Responsible Sourcing Guide:

Monk

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Lophius piscatorius Image © Scandinavian Fishing Year Book

Monkfish is of high commercial importance to fishermen in the UK. In 2011, the total weight landed in UK ports was 13,800 tonnes (t) with a first sale value of approximately £45.7 million, the UK's most valuable demersal whitefish species (1). However, UK retail consumption of monkfish products in 2012 was only 102 t (2), worth £4.9 million. The total world catch of monkfish (all species) in 2011 was approximately 83,000 t (3).

There are four species which may be marketed as monkfish (or anglerfish) on UK markets (4). The most common species caught by UK vessels is *Lophius piscatorius*, or 'white' monkfish, whilst *Lophius budegassa*, or 'black' monkfish, comprises an increasingly large part of more southerly North Atlantic catches. There are also species of monkfish in North American waters: *Lophius americanus* in the Atlantic and *Lophiodes caulinaris* and *Lophius litulon* in the Eastern Pacific. Cape monkfish, also known as devil's anglerfish, *Lophius vomerinus*, is caught in the South Atlantic, mainly off Namibia and South Africa.

Little is known of many aspects of the various monkfish species' biology, though there are numerous research programmes to improve the scientific knowledge and management of monkfish. There are corresponding uncertainties about the state of the stocks, most of which are assessed by use of abundance estimates based on fisheries/survey catch-per-unit-effort.

Monkfish stocks along the coast of the Iberian Peninsula appear to have increased since the late 1990s, whilst those off north-western Europe generally peaked around 2006-08, since when they have remained stable (north Biscay and Celtic Sea) or declined in abundance (west of Ireland and Scotland, and northern North Sea). This is reflected in the scientific advice for a reduction in catches for these areas.

The purpose of this guide is to outline the status of monkfish stocks and describe some of the measures being taken to protect them.

BUYERS' TOP TIPS

Know your source of supply and stock status

Biological stocks are distinct populations which inhabit particular geographical areas; each one has a different spawning area, but there may be some mixing between them. Monkfish are assessed and managed in 'stock' areas that do not necessarily match biological stocks. Find out the management stock from which the fish has been caught.

Buying policy

Despite uncertainties surrounding the status of some monkfish stocks, fisheries' managers have decided that the fisheries can continue, subject to measures designed to limit catches within current levels of exploitation, whilst further scientific information is gathered. There are national and international research programmes, including science/industry collaboration, to improve knowledge and management of these stocks. This research is aimed to enable long-term sustainable exploitation without the need to close fisheries.

Seafish Responsible Sourcing Service

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Status of monkfish stocks March 2013

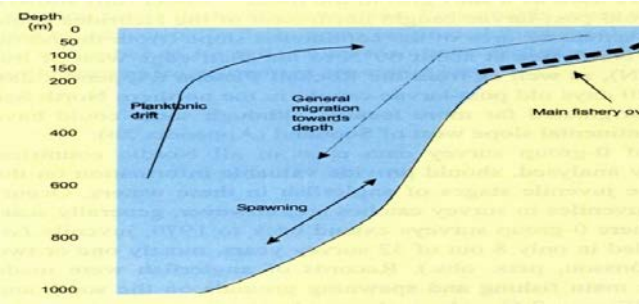
Biology

Knowledge of the biology, migration and spawning behaviour of monkfish is far from complete. Monkfish are found on sandy and muddy sediments in depths of up to 1000m, where they lie half-buried in wait of prey such as small fish, sandeels, and occasionally larger fish (5). Tagging studies have shown that the species can undertake extensive migrations, from Shetland to Faroe and Iceland, for example (6).

Spawning areas are considered to be at the edge of the continental shelf and in deeper waters, where the eggs are released in long, gelatinous ribbons. The young fish drift in the plankton, possibly for hundreds of km meanwhile growing rapidly and, after approximately 120 days, settle out into the demersal phase in the relatively shallow water of the continental shelf (7). This is why monkfish stock management areas tend to be extensive.

The two European anglerfish species are usually caught and recorded together in the landing statistics, and are managed under a combined species TAC.

Figure 1: Hypothesised life cycle of monkfish



Assessment

The population dynamics of most commercially important fish stocks are assessed with analytical models that use information on the size or age structure of the catch and fishery-independent information from research surveys to estimate future yield and stock status in relation to biological reference points. However, such analytical population models are used for very few monkfish stocks, chiefly because there is a lack of information on age structures and growth rates for monkfish. Length-based models are used for some stocks, whilst others are assessed using production models, which simplify populations to unified biomass (all sizes/ages combined). In the vast majority of cases, the quantity of fish caught per hour's fishing – catch-per-unit-effort (CPUE) – in the commercial fishery or on scientific trawl surveys is used as an index of stock abundance. This reveals how biomass is changing in response to fishing pressure and other potential influences, such as predation and environmental change.

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

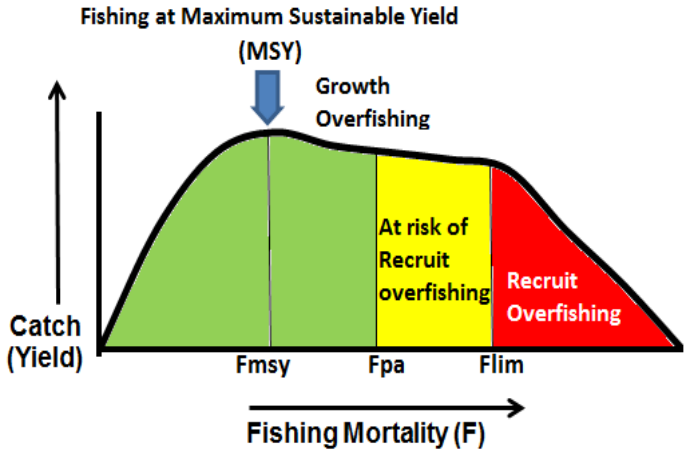
Current ICES advice on fish stocks is given on the basis of MSY and the precautionary approach (8). MSY means fishing at a level that takes the maximum catch (yield) that can safely be removed from a fish stock, on a continuous basis, whilst maintaining its long-term productive capacity. This is achieved by keeping the stock above the biomass action point $\mathbf{MSY_{Btrigger}}$. The precautionary approach aims to limit fishing mortality (F) and catches to levels that avoid depleting the stock's reproductive capacity, keeping its spawning stock biomass (SSB) above its reference level (defined as $\mathbf{B_{pa}}$).

These concepts are illustrated in the schematic (Fig. 2). This shows how catches from an unfished stock would increase in line with exploitation (= 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 $\mathbf{F_{MSY}}$ 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 ($\mathbf{F_{lim}}$) 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 (Figs 3, 4 p 6) 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 $\mathbf{F_{MSY}}$, or reduce fishing mortality to return the stock to within safe biological limits (>$\mathbf{B_{pa}}$). For most monkfish stocks, however, these reference points have not been identified and there is insufficient information to evaluate the status of the stock. In these cases ICES advice is given on its approach for data-limited stocks (see Figs. 5 & 6 page 7) which is designed to keep the biomass stable.

Figure 2: Schematic of ICES' MSY and PA reference points in relation to fishing mortality and Yield



Organisation key

GFCM: The General Fisheries Commission for the Mediterranean promotes the development, conservation, rational management and best utilisation of living marine resources in the Mediterranean.

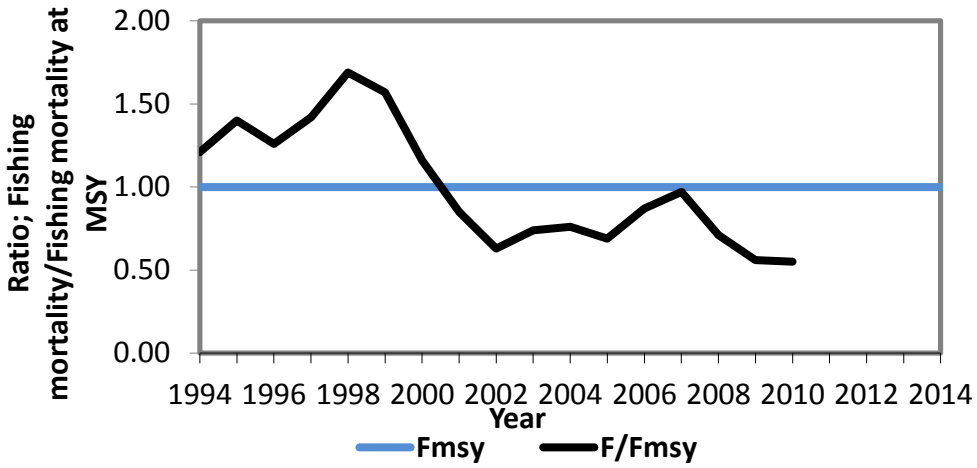
ICES: The International Council for Exploration of the Sea is responsible for providing scientific advice for North East Atlantic fishery management.

EU: The European Union manages fisheries within the Exclusive Economic Zone and in cooperation with Norway for certain stocks.

Table 1: Management Stock	Agreed TAC 2013 (t) (14)	Advisory TAC 2013 (t)	Scientific advice and management (June 2012 ICES advice (9) unless otherwise stated)
NORTH EAST ATLANTIC AND MEDITERRANEAN MONKFISH STOCKS – white monkfish (*Lophius piscatorius)* and black monkfish (*Lophius budegassa*)			
Stocks assessed using a production model; appropriate to Maximum Sustainable Yield			
North and West Spain and Portugal; ICES Divisions VIIIc and IXa	2,475 *L.pisc.* combined with *L.bud.*	2,090 *L.pisc.* combined with *L.bud.*	The stock status of *L. budegassa* is assessed using a surplus production model with data on landings and three commercial CPUE series. Fishing mortality has remained below F_{MSY} since 2001, and biomass is currently well above $MSY_{Btrigger}$ (see Figs 3 & 4).The stock status of *L. piscatorius* is assessed using a new length-based model with data on landings, length distribution, two commercial and one survey series CPUE series. Fishing mortality on *L. piscatorius* has decreased since 2005, but remained just above F_{MSY} in 2010, whilst biomass has increased since 1994 and remained stable from 2009 (no $MSY_{Btrigger}$ has been defined for this stock). As both species of anglerfish are caught in the same fisheries and are subject to a combined TAC, the ICES catch forecast for both species is based on the fishing mortality for *L. piscatorius*, the stock exploited with an F higher than F_{MSY}. ICES advice is given on the basis of transition to MSY by 2015.
Reference points not defined; advice given on the basis of relative abundance and biomass			
Celtic Sea and Biscay; ICES Divisions VIIb-k and VIII a,b,d	**2013; 36,953** *L.pisc.* combined with *L.bud.*	**2014; 37,450** *L.pisc.* combined with *L.bud.*	**October 2013** The majority of the catches in this area are *L. piscatorius*, with some *L. budegassa*, but there are no assessments or reference points for either stock due to problems with growth estimates and uncertainties in ageing, and a catch forecast cannot be presented. ICES advice in 2013 is based on the ICES approach for data-limited stocks (15). The change in biomass index from the past two years is compared with the previous three years in Figures 5 and 6, p 7. Survey data shows the average stock biomass indicator in the last two years (2011–2012) is 55% higher for *L. piscatorius* and 25% higher for *L. budegassa* than the averages of the three previous years (2008-2010). There is evidence of medium recruitment for *L. piscatorius* in the period 2008 to 2012 and strong recruitment for *L. budegassa* in 2008, 2011 and 2012. The change in biomass is then applied, with a precautionary maximum of 20% to the last 3 years (2010-2012) to calculate the TAC for 2014. The advice corresponds to a catch of 37,450 tonnes for 2014, close to the TAC set for 2013.
Iceland; ICES Division Va	1,800 (Sept. 2012 to August 2013; Icelandic fishing year)	1,500 (2012 /13)	Since 2002, landings of *L. piscatorius* from Icelandic waters have increased rapidly, peaking at around 4,000 t in 2009. Previous results from surveys and commercial CPUE indicated a large fishable stock due to good recruitment during the period 1998–2007, though subsequent year classes appear to be poor and the fishable stock has now begun to decline. The MRI recommends 1,500 t as the TAC for the quota year 2012/2013, and an effort should be made to reduce the bycatch of juveniles (16).

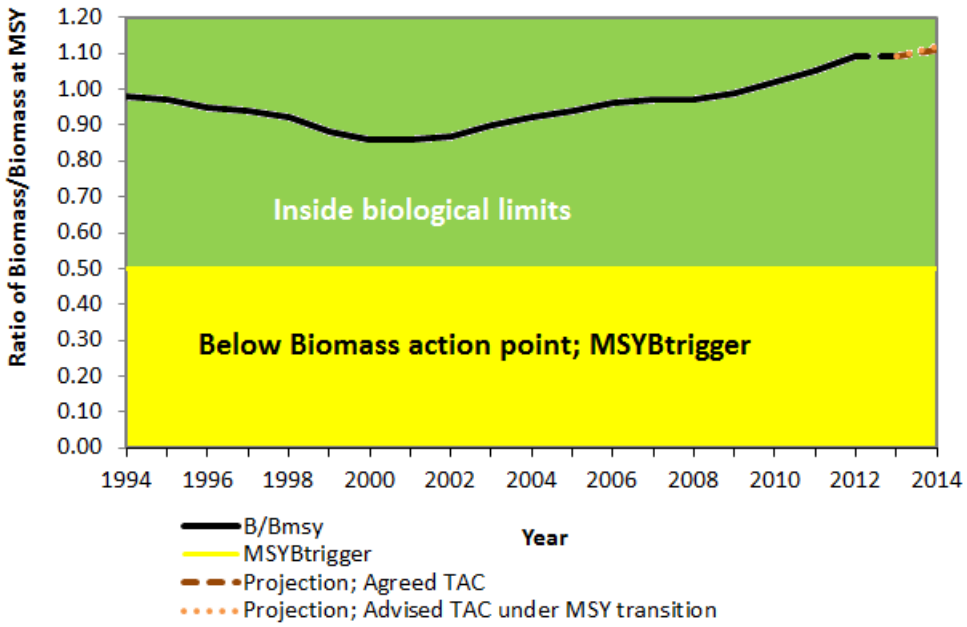
Table 1: Management Stock	Agreed TAC 2013 (t) (14)	Advisory TAC 2013 (t)	Scientific advice and management (June 2012 ICES advice (9) unless otherwise stated)
Faroe; ICES Division Vb		Effort limitations. 2011 catch 1,920	There is no formal assessment of this stock, and advice dates back to 2008. Catch-per-unit-effort indices from research vessel hauls in Faroese waters indicate stable abundance, with some fluctuations over the period 1996-2008. Catches varied from 1,400 t to 4,300 t over the same period, and were around 1,900 – 2,100 t per annum during 2008 - 2011. Fishing effort is managed by restricting the number of licences for gill/tangle nets to five vessels and limiting the numbers of days at sea in the trawl fishery (17).
Northern Shelf: North Sea and Kattegat and Skaggerak; ICES Divisions IIa and IIIa; Subareas IV and VI	13,627t	Approx. 15,000	The majority of the catches in this area are *L. piscatorius*, with some *L. budegassa*, but there are no assessments or reference points for either stock due to problems with growth estimates and uncertainties in ageing, and catches cannot be forecast. Dedicated anglerfish surveys in Division IVa and Subarea VI indicate that the average biomass over this area in the last two years (2010–2011) was 20% lower than the average biomass of the three previous years (2007–2009). ICES advice of around 15,000 t is a 20% reduction in relation to average of last three years (2010-2012), based on its approach to data-limited stocks (15). Due to the uncertainty in the landings data, ICES is not able to quantify the resulting catch.
NORTHWEST ATLANTIC MONKFISH STOCKS (*Lophius americanus*)			
Stocks assessed using a production model; appropriate to Maximum Sustainable Yield			
Northern and southern Fishery Management Areas	8,585 (2011) (3)	2013 10,700 (based on 2009 F)	Landings of *L. americanus* peaked at around 26,000 t in 2003 and have since declined. The 2010 assessment was based on an updated yield-per-recruit analysis and a length-tuned population model incorporating multiple survey indices and catch data, though there remains some uncertainty in the catch data and key biological parameters. Based on updated reference points from these analyses, fishing mortality on monkfish in both the northern and southern management areas is well below the respective overfishing thresholds (proxy for F_{MSY}), and the biomass estimates in 2009 were above the respective biomass targets (18,19).
MONKFISH ELSEWHERE			
Mediterranean and Black Sea	5,598 (2011) (3)		At present there are no stock assessments, though efforts are being made under the GFCM to improve fisheries management in this area.
CAPE MONKFISH STOCKS (*Lophius vomerinus*)			
South East Atlantic	7,740 2009 (3)		Recent catches of more than 12,000 t pa are considered unsustainable and the species is listed as near threatened on the IUCN red list (20,21).
PACIFIC MONKFISH STOCKS			
Pacific Ocean	15,808 2010 (3)		Fishery assessment and management information do not appear to be available.

Figure 3. Fishing mortality trajectory for black anglerfish (*Lophius budegassa*) in ICES Divisions VIIIc and IXa. ICES 2012 assessment.



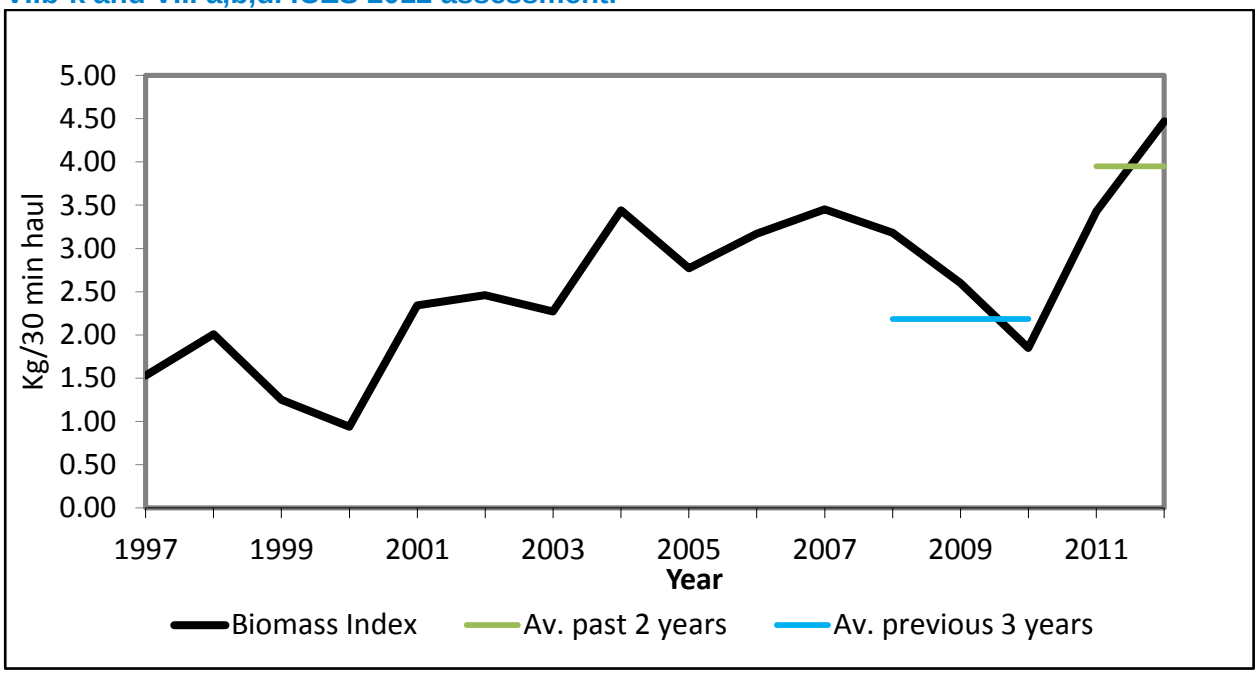
The fishing mortality rate was higher than that which would yield MSY (F_{MSY}) until 2001, since when the stock has been exploited sustainably at a rate lower than F_{MSY}.

Figure 4: Biomass trajectory for black anglerfish (*Lophius budegassa*) in ICES Divisions VIIIc and IXa. ICES 2012 assessment.



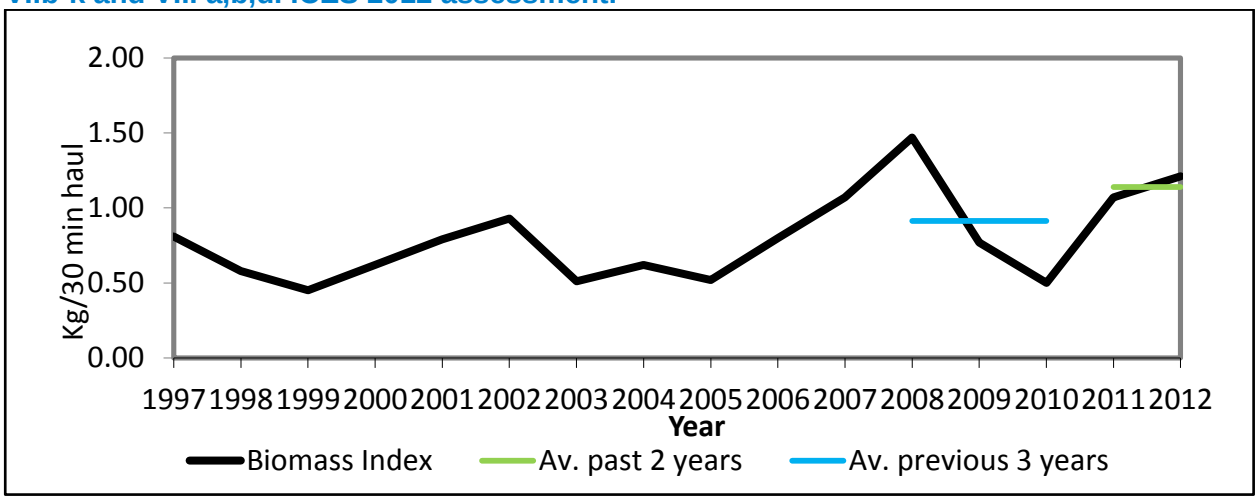
The stock has been above the biomass action point for the past 20 years. The projection for the agreed TAC for 2013 (dashed brown line) is very close to the advised TAC under the transition to M_{SY} by 2015 (dotted orange line).

Figure 5: Biomass trajectory for white anglerfish (*Lophius piscatorius*) in ICES Divisions VIIb-k and VIII a,b,d. ICES 2012 assessment.



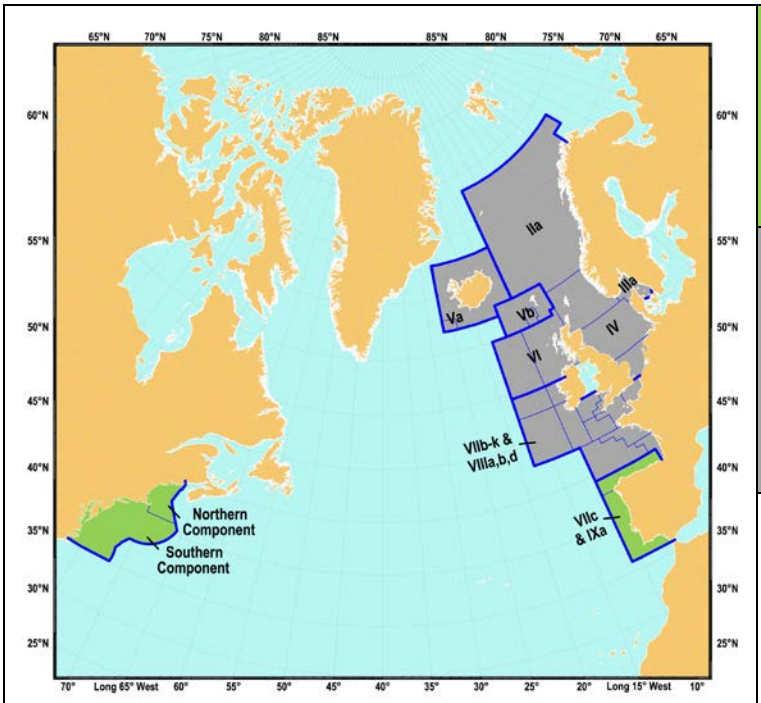
The stock is assessed under the data limited framework, using the index of catch-per-unit-effort of research vessel trawl surveys. The average stock biomass index for the past two years (2011-2012) is 55% higher than the average for the previous 3 years (2008-2010).

Figure 6: Biomass trajectory for black anglerfish (*Lophius budegassa*) in ICES Divisions VIIb-k and VIII a,b,d. ICES 2012 assessment.



The stock is assessed under the data limited framework, using the index of catch-per-unit-effort of research vessel trawl surveys. There is no overall trend, though the average stock biomass index for the past two years (2011-2012) is 29% higher than the average for the previous 3 years (2008-2010)

Monkfish stock areas (colour keyed by status)



	Stocks exploited close to/appropriate to Maximum Sustainable Yield
	Reference points not defined; advice given on the basis of relative abundance and biomass

Fisheries: management and conservation measures

Fisheries

Monkfish are taken mainly as a by catch in bottom-trawl fisheries on the continental shelf, where they generally make up a small but valuable proportion of the total catch, which includes a mixture of whitefish species and/or *Nephrops* (9).There are some targeted fisheries for monkfish, including large-mesh gill and tangle netting on the continental shelf, predominantly in the Celtic Sea and along the Norwegian coast in waters deeper than 200m.The fishery has expanded into deeper waters since the mid-1990s, areas believed to have been a refuge for adult anglerfish, so this has increased the vulnerability of the stock to overexploitation. Immature fish are subjected to exploitation for a number of years prior to first maturity.

Research into monkfish

In recent years, there has been a substantial increase in European research on monkfish. This includes studies of the biology and ecology (5, 6, 7, 10) and methods to estimate age and growth of the fish (11) for stock assessment purposes. There has been close collaboration between fishermen and scientists in improving monkfish catch and assessment information. Designated surveys on research and chartered commercial vessels covering the North Sea, north and west of Scotland, Rockall, Irish Sea and west of Ireland, and the Celtic Sea (12), have been implemented

to improve the information available for assessment and management of monkfish stocks. These initiatives are being carried out under the Fisheries/Science Partnership financed by the UK and Irish Governments. Researchers at Fisheries Research Services, Scotland, run a 'Skippers' tally book' scheme, in which commercial vessels voluntarily collect information on monkfish catches and make it available anonymously to scientists. There have also initiatives to improve knowledge of Scandinavian monkfish stocks (13).

Targeted monkfish fisheries on North East Atlantic stocks are relatively new, so management of the fisheries is evolving along with improving scientific knowledge.

The main issues for management of monkfish stocks are:

Protection of juveniles

In most trawl fisheries that catch monkfish, a reduction in the mortality of young fish would result in a better long-term yield by enabling more fish to survive to maturity. However, the body shape of monkfish means that most trawl gears are not particularly selective for the species and there is no EU minimum landing size, though European marketing standards specify a minimum marketing weight of 500g for whole monkfish (22), which may discourage targeting of small monkfish. Attempts to protect juvenile monkfish by utilising closed areas would potentially involve large areas since small monkfish appear to be widespread, and would affect catches of other economically important species taken by mixed fisheries.

Spawning stock

The proportion of the catch that is mature appears to be quite small, which may mean that mature fish are relatively inaccessible to many fisheries. It is thought that they are found predominantly in deep water off the continental shelf edge, perhaps on rough ground, though targeted surveys have failed to find this part of the stock (13).

If the parent stock is largely limited to deep waters, which are accessible to modern fishing gear, management of these fisheries could be key to conservation of monkfish stocks. Measures have been taken to control some deepwater fisheries. Gill and tangle netting for monkfish is restricted to depths of less than 600m in the European EEZ in waters west of 4ºW (23) and less than 200m in international waters (24), though there are some areas (east of 4ºW) within ICES Division IVa where gill and tangle netting is permitted at depths greater than 600m. Ghost fishing – where lost nets continue to catch fish – is a serious risk in deep waters where nets are not disturbed by currents (25). In Norwegian waters, regular net-retrieval operations to recover lost gear are used to control ghost fishing (26). Deep water trawling in European waters was reduced by 25% in the period 2003-2007 and certain areas near Rockall are closed to all fishing to protect seabed habitats (27).

Product characteristics and seasonal cycles

The two species of European monkfish, *Lophius piscatorius* and *Lophuis budegassa*, are not normally separated for marketing purposes. They can be distinguished by the darker colouration of the mouth and body wall of the *Lophius budegassa*, which is why it is sometimes referred to as the 'black monkfish, or 'black anglerfish'. This species also tends to be smaller. Monkfish is presented on the market either as gutted whole fish or as monkfish tails with the head removed.

Supply chain standards

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

• **SeafishResponsible Fishing Scheme.** Sets best practice standards for fishing vessels, based on British Standards Institution specifications(BSi: PAS 72:2006) (28);

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

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For further guides see: http://tinyurl.com/seafishrsg

*European legislation available on: http://europa.eu/

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