NatureScot
Scotland's Nature Agency
Buidheann Nàdair na h-Alba

Conservation Objectives and Advice to Support Management

NOSS HEAD MPA

JUNE 2024

This document provides advice to Public Authorities and stakeholders about the activities that may affect the protected features of Noss Head Nature Conservation Marine Protected Area (MPA). It provides advice from Scottish Natural Heritage (SNH) (operating under the name of and hereinafter referred to as NatureScot) under Section 80 of the Marine (Scotland) Act 2010 to public authorities as to matters which are capable of damaging or otherwise affecting the protected features of MPAs, how the Conservation Objectives of the site may be furthered or their achievement hindered, and how the effects of activities on MPAs may be mitigated. It covers a range of different activities and developments but is not exhaustive. It focuses on where there is a risk to achieving the Conservation Objectives. The paper does not attempt to cover all possible future activities or eventualities (e.g. as a result of accidents), and does not consider cumulative effects.

Further information on marine protected areas and management is available at -

www.gov.scot/policies/marine-environment/marine-protected-areas/

For the full range of MPA site documents and more on the fascinating range of marine life to be found in Scotland's seas, please visit -

www.nature.scot/mpas or www.jncc.defra.gov.uk/scottishmpas

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Contents

1 Overview of document

This document provides details of the Conservation and Management Advice for Noss Head Nature Conservation Marine Protected Area (MPA) and it is divided into eight main sections. The introduction in section 2 gives an overview of Noss Head MPA and its contribution in terms of conservation and wider benefits. Section 3 provides an overview of the roles of the various bodies involved with advising, regulating and managing the marine protected area. Section 4 describes the protected features and their condition, and section 5 introduces the Conservation Objectives for the site. Section 6 describes the threats and pressures to which the protected features are sensitive, and section 7 provides the management advice for these activities. Section 8 identifies what further research and surveys may be required to increase our understanding of how the protected features utilise the site for which they are designated.

Annex 1 sets out the Noss Head MPA Conservation Objectives. Annex 2 provides supporting information relating to the protected features.

2 Introduction

2.1 Purpose statement

The Noss Head MPA has been designated to protect horse mussel beds. By doing so it contributes to the Scottish, UK and OSPAR MPA networks, the conservation of the wider marine environment around Scotland, and progress towards Good Environmental Status. The main purpose of the Noss Head MPA is to conserve the protected feature in favourable condition. This makes a contribution to the OSPAR MPA network in the North-East Atlantic.

2.2 Conservation benefits

Noss Head MPA provides conservation benefits by affording protection to the protected features and their associated species. In summary the conservation benefits of this designation are:

- Noss Head MPA is home the largest confirmed horse mussel bed in Scotland's waters, with an estimated area of 3.85km^2.
- Horse mussels beds have a restricted distribution in north-west European waters and Scotland has the majority of the habitat – Noss Head protects an example of horse mussel beds on an open coast.

2.3 Wider benefits

Noss Head MPA provides ecosystem services locally and to the wider marine ecosystem. We describe these ecosystem services in terms of their functions (the support or provision of something to the wider ecosystem e.g. habitat, nutrient cycling, sediment stabilisation) and natural resources (e.g. fish and shellfish, aggregates, wildlife), which in turn lead to benefits for people.

Figure 1 illustrates how the protected feature of Noss Head MPA contribute to benefits for people. There can be many complex interactions and dependencies amongst the protected features, their functions, associated natural resources and the benefits we gain from them.

The functions associated with the protected feature of Noss Head MPA are described in Annex 1 as part of the site's Conservation Objectives. The feature contributes to certain functions more than others, e.g. carbon storage and nutrient cycling. The functions of the protected feature are fundamental to the continued supply of natural resources and benefits associated with this MPA, and to the long-term health of the protected features.

By protecting Scotland's largest known horse mussel bed, the MPA in turn supports a variety of natural resources. The fish and shellfish (including juveniles) living within the MPA that can be harvested by humans or utilised by other marine species, are the most obvious resource. Horse mussel beds within the MPA act as carbon stores, storing both inorganic and organic carbon. Horse mussels are filter feeders, so they benefit from clean water entering the MPA. Water leaving the MPA will be even cleaner as horse mussels filter substantial amounts of seawater, helping to provide the clean seas that are needed for fish and shellfish to be harvested for human consumption. Clean seas off the coast of Caithness are also vital for people who enjoy water sports such as wild swimming, kayaking or sailing. Although horse mussels are found below the water, and cannot themselves be seen from land or boats, they provide ecosystem services that support the more conspicuous wildlife such as seabirds and cetaceans that are enjoyed both by people who live locally and by visitors. Wildlife tourism supports the economy of Caithness by increasing the length of stay by visitors encouraging greater spending in local businesses such as shops, accommodation and boat tours.

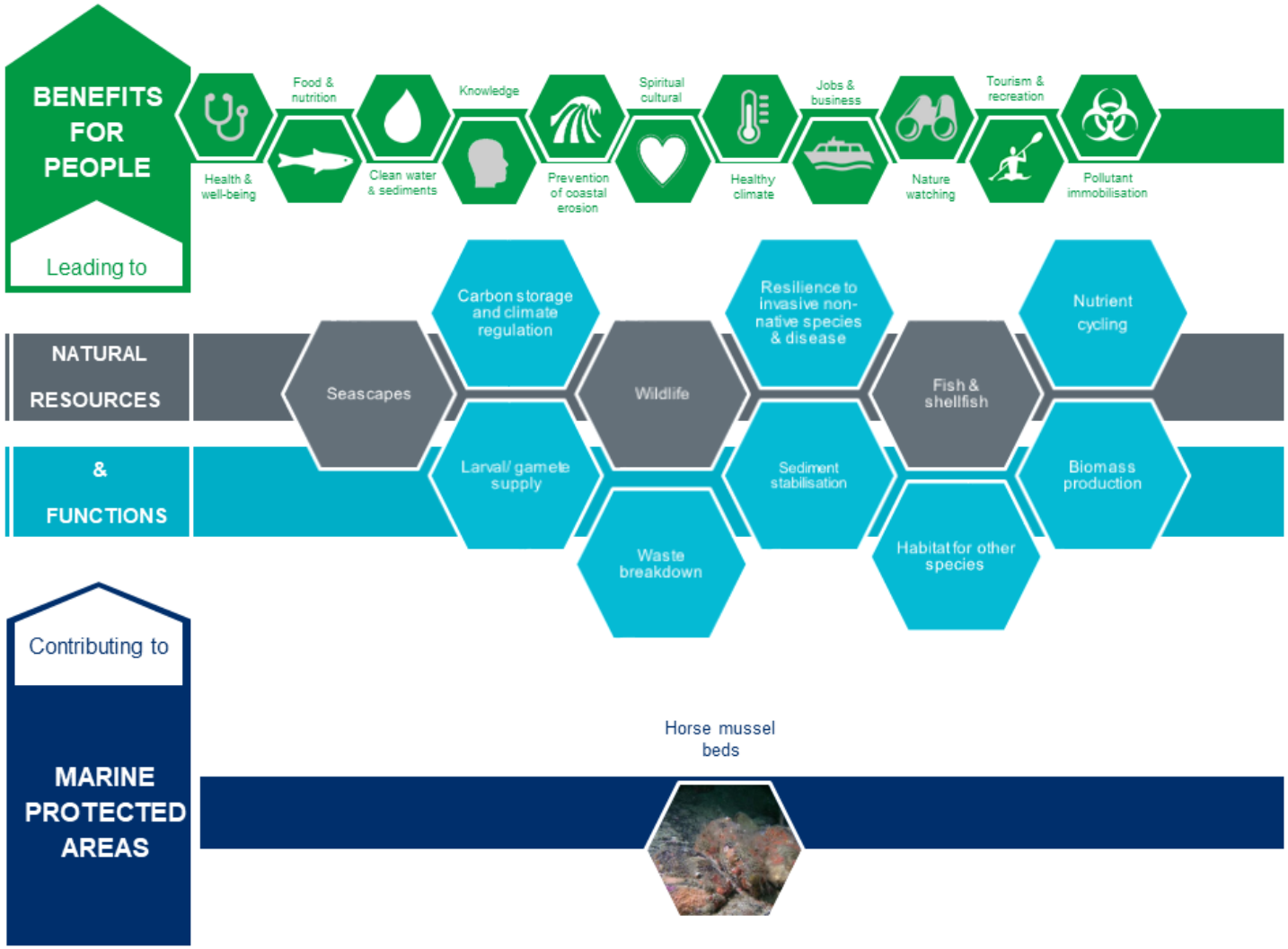


Figure 1 *Benefits to people associated with protected features of the Noss Head MPA.*

2.4 Contribution to policy commitments

Managing this MPA to conserve horse mussel beds will ensure the continued provision of the benefits above as well as the site's contribution to:

- An ecologically coherent network of MPAs, which are well managed under the OSPAR convention and national legislation.
- The protection of horse mussel beds which are an OSPAR threatened and declining habitat and a Priority Marine Feature.
- Progress towards achieving Good Environmental Status in relation to biological diversity and seafloor integrity.
- Protection, enhancement and health of the marine area under the Marine (Scotland) Act 2010.
- Restoring marine and coastal ecosystems and increasing the environmental status of our seas under the Scottish Biodiversity Strategy.
- Helping to adapt to climate change under The Scottish Climate Change Adaptation Programme by increasing the resilience of habitat and species in the area.

3 Roles

This document provides advice for Noss Head MPA in relation to activities that may affect the protected feature. More detailed advice can be provided to public authorities to inform their decision making as required. In doing this, our aim is to ensure the Conservation Objectives for the protected features are met.

Section 80 of the Marine (Scotland) Act 2010 gives NatureScot the remit to provide advice and guidance to public authorities as to the matters which are capable of damaging or otherwise affecting the protected features of MPAs, how the conservation objectives of the site maybe furthered or their achievement hindered, and how the effects of activities on MPAs may be mitigated.

It is the role of public authorities to ensure that the activities they regulate, permit or licence do not hinder the achievement of the Conservation Objectives of Noss Head MPA. The management advice in this document is provided to assist public authorities in managing the activities outlined in Table 2 and carrying out their duties under Section 82 and 83 of the Marine (Scotland) Act 2010.

Stakeholders can provide additional evidence to support the development of management including local knowledge of the environment and of activities. This will contribute to the development of well-designed and effective management measures.

4 Protected features and status

The Noss Head MPA has been selected to become part of Scotland's MPA network which in turn has been established to help conserve and recover a range of Scotland's important marine habitats, wildlife, geology and landforms.

Table 1 provides a summary of the protected features within the MPA, their condition within the site, and the broader conservation status of the protected features.

The locations and extent of the protected feature within the Noss Head MPA are shown on Figure 2. This may have been superseded by more up-to-date information on

extent/distribution of features since the publication of this document. The most up-to-date distribution of the features described is available to view at National Marine Plan Interactive[1].

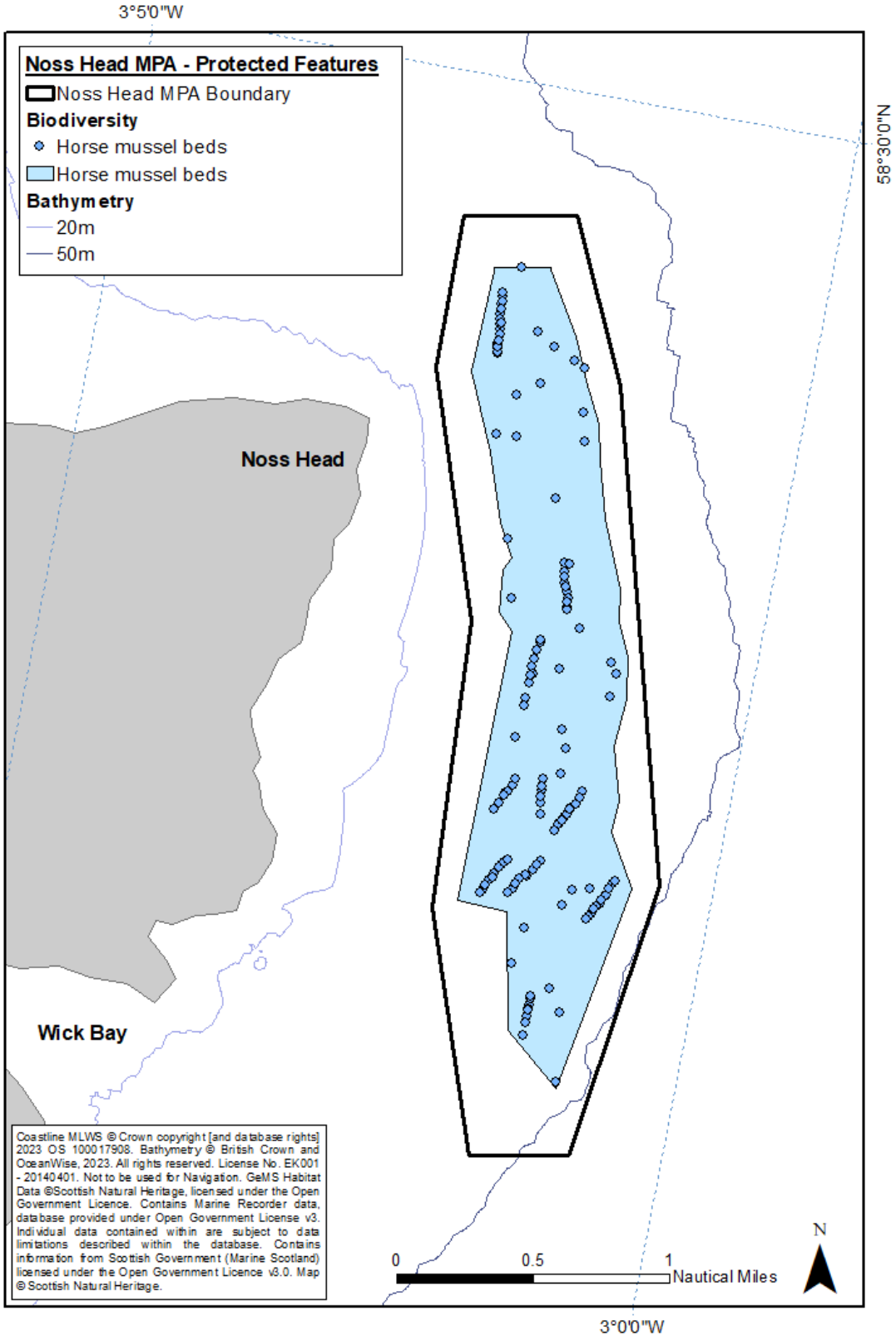
Table 1. Protected features and condition for the Noss Head MPA. Feature condition refers to the condition of the protected feature assessed at a site level. Broader conservation status is the overall condition of the feature throughout its range as outlined by the *.

Protected Features	Feature condition	Assessment date	Broader conservation status
Horse mussel beds	Favourable	2014	OSPAR Threatened and/or Declining [#]

[#] This is the status for Region II – Celtic Sea under the OSPAR Convention.

[1] https://marinescotland.atkinsgeospatial.com/nmpi/

Figure 2 Location of the Noss Head MPA and distribution of horse mussel beds.



5 Conservation objectives

5.1 Background

Conservation objectives set out the desired quality of the protected features within the Noss Head MPA (Annex 1) and they are in place at the time the site is formally designated. They provide the framework for the setting of site conservation measures (management) and for public authorities in managing the activities outlined in Table 2 and carrying out their duties under Section 82 and 83 of the Marine (Scotland) Act 2010.

5.2 Relationship between feature condition and Conservation Objectives

The Conservation Objectives seek to *conserve* protected feature of a MPA where evidence exists that it is in favourable condition in the site, or where there is uncertainty concerning the assessed condition of a feature (see section 4) but no reason to suspect deterioration in condition since designation. Where evidence exists that a feature is declining and/or damaged and therefore is in unfavourable condition in the site, the Conservation Objectives will seek to *recover* the protected feature.

The biodiversity feature is in favourable condition at Noss Head MPA and therefore the Conservation Objectives seek to *conserve* this condition.

5.3 Overlapping Protected Areas

The following protected areas overlap with, or are immediately adjacent to, the Noss Head MPA:

- East Caithness Cliffs MPA
- East Caithness Cliffs SPA

Conservation measures in the adjacent protected areas need to ensure the Conservation Objectives of all the sites are met. Priority would be given to the SPAs.

There are no apparent management conflicts between the protected features of the Noss Head MPA and the protected features of the other adjacent areas.

Site information including the Conservation Objectives for the MPAs adjacent Noss Head MPA are available on SiteLink.

6 Feature sensitivity

The following sections provide an overview of the pressures most relevant to the protected features. Further information on feature sensitivity, can be found at Marine Scotland's Feature Activity Sensitivity Tool (FeAST)[2] and also for the features not covered by FeAST, Marine Evidence based Sensitivity Assessment (MarESA)[3]. The information in FeAST reflects our current understanding of the interactions between activities, pressuresand features. It highlights that activities can give rise to a range of pressures, which the protected features may be sensitive to. Our assessment of sensitivity is based on a feature's tolerance (response to change) and its ability to recover.

[2] feature-activity-sensitivity-tool.scot

[3] https://www.marlin.ac.uk/sensitivity/sensitivity_rationale

6.1 Horse mussel beds

Horse mussel beds are most sensitive to physical disturbance, siltation and smothering. Changes in environmental conditions such as temperature, salinity and water flow would also impact upon horse mussel beds. Horse mussel beds are likely to take considerable time to recolonize and to develop into a bed similar in size and in the diversity and species richness they support. Recruitment is sporadic, highly variable and some areas receive little or no recruitment for several years therefore recoverability is low.

7 Management advice

7.1 Advice to support management

Table 2 provides NatureScot's advice on management for activities where we consider this may be necessary to achieve the Conservation Objectives for the protected features. The advice is focused on the activities that cause an effect (a pressure) that a feature is sensitive to. Pressures can be physical (e.g. abrasion of the seabed), chemical or biological. Different activities may cause the same pressure, e.g. fishing using bottom gears and aggregate dredging both cause abrasion which can damage the surface of the seabed.

Our advice takes a risk-based approach, i.e. we are focusing on providing advice where we believe there is a risk to achieving the Conservation Objectives. We have identified risks to achieving the Conservation Objectives where there is an overlap between protected features and activities associated with pressures that the features are sensitive to. We have provided management advice to support public authorities and others in managing these risks. Our advice is based on existing data and information on protected features and relevant activities, and our understanding of the relationships between the features and activities. We have identified a range of management advice:

- management to remove or avoid pressures;
- management to reduce or limit pressures; or
- no additional management required.

For our advice on fisheries management we have also stated where we think this should be 'considered' or 'recommended'. The term 'considered' is included to highlight that a fishery-feature interaction exists, but circumstances mean that a specific recommendation for action cannot / or need not be made at this point. However, there is sufficient cause to make fishery managers aware and for them to consider if a fishery management measure may be helpful in achieving Conservation Objectives – particularly where there may be a synergy between the benefits of management actions for the fishery and the Conservation Objectives for the feature. The term 'recommended' highlights than an issue of fishery-feature interaction exists, there is a reasonable evidence base and a specific recommendation can be made/ justified.

New or other activities would need to be considered on a case-by-case basis.

We recognise that stakeholders can provide local environmental knowledge and more detailed information on activities, including in relation to intensity, frequency and methods. This additional information will help public authorities and others develop more specific management, focussed on the interaction between features and activities. If new information becomes available our management advice may be revised.

Activities that are considered not likely to affect the protected features (other than insignificantly) are listed in Table 3. Spatial data relating to the location and extent of the

activities listed can be accessed on Marine Scotland's National Marine Plan Interactive[4] (where available).

7.2 Best Practice

In our management advice for activities in Table 2 we refer to the development, adoption or use of 'best practice' as a way of managing interactions between activities and the features. Best practice is taken to mean approaches or procedures that are developed and accepted by regulators and relevant stakeholders as being an effective way of dealing with an interaction between a habitat or species and the pressures created by an activity. Much of this best practice is already being implemented by sectors and regulators, e.g. pre-application discussions between developers and regulators, the Scottish Marine Wildlife Watching Code, Scottish Outdoor Access Code, and Technical Standards for Scottish Finfish Aquaculture.

7.3 Conservation Measures

The following conservation measures are currently in place for the Noss Head MPA:

- Activities and developments subject to licensing that could affect the protected features of the MPA also need to be assessed. Authorities need to determine whether if by carrying out their duties e.g. permitting an activity to take place, it would hinder the achievement of the Conservation Objectives of the MPA. This is referred to as an assessment under Section 82 or Section 83 of the Marine (Scotland) Act 2010.
- *Fishing – demersal/mobile/active gear* - Fishing for sea fish with a dredge, beam trawl, demersal trawl or demersal seine net is prohibited in the Noss Head Protected Area as is fishing for horse mussels, under the The Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 2015 (No. 435).

[4] https://marinescotland.atkinsgeospatial.com/nmpi/

Table 2. NatureScot's advice to support management for Noss Head MPA for activities which are considered capable of affecting the protected features.

The text under the 'Advice to support management' columns provides NatureScot's management advice for the features in relation to the activities (further details about the terminology used are provided in section 7.2). Where a cell is coloured grey this indicates that management is already in place, this includes where there are existing regulatory requirements for new proposals. Cells are also coloured grey where it is considered there is no additional management required to achieve the Conservation Objectives. For some activities, the pressures associated with new proposals are considered unlikely to affect some the features either because these activities do not occur in the same locations as the features or the pressure is unlikely to be at levels that can affect the features (see also Table 3).

Activities considered capable of affecting the proposed protected features	Advice to support management
	Horse mussel beds
Aquaculture	**Remove or avoid pressures** associated with new farms and undeveloped consents as well as the expansion or relocation of existing farms.
Anchorage areas	**Remove or avoid pressures** associated with new anchorage areas.
Cables and pipelines	**Remove or avoid pressures** – associated with further cable and pipeline infrastructure in areas where there would be likely to lead to cumulative impacts on horse mussel beds.
Coastal development - other	**Remove or avoid pressures** associated with new coastal development.
Dredging/extraction of material	**Remove or avoid pressures** (disturbance, damage of habitat) associated with new capital dredging projects and associated maintenance dredging.

Activities considered capable of affecting the proposed protected features	Advice to support management
	Horse mussel beds
Fishing - demersal mobile/active gear	**Remove or avoid pressures is recommended** – *existing management measures in place (see section 7.3)*
Fishing – static gear (including bottom set nets, drift nets, fyke nets)	**Reduce or limit pressures** should be considered where horse mussels are present.
Fishing – hydraulic (diver or vessel)	**Remove or avoid pressures is recommended -** *existing management measures in place (see section 7.3)*
Marine disposal sites	**Remove or avoid pressures** associated with marine disposal sites.
Moorings	**No additional management is required for current moorings** **Remove or avoid pressures** associated with new moorings.
Renewable energy	**Remove or avoid pressures** associated with new renewable energy infrastructure.
Scientific survey/research	**Reduce or limit pressures** associated with survey work in areas where there would be likely to be an impact upon horse mussel beds. Early discussion of the survey/research proposals is recommended to reduce potential impacts.

Table 3. Activities that are considered not likely to affect the protected features (other than insignificantly)[5]

Activity	Comments
Commercial shipping	Whilst commercial shipping routes are present in the MPA, they are unlikely to reach a level where they affect the protected feature.
Discharges – industrial and agricultural	Discharges are unlikely to enter the site directly and are considered unlikely to reach a level where they will affect the protected feature of this site.
Discharges - sewage	Sewage may enter the surrounding water via the wick sewage treatment plant outlet on land opposite the MPA. Discharges are unlikely to enter the site directly and are considered unlikely to reach a level where they will affect the protected feature of this site.
Fishing - recreational	Existing but due to the low level of recreational fishing (both angling from shore and off private and chartered boats) it is not considered to be at a level where it affects the protected feature.
Fishing – diver collection of bivalves	Diver collection of bivalves may take place but it is not considered to be at a level where it affects the protected feature of this site.
Leisure boat users (sailing, motor boats)	One cruising route crosses the MPA but is not likely to affect the protected feature.
Ports and harbours	Wick harbour, Staxigoe harbour and Keiss harbour are all located close to but outside the MPA and are not likely to affect the protected feature.

8 Research and survey requirements

We recognise that there are still important gaps in our understanding and knowledge of the features of this site. We will identify research and survey projects to inform our understanding of these aspects. The requirements identified below are not a commitment to undertake this work. However, by highlighting these gaps we hope to inform future discussions with parties interested in undertaking research in this site and/or on these features, to help direct research and aid monitoring priorities. The following list of research and survey needs is not prioritised and is not exhaustive.

1. Monitoring any changes in extent, structure, function and biological communities of horse mussel beds since management measures have been put in place.

[5] Only the specific examples of activities listed in the table have been excluded, rather than the broad activity types. New plans or projects will still need to be considered by the relevant competent authority (see Annex 1 for further details).

Annex 1. Noss Head MPA Conservation Objectives

The box below provides the high-level Conservation Objective statements. The full Conservation Objectives, which includes site-specific advice and information on the features that form part of this MPA, are provided in the tables that follow.

These tables are grouped split by feature type, i.e. habitats, species, large scale features, and geomorphology. The site-specific advice and information provides more detail in relation to each of the high level Conservation Objective statements for each feature type, e.g. detail on the extent of a habitat within a site and what the supporting features are for a species.

Information is also provided below on how minor changes to features should be considered and the influence of environmental change on features, particularly in relation to climate change for context.

A definition of the terms used is in the Glossary.

A map of the MPA, the location of the features and the place names mentioned in the site-specific information is provided in Figure 2.

Noss Head MPA
Protected features: Habitats - Horse mussel beds
The Conservation Objectives of the Noss Head MPA, are that the protected features: • so far as already in favourable condition, remain in such condition; • so far as not already in favourable condition, be brought into such condition, and remain in such condition. "Favourable condition", with respect to a marine habitat, means that: a) its extent is stable or increasing; and b) its structures and functions, its quality, and the composition of its characteristic biological communities are such as to ensure that it is in a condition which is healthy and not deteriorating. In paragraph (b) the reference to the composition of the characteristic biological communities of a marine habitat includes a reference to the diversity and abundance of species of marine flora and fauna forming part of, or inhabiting, that habitat. Any temporary deterioration in condition is to be disregarded if the habitat is sufficiently healthy and resilient to enable its recovery from such deterioration. For the purpose of determining whether a protected feature is in favourable condition any alteration to that feature brought about entirely by natural processes is to be disregarded.

Interpretation of temporary deterioration in condition and consideration of minor changes
For marine habitats any temporary deterioration in condition is to be disregarded if the marine habitat is sufficiently healthy and resilient to enable its recovery from such deterioration. In order to determine what "temporary deterioration" is we must know the longevity of the habitat and timescales involved to enable a habitat (protected feature) to

fully recover. Resilience can vary widely between ecosystems and ecological resilience has been defined as "the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks". It is generally recognised that high biodiversity in a system makes it more resilient to some forms of disturbance.

Assessments should consider the timing, duration and scale of the impact on the features and their ability to recover. Factors determining the potential for features to recover following temporary deterioration vary between features. These are described in more detail in Annex 2 ‘*Factors determining the potential for features to recover’*.

Environmental Change	
The Conservation Objectives recognise and acknowledge that the protected features of the MPA are part of a complex, dynamic and multi-dimensional marine environment. Habitats and mobile species are exposed to a wide range of drivers of change. This may include changes to their population and habitats that reflect their natural cycles, and also broader environmental changes, i.e. those related to climate change and environmental variability that are beyond the scope of the MPA. Any alterations to the proposed protected features that are brought about by entirely by natural processes is to be disregarded when assessing against the Conservation Objectives. In relation to the Noss Head MPA and its protected feature, the following effects of climate change are relevant as outlined below. These effects should be taken into account when considering plans and projects within Noss Head MPA as additional pressures may reduce the habitat’s resilience to climate change, and additionally climate change impacts may start to hinder the habitat’s ability to recover from human activities.	
Horse mussel beds	Predictive habitat modelling has estimated that, under projected ocean temperatures increases, there would be around a 60% reduction in the most suitable habitat for horse mussels in Scotland, based on where horse mussels are currently restricted to in the UK (Gormley *et al*., 2013). Under this model, by 2030, around 75% of the most suitable habitat will be in the northern parts of Scotland. Horse mussels have been assessed as having high sensitivity to the predicted increases in ocean acidification, and several of the typical species associated with this habitat, e.g. crabs, squat lobsters, whelks could be subject to reduced growth and lower survival rates as larvae and juveniles/adults under the projections (Strong *et al*., unpublished). The development of horse mussel beds and the dispersal of larvae between beds (connectivity) are also reliant on adequate water flow and patterns of circulation, and horse mussel beds are moderately sensitive to changes in these which might occur under climate change (Strong *et al*., unpublished). Changes in the supporting environment as outlined above could result in a change in the extent, distribution, density of horse mussel beds, and the dispersal of larvae between beds (connectivity) of this feature within this MPA and throughout the habitat’s range in the future, as well as changes in typical species abundance, diversity and distribution in the MPA.

HABITATS

(a) Extent		
Feature	**Site specific advice**	**Site specific information**
Horse mussel beds	Conserve the current extent and distribution of horse mussel beds within the site so that it is stable or increasing.	A large horse mussel bed is present throughout the MPA and estimated to be 3.85km^2 – the largest known in Scotland. Throughout the bed, horse mussel exist in varying densities from Frequent (1-9 / 10 m^2) to Super Abundant (1-9 / 0.1m^2) (Hirst *et al.,* 2012; Moore *et al*., 2019). The horse mussel bed is present within a depth range of 38-50m (Moore *et al*., 2019). Assessments should focus on activities involving significant abrasion or disruption of seabed sediments, those which may significantly alter local water hydrographic and sedimentary processes and those which may lead to an increase in organic particulate matter in the immediate area. Species associated with this feature are sensitive to changes in water movement and water clarity which can result in smothering. Such changes to the environment may reduce the distribution of this feature.

(b) Structures		
Feature	**Site specific advice**	**Site specific information**
Horse mussel beds	Conserve the current density of live horse mussel (*Modiolus modiolus*) individuals, and associated proportions of dead shell material and fine sediments.	Within this MPA, the horse mussel beds are characterised by the '*Modiolus modiolus* beds with hydroids and red seaweeds on tide-swept circalittoral mixed substrata' biotope (SS.SBR.SMus.ModT). *M. modiolus* is considered to form a bed biotope when abundances are at least 'Frequent' (1-9 / 0.1 m^2). *M. modiolus* can grow up to 20cm long and where it forms beds it provides a three-dimensional habitat to a range of flora and fauna. Species that are typical of *Modiolus* beds (such as encrusting and mobile fauna) and can alter the three dimensional structure both above and below the sediment surface (Hirst *et al.,* 2012). The density of *M. modiolus* beds within the site varies from Frequent (1-9 / 10 m^2) to Super Abundant (1-9 / 0.1m^2). Overall, there is a lack of obvious pattern in the patchiness to the horse mussels, with areas where they were frequent, abundant or superabundant interspersed throughout the bed extent. (Hirst *et al.,* 2012)

		Assessments should focus on activities which may significantly alter water flow characteristics as well as those involving significant abrasion or disruption of seabed sediments.

(b) Function and quality

The boxes below provide the site-specific advice on the '**function of the habitat and its quality'** element of this conservation objective.

'Quality' in this context is taken to mean the processes relevant to the features e.g. water movement, chemical water quality parameters etc and are referred to as environmental conditions in the table below. Consideration of the functioning of the habitat and supporting environment on which it relies needs to take into account the wider functioning and environmental conditions within this water body.

Noss Head MPA encompasses a stretch of sea off the Caithness coast in the outer Moray Firth. Noss Head has been assessed as having 'Good' overall water body status in 2020 in relation to the River Basin Planning Assessments for the Water Environment and Water Services (Scotland) Act 2003. This assessment includes consideration of water chemistry, pollutants, the physical condition of the water body, plant and animal communities, including plankton, and the risk from invasive non-native species.

There is inter-dependence between the functions of the habitats in Noss Head and the supporting environment. Together, the habitats and supporting environment lead to direct and indirect benefits for people. The sections below identify key functions associated the protected habitat. It is also useful to consider some functions at the scale of the whole site / local ecosystem, such as resilience to invasive non-native species (INNS) and disease, and carbon storage and climate regulation. For resilience to INNS and disease, the combined function of healthy and biodiverse habitats in Noss Head is likely to contribute to the ability of the local ecosystem to resist, recover from or adapt to the introduction of a non-native or disease/pathogen. For carbon storage and climate regulation the site as a whole ranked 4th (per unit area) in the total carbon stocks of Scotland's Inshore MPAs (Burrows *et al*., 2017), partly due to the large contribution of the horse mussel bed to inorganic carbon storage. The presence and maintenance of this stock is linked to other habitat functions and external factors.

Feature	**Site specific advice**		**Site specific information**
Horse mussel beds	Conserve the functions provided by horse mussel beds and the environmental conditions that support them.	<u>Key functions</u> • Biomass production • Larval/gamete supply (supporting connectivity) • Habitat for other species (supporting biodiversity)	A key function of horse mussel beds is the formation of habitat which is occupied by a range of infaunal and epifaunal species which subsequently contribute to biomass production in the area. As relatively large filter-feeding bivalves, they are also important in the breakdown, cycling and/or detoxification of organic and inorganic matter from the water column. Recent genetic studies (Mackenzie *et al*., 2022) suggest that horse mussel beds can be a source of larvae for beds

	Conserve the overall water body condition status of Noss Head MPA	• Nutrient cycling • Sediment stabilisation • Carbon storage and climate regulation • Waste breakdown and detoxification of water and sediments <u>Environmental conditions</u> • Water movement • Water quality	elsewhere, with Scottish horse mussel bed populations having a moderate to high level of genetic connectivity. Horse mussel beds are known to provide important functions, including habitat provision and bentho-pelagic coupling (Kent *et al.,* 2017) which involves cycling primary production in the phytoplankton that they filter into detritus on the seabed via their pseudo faeces. It is difficult to quantify these functions, however, assuming these functions are related to density and size of bed, the density of live horse mussels should be maintained throughout the MPA. Maintaining the horse mussel beds relies on adequate supply of larval recruits and food (plankton), the presence of suitable habitat (existing beds) to act as a settlement site for larvae, and suitable environmental conditions for growth. Environmental conditions, including water movement patterns and water quality are important in the provision of these requirements. Horse mussel beds also require good water quality, to maintain the conditions needed for their survival and growth, including an adequate food supply. Noss Head was assessed as having a 'good' overall water body status in 2016 (SEPA). This assessment includes consideration of water chemistry, pollutants, the physical condition of the water body, plant and animal communities, including plankton, and the risk from invasive non-native species. The current water body status provides suitable conditions for sustaining the horse mussel beds. If any of the environmental conditions were to be significantly altered it could detrimentally affect the function of the horse mussel beds.

(b) Composition of its characteristic biological communities
Consideration of characteristic biological communities should not be limited to the list provided below, however it does give an indication of the main species we would expect to be present.

Feature	Site specific advice	Site specific information
Horse mussel beds	Conserve the diversity, abundance and distribution of characteristic species associated with horse mussel beds (including *Modiolus modiolus,*).	Tide-swept horse mussel beds (SS.SBR.SMus.ModT) are present at Noss Head MPA. The characterising species of this features is horse mussels (*Modiolus modiolus*) which has been recorded as horse mussel exist in varying densities from Frequent (1-9 / 10 m^2) to Super Abundant (1-9 / 0.1m^2) in some locations (Moore, 2019). Infaunal grab samples from Noss Head MPA show that the horse mussel supports a diverse range of species. The number of species found ranges from 22 to 141, with Shannon diversity index range of 2.35 to 3.75 and a Pielou's Eveness index range of 0.74 to 0.83. (Hirst *et al.,* 2012) Brittlestars (*Ophiothrix fragilis*, *Ophiocomina nigra, Ophiura albida*) are present at high densities throughout the bed, with some species present in some areas and largely absent on others. Other routinely encountered echinoderms include the common sunstar (*Crossaster papposus*), edible urchin (*Echinus esculentus*), common starfish (*Asterias rubens)* and *Henricia* sp. Encrusting species such as *Bryozoa* sp., sponges and hydroids (*Halecium* sp., *Kirchenpaueria pinnata*, whiteweed (*Sertularia cupressina*) are present throughout the bed. Crustaceans, including edible crab (*Cancer pagurus*) and hermit crab (*Pagurus bernhardus*) can also be encountered. (Hirst *et al.,* 2012) Assessments should focus on activities which involve physical change to and/ or the removal of substratum, those which may significantly alter local hydrographic and sedimentary processes and those which may lead to an increase in organic particulate matter in the immediate area.

Annex 2. Supporting information

Factors limiting the recovery of features

Horse mussel beds

To date, no studies have observed recovery of horse mussel beds, following either passive re-colonisation or active restoration after a disturbance. Several elements of the biology and ecology of the horse mussel (*Modiolus modiolus*) significantly reduce the ability of the species and the beds it forms to recover. *M. modiolus* is a relatively long-lived species taking 3-8 years to reach maturity (Holt *et al*., 1998), and their recruitment is sporadic with high variability between seasons, years and with location. Recruitment success is generally reported to be very low and is likely to be erratic, which is partly due to the length of time it takes juveniles to reach adulthood, during which time mortality can be very high, e.g. from predation. The development and recovery of horse mussels beds requires suitable depth, current flow and substrate (in particular larvae prefer to settle on adult shells) (Fariñas-Franco *et al*., 2014), as well as sufficient larvae and growth of juveniles/adults from within and outside the Loch. Therefore, where environmental conditions change, adults are reduced in number and sources of larvae inside/outside the site are affected, this will negatively affect the ability of the horse mussel beds to recover. Further details are available in Mazik *et al*., (2015).

Glossary for Conservation Objectives

Conservation Objective term	Definition
Composition of characteristic biological communities	This should include a reference to the diversity and abundance of species forming part of, or inhabiting, that habitat. In particular this includes those species that are especially relevant to the habitat's definition, e.g. species that form the structure of a bivalve bed, or sea pens on burrowed mud. In ecological terms, "community composition" means the number and abundance of flora and fauna included in the habitat. This is also referred to as biodiversity - the variety of life in a particular habitat.
Extent (and distribution)	The "extent" of a feature is the total area that it covers. This should also include consideration of the "distribution" i.e. how it is spread out within the MPA. A feature could be continuous and contained within one area, dispersed in smaller patches over a wider area, or as a mosaic with other habitats/features. Indeed, it could also be a combination of these.
Favourable condition	Favourable condition for each protected feature type for MPAs is defined in the box at the start of Annex I which summarises the conservation objectives for the site.
Function	The habitat must be able to be maintained in terms of the growth and reproduction of the habitat-forming species (e.g. through self-recruitment of larvae) and also help to maintain the provision of essential ecosystem services that the habitat provides. The text within the supplementary advice explains function in relation to both of these factors for the feature concerned where information is available.
Integrity (geodiversity)	For geodiversity features, integrity is the way the component elements make up the full extent of the feature. Integrity relates to the relationship between the component elements, where the whole is greater than the sum of the parts. In other words, integrity refers to the full assemblage of component elements.
Quality / Processes	Quality outlines the processes relevant to the habitat/feature and include but are not limited to hydrography and supporting water currents, chemical water quality parameters, suspended sediment levels, radionuclide levels.
Supporting environment	This includes the following environmental conditions (but is not limited to) which are important for maintaining/restoring the protected features, e.g. hydrography and supporting water currents, chemical water quality parameters, suspended sediment levels, radionuclide levels.
Structure	The structure of a habitat/feature includes what it is created from and what it requires to exist, e.g. habitat forming species, geological features or sediment; the depth of the substrate or thickness or height of the biogenic structures from the seabed; biogenic material forming the structure should still retain a live component where this exists at baseline.

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