in brackets above) in addition to landings for 2015. These are based on the assumption that discard rates do not change from the average of the last three years (2011-2013). Note that the catch estimate includes *Nephrops* expected to survive the discarding process - assumed to be 25% of the total number discarded.

ICES management advice is formulated for *Nephrops* FUs, whereas management continues to be applied to the larger ICES finfish areas. STECF supports the ICES advice and considers that management of fishing mortality on *Nephrops* stocks would best be achieved if measures, including catch restrictions, were implemented at the level of the functional unit.

// BROWN CRAB

Latin name	: <i>Cancer pagurus</i>
Common names	: edible crab, brown crab
Landed into Scotland in 2013 (by UK vessels)	: 10,800 tonnes
Value for 2013	: £13.8 million

Introduction

The brown crab fishery is economically a very important fishery for Scotland with total landings in 2013 of around 10,800 tonnes and a value of £13.8 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 over half of total landings. Landings from the six principal brown crab assessment units: the Hebrides, Sule, Papa, South Minch, East Coast and Orkney, made up 79 % of the total in 2013. 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

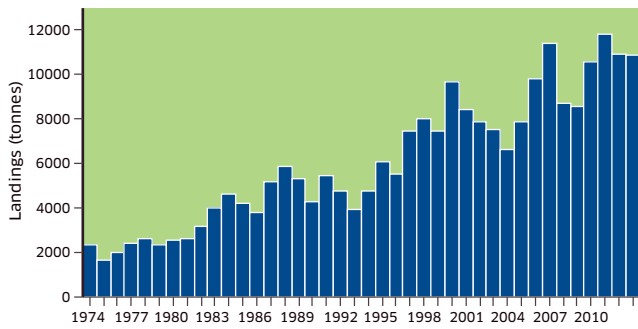
The brown crab is found all around the Scottish coast from the shallow sub-littoral into offshore waters to depths exceeding 100 m. It inhabits rocky reefs, mixed coarse grounds and soft sediments (muddy sand) particularly on the offshore grounds. Brown crabs eat mainly benthic invertebrates, particularly 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 the connectivity of stocks. The structure of brown crab populations around Scotland is poorly understood.



Management

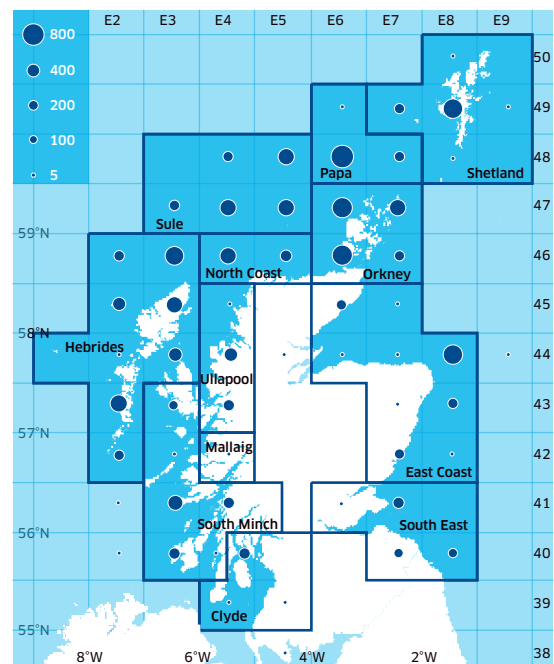
The brown crab fishery is not subject to EU TAC regulations or national quotas although there are EU measures in place to restrict the fishing effort (kW days) of all vessels > 15 m (including creel boats) in ICES Subarea VI. In Scotland, vessels landing brown crabs are required to hold a licence with a shellfish entitlement. Vessels without this entitlement are only allowed to land 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).



LANDINGS (TONNES) OF BROWN CRAB INTO SCOTLAND BY UK VESSELS, 1974 TO 2013

Assessment

Age determination is generally not possible for animals that 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 programme¹. LCA results are presented in terms of yield-per-recruit and biomass-per-recruit, providing estimates of fishing mortality (**F**) and 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. It is not possible to directly estimate the maximum sustainable yield (MSY) for these stocks, hence F_{MAX} is used as a proxy for F_{MSY} ². 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.



CREEL FISHERY ASSESSMENT AREAS AND SCOTTISH BROWN CRAB LANDINGS (TONNES) IN 2013.

¹Size frequency data used in the historical assessments for the Shetland area were provided by the NAFC Marine Centre with the permission of the Shetland Shellfish Management Organisation. Recent data for Shetland have been collected and provided by staff from NAFC Marine Centre under the Memorandum of Understanding between NAFC Marine Centre and MSS.

²This approach has been used by ICES for other crustaceans such as *Nephrops*. F_{MSY} proxy values were calculated from a per-recruit analysis from a LCA of 2006–2008 landings-at-length data. Where 2006–2008 sampling data were unavailable, data from 2009–2012 were used instead. All F_{MSY} proxy values remain preliminary and may be modified following further data exploration and analysis.

		F (Fishing Mortality)					F (Fishing Mortality)		
		2002-2005	2006-2008	2009 - 2012			2002-2005	2006-2008	2009 - 2012
Clyde	Males	?	✗	? Unknown	East Coast	Males	✗	✗	✗ Above F_{MSY}
	Females	?	✗	? Unknown		Females	0	✗	✗ Above F_{MSY}
Hebrides	Males	✗	✗	✓ Below F_{MSY}	Mallaig	Males	?	?	? Unknown
	Females	✗	✗	✗ Above F_{MSY}		Females	?	?	? Unknown
North Coast	Males	✗	✗	✓ Below F_{MSY}	Orkney	Males	✗	✗	✗ Above F_{MSY}
	Females	0	✗	✓ Below F_{MSY}		Females	0	✗	✗ Above F_{MSY}
Papa	Males	✓	?	✓ Below F_{MSY}	South East	Males	✗	✗	✗ Above F_{MSY}
	Females	✓	?	✓ Below F_{MSY}		Females	✗	✗	✗ Above F_{MSY}
Shetland	Males	✓	✗	0 At F_{MSY}	South Minch	Males	✗	✗	✗ Above F_{MSY}
	Females	✓	✓	✓ Below F_{MSY}		Females	✗	✗	✗ Above F_{MSY}
Sule	Males	✗	✗	0 At F_{MSY}	Ullapool	Males	?	?	? Unknown
	Females	✗	0	✗ Above F_{MSY}		Females	?	?	? Unknown

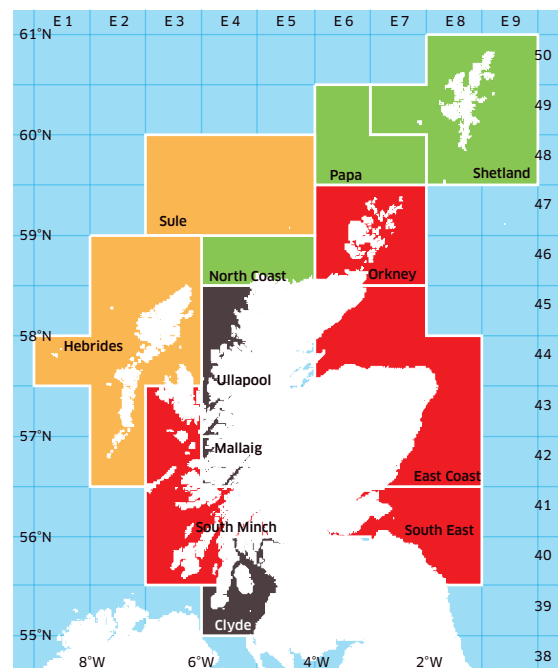
BROWN CRAB STOCK STATUS, RELATIONSHIP BETWEEN F AND F_{MSY} PROXY FOR 2002-2005, 2006-2008 AND 2009-2012.

State of the stocks

Results of assessments based on LCAs for the period 2009-2012 for nine of the twelve assessment units, summarising estimates of fishing mortality in relation to the F_{MSY} proxy, are shown above. There were insufficient sampling data from the Mallaig, Ullapool and Clyde areas to conduct LCAs. Of the nine assessed areas, six were fished above the F_{MSY} proxy to some extent. Fishing mortality was estimated to be above F_{MSY} for both males and females in South Minch, Orkney, East Coast and South East. In Sule and Hebrides, fishing mortality for males was at F_{MSY} or below while females were fished above F_{MSY} . In the North Coast, Papa and Shetland, recent fishing mortality was approximately at F_{MSY} or lower.

Management advice

Overall, assessments for the period 2009-2012 showed that most brown crab assessment units in Scotland were fished close to or above the F_{MSY} proxy. 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 UNITS AND ESTIMATED FISHING MORTALITY, 2009 - 2012.

- Fishing mortality around or below F_{MSY} .
- Fishing mortality above F_{MSY} for either males or females
- Fishing mortality above F_{MSY} for both males and females
- Not assessed for the period 2009 - 2012

// VELVET CRAB

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

**Landed into
Scotland in 2013
(by UK vessels):** 1,600 tonnes
Value for 2013: £4.0 million

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 2013, the fishery landed 1,600 tonnes of velvet crab into Scotland with a value of £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 2013, the majority of landings came from Orkney, South Minch, Shetland, East Coast, South East and Hebrides. Most velvet crabs are landed between July and November.

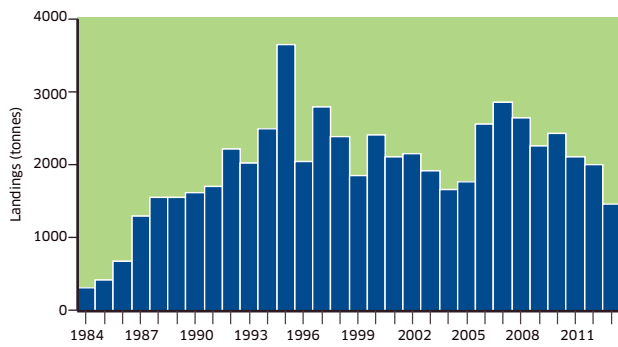
Biology and life cycle

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. These differences 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. 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

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 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).





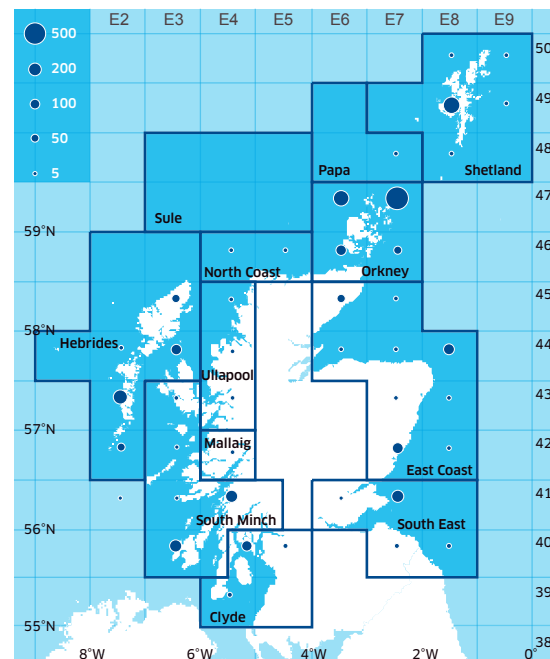
LANDINGS (TONNES) OF VELVET CRAB INTO SCOTLAND BY UK VESSELS, 1984 -2013



© ISTOCK

Assessment

Age determination is generally not possible for animals that 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 presented in terms of yield-per-recruit and biomass-per-recruit, providing estimates of fishing mortality (**F**) and 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. It is not possible to directly estimate the maximum sustainable yield (MSY) for these stocks, hence F_{MAX} is used as a proxy for F_{MSY} ². 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.



CREEL FISHERY ASSESSMENT AREAS AND SCOTTISH VELVET CRAB LANDINGS (TONNES) IN 2013.

State of the stocks

Results of assessments based on LCAs for the period 2009-2012 for six of the twelve assessment units, summarising estimates of fishing mortality in relation to the F_{MSY} proxy are shown below. There were insufficient

¹Size frequency data used in the historical assessments for the Shetland area were provided by the NAFC Marine Centre with the permission of the Shetland Shellfish Management Organisation. Recent data for Shetland have been collected and provided by staff from NAFC Marine Centre under the Memorandum of Understanding between NAFC Marine Centre and MSS.

²This approach has been used by ICES for other crustaceans such as *Nephrops*. F_{MSY} proxy values were calculated from a per-recruit analysis from a LCA of 2006-2008 landings-at-length data. Where 2006-2008 sampling data were unavailable, data from 2009-2012 were used instead. All F_{MSY} proxy values remain preliminary and may be modified following further data exploration and analysis.

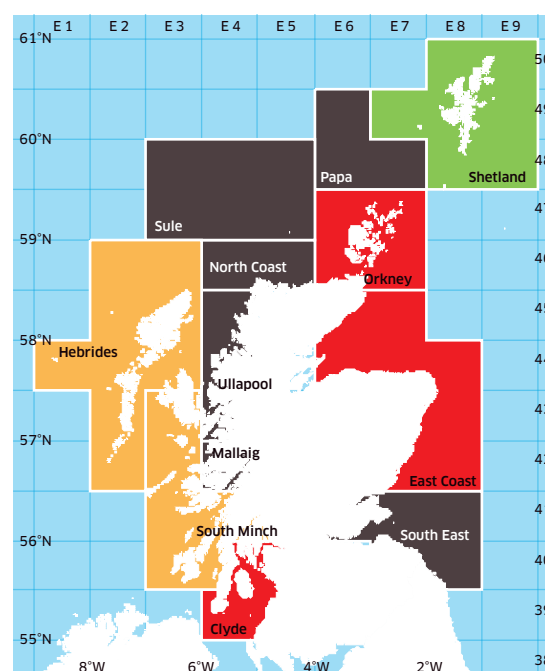
		F (Fishing Mortality)					F (Fishing Mortality)		
		2002-2005	2006-2008	2009 - 2012			2002-2005	2006-2008	2009 - 2012
Clyde	Males	✗	✗	✗ Above F_{MSY}	East Coast	Males	○	✗ Above F_{MSY}	
	Females	✗	✗	✗ Above F_{MSY}		Females	○	✗ Above F_{MSY}	
Hebrides	Males	✗	✓	✓ Below F_{MSY}	Mallaig	Males	?	? Unknown	
	Females	✗	✗	✗ Above F_{MSY}		Females	?	? Unknown	
North Coast	Males	?	?	? Unknown	Orkney	Males	✗	✗ Above F_{MSY}	
	Females	?	?	? Unknown		Females	✗	✗ Above F_{MSY}	
Papa	Males	?	?	? Unknown	South East	Males	✓	○ ? Unknown	
	Females	?	?	? Unknown		Females	○	✗ ? Unknown	
Shetland	Males	?	?	✓ Below F_{MSY}	South Minch	Males	✗	✗ Above F_{MSY}	
	Females	?	?	✓ Below F_{MSY}		Females	○	✗ Below F_{MSY}	
Sule	Males	?	?	? Unknown	Ullapool	Males	?	? Unknown	
	Females	?	?	? Unknown		Females	?	? Unknown	

VELVET CRAB STOCK STATUS, RELATIONSHIP BETWEEN F AND F_{MSY} PROXY FOR 2002-2005, 2006-2008 AND 2009-2012.

sampling data from the South East, Mallaig, Ullapool, North Coast, Sule and Papa areas to conduct LCAs. Of the assessed areas, velvet crabs in Shetland were fished below F_{MSY} . In the Clyde, Orkney and East Coast, both males and females were fished at levels above F_{MSY} . In the Hebrides, the fishing mortality for males was below F_{MSY} while females were fished above F_{MSY} . In the South Minch, females were fished below F_{MSY} while males were fished above F_{MSY} .

Management advice

Overall, assessments for the period 2009-2012 in areas with sufficient sampling data, showed that most velvet crab assessment units in Scotland were being fished close to or above the F_{MSY} proxy. 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 ESTIMATED FISHING MORTALITY, 2009 -2012.

- Fishing mortality around or below F_{MSY} .
- Fishing mortality above F_{MSY} for either males or females
- Fishing mortality above F_{MSY} for both males and females
- Not assessed for the period 2009-2012

// EUROPEAN LOBSTER

Scientific name : *Hommarus gammarus*

Common names : clawed lobster,
European lobster

Landed into

Scotland in 2013

(by UK vessels) : 1,000 tonnes

Value for 2013 : £10.6 million

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 UK vessels have increased substantially in recent years, from 290 tonnes in 2001 to about 1,000 tonnes, with a value of over £10.6 million, in 2013. 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 are not known to 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-

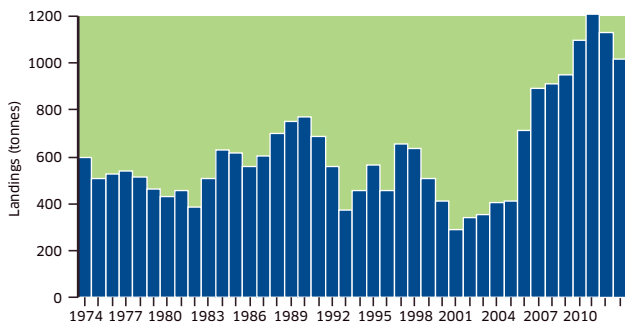
July. Juveniles moult more frequently and grow faster than older animals. Mating occurs just after moulting while the female's shell is still soft. Size at maturity in females varies across Scotland; for example, females mature at smaller sizes in the South East than in the Hebrides.

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 nine 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 live 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.



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 five 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.

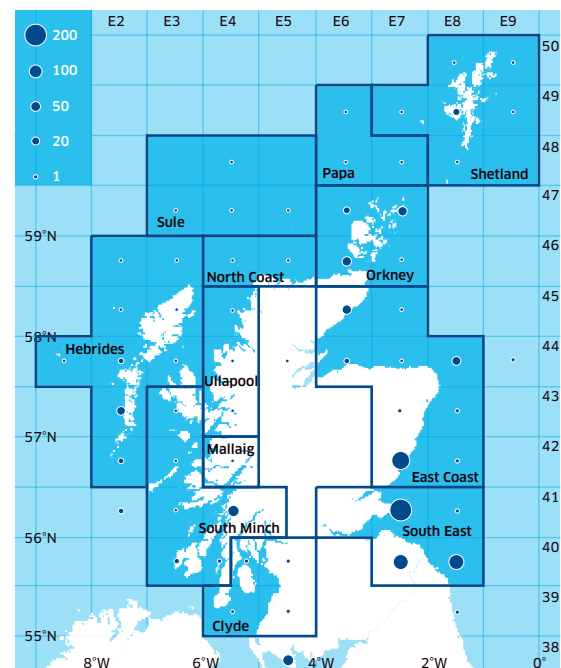


LANDINGS (TONNES) OF LOBSTER INTO SCOTLAND BY UK VESSELS, 1974-2013



Assessment

Age determination is generally not possible for animals that 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 presented in terms of yield-per-recruit and biomass-per-recruit, providing estimates of fishing mortality (**F**) and 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. It is not possible to directly estimate the maximum sustainable yield (MSY) for these stocks, hence F_{MAX} is used as a proxy for F_{MSY} ². 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.



CREEL FISHERY ASSESSMENT AREAS AND SCOTTISH LOBSTER LANDINGS IN 2013 (TONNES)

State of the stocks

Results of assessments based on LCAs for the period 2009-2012 for eight of the twelve assessment units, summarising estimates of fishing mortality in relation to the F_{MSY} proxy are shown below. There were insufficient sampling data from the Mallaig, North

¹ Size frequency data used in the historical assessments for the Shetland area were provided by the NAFC Marine Centre with the permission of the Shetland Shellfish Management Organisation. Recent data for Shetland have been collected and provided by staff from NAFC Marine Centre under the Memorandum of Understanding between NAFC Marine Centre and MSS.

² This approach has been used by ICES for other crustaceans such as *Nephrops*. F_{MSY} proxy values were calculated from a per-recruit analysis from a LCA of 2006-2008 landings-at-length data. Where 2006-2008 sampling data were unavailable, data from 2009-2012 were used instead. All F_{MSY} proxy values remain preliminary and may be modified following further data exploration and analysis.

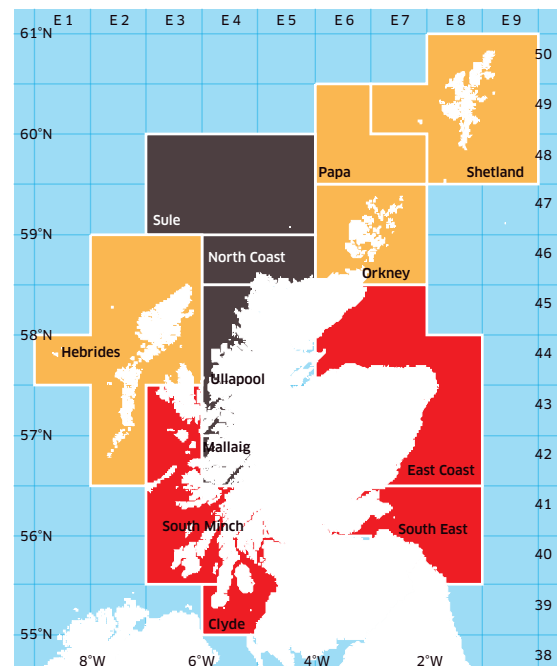
		F (Fishing Mortality)					F (Fishing Mortality)		
		2002-2005	2006-2008	2009 - 2012			2002-2005	2006-2008	2009 - 2012
Clyde	Males	?	✗	✗ Above F_{MSY}	East Coast	Males	?	✗ Above F_{MSY}	
	Females	?	✗	✗ Above F_{MSY}		Females	?	✗ Above F_{MSY}	
Hebrides	Males	✗	✗	✗ Above F_{MSY}	Mallaig	Males	?	? Unknown	
	Females	✓	✓	✓ Below F_{MSY}		Females	?	? Unknown	
North Coast	Males	?	?	? Unknown	Orkney	Males	✗	✗ Above F_{MSY}	
	Females	?	?	? Unknown		Females	✓	0 At F_{MSY}	
Papa	Males	?	?	✗ Above F_{MSY}	South East	Males	✗	✓ Above F_{MSY}	
	Females	?	?	✓ Below F_{MSY}		Females	✗	✗ Above F_{MSY}	
Shetland	Males	?	?	✓ Below F_{MSY}	South Minch	Males	✗	? Above F_{MSY}	
	Females	?	?	✗ Above F_{MSY}		Females	✓	? Above F_{MSY}	
Sule	Males	?	?	? Unknown	Ullapool	Males	?	✗ Unknown	
	Females	?	?	? Unknown		Females	?	✓ Unknown	

LOBSTER STOCK STATUS, RELATIONSHIP BETWEEN F AND F_{MSY} PROXY FOR 2002-2005, 2006-2008 AND 2009-2012.

Coast, Sule and Ullapool areas to conduct LCAs. Lobsters in all the assessed areas were fished above the F_{MSY} proxy to some extent, particularly males. Fishing mortality was estimated to be above F_{MSY} for both males and females in Clyde, South Minch, East Coast and South East. In the Hebrides, Orkney and Papa, fishing mortality for females was at F_{MSY} or below while males were fished above F_{MSY} . In Shetland, males were fished below F_{MSY} and females above F_{MSY} .

Management advice

Overall, assessments for the period 2009-2012 show that most lobster assessment units in Scotland were fished close to or above the F_{MSY} proxy. 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 ESTIMATED FISHING MORTALITY, 2009 - 2012.

- Fishing mortality around or below F_{MSY} .
- Fishing mortality above F_{MSY} for either males or females
- Fishing mortality above F_{MSY} for both males and females
- Not assessed for the period 2009-2012

// FISH STOCK SUMMARY TABLE 2015

Stock	ICES Reference Points							Current Assessment			Outcomes for EU Fisheries	
	B _{lim} (t)	B _{pa} (t)	F _{lim}	F _{pa}	MSY B _{trigger} (t)	F _{MSY}	F 2013	SSB (t) 2014	TAC (t)	UK Quota (t)		
Mackerel – Northeast Atlantic	1,840,000	2,300,000	0.39	0.26	2,360,000	0.25	0.217	4,421,546	521,689 ³	247,296		
Herring – North Sea	800,000	1,000,000	ND	ND	ND	0.27	0.033 ¹ 0.121 ²	1,900,000	267,197	62,292		
Herring – West of Scotland	50,000	ND	ND	ND	ND	0.25	0.268	80,836	22,690	13,711		
Haddock – North Sea, Skagerrak and West of Scotland	63,000	88,000	ND	ND	88,000	0.35	0.183	173,360	32,108	40,882		
Haddock – Rockall	6,000	9,000	ND	0.40	9,000	0.3	0.246	2,743	2,580	2,079		
Cod – North Sea	70,000	150,000	0.86	0.65	150,000	0.19	0.398	68,528	24,227	11,369		
Cod – West of Scotland	14,000	22,000	0.80	0.60	22,000	0.19	0.990	2,043	0	0		
Whiting – North Sea	184,000	ND	ND	ND	ND	ND	0.186	204,360	13,060	8,739		
Whiting – West of Scotland	16,000	22,000	1.0	0.60	ND	ND	Uncertain	Uncertain	263	150		
Saithe – North Sea and West of Scotland	106,000	200,000	0.60	0.40	200,000	0.3	0.301	188,837	37,732	8,271		
Monkfish – North Sea, Celtic Sea and West of Scotland	ND	ND	ND	ND	ND	ND	Uncertain	Uncertain	14,703	9,276		

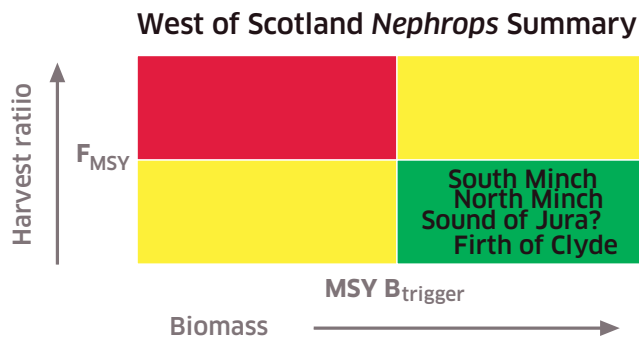
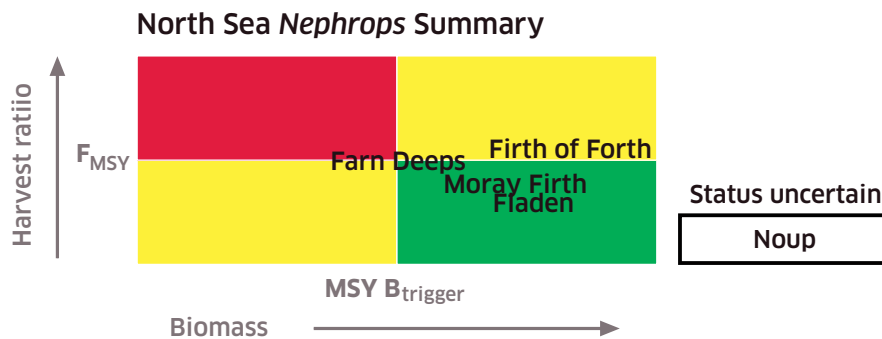
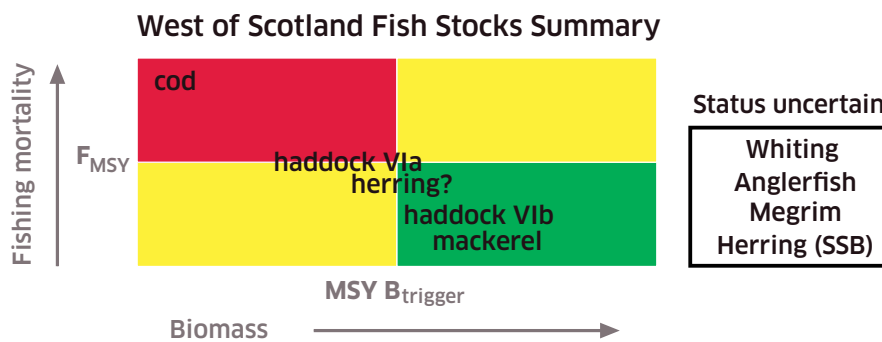
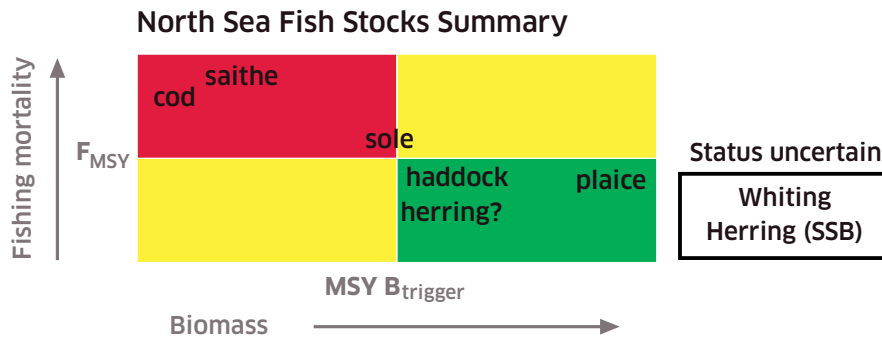
¹For juvenile North Sea herring – ages 0-1 ND = not defined

²For adult North Sea herring – ages 2-6 (t) = metric tonnes

³EU TAC only

// STATE OF STOCK SUMMARY TABLE – 2014 ASSESSMENTS

MSY approach





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OGL

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