Indicators and trends

Monitoring climate change adaptation

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Indicator name	Version
NM21 Occurrence of warm water species in fish stocks exploited by Scottish fisherman; European anchovy; Squid; (red mullet; John Dory; European sea bass)	**01/08/16**

Indicator type:	Risk/opportunity	Impact	Action
		X	

SCCAP Theme	SCCAP Objective	CCRA risk/opportunity
Natural Environment	N3 - Sustain and enhance the benefits, goods and services that the natural environment provides	MAr1 Species migration (marine) MA4a/b/Changes in fish catch latitude/centre of gravity

At a glance

- There has been an increase in the occurrence of warm water fish species in UK waters and their exploitation has now become a reality
- Squid are already more abundant in Scottish waters potentially replacing the country's target species
- Anchovy, sea bass, John Dory and red mullet will increase in abundance and/or become more accessible to the local fleets in coming decades
- There is the potential that the industry may adapt if stocks become commercially viable.

Latest Figure

Year	2011	2012	2013	2014	2015
European anchovy	1.2	0.5	0.0	0.2	87.3
Squid	7.2	21.8	4.5	20.0	14.7

Mean catch per unit effort (CPUE, per hour of trawl) for the European anchovy (*Engraulis encrasicolus*) and squid (*Loligo forbesi*) in the Northern North Sea Area (east coast of Scotland) (data taken from the ICES NS-IBTS areas 1,2 and 3).

Trend

- There has been an increase in the occurrence of warm water fish species in UK waters.
- It is predicted that anchovy, sea bass, John Dory and red mullet will increase in abundance and/or become more accessible to the local fleets in coming decades.

Why is this indicator important?

Fishing is a commercially important activity within the UK employing more than 12,000 people and with a first-sale value in excess of £800 million in 2011 alone (Pinnegar et al, 2013). The industry is

particularly important in Scotland and although it only contributes 0.39% to the GDP of the country, in some regions fishing is the mainstay of employment (Pinnegar et al, 2013) and about 60% of the UKs commercial marine fish is landed in Scotland (MCCIP, 2012).

In the past 30 years the average sea surface temperature (SST) has risen in the North Atlantic, with 2000 - 2009 being the warmest on record (IPCC, 2013). The most recent warming can be seen at more local scales in Scottish records for offshore temperature monitoring stations. Pinnegar et al (2013) identified key warm water species appearing in UK waters. The proposed indicator will monitor the appearance and increase in abundance of these potentially exploitable warm water fish species in Scottish waters. It will use data records arising from research surveys rather than commercial landings data, which can be biased by quotas and industry market forces. Significant shifts in the distribution and an associated increase in abundance of these warm water species could lead to Scottish fisherman adapting their practice and exploiting these new resources.

Related indicators:
NM1 Changes in average sea surface temperature (SST)

What is happening now?

Squid (*Loligo forbesi*) is thought to respond to climate change (Hastie et al, 2009a) and is showing an increase in abundance in Scottish waters with an increasing number of fisherman targeting this species (Hastie et al, 2009b) (Figure 1). The European anchovy (*Engraulis encrasicolus*) has also increased in abundance in Scottish waters and it is thought this is in response to climate change (Beare et al, 2004). Research surveys have shown the anchovy numbers to be variable in recent years (Figure 1). The anchovy is starting to be targeted by some UK vessels (Pinnegar et al 2013).

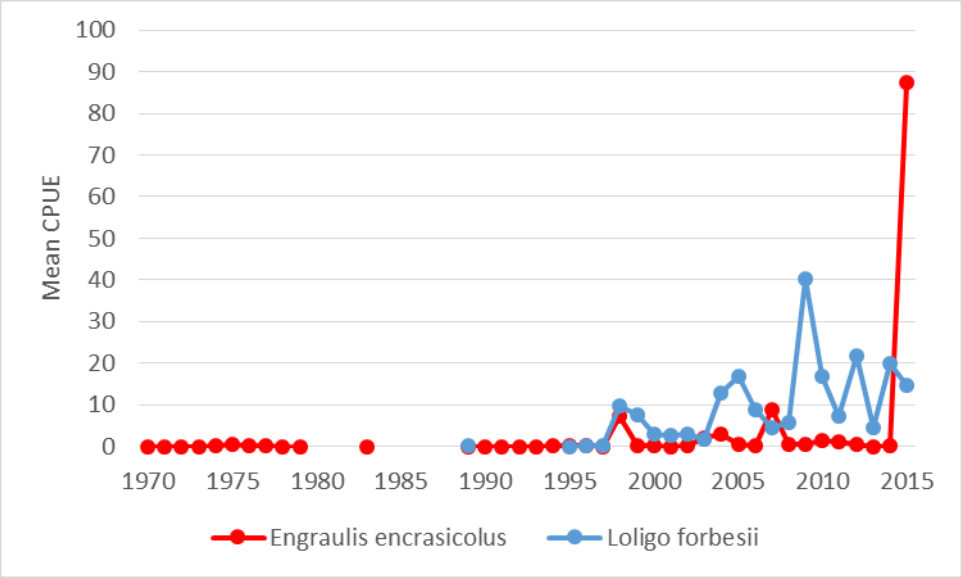

Figure 1 Average catch per unit effort (CPUE, per hour of trawl) for the European anchovy (*Engraulis encrasicolus*) and squid (*Loligo forbesi*) in the Northern North Sea Area (east coast of Scotland) (data taken from the ICES NS-IBTS areas 1,2 and 3).

Other examples of new and expanding fish species with the potential for exploitation are the red mullet (*Mullus surmuletus*), John Dory (*Zeus faber*) and sea bass (*Dicentrarchus labrax*). These species have shown an increase in occurrence in southern UK waters with occasional records of sea bass in Scottish waters (Figure 2). Commercial fishermen in the UK are already beginning to respond to

opportunities as new exploitable fish species appear in their regions stocks. We are already seeing warm water fish species appearing in Scottish waters with other species that are present in southern UK waters likely to appear and increase in abundance in the near future.

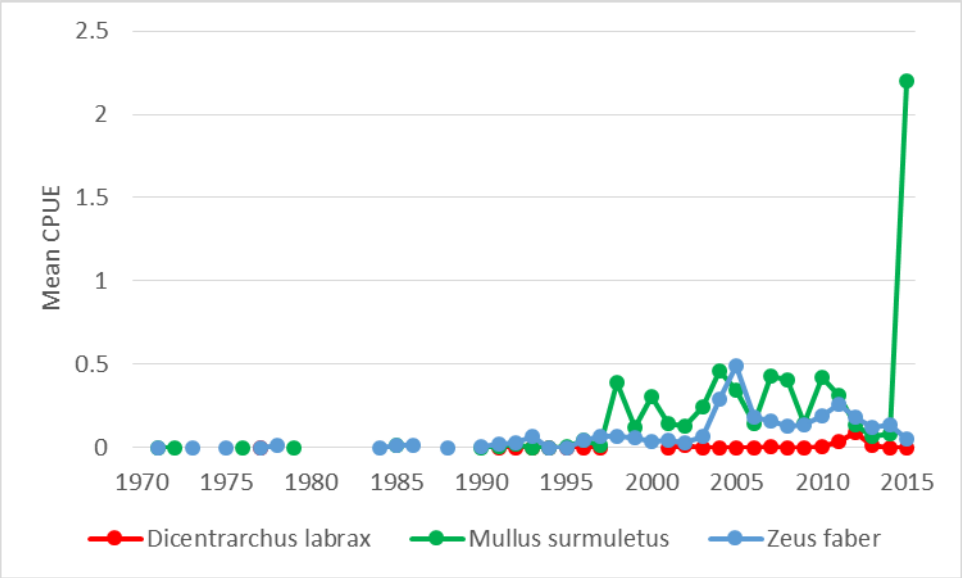

Figure 2 Average catch per unit effort (CPUE, per hour of trawl) for the red mullet (*Mullus surmuletus*), John Dory (*Zeus faber*) and sea bass (*Dicentrarchus labrax*) in the Northern North Sea Area (east coast of Scotland) (data taken from the ICES NS-IBTS areas 1,2 and 3).

What has happened in the past?

Changes in fish distribution exhibit a strong link to long-term changes in temperature (Pinnegar et al, 2013). Simpson et al (2011) showed that 70% of the most abundant fish species in the UK and Ireland changed their distribution in response to climate and oceanic warming. In general, the currently exploited cold water, large bodied fish species have decreased in abundance in UK waters while some smaller bodied warm water species (such as those discussed in this indicator) have increased (Pinnegar et al, 2013). Analyses of long term datasets have shown exploited species such as cod, haddock, plaice and sole as well as non-exploited species have all shifted their North Sea distributions noticeably over the last 25 years (Perry et al, 2005; Dulvy et al, 2008).

What is projected to happen in the future?

Further temperature rises in UK waters are likely to have significant effects on fish distributions and impact commercial fisheries (Perry et al, 2005; Dulvy et al, 2008). Considerable progress has been made in recent years to make future projections for fisheries which make use of very complex ecosystem and fish distribution models. These models incorporate many elements, including not only climate models but fish physiology and food availability. However, there remains little consensus on the most appropriate methodology to use in different circumstances and the precise nature of the changes in the distribution of particular fish species is unclear (Pinnegar et al, 2013). In general, the models suggest that some of the currently exploited cold water fish species are expected to decrease in abundance in UK waters while some warm water species, like those listed above, are expected to increase. It is predicted that the fishing grounds for cod will become increasingly more remote, red mullet and plaice will become more readily available and there will be a continued increase in the anchovy and sea bass populations (MCCIP, 2012).

Patterns of change

As the research on modelling future projections for fisheries has shown, the patterns of change are complex and species specific (Pinnegar et al, 2013).

Interpretation of indicator trends

An increase in the number of warm water species in statutory surveys will indicate a shift in distribution. This shift is likely to be in response to climate warming. If the stocks become exploitable and Scottish fishermen start to take advantage of these stocks then this can be a future adaptation action indicator. The response of Scottish fishermen will depend on a number of other factors, including quotas (political processes), industry market forces and technological advances (industry processes), which makes it difficult to predict the nature and direction of the response.

Limitations

The indicator is reliant on statutory surveys to provide stock assessment data. For inshore fisheries it is known that there are data deficient stocks and the lack of some survey data for inshore species could make prediction of change in inshore waters less reliable.

Changes to IBTS procedures may affect the usefulness of the time series (as has been found in the Clyde) (Bailey, 2015).

Future updates to this indicator will present the data in the context of proportion of all species caught.

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Further information

MCCIP Report Cards and Scientific Reports - http://www.mccip.org.uk/annual-report-card/2013.aspx

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ICES - International Council for the Exploration of the Sea
DATRAS stores data collected during various fish trawl surveys coordinated by ICES expert groups

Appendix One: Indicator metadata and methodology

Table 1: Indicator metadata

	Metadata
Title of the indicator	NM21 Occurrence of warm water species in fish stocks exploited by Scottish fisherman; European anchovy; Squid; (red mullet; John Dory; European sea bass)
Indicator contact: Organisation or individual/s responsible for the indicator	**Anna Moss** (CXC, University of Dundee)
Indicator data source	**ICES** – DATRAS online database Surveys relevant to Scottish waters:- **NS-IBTS** – North Sea International Bottom Trawl Survey (areas 1, 2 & 3) **SWC-IBTS** – Scottish IBTS (all areas)
Data link: URL for retrieving the indicator primary indicator data.	https://datras.ices.dk/Data_products/Download/Download_Data_public.aspx

Table 2: Indicator data

	Indicator data
Temporal coverage: Start and end dates, identifying any significant data gaps.	**ICES:-** **NS-IBTS** – 1965 to present **SWC-IBTS** – 1985 to present
Frequency of updates: Planned or potential updates	**ICES** – data uploaded regularly depending on the data source.
Spatial coverage: Maximum area for which data is available	**ICES** – See below for 'DATRAS survey area maps' document: http://www.ices.dk/marine-data/data-portals/Pages/DATRAS-Docs.aspx
Uncertainties: Uncertainty issues arising from e.g. data collection, aggregation of data, data gaps	Reliant on statutory surveys to provide stock assessment data
Spatial resolution: Scale/unit for which data is collected	Trawls expressed as Catch Per Unit Effort (CPUE) which can be per length per haul, per age per haul, etc (see 'data products' on the website). Other indices are also available. See below for 'Units and codes in DATRAS data products' document:- http://www.ices.dk/marine-data/data-portals/Pages/DATRAS-Docs.aspx

Categorical resolution: Potential for disaggregation of data into categories	Data is categorised according to data product (eg CPUE), Survey, Quarter, Year, Ship, Fishing Gear, Area and Species (standard species and all species).
Data accessibility: Restrictions on usage, relevant terms & conditions	Freely available to download from the DATRAS website

Table 3 Contributing data sources

Contributing data sources Data sets used to create the indicator data, the organisation responsible for them and any URLs which provide access to the data.
ICES – DATRAS online database Surveys relevant to Scottish waters:- **NS-IBTS** – North Sea International Bottom Trawl Survey (areas 1, 2 & 3) **SWC-IBTS** – Scottish IBTS (all areas)

Table 4 Indicator methodology

Indicator methodology The methodology used to create the indicator data
Data can be downloaded from the DATRAS website. Data can be expressed as Catch Per Unit Effort (CPUE) which can be per length per haul, per age per haul, etc (see 'data products' on the website). Other indices are also available.