Responsible Sourcing Guide:

Mackerel

Version 7 – May 2013

Scomber scombrus Image © Scandinavian Fishing Year Book

The annual catch of Atlantic mackerel, *Scomber scombrus,* in North East Atlantic waters was around 927,000 tonnes (t) in 2011 (1), of which UK landings were 94,400 t. In the Northwest Atlantic, USA and Canadian landings have been round 50,000 t per annum, but dropped to 8,500 t in 2011 (2). Catches of other Atlantic *Scomber* species, most notably *Scomber colias,* average around 60,000 t per annum and occur in the Bay of Biscay and further south. All the assessment and catch data in this guide relate to *Scomber scombrus*, although all species of the genus *Scomber* can be described as mackerel on the UK market (3).

There are two assessed mackerel stocks in the North Atlantic. The spawning stock biomass of the North East Atlantic stock has increased considerably since 2002 and remains high, but is currently declining. There is an ongoing dispute regarding fishing of mackerel in the North East Atlantic. ICES has advised a Total Allowable Catch (TAC) for the whole area of the stock, which follows the agreed Coastal states management plan. However, the Faeroe Islands and Iceland have set catch quotas outside this TAC.

Although a number of measures designed to improve sustainability have been implemented, there is no comprehensive management regime or internationally-agreed catch limit, and the current situation may result in an unsustainable fishery.

The USA and Canadian stocks are now assessed as one stock. Landings have been falling and the biomass of the Canadian contingent is declining.

The purpose of this guide is to outline status and trends in North Atlantic mackerel stocks distribution. The guide describes measures being taken to protect mackerel and discusses future prospects for sustainability in relation to the fisheries management regime.

BUYERS' TOP TIPS

Know your source of supply and stock status

Mackerel populations inhabit vast areas, within which individual spawning components are recognised. Find out about the management stock and its spawning component from which your mackerel has been caught.

Ensure your supplies are from legal fisheries

In recent years there have been serious problems with illegal fishing of some mackerel stocks. Traceability systems can help to assure the origin of product.

An informed buying policy

Buyers need an informed approach to stock status and management. Whilst it is clear that the NE Atlantic mackerel stock is currently in good condition, there is at present no internationally agreed limit on catches although the EU and Norway set their annual TAC based on a 10 year management plan (p 11).

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Status of mackerel stocks September 2012

Biology

Mackerel (*Scomber scombrus*) is a pelagic fish, living in shoals swimming above the sea bed. It is highly migratory, inhabiting vast areas within which there are large-scale seasonal movements between spawning and feeding areas that are influenced by water temperature. In the North East Atlantic (NEA), mackerel is considered to have a single stock (though with three separate spawning components) that extends from southern Portugal to northern Norway. Mackerel in the Northwest Atlantic (NWA) is also assessed as a single stock (North Carolina to Labrador), with northern and southern spawning components. Table 1 gives an overall picture of the status and overall catch of North Atlantic mackerel by stock area.

Fishing gear

Most mackerel fisheries target large shoals offshore using mid-water trawls, pair trawls or purse seines, and the adoption of dual and triple frequency sonar technology on some vessels has enabled skippers to differentiate between pelagic species. In inshore areas, small vessels use hand lines and gillnets, including a substantial Spanish fleet (4,950 vessels in 2009) and hand-line fleets off the South West coast of England and around Scotland. Most mackerel caught in European waters are landed fresh, or chilled in refrigerated seawater, to shore processors, although the large freezer vessels process and pack their catch at sea. Mackerel is also an important quarry species for recreational anglers.

Assessments

The concept of sustainable management of a fish stock is based on balancing the quantity of fish removed by fishing and natural deaths, against additions due to growth and new recruits (young fish) entering the fishery each year. Various techniques are used by scientists to estimate these parameters.

For NEA mackerel, an analytical model is used with catch numbers-at-age data from the fishery and fishery-independent abundance indices from egg surveys (4, 5). Research cruises are undertaken to obtain quantitative samples of planktonic eggs produced over the whole spawning period. Knowing the number of eggs produced per female, and the size and sex composition of the population, allows scientists to estimate the abundance of adult mackerel in the stock – the spawning stock biomass (SSB) (6). This survey has been carried out every three years since 1977, the latest in 2010. These estimates are used to make an assessment of the status of the stock in relation to Maximum Sustainable Yield (MSY) and precautionary reference points. See Page 3.

In the NWA, the first assessment of the combined Canadian and American contingents was in March 2010, using a population model based on index series from three fishing surveys. There was a further assessment of the Canadian mackerel contingent in April 2012 (2). For the first time, a sequential population analysis was used to assess stock abundance.

Maximum Sustainable Yield (MSY) and the Precautionary Approach (PA)

Current ICES advice on cod stocks is given on the basis of MSY and the precautionary approach (6). MSY means fishing at a level that takes the maximum catch (yield) that can safely be removed from a fish stock, on a continuous basis, whilst maintaining its long-term productive capacity, and is achieved by keeping the Spawning Stock Biomass (SSB) above the biomass action point **$MSY_{Btrigger}$**. The precautionary approach aims to limit fishing mortality (F) and catches to levels that avoid depleting the stock's reproductive capacity, keeping its SSB above its biomass reference level (defined as **$B_{pa:}$** see Fig. 3).

These concepts are illustrated in the schematic (Fig. 1). This shows how catches from an unfished stock would increase in line with exploitation (or fishing mortality, F), up to a point where the total mortality on the stock causes so many fish to be caught at a relatively small size (and discarded or landed) that the potential production of the stock, based on growth of individual fish, is not realised ('growth overfishing'). The peak of this curve represents MSY and indicates where **F_{MSY}** lies.

However, providing sufficient fish survive to become adults and spawn, they may still have the reproductive capacity to replace themselves. Stock collapse can occur when fishing mortality reaches a level (**F_{lim}**) where removals from a stock are so high, and its spawning capacity is so diminished, that fewer and fewer juveniles are produced. So, not only is the size of the stock being reduced by too high a level of exploitation, but there are fewer juvenile fish to replace those that are caught, and stock levels are likely to fall even lower ('recruit overfishing'). The yellow area between the green (inside safe limits) and red (outside safe limits) zones in the schematic and stock trajectories (North Sea example at Fig 2 & 3) represents levels of F or SSB that management should seek to avoid to ensure that the stock has a high probability of remaining sustainable.

Scientific advice given under the twin MSY/precautionary approach strategy will aim to either achieve catches consistent with fishing levels that would result in **F_{MSY}**, or reduce fishing mortality to return the stock to within safe biological limits (> **B_{pa}**). For many fish stocks, including NEA mackerel, parties exploiting the stock have management plans (7, 8), and ICES also provides advice on catches compatible with such plans. Such reference points have not been adopted for NWA mackerel.

Figure 1 Schematic of ICES' MSY and PA reference points in relation to fishing mortality and Yield

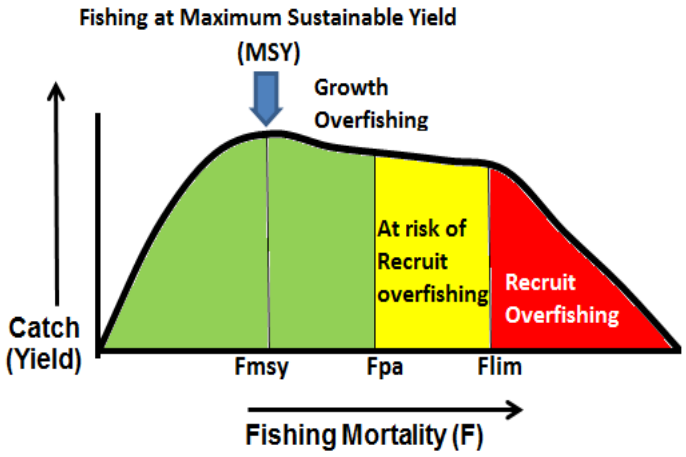

Table 1: Management Stock (colour keyed to Figure 1 and Figure 2)	**ICES estimate of catches for 2013(t) (5)**	**Advisory TAC 2013 (t)**	**Scientific advice, for management see section 'Management and Conservation' page 10 (September 2012 ICES advice) (5)** **www.ices.dk**
North East Atlantic (NEA)			
At risk of being outside safe biological limits			
NEA; All components: ICES Division and Sub-areas IIa & Vb; III & IV,V, VI, VII, VIIIa, b, d, e; VIIIc, IXa & X	TAC= 489,882 t (EU and Norway planned catches), plus Faeroe and Iceland catches. Total around 837,000 t	Between 497,000 and 542,000 t. for entire stock under manage-ment plan	**Stock components** The western component comprises 76% of the entire NEA mackerel stock. The Southern component makes up most of the rest, along with the small North Sea component. **Stock status -** In September 2012, ICES advised that fishing mortality (F) on mackerel had declined since the high levels in early 2000s and has been relatively stable since 2006, though F in 2011 was above both MSY and precautionary levels. (Figure 4 p7). The 2005 and 2006 year classes are the highest on record, boosting SSB to its highest level in the last 30 years in 2009 - 2011(Figure 3 page 7). ICES estimated that SSB in 2012 was at 2.67 million t (Mt), well above $MSY_{Btrigger}$ of 2.2 Mt and B_{pa} = 2.3 Mt.
Western Component: ICES IIa & V, parts of div IVa, Sub-areas VI,VII & Division VIIIa,b,d,e	Included in above		
Southern Component: ICES division VIIIc, Sub-areas IXa & X	Included in above		
Stock outside safe biological limits. The stock is in a condition where there is concern that reproduction may be impaired. Action should be taken appropriate to each stock to further reduce fishing and encourage stock rebuilding.			
NEA North Sea Component Sub-areas IV & IIIa	Included in above	Maximum protection - closed areas & seasons - Minimum Landing Size	Very large catches were taken in the 1960s, peaking at around 1 Mt in 1967, but the fishery collapsed and catches declined to less than 100,000 t in the late 1970s. Catches during the last five years are assumed to be about 10,000 t pa. Estimates of the SSB of the North Sea component derived from the North Sea egg survey indicate a decrease from 0.22 Mt in 2005 to 0.17 Mt in 2011.

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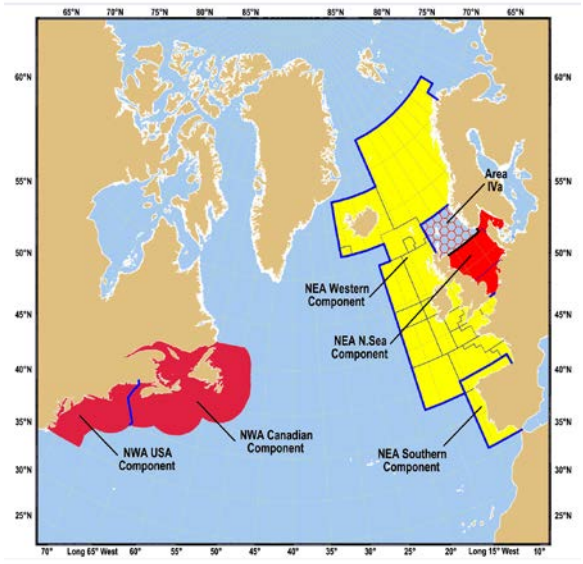
Management Stock (colour keyed to Figures 1 and Fig 2 below)	Total landed catches 2011 (t) (9)	Advisory TAC (t) 2013	Scientific advice and management
North West Atlantic (NEA)			
Reference points not defined, but likely to be outside safe limits			
Mackerel in Canadian waters: Gulf of St Lawrence, Scotian Shelf, Newfoundland (NAFO 2,3 and 4)	9,044	9,000; Canadian waters	The NWA mackerel (NAFO Subareas 2-6) stock is assessed as a single stock, with northern and southern spawning components that mix in Canadian and USA waters. **USA:** From 2000 to 2006, landings in the USA commercial fishery increased from 5,649 t to a maximum of 56,640 t. Between 2007 and 2010, they decreased from 25,547 t to 9,891 t, before reaching a historical low of 500 t in 2011. **Canadian:** Reported landings in NAFO subareas 3 and 4 increased substantially, from 16,080 t in 2000 to a historical high of 54,621 t in 2005. Between 2006 and 2011, landings decreased from 53,649 t to 8,544 t. The latest population analysis indicates that the biomass of the Canadian Atlantic mackerel contingent has been declining since the mid-2000s, reaching a very low value in 2011. This biomass decrease was caused by a lack of recruitment combined with historically higher-than-sustainable fishing mortalities (2).
Mackerel in USA waters: Cape Hatteras, Rhode Island, Georges Bank, Gulf of Maine. (NAFO 5 and 6)			

Figure 2: Management stocks of North Atlantic mackerel (colour keyed to Table)



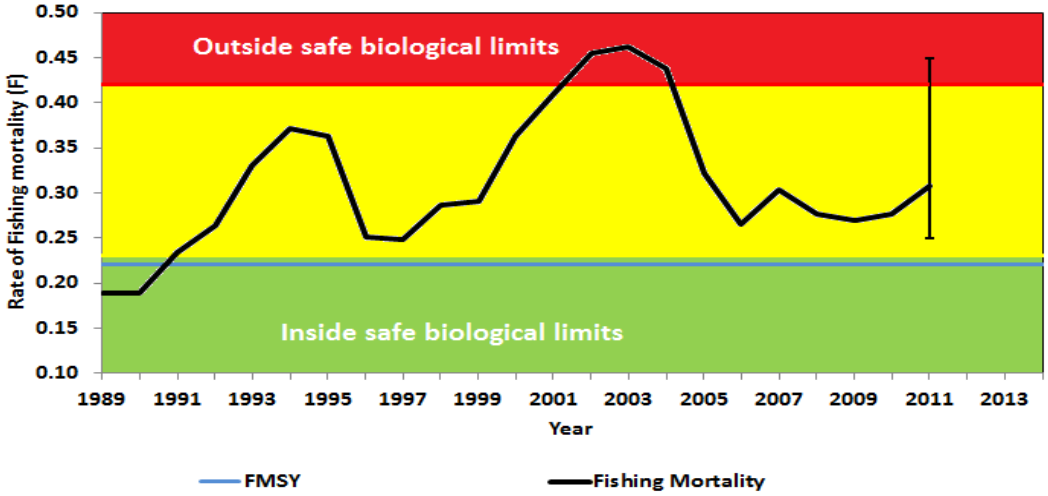
Key	Stock status
	Inside safe biological limits
	At risk of being outside safe biological limits due to fishing mortality being above F_{pa}
	Outside safe biological limits. Note that the western component is present in Division IVa during the period 1 Sept- 15 Feb (see p6)
	Reference points not defined

Organisation key:

ICES: International Council for the Exploration of the Sea. Responsible for providing scientific advice for NEA fisheries.
EU: The European Union manages fisheries within the European Economic Zone.
FAO: Food and Agriculture Organisation of the United Nations. Acts as a neutral forum where all nations meet as equals to negotiate agreements and debate policy.
MSC: The Marine Stewardship Council is an independent, non-profit organisation that promotes responsible fishing practices and certifies sustainable fisheries.
NAFO: Northwest Atlantic Fisheries Organisation. Provides science and management in NWA international waters.
NEAFC: North East Atlantic Fisheries Commission. Recommends measures to maintain rational exploitation of fish stocks in the high seas Atlantic and Arctic Oceans.
MAFMC: The Mid-Atlantic Fishery Management Council. Responsible for management of fisheries in United States federal waters off the mid-Atlantic coast of America.

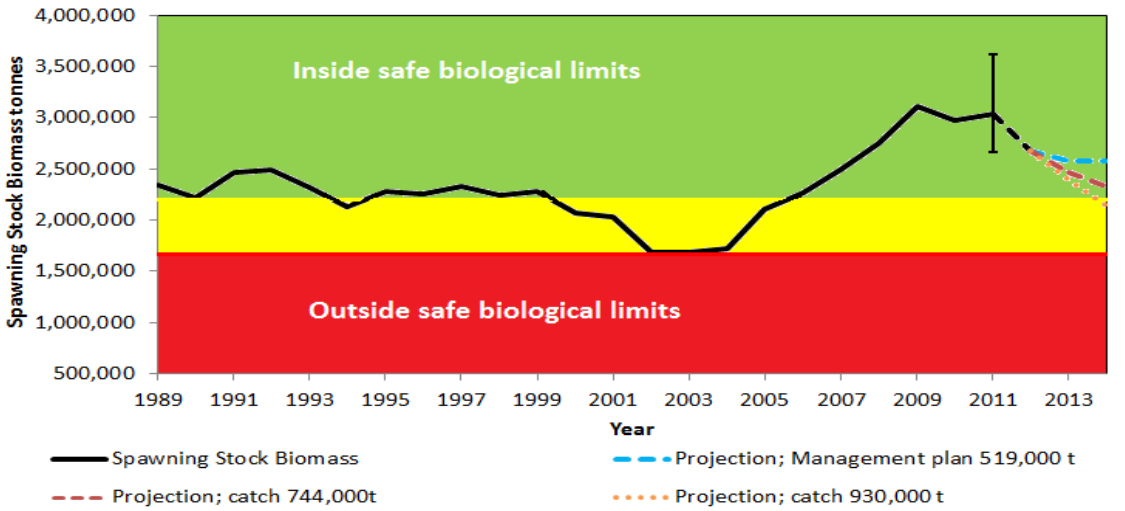
North East Atlantic mackerel stock:Trajectories

Figure 3: Fishing mortality trajectory for NE Atlantic mackerel. ICES 2012 assessment.



Error bar shows 95% confidence interval for 2011 estimate. Fishing the stock at F_{MSY} would require fishing mortality to be reduced to 0.22 (blue line).

Figure 4: Spawning Stock Biomass trajectory of NE Atlantic mackerel. ICES assessment 2012 and projections for 2013 and 2014.



$MSY_{Btrigger}$ is set at 2,200,000 t and safe biological limits (B_{lim}) is at 1,670,000 t. Error bar shows 95% confidence interval for 2011 estimate. Projection in line with management plan (blue line) would imply catches of 519,000 t in 2013. Other projections shown are for catches of 744,000 t (brown line)/930,000 t (orange line) in 2013. Catch is likely to be somewhere between these last two levels (see p 10)

Management and conservation measures

The key to successful management of fisheries is to design regulations to control their impact on stocks which take account of the biology of the fish and environmental factors that influence the populations' dynamics and production. The main measures for control of mackerel fisheries and their environmental effects are described below, whilst major trends in stocks and implications for management are discussed overleaf.

The major part of mackerel catches are taken in a single-species fishery by relatively few large vessels, using purse seine or trawl. It should, therefore, be easier to enforce catch limits and bans on mackerel fisheries than on mixed fisheries exploiting many species. However, there have been substantial levels of illegal landings from the NE Atlantic mackerel fishery, though the introduction of the Registration of Buyers and Sellers legislation in 2005/6 (10) should have eliminated most illegal landings.

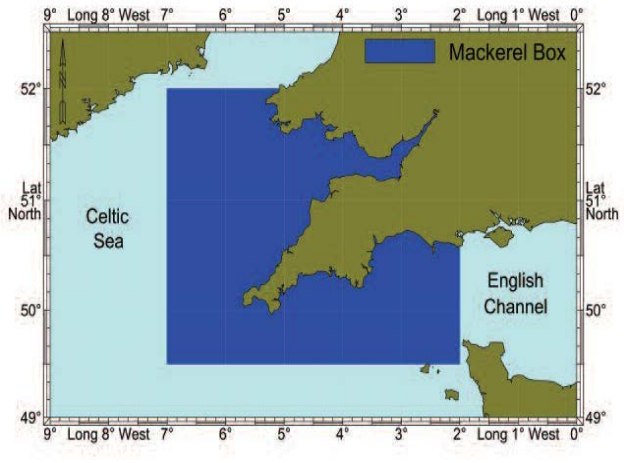
Another source of uncertainty is when fish are discarded at sea due to the size or species composition of the catch not being suited to market needs. ICES estimates that 1% of the mackerel catch is discarded, but this is considered to be an underestimate. The EU-Norway agreement (11) includes a ban on high grading and slipping (letting fish go before they are landed on deck). These measures should enhance conservation of mackerel in EU and Norwegian waters.

Seasonal and spatial management

Strict management measures remain in force to aid continued recovery of the North Sea spawning component, including no targeted fishing for mackerel in ICES Division IIIa and IVb and c at any time; and a seasonal restriction on fishing in Division IVa (the fishery is open from 1 Aug to 14 Feb. when the Western component of the NE Atlantic stock is present in this area, see Fig. 2).

Juvenile mackerel are protected within the 'mackerel box' off the Cornish coast and in the eastern Celtic Sea (12) (Figure 5), in which there is a ban on targeted fishing for mackerel by trawlers and purse seiners and where a hand-line fishery operates with a separate quota allocation.

Figure 5: The South West of England Mackerel Box



Management and conservation measures contd

Direct ecosystem effects

There is a small risk of cetaceans (dolphin and porpoise) being taken in pelagic trawl fisheries. Recent monitoring of UK vessels required by EU regulations (13, 14) found no by-catches of cetaceans in mackerel trawl fisheries. However, a by catch of salmon has been reported from Norwegian mackerel fisheries and, most recently, from areas off eastern and north east Iceland during the early summer (15).

Mackerel feed mainly on zooplankton and small pelagic fish (16). They are eaten by large demersal fish, cetaceans and other species (17). Depletion of mackerel stocks by fishing has the potential to affect these feeding relationships, but good management can help to avoid any adverse ecological effects on food chains.

Ocean warming and mackerel distributions

Trawl catches and acoustic surveys in the Norwegian Sea indicate that the distribution of NEA mackerel has recently extended further north and west during the summer feeding migration (4,5). This is reflected in the pattern of spawning by the western component, which has shown a statistically significant northward shift in egg distribution (1977–2010) that is positively correlated with the mean sea surface temperature of the NE Atlantic (18).

A similar temperature-related distribution shift has been observed in the overwintering distribution of NWA mackerel (19). Between 1968 and 2008, the stock moved progressively from the deeper offshore mid-Atlantic region to the shallower southern New England continental shelf, a northwards shift of about 250 km, most recently moving onto Georges Bank. This shift is associated with warming of continental shelf waters, leading to an increase in the area over which the stock can be distributed (Atlantic mackerel prefer water above 5 °C). This may explain the decline in the U.S. mackerel fishery in recent decades.

These changes in mackerel distribution are related to large-scale environmental forces, or climate drivers such as the North Atlantic Oscillation and the Atlantic Multi-decadal Oscillation, which support a general warming trend on the continental shelf. At present, it is not known whether these distribution changes are a direct consequence of observed warming (habitat availability), changes in food availability, or increased stock size in which more large individuals are able to migrate long distances during their search for food (4).

The increased temperature observed in the Nordic Seas during recent summers (4,5) might have increased the potential habitat for mackerel, though a decline in zooplankton biomass since 2002 could be increasing feeding competition between mackerel and herring, forcing the pelagic species to expand their feeding areas. Since mackerel plays a central role in the food web of the ecosystem, there may be implications of these distribution changes for other species, but no evidence of impacts has been published.

Management and stock sustainability - implications of distribution change

Between 2001 and 2009, the internationally agreed TACs for NEA mackerel have covered most of the stock's distribution area. The advised TAC covered Northern (ICES Subareas and Divisions IIa, IIIa,b,d, IV, Vb, VI, VII, VIIIa,b,d,e, XII, XIV) and Southern components (Divisions VIIIc and IXa).

However, there has been a rapid expansion in the previously insignificant fisheries for mackerel by Iceland and the Faeroese since 2006. Their combined catches represented around 21% of the total reported NE Atlantic mackerel landings in 2010, and 32% in 2011.

The TAC for 2009 was set in accordance with the long-term management plan, evaluated by ICES as precautionary, and agreed in October 2008. This plan formalised the Coastal States/NEAFC agreements between the EU, Norway and the Faeroe Islands, which were in force from 1999 to 2009 and were designed to ensure sustainable exploitation of NE Atlantic mackerel and stability of the catches.

Unilateral action

Since 2010, Iceland and the Faeroe Islands have set unilaterally high mackerel fishing quotas outside the Coastal States/NEAFC agreements. In the present situation, with no international agreements on management of mackerel fisheries and no overall TAC, there is a risk that the NEA mackerel stock could collapse, to the detriment of the fleets and industries concerned. As a consequence, the MSC has suspended its certification of all seven fisheries on this stock that were previously certified (20).

ICES advice

The time series in Figures 3 and 4 show the spawning stock biomass (SSB) and fishing mortality (F) trajectories of the NEA mackerel stock over the period since 1989. Currently, the SSB is inside safe biological limits, but F appears to be increasing and a reduction in catch is required to maintain sustainability. On the basis of the management plan, ICES advises a catch in 2013 of between 497,000 t to 542,000 t, with a mid-point of 519,000 t. This is predicted to lead to a fishing mortality that is compatible with the management plan and MSY, and to result in a SSB of around 2.68 million t in 2013, well above $MSY_{Btrigger}$.

However, total catches in 2012 were estimated at 930,000 t and, if catches remain at that level in 2013, SSB is predicted to be below $MSY_{Btrigger}$ in 2014 and fishing mortality will continue to increase. Both the EU, Norway and Iceland have agreed to a reduction of around 10% in their planned catches for 2013, and it seems likely that the Faeroes with follow suit, so the catch is likely to be around 837,000 t in 2013. The SSB prediction for this level of catch suggests that the stock will remain just above $MSY_{Btrigger}$ in 2014. The next egg-production survey, due in 2013, will give a fishery-independent estimate of SSB that will help to indicate stock status and guide future management.

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Product characteristics and seasonal cycles

The mackerel is one of the most easily recognisable of all fish, with blue and green stripes along its back. It rarely grows larger than 45cm in length or 2kg in weight. Mackerel is a very oily fish, building up high energy reserves during the spring and summer when the oil content rises to 25-30% of its total body weight. It needs these reserves both for migration and subsequent gonad development, which occur over winter when oil content falls as low as 10% (21). The variable oil content has implications for processing and marketing. It is also requires effective chilling from capture to avoid undesirable spoilage and rapid chilling after catching to 0ºC and effective chilling to below 5ºC in the chilled supply chain (22).

Observed seasonal spawning periods for mackerel

	J	F	M	A	M	J	J	A	S	O	N	D
North East Atlantic												
Central North Sea						■	■					
Skagerrak – Kattegat						■	■					
Southern North Sea						■	■					
Southern England					■	■						
Northern France					■	■						
West of British Isles			■	■	■	■	■					
North and West coast of Spain			■	■	■							
Coast of Portugal		■	■									
Northwest Atlantic												
Gulf of St Lawrence					■	■	■					
NAFO 4			■	■	■	■	■	■				
NAFO 5 & 6				■	■	■						
	■	**Spawning**										

Supply chain standards

Responsible practice in the chilled and frozen supply chain depends on correct catching, gutting, washing, chilling or freezing, processing and handling practices throughout the chain. There are standards which cover these aspects from capture to retailer:

• **Seafish Responsible Fishing Scheme.** Sets best practice standards for fishing vessels, based on British Standards Institution specifications (BSi: PAS 72:2006);

• **British Retail Consortium (BRC) Global Standard and Safe & Local Supplier Approval (SALSA) certification.** Designed to raise standards in the seafood processing and wholesaling sectors.

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