Supplementary Advice on Conservation Objectives for North-west Orkney Nature Conservation Marine Protected Area

April 2018

jncc.defra.gov.uk

Contents

Introduction

What the conservation advice package includes

The information provided in this document sets out JNCC's supplementary advice on the conservation objectives set for this site. This forms part of JNCC's formal conservation advice package for the site and must be read in conjunction with all parts of the package as listed below:

- Background Document explaining where to find the advice package, JNCC's role in the provision of conservation advice, how the advice has been prepared, when to refer to it and how to apply it;
- Conservation Objectives setting out the broad ecological aims for the site;
- Statements on:
  - the site's protected feature condition;
  - conservation benefits that the site can provide; and
  - conservation measures needed to further the conservation objectives stated for the site. This includes information on those human activities that, if taking place within or near the site, can impact it and hinder the achievement of the conservation objectives stated for the site; and
- Supplementary Advice on Conservation Objectives (SACO) providing more detailed and site-specific information on the conservation objectives (this document).

The most up-to-date conservation advice for this site can be downloaded from the conservation advice tab in the Site Information Centre (SIC) on JNCC's website.

The advice presented here describes the ecological characteristics or 'attributes' of the site's protected feature: Sandeels specified in the site's conservation objective. These attributes are: extent and distribution, structure and function and supporting processes.

Supplementary advice on the conservation objectives for the geomorphological features: sand banks, sand wave fields and sediment wave fields representative of the Fair Isle Straight Marine Process Bedforms Key Geodiversity Area are not currently provided in this document. Further information regarding these features can be found on the Site information Centre.

Figure 1 below illustrates the concept of how a feature's attributes are interlinked: with impacts on one potentially having knock-on effects on another e.g. the impairment of any of the supporting processes on which a feature relies can result in changes to its extent and distribution and structure and function.

Collectively, the attributes set out in the following table describe the desired ecological condition (favourable) for the site's feature. Each feature within the site must be in favourable condition as set out in the site's conservation objective. All attributes listed in the following table must be taken into consideration when assessing impacts from an activity.

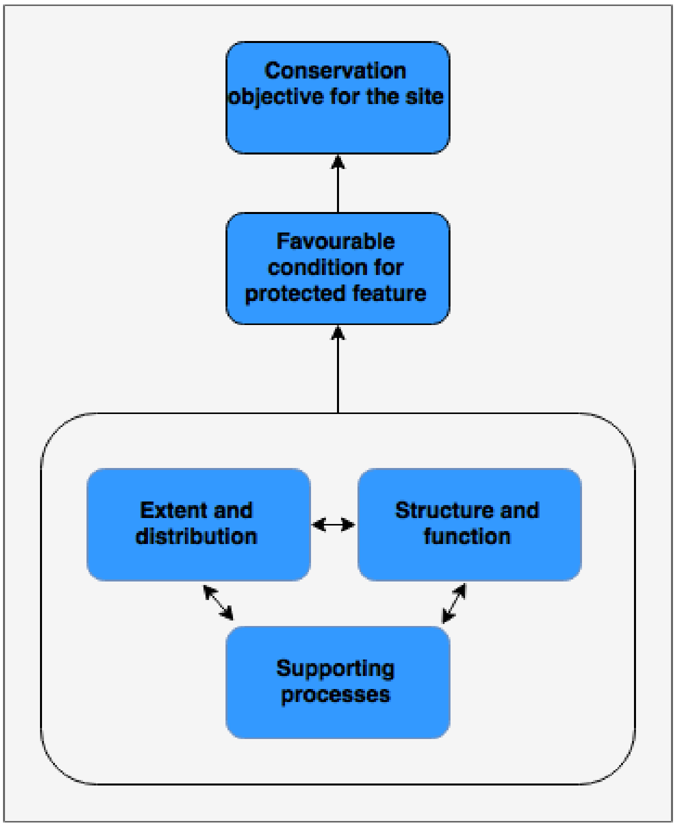

Figure 1. Conceptual diagram showing how a feature's attributes are interlinked and collectively describe favourable condition and contribute to the conservation objectives stated for the site.

In Table 1 below, the attributes for Sandeels are listed and a description provided in the explanatory notes.

Please note our current understanding of whether the available evidence indicates that each attribute needs to be recovered or conserved is not provided. However, links to available evidence for the site are provided in the table below and should you require further site-specific information on the attributes listed for the site’s feature, please contact JNCC at OffshoreMPAs@jncc.gov.uk.

Table 1: Supplementary advice on the conservation objectives for Sandeels in North-west Orkney NCMPA.

Attribute: Presence and distribution
Objective: An objective has not been set for this attribute. Links to available evidence are provided below. Please contact JNCC at OffshoreMPAs@jncc.gov.uk for further site-specific information on this attribute.
Explanatory notes Presence describes Sandeel occurrence, with the spatial distribution providing a more detailed overview of the location(s) and pattern of occurrence within a site, both in the water column and the seabed. Sandeels may use a site for feeding on zooplankton in the water column, courtship or spawning purposes as well as nursery grounds. It is important to consider the key life stages and behaviours of Sandeels within a site as this may influence its distribution within a site which can fluctuate over time and be patchy in nature (Jensen *et al*., 2011). Sandeels spawn with a single batch of demersal eggs (per year) between November and January (Macer, 1966; Reay, 1970). The eggs are laid onto sand grains on the seabed and remain there for 1-3 months until hatching (Macer, 1966; Wright, 1993; Wright and Bailey 1996; Jensen, 2001). The hatched larvae are planktonic and after metamorphosis, are recruited as juveniles into the Sandeel population as they settle and bury into the seabed (Winslade, 1971). Sandeels come out of their burrows to feed on zooplankton in the water column during spring and summer. This behaviour is strongly influenced by the availability and distribution of their zooplanktonic prey (*Calanus* species). Sandeels have specific sediment requirements which affect presence and density (Wright *et al*., 2000). Sandeels are unlikely to relocate in response to changing conditions, and are therefore considered particularly vulnerable to the impacts of climate change (Engelhard *et al.,* 2008; Heath *et al.,* 2012). Recovery of the feature within a site is likely to be reliant on a supply of recruits from elsewhere/sufficient numbers remaining for self-recruitment and highly dependent on wider environmental pressures, such as climate change. The areas of seabed that are known to support Sandeels are important for the conservation of the species and its distribution within a site. Conserving Sandeel presence and distribution within a site involves ensuring the continued access of individuals to resources within the site on which they rely, including, but not limited to, feeding, courtship, spawning or use as nursery grounds. Advice on the conservation of supporting processes, including supporting habitats is provided further down in this table. ---

Presence and distribution of the Sandeels within the site

The presence and distribution of the Sandeels within the site is shown in the site map. For further site-specific information please see the Site Information Centre.

For information on activities capable of affecting the protected features of the site, please see FeAST.

Attribute: Supporting processes

Objective:

An objective has not been set for this attribute. Links to available evidence are provided below. Please contact JNCC at OffshoreMPAs@jncc.gov.uk for further site-specific information on this attribute.

Explanatory notes

For the site to fully deliver the conservation benefits set out in the statement on conservation benefits, the following natural supporting processes within a site must remain largely unimpeded:

Hydrodynamic regime;
Structure and function of supporting habitat; and
Water and sediment quality.

Hydrodynamic regime

Hydrodynamic regime refers to the speed and direction of currents, seabed shear stress and wave exposure. These mechanisms circulate food resources and propagules, as well as influencing water properties by distributing dissolved oxygen and transferring oxygen from the surface to the seabed (Chamberlain *et al.,* 2001; Biles *et al.,* 2003; Hiscock *et al.,* 2004). Hydrodynamic regime also effects the movement, size structure and sorting of sediment particles. Shelf hydrography effects the distribution and abundance of Sandeels and can affect nutrient and plankton availability (Cushing, 1989; Scott *et al.,* 2006) as well as egg and larval dispersal (Proctor *et al.,* 1998). Sandeel eggs hatch in February and March (Macer, 1966), releasing planktonic larvae into the water column which can then disperse (Conway *et al.,* 1997). Larval drift between areas in the North Sea is driven by the prevailing sea circulation patterns (Wright, 1996).

Biological connectivity is the extent to which populations in different parts of a species' range are linked by the movement of eggs, larvae or other propagules, juveniles or adults. Connectivity is important for maintaining genetic mixing, local stocks and facilitating stock recovery. Sandeel dispersal occurs primarily during the larval stage when the young move into the water column after hatching and is strongly influenced by the prevailing hydrodynamic regime.

The distribution of *Ammodytes marinus* is highly fragmented in the North Sea because of its preference for coarse sand with little silt (Jensen *et al.,* 2011); mixing among subpopulations is therefore dependent on dispersal of planktonic larvae over long distances and the movement of pre-settled juveniles between colonised habitat patches (Wright, 1996; Proctor *et al.,* 1998; Christensen *et al.,* 2008). Dispersal can occur over distances as far as 300 km but typically less than 100 km (Proctor *et al.,* 1998; Christensen *et al.,* 2008). It has been suggested that some sub-populations can act as sources for the rest of the North Sea (Christensen *et al.,* 2008).

The hydrodynamic regime plays a critical role in the natural distribution of Sandeels. Alterations to the natural movement of water could affect the presence, distribution, connectivity and recruitment of Sandeel sub-populations. It is therefore important to avoid impeding the wider natural hydrodynamic regime within a site.

Structure and function of supporting habitat

As mentioned previously, the areas of seabed that are known to support Sandeel are important for the conservation of the species and its distribution within a site. Supporting habitats provide a function for Sandeels by offering refuge from predators. Once settled, adult Sandeels show limited movement between sub-populations (Proctor *et al.,* 1998; Christensen *et al.,* 2008; ICES, 2017). They tend to stay in the same place (Kunzlik *et al.,* 1986; Gauld and Hutcheon, 1990), rarely found further than 15 km away from their initial settlement habitat (Wright, 1996; Engelhard *et al.,* 2008; van der Kooij *et al.,* 2008).

For Sandeels, the structure and function of the supporting habitat plays an important role in determining the presence and distribution of the species. Sandeels are normally buried within seabed sediments for large parts of their life. It is important therefore to avoid infilling burrows occupied by Sandeels. Evidence indicates that Sandeels can typically bury in sediment to between 8 cm and 12 cm depth (Holland et al., 2005). Sandeel seabed habitat preference is particularly important as juveniles select locations to settle, burying into sediments containing a high proportion of coarse sand and little silt (Wright *et al.,* 2000; Holland *et al.,* 2005). Wright *et al.,* (2000) reported that Sandeels were not found in sediment samples in the North Sea where the silt content in the sediment was greater than 10%. To conserve the natural Sandeel presence and distribution within a site, it is therefore important to avoid changing the natural sediment composition of the supporting habitat, particularly increasing the silt content. It is also important to avoid changing the natural distribution and depth of the supporting habitat.

Water and sediment quality

While little is known about how Sandeels specifically are impacted by contaminants, it is known that contaminants can impact the health of marine fauna through a range of effects, depending on the nature of the contaminant (JNCC, 2004; UKTAG, 2008; EA, 2014). It is important therefore to avoid changing the natural water and sediment quality properties of a site and, as a minimum, ensure compliance with existing Environmental Quality Standards (EQS) as set out below.

Environmental Quality Standards (EQS)

The targets listed below for water and sediment contaminants in the marine environment are based on existing targets within OSPAR or the Water Framework Directive (WFD) and require concentrations and effects to be kept within levels agreed in the existing legislation and international commitments. These targets are set out in The UK Marine Strategy Part 1: The UK Initial Assessment, 2012.

Aqueous contaminants must comply with water column annual average (AA) Environmental Quality Standards (EQS) according to the amended Environmental Quality Standards Directive (EQSD) (2013/39/EU), or levels equating to (High/Good) Status (according to Annex V of the Water Framework Directive (WFD) (2000/60/EC), avoiding deterioration from existing levels.

Surface sediment contaminants (<1cm from the surface) must fall below the OSPAR Environment Assessment Criteria (EAC) or Effects Range Low (ERL) threshold. For example, mean cadmium levels must be maintained below the ERL of 1.2 mg per kg. For further information, see Chapter 5 of the OSPAR Quality Status Report (OSPAR, 2010) and associated QSR Assessments.

The following sources provide information regarding historic or existing contaminant levels in the marine environment:

- Marine Environmental and Assessment National Database (MERMAN);
- The UK Benthos database available to download from the Oil and Gas UK website;
- Cefas Green Book;
- Strategic Environmental Assessment Contaminant Technical reports available to download from the British Geological Survey website; and

- Charting Progress 1: The State of the UK Seas (2005) and Charting Progress 2: The State of the UK Seas (2014).

Water quality
The water quality properties that can influence the presence and distribution of Sandeels include salinity, pH, temperature, suspended particulate concentration, nutrient concentrations and dissolved oxygen.

Sandeels are particularly sensitive to changes in water temperature; a study on Dogger Bank found that Sandeels were most likely to be present in water temperatures between 8.5 – 9.5°C (van der Kooij *et al.,* 2008). Other studies have shown that changes in temperature have a significant effect on the metabolic rate and energy consumption of Sandeels, affecting their ability to overwinter and therefore impacting on adult reproductive capacity and mortality (Behrens *et al.,* 2007; Behrens and Steffensen, 2007; Wright *et al.,* 2000). A change of two-degrees Celsius could also lead to a substantial change in the structure of the wider biological community, affecting Sandeel food availability (Frederiksen *et al.,* 2007). Water salinity may also impact Sandeel presence and distribution, with a modelling study suggesting that, in areas where Sandeel are present, abundance was highest where surface salinity was 34.9 to 35.0 parts per thousand (ppt) (van der Kooij *et al.,* 2008). In the open offshore marine environment, salinity is not expected to naturally fluctuate.

Sandeels are pelagic feeders with their diet varying as they mature; Sandeel larvae feed on phytoplankton (diatoms in particular) while adults feed on zooplankton (copepods) (Ryland, 1964; Arnott and Ruxton, 2002). Adult Sandeels emerge to feed during spring and summer to increase body condition (to facilitate winter survival) and to produce gonad tissue for spawning (Greenstreet *et al.,* 2006). Zooplankton availability has a strong effect on adult Sandeel distribution and abundance during these seasons. The availability of copepod prey (especially *Calanus finmarchicus*) is an important determinant of Sandeel larval growth rates after larvae hatch in early spring, affecting early survival rates and subsequent recruitment (Wright and Bailey, 1996; Gurkan *et al.,* 2012). It is therefore important to avoid reducing natural water quality within a site so that Sandeels can continue to use the site.

Sediment quality
Sandeels require the presence of oxygen in the seabed sediment to survive when buried (Lohse *et al.,* 1996), therefore a decrease in oxygen levels in sandy sediments could reduce Sandeel habitat availability (Behrens *et al.,* 2007; Behrens and Steffensen, 2007). Sandeels also have a high sensitivity to phytoplankton enrichment of sediment, which has been implicated in some local declines of Sandeels (Jensen, 2001). It is important to avoid reducing natural sediment quality within a site so that Sandeels can continue to use the site.

Supporting processes for the feature within the site

For further site-specific information on the natural processes which support the feature within the site, please see the Site Information Centre.

For information on activities capable of affecting the protected features of the site, please see FeAST.

References

Arnott, S.A. and Ruxton, G.D. (2002). Sandeel recruitment in the North Sea: demographic, climatic and trophic effects. *Marine Ecology Progress Series*, 238: 199-210.

Behrens, J.W., Stahl, H.J., Steffensen, J.F. and Glud, R.N. (2007). Oxygen dynamics around buried lesser sandeels *Ammodytes tobianus* (Linnaeus 1785): mode of ventilation and oxygen requirements. *Journal of Experimental Biology*, 210(6): 1006-1014.

Behrens, J.W. and Steffensen, J.F. (2007). The effect of hypoxia on behavioural and physiological aspects of lesser sandeel, *Ammodytes tobianus* (Linnaeus, 1785). *Marine Biology*, 150(6): 1365-1377.

Biles, C.L., Solan, M., Isaksson, I., Paterson, D.M., Emes, C. and Raffaelli, D.G. (2003). Flow modifies the effect of biodiversity on ecosystem functioning: An in situ study of estuarine sediments. *Journal of Experimental Marine Biology and Ecology*, 285/286: 165-177.

Chamberlain, J., Fernandes, T.F., Read, P., Nickell, T.D. and Davies, I.M. (2001). Impacts of biodeposits from suspended mussel (*Mytilus edulis* L.) culture on the surrounding surficial sediments. *ICES Journal of Marine Science*, 58: 411-416.

Christensen, A., Jensen, H., Mosegaard, H., St. John, M. and Schrum, C. (2008). Sandeel (*Ammodytes marinus*) larval transport patterns in the North Sea from an individual-based hydrodynamic egg and larval model. *Canadian Journal of Fisheries and Aquatic Sciences*, 65(7): 1498-1511.

Conway, D.V.P., Coombs, S.H. and Smith, C. (1997). Vertical distribution of fish eggs and larvae in the Irish Sea and southern North Sea. *ICES Journal of Marine Science*, 54(1): 136-147.

Cushing, D.H. (1989). A difference in structure between ecosystems in strongly stratified waters and those that are only weakly stratified. *Journal of Plankton Research*, 11: 1-13.

Engelhard, G.H., van der Kooij, J., Bell, E.D., Pinnegar, J.K., Blanchard, J.L., Mackinson, S. and Righton, D.A. (2008). Fishing mortality versus natural predation on diurnally migrating sandeels *Ammodytes marinus*. *Marine Ecology Progress Series*, 369: 213-227.

Environment Agency (EA) (2014). Water Framework Directive: Surface water classification status and objectives [Online]. Available at: http://www.geostore.com/environmentagency/WebStore?xml=environment-agency/xml/ogcDataDownload.xml [Accessed 20 March 2017].

European Commission (EC). (2000). Council Regulation (EC) No 1298/2000 of 8 June 2000 amending for the firth time Regulation (EC) No 850/98 for the conservation of fishery resources through technical measures for the protection of juveniles of marine organisms. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32000R1298&from=EN [Accessed 09 January 2018].

European Topic Centre (ETC). (2011). Assessment and reporting under Article 17 of the Habitats Directive. Explanatory notes and guidelines for the period 2007-2012. Available at: https://circabc.europa.eu/sd/a/2c12cea2-f827-4bdb-bb56-3731c9fd8b40/Art17%20-%20Guidelines-final.pdf [Accessed 17 October 2017].

Frederiksen, M., Furness, R.W. and Wanless, S. (2007). Regional variation in the role of bottom-up and top-down processes in controlling sandeel abundance in the North Sea. *Marine Ecology Progress Series*, 337: 279-286.

Gauld, J.A. and Hutcheon, J.R. (1990). Spawning and fecundity in the lesser sandeel, *Ammodytes marinus* Raitt, in the north-western North Sea. *Journal of Fish Biology*, 36(4): 611-613.

Greenstreet, S.P., Armstrong, E., Mosegaard, H., Jensen, H., Gibb, I.M., Fraser, H.M., Scott, B.E., Holland, G.J. and Sharples, J. (2006). Variation in the abundance of sandeels *Ammodytes marinus* off southeast Scotland: an evaluation of area-closure fisheries management and stock abundance assessment methods. *ICES Journal of Marine Science*, 63(8): 1530-1550.

Gurkan, Z., Christensen, A., van Deurs, M. and Mosegaard, H. (2012). Growth and survival of larval and early juvenile Lesser Sandeel in patchy prey field in the North Sea: An examination using individual-based modelling. *Ecological Modelling*, 232: 78-90.

Heath, M.R., Neat, F.C., Pinnegar, J.K., Reid, D.G., Sims, D.W. and Wright, P.J. (2012). Review of climate change impacts on marine fish and shellfish around the UK and Ireland. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 22(3): 337-367.

Hiscock, K., Langmead, O., Warwick, R. and Smith, A. (2004). Identification of seabed indicator species to support implementation of the EU Habitats and Water Framework Directives. Report to the Joint Nature Conservation Committee and the Environment Agency from the Marine Biological Association. Plymouth: Marine Biological Association. JNCC Contract F90-01-705.

Holland, G.J., Greenstreet, S.P.R., Gibb, I.M., Fraser, H.M. and Robertson, M.R. (2005). Identifying sandeel *Ammodytes marinus* sediment habitat preferences in the marine environment. *Marine Ecology Progress Series*, 303: 269-282.

ICES. (2017). Report of the Benchmark Workshop on Sandeel (WKSand 2016), 31 October-4 November 206, Bergen, Norway. ICES CM 2016/ACOM:33.301.

Jensen, H. (2001). *Settlement dynamics in the lesser sandeel (Ammodytes marinus) in the North Sea.* PhD. thesis, University of Aberdeen, Aberdeen, Scotland, UK.

Jensen, H., Rindorf, A., Wright, P.J. and Mosegaard, H. (2011). Inferring the location and scale of mixing between habitat areas of lesser sandeel through information from the fishery. *ICES Journal of Marine Science*, 68(1): 43-51.

Joint Nature Conservation Committee (JNCC) (2004). Common standards monitoring guidance for littoral rock and inshore sublittoral rock habitats [online]. Available at: http://jncc.defra.gov.uk/pdf/CSM_archived200402s_marine_rock.pdf [Accessed 20 September 2017].

Lohse, L., Epping, E.H.G., Helder, W. and van Raaphorst, W. (1996). Oxygen pore water profiles in Continental Shelf sediments of the North Sea: turbulent versus molecular diffusion. *Marine Ecology Progress Series*, 145: 63-75.

Kunzlik, P.A., Gauld, J.A. and Hutcheon, J.R. (1986). Preliminary results of the Scottish sandeel tagging project. ICES CM (Demersal Fish Comm.) 1986/G:7.

Macer, C. (1966). Sand eels (*Ammodytidae*) in the south-western North Sea; their biology and fishery. UK Ministry of Agriculture, Fish and Food, Fish Investment (Series 2), Vol. 24.

OSPAR Commission. (2010). Quality Status Report 2010. London.

Proctor, R., Wright, P.J. and Everitt, A. (1998). Modelling the transport of larval sandeels on the north-west European shelf. *Fisheries Oceanography*, 7: 347-354.

Reay, P.J. (1970). Synopsis of biological data on North Atlantic sandeels of the genus Ammodytes (*A. tobianus*, *A. dubius*, *A. americanus* and *A. marinus*). *FAO Fish Synop*, 82: 1-51.

Ryland, J.S. (1964). The feeding of plaice and sand-eel larvae in the southern North Sea. *Journal of the Marine Biological Association of the United Kingdom*, 44: 343-364.

Scott, B.E., Sharpes, J., Wanless, S., Ross, O., Frederiksen, M. and Daunt, F. (2006). The use of biologically meaningful oceanographic indices to separate the effects of climate and fisheries on seabird breeding success. In: Top predators in marine ecosystems: their role in monitoring and management. Cambridge University Press, Cambridge, UK. 46-62.

UK Technical Advisory Group on The Water Framework Directive (UKTAG) (2008). Proposals for Environmental Quality Standards for Annex VIII Substances. UK Technical Advisory Group on the Water Framework Directive.

van der Kooij, J., Scott, B.E. and Mackinson, S. (2008). The effects of environmental factors on daytime sandeel distribution and abundance on the Dogger Bank. *Journal of Sea Research*, 60(3): 201-209.

Winslade, P. (1971). *Behavioural and embryological studies on the lesser sandeel Ammodytes marinus (Raitt).* PhD thesis. University of East Anglia, England.

Wright, P. (1993). Otolith microstructure of the lesser sandeel, *Ammodytes marinus*. *Journal of the Marine Biological association of the United Kingdom*, 73: 245-248.

Wright, P.J. (1996). Is there a conflict between sandeel fisheries and seabirds? A case study at Shetland in: Greenstreet, S.P.R. *et al*. (Ed.) *Aquatic predators and their prey*, 154-165.

Wright, P. and Bailey, M. (1996). Timing of hatching in *Ammodytes marinus* from Shetland waters and its significance to early growth and survivorship. *Marine Biology*, 126: 143-152.

Wright, P.J., Jensen, H. and Tuck, I. (2000). The influence of sediment type on the distribution of the lesser sandeel, *Ammodytes marinus*. *Journal of Sea Research*, 44(4): 243–256.