Indicators and trends

Monitoring climate change adaptation

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Indicator name			Version
NM46 Change in the latitudinal distribution of industry sectors in response to shifting optimal conditions for species specific growth: aquaculture			**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	MA30 Damage to cultured aquatic species, MAr1 Species migration (marine)

At a glance

- Currently, there is little observed evidence for any direct effects of climate change on UK aquaculture.
- Research suggests that the seas in all regions of the UK will continue to warm. This continued warming could have an impact on the shellfish and finfish industry in the long term, forcing the placement of new aquaculture sites in more northerly latitudes.

Latest Figure	Trend
This indicator does not currently present quantitative data but provides an overview of the current distribution of the industry. Future updates to this indicator will consider changes in the decadal latitudinal distribution of facilities.	No trend at this time

Why is this indicator important?

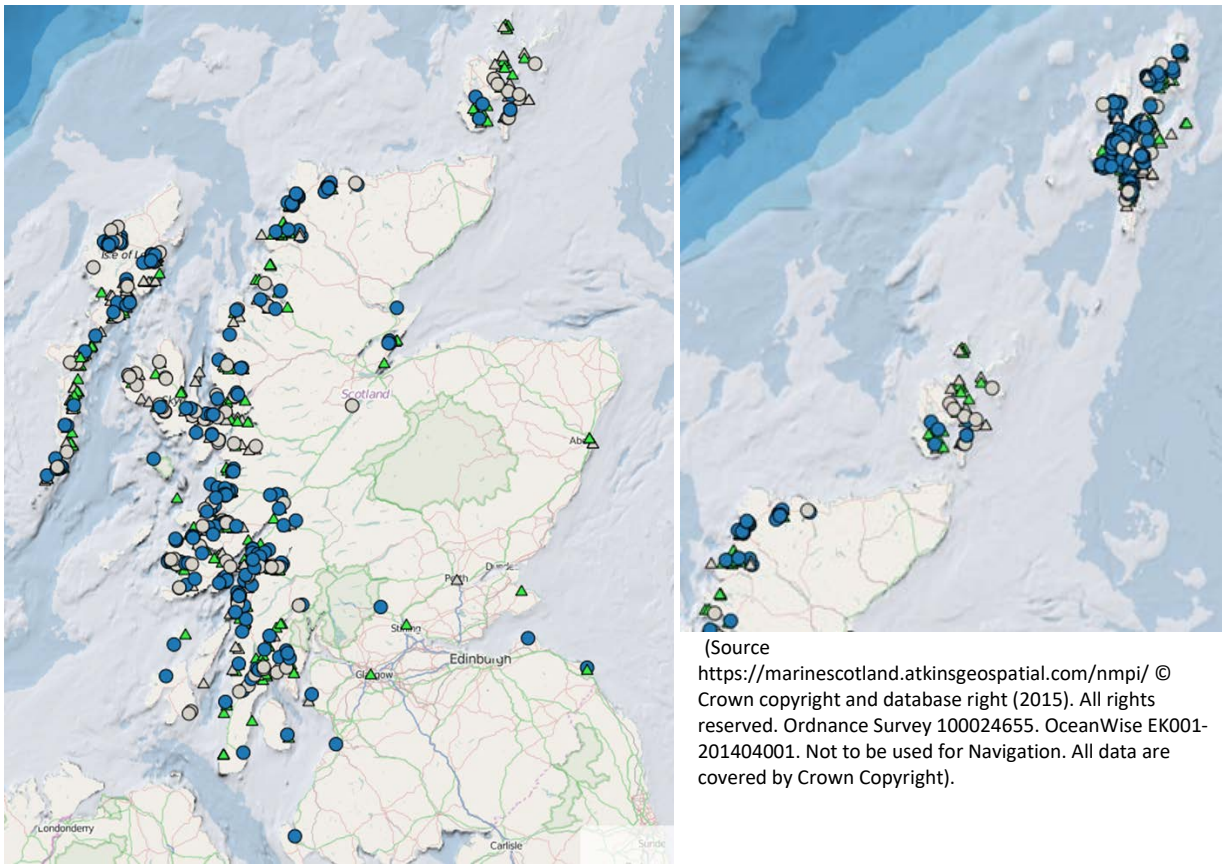
Aquaculture, including the shellfish and finfish industries, is very important with 99% of the UK finfish industry concentrated in Scotland (Gubbins *et al*, 2013). The finfish industry is dominated by the production of Atlantic Salmon and Scotland produced 163,234 tonnes in 2013 with an estimated value of £677 million (Scottish Fish Farm Production Survey 2013). The shellfish industry in Scotland is comprised largely of mussel farms and the sector as a whole is estimated to be worth £17 million. The industry is considered to be adaptive (MCCIP, 2012) and in a warming climate is expected to respond for the benefit of the industry by shifting location to maintain optimal growth conditions for its stock

(see below). This indicator will examine trends in the placement of aquaculture sites over time through the use of georeferenced data associated with site licences.

Related indicators:
NM1 Changes in average sea surface temperature (SST)
NM9b Damage to cultured aquatic species: Frequency of escapes from fish farms due to weather

What is happening now?

At this time there have been no observed impacts on the UK aquaculture industry that can be directly attributed to climate change (Gubbins *et al*, 2013). Therefore, there is no observed change in the latitudinal distribution of aquaculture sites in response to shifting optimal conditions for species-specific growth. Current placement of active and inactive aquaculture (marine finfish and shellfish) sites show the westerly bias in the placement of these facilities (Fig. 1).



(Source https://marinescotland.atkinsgeospatial.com/nmpi/ © Crown copyright and database right (2015). All rights reserved. Ordnance Survey 100024655. OceanWise EK001-201404001. Not to be used for Navigation. All data are covered by Crown Copyright).

Figure 1. Current placement of active finfish sites (green triangles), inactive finfish sites (grey triangles), active shellfish sites (blue circles) and inactive shellfish sites (grey circles) for Scotland.

What has happened in the past?

The aquaculture industry has only operated on a large commercial scale in Scotland for about 35 years and therefore there is no long term record of climatic influence on production. Thus far, natural variation, the influence of disease, both naturally occurring and introduced, together with rapid advances in husbandry and production technologies would make it impossible to attribute any trends to climate change.

What is projected to happen in the future?

Based on UK Climate Projections 2009 (UKCP09; Lowe et al., 2009), Dye et al (2013) suggest that the seas in all regions of the UK will continue to warm. A temperature rise of 2°C is likely to expose some species in Scottish aquaculture facilities to temperatures beyond their thermal optima for extended periods during the summer (Gubbins *et al*, 2013). Cultured finfish such as salmonids show a greater tolerance to higher temperatures when compared to other cold water fish species (Gubbins *et al*, 2013 and references therein). However, extended periods of summer high temperatures are likely to cause some stress in sheltered locations and will mean that any expansion of the industry will be confined to more northerly latitudes (Gubbins *et al*, 2013). The shellfish industry shows similar patterns with some species able to tolerate the temperature fluctuations, e.g. mussels from the genus *Mytilus*, and others will show an increase in mortality events with increasing temperatures, e.g. the Pacific oyster (*Crassostrea gigas*) (Gubbins *et al*, 2013). Although the shellfish industry in Scotland is only responsible for 12% of the total production in the UK and Ireland as a whole, it is a growing sector and continued temperature rises are likely to mean that any expansion of the industry will be confined to more northerly latitudes.

Patterns of change

In a warming climate we may see an overall latitudinal shift in the site placement of marine finfish and shellfish aquaculture sites.

It is planned that the next update to this indicator will consider changes in decadal latitudinal distribution of facilities.

Interpretation of indicator trends

An overall northward latitudinal shift in the site placement of marine finfish and shellfish aquaculture sites would indicate the industry is adapting to climate warming.

Limitations

There are a number of confounding factors, such as disease, planning regulations, commercial and political decisions that could also influence where aquaculture takes place, which would undermine the use of latitudinal change of industry activity (used in isolation) as an indicator of adaptation to climate change.

It is currently not possible to monitor the spatial pattern based on the volume of production. The production data from each individual site is provided voluntarily by each Aquaculture Production Business in Scotland. This data is commercially sensitive and is not released in disaggregated form, where the production of an individual company, or site, can be identified.

The next update to this indicator will consider changes in decadal latitudinal distribution of facilities. However, currently the data available identifies if a facility has been inactive for the last three years, but does not provide the actual date inactivity commenced.

References

Dye, S.R., Hughes, S.L., Tinker, J., Berry, D.I., Holliday, N.P., Kent, E.C., Kennington, K., Inall, M., Smyth, T., Nolan, G., Lyons, K., Andres, O. & Beszczynska-Möller, A. (2013) *Impacts of climate change on temperature (air and sea)*. MCCIP Science Review 2013, 1-12. doi:10.14465/2013.arc01.001-012

Gubbins, M., Bricknell, I. & Service, M. (2013) *Impacts of climate change on aquaculture*. *MCCIP Science Review 2013*, 318-327, doi:10.14465/2013.arc33.318-327

Lowe, J.A., Howard, T.P., Pardaens, A., Tinker, J., Holt, J., Wakelin, S., Milne, G., Leake, J., Wolf, J., Horsburgh, K., et al. (2009) *UK Climate Projections science report: Marine and coastal projections*. Met Offce Hadley Centre, Exeter, UK.

MCCIP (2012). *Marine Climate Change Impacts on Fish, Fisheries and Aquaculture*. (Eds. Frost M, Baxter JM, Buckley PJ, Cox M, Dye SR and Withers Harvey N) Summary Report, MCCIP, Lowestoft, 12pp.

Scottish Fish Farm Production Survey 2013 - www.gov.scot/Resource/0045/00459981.pdf

Further information

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

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Appendix One: Indicator metadata and methodology

Table 1: Indicator metadata

	Metadata
Title of the indicator	NM46 Change in the latitudinal distribution of industry sectors in response to shifting optimal conditions for species specific growth; aquaculture
Indicator contact: Organisation or individual/s responsible for the indicator	**Anna Moss** (CXC, University of Dundee)
Indicator data source	**Marine Scotland and Industry** Aquaculture facilities for 'Marine Finfish Aquaculture Sites' and 'Shellfish Aquaculture Sites' are found with the 'Site Details' section of the url below**.**
Data link: URL for retrieving the indicator primary indicator data.	Marine Scotland data held on the Scotland's Aquaculture website:- http://aquaculture.scotland.gov.uk/data/data.aspx

Table 2: Indicator data

	Indicator data
Temporal coverage: Start and end dates, identifying any significant data gaps.	**Marine Finfish Aquaculture Sites –** 07/01/1982 to 07/04/2015 **Shellfish Aquaculture Sites –** 15/03/1972 to 07/04/2015
Frequency of updates: Planned or potential updates	Monthly?
Spatial coverage: Maximum area for which data is available	Scotland and Islands within Scottish territorial waters
Uncertainties: Uncertainty issues arising from e.g. data collection, aggregation of data, data gaps	
Spatial resolution: Scale/unit for which data is collected	Farm by farm
Categorical resolution: Potential for disaggregation of data into categories	Sites are categorised by site name, operator, OSGB grids, species
Data accessibility: Restrictions on usage, relevant terms & conditions	Statutory data - public domain

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.
Marine Scotland data held on the Scotland's Aquaculture website

Table 4 Indicator methodology

Indicator methodology The methodology used to create the indicator data
Long term analysis of the siting of aquaculture facilities to see if there is a latitudinal shift in the trend.