

Scottish MPA Project
Assessment against the MPA Selection Guidelines

LOCH SWEEN POSSIBLE NATURE CONSERVATION MPA

Document version control			
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Version 1	20/02/2013	Siobhan Mannion	Revised protected feature / possible MPA format, updating original MPA search location format (ver. 7).
Version 2	17/05/2013	Lisa Kamphausen	Added detail / updated to reflect 2013 survey work.
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Purpose

This document provides details of the assessment of the Loch Sween possible Nature Conservation MPA against the Scottish MPA Selection Guidelines. It presents the assessment for each of the proposed protected features.

We have used the terminology set out in the Selection Guidelines to describe the five main stages in the assessment process from the identification of MPA search locations through to the development of MPA proposals. This area has now become a possible Nature Conservation MPA because, following advice from SNH and/or JNCC, Scottish Ministers have decided to consult on whether it should be formally designated.

The main terms used are described below.

MPA search location - this describes a location identified at stage 1 until it passes the assessment at stage 4.

Potential area for an MPA - if an MPA search location passes the assessment at stage 4 it goes on to become a potential area for an MPA for consideration at stage 5.

MPA proposal - a potential area for an MPA that has passed the assessment at stage 5 and which has been formally recommended for designation by SNH and/or JNCC to Scottish Ministers.

Possible MPA - an MPA proposal approved by Scottish Ministers for public consultation. From this time the location is given policy protection as if it were designated.

MPA search features - specified marine habitats, species and large-scale features that underpin the selection of Nature Conservation MPAs.

Geodiversity features - specified geodiversity interests of the Scottish seabed categorised under themed 'blocks' that are analogous to the MPA search features for biodiversity.

Representative features - habitats and/or species which are not MPA search features or key geodiversity features. They have been assessed to determine whether they would add to the broader representativity of the network.

Proposed protected feature - any feature (habitats, species, large-scale features and/or geodiversity features) which has been proposed by SNH and/or JNCC for designation as part of a Nature Conservation MPA.

History of development

The Loch Sween possible Nature Conservation MPA was identified for the following MPA search features - burrowed mud; maerl beds; native oysters. Sublittoral mud and mixed sediment communities is not an MPA search feature but has been recommended as a proposed protected feature because we consider that it would add to the broader representativity of the Scottish MPA network (i.e. a representative feature).

Inshore deep mud with burrowing heart urchins (another MPA search feature) was also identified as a proposed protected feature for this site in SNH and JNCC's 2012 MPA network advice (SNH and JNCC, 2012). However, recent survey work (Moore and Harries, 2013) failed to validate the presence of this feature (multiple samples were taken in and around the small number of previous records) and it has now been dropped as a feature of this possible MPA.

The Loch Sween possible Nature Conservation MPA encompasses the area and a number of the features identified within a third-party proposal from the Marine Conservation Society (MCS).

Details of supporting evidence are provided in the Loch Sween data confidence assessment.

LOCH SWEEN POSSIBLE NATURE CONSERVATION MPA - APPLICATION OF THE MPA SELECTION GUIDELINES

Stage 1 - Identifying search locations that would address any significant gaps in the conservation of MPA search features¹

Summary of assessment	Much of the seabed of the main body of Loch Sween, Sailean Mhor, Loch a'Bhealaich and the Achnamara arm (see map overleaf) is floored by burrowed mud. Large mounds of the mud volcano worm <i>Maxmuelleria lankesteri</i> are distributed widely and this habitat covers an estimated 580 ha within the possible MPA. The proposed protected features also include beds of native oysters, a habitat now thought to be present in only a handful of locations around Scotland, maerl beds (of both species of coralline algae that typically form beds in Scottish waters) and other sublittoral mud and mixed sediment communities representative of Scotland's seas more generally. Burrowed mud, maerl beds and native oysters are OSPAR Threatened and / or Declining habitats or species, considered to be under threat and in decline in Scottish waters.
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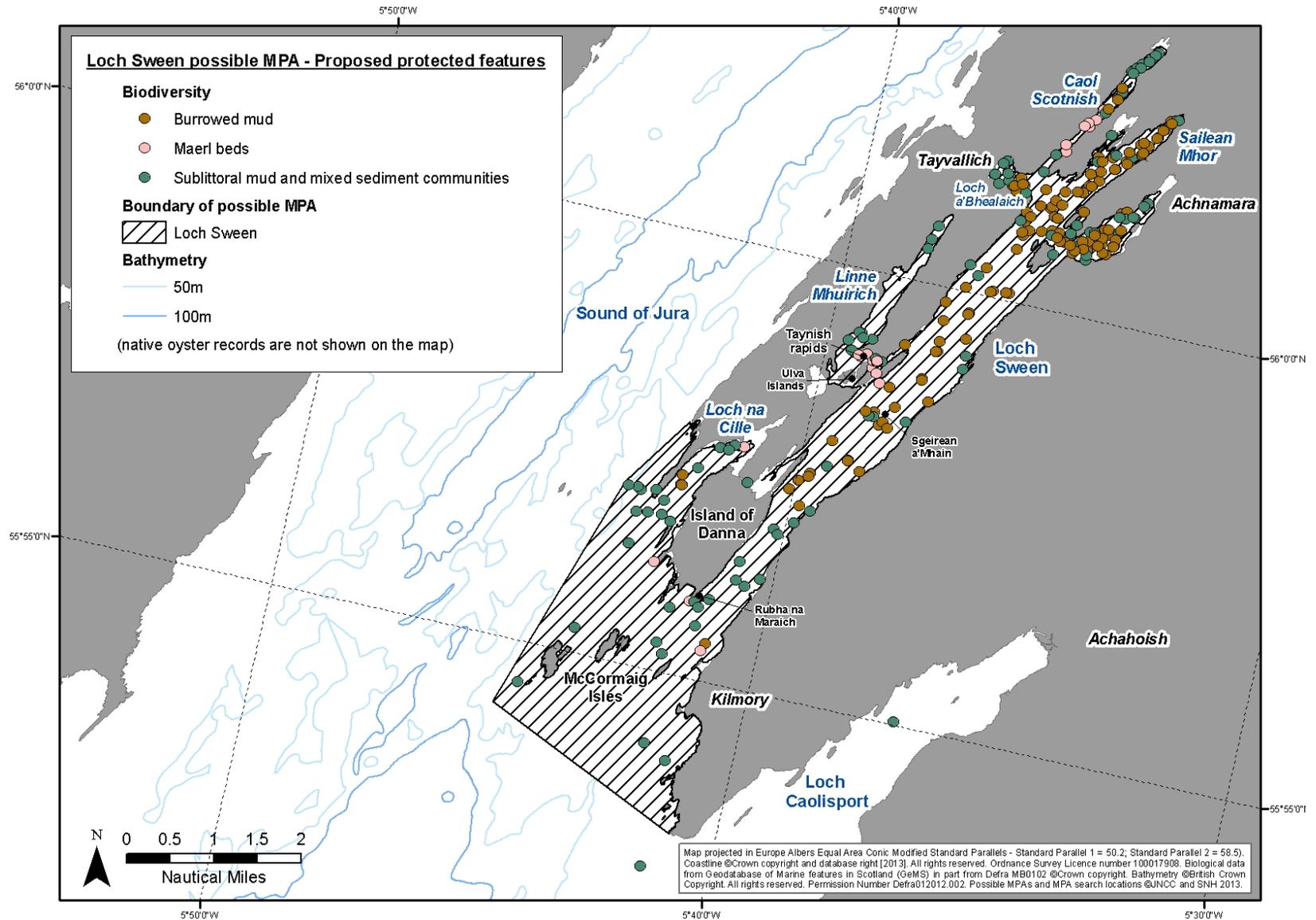
Detailed assessment			
Proposed protected features	Guideline 1a <i>Presence of key features</i> [MPA search features and geodiversity equivalents]	Guideline 1b <i>Presence of features under threat and/or subject to rapid decline</i>	Guideline 1c <i>Functional significance for the overall health and diversity of Scottish seas</i>
<i>Biodiversity</i>			
Burrowed mud	✓	✓ OSPAR T&D ²	
Maerl beds	✓	✓ OSPAR T&D ²	
Native oysters	✓	✓ OSPAR T&D ²	
Sublittoral mud and mixed sediment communities ³	<i>Representative feature</i>		

¹ All proposed protected features of the possible MPA are listed in the stage 1 detailed assessment table and subsequently assessed against the MPA Selection Guidelines (wherever practicable) to facilitate read across to SNH and JNCC's formal 2012 MPA network advice (SNH and JNCC, 2012).

² OSPAR list of Threatened and/or Declining species and habitats (see OSPAR, 2008 a & b).

³ Comprising 'Infralittoral sandy mud' (**SS.SMu.ISaMu** - A5.33), 'Infralittoral fine mud' (**SS.SMu.IFiMu** - A5.34), 'Infralittoral mixed sediment' (**SS.SMx.IMx** - A5.43), and 'Circalittoral mixed sediment' (**SS.SMx.CMx** - A5.44).

Map of the Loch Sween possible MPA showing the known distribution of proposed protected features



Stage 2 - Prioritisation of search locations according to the qualities of the MPA search features they contain

Summary of assessment	<p>The Loch Sween possible MPA is proposed for four spatially linked protected features. Burrowed mud, the most extensive feature covering much of the main body of the loch, and adjacent shallower sublittoral mud communities are of naturally low to moderate biological diversity. The maerl beds and some of the mixed sediment communities in the outer parts of the possible MPA support more diverse associated communities of plants and animals. The proposed protected features are sensitive to a range of pressures and due to the well-studied nature of this sea loch, a number are known to have been modified to some degree by human activities in recent decades. The native oyster populations have been subject to exploitation historically. At a <u>regional</u> level the features are also considered to be at risk of future damage. However, on the basis of available evidence, significant proportions of all features within the possible MPA are currently considered to be in a natural state and largely undisturbed (some uncertainties remain about one component of the sublittoral mud and mixed sediment communities feature).</p> <p>All of the five Stage 2 guidelines have been met (2a - 2e).</p>
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Detailed assessment

Guideline 2a The search location contains combinations of features, rather than single isolated features, especially if those features are functionally linked

The Loch Sween possible MPA is proposed for four protected features. A number of the seabed habitats grade into one another across depth and/or exposure gradients e.g. transition between infralittoral mud habitats and deeper circalittoral examples - each with overlapping but distinctive associated biological communities. **Guideline met.**

Interpretation of the burrowed mud MPA search feature

This summary overview is provided to aid interpretation of the terminology used within this technical assessment. Further details on the burrowed mud MPA search feature are available online at - <http://www.scotland.gov.uk/Resource/0039/00394205.doc>. The burrowed mud feature encompasses five components considered to be of particular relevance in a Scottish context: two component biotopes (**relevant biotope⁴ codes provided in bold text below**) and three specific species:

- Biotope - "Seapens and burrowing megafauna in circalittoral fine mud" (**SS.SMu.CFiMu.SpM**eg)
- Biotope - "Burrowing megafauna and the mud volcano worm *Maxmuelleria lankesteri*" (**SS.SMu.CFiMu.MegMax**)
- Species - *Funiculina quadrangularis* (the tall seapen)
- Species - *Pachycerianthus multiplicatus* (the fireworks anemone)
- Species - *Maera loveni* (a mud burrowing amphipod)

Guideline 2b The search location contains example(s) of features with a high natural biological diversity

Burrowed mud	Within the Loch Sween possible MPA the burrowed mud proposed protected feature is dominated by burrowing megafauna and the mud volcano worm <i>Maxmuelleria lankesteri</i> (assigned to the SS.SMu.CFiMu.MegMax biotope).
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⁴ Further details on the UK marine habitat classification are available online at <http://jncc.defra.gov.uk/page-5931>

Guideline 2b	The search location contains example(s) of features with a high natural biological diversity
Burrowed mud cont.	<p>Good examples of the biotope displaying large <i>Maxmuelleria</i> mounds appear to be widespread with confirmed dense populations of the worm together with burrowing crustaceans including <i>Nephrops norvegicus</i>, <i>Jaxea nocturna</i>, <i>Calocaris macandreae</i> and <i>Callianassa subterranea</i> (Moore and Harries, 2013). In addition to these specialist or obligate burrowers, other species that opportunistically inhabit their burrows within the loch such as the black goby <i>Gobius niger</i>, were routinely recorded during the 2013 survey (the black goby takes up residence in burrows belonging to <i>Maxmuelleria lankesteri</i>, often enlarging the openings - Atkinson, 1987). The SS.SMu.CSaMu.SpMmeg component biotope of the burrowed mud feature has also been recorded within the main body of the loch and in the upper parts of the arms of Loch Sween. In 2013 this habitat appeared to fringe the central core area of SS.SMu.CFiMu.MegMax habitat, with slender seapens <i>Virgularia mirabilis</i> and tower shells <i>Turritella communis</i>. The SS.SMu.CSaMu.SpMmeg biotope grades into shallower infralittoral muds (SS.SMu.IFiMu encompassed by the sublittoral mud and mixed sediment communities proposed protected feature) around the margins of the loch and at the head of the inlets. Isolated historical records of the fireworks anemone and the tall seapen exist, but a detailed review of the data revealed that the records are highly dubious and neither species was recorded in the 2013 survey (Moore, 2013; Moore and Harries, 2013).</p> <p>Early accounts of infaunal sampling across the loch (not constrained to just the burrowed mud habitat), describe a general pattern of biological diversity; with relative impoverishment in the inner parts of the loch system and a progressive increase in abundance, biomass and species richness towards the outer reaches (observations from sampling undertaken by Pearson and Ansell in 1973 - summary reproduced in Earll, 1982). Subsequent work in the 1980s broadly supported the conclusions that mud habitats within Loch Sween are of moderate biological diversity but also highlighted some areas in the upper loch and the three arms with similar environmental / sedimentary conditions that have a much higher biodiversity (Earll, 1984).</p> <p>More recent benthic sampling includes work undertaken by SEPA in November 2010. Twenty-four stations were assessed along the length of the loch from Sailean Mhor and the Achnamara arm through to the outer approaches. Video footage was taken at a limited number of stations to supplement the infaunal sampling but due to adverse weather conditions the footage collected provided relatively little information on the biota present (Allen and Birkett, in prep.). The burrowed mud was characterised by the brittlestars <i>Amphiura chiajei</i> and <i>Amphiura filiformis</i>, the bivalve <i>Kurtiella bidentata</i>, polychaetes <i>Nephtys incisa</i> and <i>Melinna palmata</i>, the gastropod <i>Hyala vitrea</i> and horseshoe worms <i>Phoronis</i> sp. Burrowing megafauna sampled by the grab included the thalassinidean crustacean <i>Jaxea nocturna</i> which was recorded at approximately half the stations and one record of the langoustine <i>Nephrops norvegicus</i>. On the basis of infaunal and sediment composition analyses, the 2010 burrowed mud records were assigned to a composite SS.SMu.CFiMu.MegMax / SS.SMu.CFiMu.SpMmeg biotope class. Allen and Birkett (in prep.) note that additional video and or diver surveys would be required to refine this categorisation and confirm the presence of the SS.SMu.CFiMu.MegMax biotope (as per 2013 sampling). At the stations ascribed to the burrowed mud feature, infaunal diversity and abundance were low but not atypical for the inner regions of Scottish lochs (Moore <i>et al.</i>, 2011), with 5 - 13 taxa per grab and 9 - 50 ind./0.1m². Diversity indices calculated ranged from 0.91 to 2.84 (Shannon Wiener H') with a low - moderate mean H' of 2.17. A few of the burrowed mud stations had moderately high biomass values reflecting the presence of occasional larger animals (or parts thereof) such as burrowing megafauna. The levels of diversity broadly reflect those encountered during earlier studies (e.g. Earll, 1984).</p>

Guideline 2b The search location contains example(s) of features with a high natural biological diversity	
Maerl beds	<p>Loch Sween supports two distinctly different forms of maerl beds. Within the Caol Scotnish rapids, <i>Lithothamnion glaciale</i> is the dominant species and forms a dense bed with exceptionally large maerl thalli (classified as '<i>L. glaciale</i> maerl beds in tide-swept variable salinity infralittoral gravel' and assigned to the SS.SMp.Mri.Lgla biotope). The beds within the Taynish rapids comprise both <i>Lithothamnion glaciale</i> and <i>Phymatolithon calcareum</i>, but the latter is the dominant maerl forming species and beds here are classified as '<i>P. calcareum</i> maerl beds in infralittoral clean gravel or coarse sand' (assigned to the SS.SMp.Mri.Pcal biotope and in places to the SS.SMp.Mri.Pcal.R sub-biotope which reflects the presence of a higher abundance of red algal species on the surface of the bed). Both beds can be characterised as supporting rich live maerl biomass, at least over part of their distributional limits (maximum live maerl cover of 95% and 90%; and mean live maerl cover of 67% and 41% respectively - Moore and Harries, 2013).</p> <p>The maerl bed in Caol Scotnish is best developed along the central portion of the narrows in approx. 4 - 4.5 m water depth. The red alga <i>Phyllophora crispa</i> was the main epiphyte on the maerl rhodoliths in 2013. Other characterising algal species included sugar kelp <i>Saccharina latissima</i> (with Frequent⁵ abundance), the sea oak <i>Halidrys siliquosa</i> (Frequent) and the brown fan weed <i>Dictyota dichotoma</i> (Present as a short turf on maerl gravel). Common and black brittlestars (<i>Ophiothrix fragilis</i> and <i>Ophiocoma nigra</i> respectively) were Superabundant above and amongst the maerl. Other echinoderms present included the common starfish <i>Asterias rubens</i>, the spiny starfish <i>Marthasterias glacialis</i>, the common sunstar <i>Crossaster papposus</i> and the edible urchin <i>Echinus esculentus</i>. Juvenile scallops <i>Aequipecten opercularis</i> were Frequent on the surface of the bed. The sea squirts <i>Ascidia virginea</i> and <i>Asciidiella aspersa</i> were also present. Butterfish <i>Pholis gunnellus</i> were recorded swimming in and out of the maerl matrix.</p> <p>The mixed maerl beds present within the Taynish rapids are scattered throughout the main channel of the narrows area with fairly dense live maerl interspersed with maerl gravel in places. The beds here also support Abundant brittlestars but the epifloral composition differs somewhat with a greater coverage of <i>D. dichotoma</i> (Abundant), sea cauliflowers <i>Leathesia difformis</i> (Abundant) and in some areas, a Superabundant cover of the coral weed <i>Corallina officianalis</i>, another pink encrusting algae growing directly onto the maerl nodules. Sugar kelp and sea oak are present at similar abundance to Caol Scotnish but a number of filamentous red algal species are additional to the beds in this location. One of the important aspects of the beds at Taynish lies in their unusually shallow distribution, extending into the littoral zone (and down to ca. 2.5 m), and the contribution they make to the high diversity of the rapids system as a whole. Large numbers of amphipod tubes were observed in the sediment around the maerl nodules in 2013. It has been hypothesised that these may help to bind the maerl together in this location enhancing the stability of the bed (Bunker, 1999). <i>Corophium sextonae</i>, a non-native species introduced to the UK in the 1930s from New Zealand (Crawford, 1937) forms a component of the amphipod fauna here (first recorded in Linnhe Mhuirich from a sea squirt in 1979 - Moore, 1980).</p> <p>Epibiotic diversity (as revealed by the 2013 detailed <i>in situ</i> diver surveys) is considered fairly low at Caol Scotnish (a total of 34 species recorded) and moderate for Taynish (50 species recorded). However, the overall biological diversity recorded will almost certainly increase following processing of the infaunal samples collected in 2013. Infaunal core sampling undertaken within the Taynish maerl beds in 1999 recorded a taxon richness range of 36 - 56 species (mean of 44 species) with substantial numbers of individual organisms recorded per core (435 - 2,320) (Bunker, 1999). A total of 107 taxa were recorded from the beds in 1999 but no other indices of biological diversity were generated with which to make meaningful comparisons against other maerl beds around Scotland. The full findings of the 2013 survey work will be reported in Autumn 2013.</p>

⁵ For details of the SACFOR scale used for reporting the abundance of marine benthic flora and fauna in biological surveys see Hiscock (1996).

Guideline 2b The search location contains example(s) of features with a high natural biological diversity	
Maerl beds <i>cont.</i>	<p>The non-native brown seaweed <i>Sargassum muticum</i> was found to be widely distributed throughout the maerl bed at Taynish (Moore and Harries, 2013). The species was not recorded here during a 2010 reconnaissance survey looking at the spread of this invasive species up the west coast (Trendall <i>et al.</i>, 2010).</p> <p><i>P. calcareum</i> has also been recorded in the outer reaches of the possible MPA. On close inspection, none of the 1985 records here describe dense beds of maerl. Mud and extensive areas of maerl gravel were observed at the head of Loch na Cille; these may represent fossil deposits (Lumb and Hiscock, 1990). Scattered live maerl amongst shell gravels was recorded at a number of distinct stations in the shallow waters fringing the south-west of the Island of Danna (Lumb and Hiscock, 1990). Remote video sampling in 2013 confirmed the continued presence of sparse maerl rhodoliths at two of these three former stations.</p>
Native oysters	<p>There are very few records of native oysters in Scotland and only three records of known beds (Moore and Harries, 2013), so it is difficult to compare levels of associated biodiversity. On the basis of observations made in 2013, Loch Sween is considered to support a relatively high quality example of the SS.SMx.IMx.Ost biotope, in very shallow waters. Native oysters in Loch Sween frequently occur in clumps of up to 7 or 8 large animals and these serve as small biogenic reefs, increasing the habitat complexity of the surrounding seabed and providing settlement surfaces and shelter to a range of associated species (Dame 1996; OSPAR 2008; UKBAP 2008). The native oyster beds occur as a very narrow band in places (<1 m wide), reflecting the small tidal ranges that occur here (amongst the lowest in the UK due to the proximity of a tidal node / amphidromic point).</p> <p>In 2013, species associated with the oyster beds included the ascidians <i>Asciidiella aspersa</i>, organ pipeworms <i>Serpula vermicularis</i>, barnacles <i>Semibalaus balanoides</i>, blue mussels <i>Mytilus edulis</i>, saddle oysters <i>Anomia ephippium</i>, scallops <i>Chlamys</i> sp. and tubeworms such as <i>Pomaroceros triqueter</i>. Scattered native oysters were also recorded in shallow seagrass beds fringing the margins of the loch amongst casts of the lugworm <i>Arenicola marina</i> and burrowing fountain anemones <i>Sagartiogeton laceratus</i> (merging into the shallow muds and sands biotopes SS.SMu.IFiMu / SS.SMu.ISaMu of the 'sublittoral mud and mixed sediment communities' feature - see below). These findings correlate with previous studies of the native oyster population in Loch Sween (Bunker, 1999; UMBSM, 2007). A single Pacific oyster <i>Crassostrea gigas</i> was recorded in 2013 (Moore and Harries, 2013) perhaps reflecting the history of oyster cultivation within the loch system (see 2d for further details). No quantitative faunal data exist with which to compare indices of biological diversity.</p>
Sublittoral mud and mixed sediment communities	<p>This proposed protected feature incorporates four discrete biotope complexes: infralittoral fine mud (SS.SMu.IFiMu); infralittoral sandy mud (SS.SMu.ISaMu); infralittoral mixed sediment (SS.SMx.IMx) and circalittoral mixed sediment (SS.SMx.CMx).</p> <p>Most of the records of these habitats come from diving studies undertaken in the early 1980s but their broad distribution was validated in 2013 (detailed biotopes have yet to be assigned to all of the 2013 samples - Moore and Harries, 2013). Infralittoral fine mud is primarily present at the heads of the embayments and arms (Linnhe Mhuirich, Caol Scotnish and the Achnamara arm) in water depths of 2 - 11 m, representing a natural habitat transition from the intertidal zone to deeper waters and the adjacent burrowed mud proposed protected feature. The shallow muds often have diatom growth on the surface with casts of the lugworm <i>Arenicola marina</i> (assigned to the biotope SS.SMu.IFiMu.Are where this is the characterising species). The green sea urchin <i>Psammechinus miliaris</i> is present with shore crabs <i>Carcinus maenas</i> and hermit crabs <i>Pagurus bernhardus</i>. The white sea slug <i>Philine aperta</i> is quite numerous in slightly deeper water, with common whelks <i>Buccinum undatum</i>, sparse slender seapens <i>Virgularia mirabilis</i> and small burrows in the mud surface (SS.SMu.IFiMu.PhiVir).</p>

Guideline 2b	The search location contains example(s) of features with a high natural biological diversity
Sublittoral mud and mixed sediment communities <i>cont.</i>	<p>The burrowing sea anemone <i>Sagartiogeton undatus</i> and clumps of the sea squirt <i>Asciidiella aspersa</i> are present on these shallow muds (SS.SM_u.IFiMu) and also in sandy mud substrates. Where these characterising species are particularly prevalent, records have been assigned to the discrete SS.SM_u.ISaMu.SundAasp biotope. Within the main body of the loch these mud and sandy mud biotopes are also present on the flanks of the shallow Sgeirean a'Mhain shoal (to the east of the Ulva islands) where the seabed drops down into deeper water. Gravelly sandy mud towards the mouth of the loch and across the shallow sill (beyond the 2013 mapped distribution of the burrowed mud feature) was sampled quantitatively by SEPA in November 2010 (see burrowed mud description above for details). The grab samples recorded high numbers of polychaete worms (including <i>Melinna palmata</i>, <i>Magelona alleni</i>, <i>Lumbrineris gracilis</i>), the amphipods <i>Ampelisca diadema</i> and <i>Ampelisca tenuicornis</i>, the bivalves <i>Kurtiella bidentata</i> and <i>Timoclea ovata</i>, the brittlestar <i>Amphiura filiformis</i> and the common tower shell <i>Turritella communis</i>. The records were assigned to the SS.SM_u.ISaMu.MelMagThy biotope which was one of the most diverse infaunal communities sampled in 2010, with a taxon richness range of 45 - 77 species (mean of 61 species) and infaunal abundances per grab of 247 - 355 ind. / 0.01 m². Diversity indices calculated ranged from 4.13 to 5.08 (Shannon Wiener H') with a high mean value of H' = 4.6 (Allen and Birkett, in prep.).</p> <p>Infralittoral mixed sediments (SS.SM_x.IM_x) are scattered throughout the possible MPA from the shallow fringes of the outer approaches around Danna and the McCormaig Isles through to the sheltered confines of Linne Mhuirich and the upper reaches of the Achnamara arm. This biotope complex encompasses the native oyster proposed protected feature (SS.SM_x.IM_x.Ost) which actually occurs on a range of substrates from silty sandy muds to coarse shelly gravels in very shallow sheltered waters around the loch. Historical records of the flame shell beds biotope (SS.SM_x.IM_x.Lim) in deep water on the outer south-western edge of the possible MPA were not validated in 2013 (see 2d overleaf). The biological communities associated with the biotope complex vary depending upon the composition of the mixed sediments which range from firm muds with an admixture of shell debris to muddy gravels with pebbles and cobbles. At the entrance to Loch na Cille, small slender seapens and the ocean quahog were recorded in 1985 in firm mud with shells; off Danna the feature was assigned to records of coarse muddy shell gravels and pebbles with chitons <i>Lepidopleurus</i> sp., limpets <i>Tectura virginea</i>, queen scallops <i>Aequipecten opercularis</i>, encrusting bryozoans and burrowing bivalves (including the banded venus <i>Clausinella fasciata</i> and razor shells <i>Ensis arcuatus</i>). South of Rubha na Maraich the substrates included scattered <i>Phymatolithon calcareum</i> maerl rhodoliths in the gravel troughs, here <i>E. arcuatus</i> appeared dominant, with blunt gaper shells <i>Mya truncate</i> and banded carpet shells <i>Paphia rhomboides</i> also Frequent or Common within the mixed sediments (Lumb and Hiscock, 1990). The feature has also been recorded across the sill as a mixture of cobbles, pebbles and shell gravel with an increased infaunal diversity. In more sheltered waters to the east of Keillbeg jetty in Loch na Cille and within the upper arms of the main loch (Achnamara and Sailean Mhor) more specific infralittoral biotopes are recognised where the mixed sediments support peacock worms <i>Sabella pavonina</i>, sponges and <i>Sagartiogeton</i> sp. burrowing anemones (SS.SM_x.IM_x.SpavSpAn). Sheltered gravel habitats at the edge of the shore also support carpet shells <i>Veneropsis senegalensis</i> with small brittlestars (SS.SM_x.IM_x.VsenAsquAps).</p> <p>Circalittoral mixed sediment communities (SS.SM_x.CM_x) lie primarily in adjacent deeper waters, with records also distributed across the possible MPA but situated at the mouths of the arms off the main loch and in deeper parts of the outer approaches. This biotope complex does also encompass a number of shallow water records of brittlestar beds on mixed substrates in close proximity to the tide-swept narrows at Caol Scotnish and Linne Mhuirich (SS.CM_x.Oph.Mx).</p>

Guideline 2b The search location contains example(s) of features with a high natural biological diversity	
Sublittoral mud and mixed sediment communities <i>cont.</i>	At the entrance to the Achnamara arm, well-worked muddy substrates are scattered with cobbles, boulders and shells from 12 -18 m. The hydroid <i>Nemertesia ramosa</i> is often present on rock surfaces with the sponges <i>Suberites carnosus</i> and <i>Polymastia boletiformis</i> and tube anemones <i>Cerianthus lloydii</i> within the sediment (SS.CMx.CiloMx[.Nem]). These habitats have a broad distribution where suitable substrates exist along the deeper margins of the main body of the loch and out to the McCormaig Isles. The SS.SMx.CMx.FluHyd biotope (' <i>Flustra foliacea</i> and <i>Hydrallmania falcata</i> on tide-swept circalittoral mixed sediment) has a much more specific distribution, restricted to the outer reaches of the possible MPA in the tide-swept waters around the McCormaig Isles and Danna. In 1982 these current-swept gravels and stones supported quite diverse epifaunal communities (33 species recorded during a 15 minute dive - Earll, 1982) with erect hydroids such as the sea beard <i>Nemertesia antennina</i> and <i>Hydrallmania falcata</i> , the erect bryozoan <i>Securiflustra securifrons</i> , dead man's fingers <i>Alcyonium digitatum</i> , <i>Sagartia elegans</i> anemones, the solitary sea squirts <i>Polycarpa pomaria</i> , feather stars and scallops.
2b - Result	Guideline met.
Guideline 2c The search location contains coherent examples of features, rather than smaller, potentially more fragmented ones	
Burrowed mud	Burrowed mud has been extensively recorded in the upper arms of Loch Sween (Sailean Mhor and Achnamara arm), in Loch a'Bhealaich and throughout the inner three quarters of the main channel, as well as in Loch na Cille. The predominant biotope, SS.SMu.CFiMu.MegMax covers an area of ca. 580 ha (Moore and Harries, 2013), and represents one of the best known examples of this habitat in Scottish waters. The associated megafaunal communities are considered typical for a west coast sea loch example of this habitat. There has been very little research to assess the natural spatial and temporal variability of this feature. Records of burrowed mud within Loch Sween have been made continuously from the early 1900s (Kerr in 1912 referred to ' <i>tenacious mud comparatively poor in life</i> ' covering most of the bottom of the loch) suggesting a level of permanency. In the absence of significant disturbance the characterising species of the burrowed mud would be expected to persist.
Maerl beds	There are two known areas of maerl beds within the Loch Sween possible MPA; within the Taynish and Caol Scotnish rapids. The Caol Scotnish bed supports a high proportion of live maerl; within a thin band, 10 - 30 m wide, running along the centre of the narrows for a distance of around 1 km (an estimated area of 3.7 ha). The Taynish bed covers an area of ca. 2.7 ha, with small-scale patchiness present, resulting in densities of live maerl cover dropping below 10% within parts of the delimited area. The beds are considered to be of moderate extent in a Scottish context (Moore and Harries, 2013). Very little information is available to assess the area required to ensure the viability of maerl beds. Vegetative growth is the main form of propagation, so the dispersal potential of maerl is limited, probably less than 1 km, based on dispersal of adults by water movement (Hill <i>et al.</i> , 2010). Regardless of the size of a maerl bed it is therefore recommended that beds are protected to their full extent. Maerl is extremely slow growing with growth rates in Scotland in the order of tenths of millimetres to two millimetres per year. The life-span of individual plants of <i>P. calcareum</i> is estimated to be from 20 to 100 years. Both maerl beds have persisted in these locations since formal marine biological recording began in the early 1900s (Kerr, 1912) and in the absence of disturbance or any changes that affect the suitability of the habitat, they can be expected to be long-lived and stable. The recovery potential of maerl beds is low (OSPAR, 2010).

Guideline 2c The search location contains coherent examples of features, rather than smaller, potentially more fragmented ones	
Native oysters	Loch Sween is one of only three locations in Scotland where native oyster beds have been formally recorded and the possible MPA supports comparatively large numbers of the animals (Moore and Harries 2013). The density of <i>Ostrea edulis</i> along transects lines surveyed in 2013 ranged from 0.23 - 5.82 m ⁻² , with a mean of 1.89 m ⁻² . While oyster beds are restricted to a few distinct locations in Loch Sween, fragmentation within the loch system is likely to be minimal because of the animals' dispersive larval life history stage (larval development takes between 10 - 30 days to complete with dispersion distances of 10 - 40 km estimated - Hill <i>et al.</i> , 2010). The species is relatively long-lived (up to about 20 years), and is believed to have been present within the loch for several 100 years; although with active management intervention from as early as 1891 (see 2d for additional details). There has been no commercial exploitation of the population in Loch Sween since the mid-1990s. The size frequency distribution of the population in 2013 suggests that the last successful recruitment event happened about 3 years ago, while the majority of animals are at least 5 years old and 70 - 100 mm in size (Moore and Harries, 2013). The population density would appear to be sufficient to sustain the beds into the future in the absence of disturbance or any changes in the suitability of habitat. The reliance of native oyster populations on sporadic and irregular recruitment events for population maintenance makes them susceptible to collapse caused by (unlawful) over-exploitation.
Sublittoral mud and mixed sediment communities	The four different components of the sublittoral mud and mixed sediment communities feature present within the possible MPA are considered typical for this west coast sea loch physiographic setting (with varying salinity ranges in the sheltered embayments and arms). Detailed information on the extent of these habitats, a number of which occur around the margins of the loch, is not available. There has been very little research on the assorted biotopes that comprise the feature within Loch Sween to assess natural spatial and temporal variability but summary reviews presented in Hill <i>et al.</i> (2010) [based on sheltered muddy gravels, coarse coastal sediments and burrowed mud habitats], suggests that the majority of species identified as being faithful and frequent residents of the habitats have a larval phase in their development and so are capable of dispersing over large distances. In the absence of significant disturbance therefore, the feature as a whole is expected to persist (Hill <i>et al.</i> , 2010). Preliminary results from the 2013 survey work have confirmed the continued presence and broad distribution of the main biotope complex classes across the loch.
2c - Result	Guideline met.
Guideline 2d The search location contains features considered least damaged / more natural, rather than those heavily modified by human activity	
Burrowed mud	Localised modification of the burrowed mud feature has been recorded previously in different parts of the loch system. For example, a salmon farm (of 240 tonnes) was removed from Sailean Mhor in 1992 and the effects on the seabed were still apparent nearly two years later when surveyed by divers (the presence of extensive <i>Beggiatoa</i> bacterial mats indicative of organic enrichment - SNH, 1995). These observations were supported by data from infaunal sampling carried out by the Scottish Environment Protection Agency (SEPA) in the 1990s (from Sailean Mhor and another fish farm at Port Lunna). These records describe a variety of mud communities with variable but generally low to moderate diversity with some stations/years exhibiting communities indicative of a level of organic enrichment with impoverished assemblages dominated by the polychaete worms <i>Capitella capitata</i> and <i>Malacoceros fuliginosus</i> (Allen and Birkett, in prep.). However, survey work undertaken in 2013 recorded good examples of the feature (dense, large mounds of the mud volcano worm) with a widespread distribution. On the basis of recent sampling, the burrowed mud feature within the possible MPA is considered to be in a natural state and not heavily modified by human activity.

Guideline 2d	The search location contains features considered least damaged / more natural, rather than those heavily modified by human activity
Maerl beds	<p>As per the burrowed mud feature, whilst the maerl beds in Loch Sween are generally considered to be in a natural condition, human activities are known to have caused localised damage and potentially had some longer-term effects on the associated biological communities. In the 1940s, nutrient levels in Caol (Kyle) Scotnish were artificially enhanced over a period of 3-years through the addition of substantial quantities of inorganic fertiliser (on 16 occasions from 1944-1946). The experimental work was undertaken to see if the productivity of the phytoplankton-dominated sea loch could be enhanced, with the intention that increased plankton levels should be reflected in the rapid growth of a range of fish species (summarised in Nixon and Buckley, 2002). As part of these studies, the benthic fauna of the loch and adjacent rapids were sampled regularly and a dramatic increase in the number of benthic fauna was observed. Workers at the time were impressed with the maerl they sampled within the rapids but even more impressed by the large numbers of flame shells <i>Limaria hians</i> they collected, with densities attaining 1,500 m⁻² (Raymont, 1950). The high densities of these small (up to 4 cm long) bivalve molluscs that live within byssus nests, were not believed to be a by-product of the fertilisation experiments, with 'great masses of [flame shell] nests constructed of pink calcareous alga' being recorded from the rapids in the early 1900's (Kerr, 1912). However, the nutrient enrichment and the associated seabed sampling might have taken their toll because despite extensive searches, flame shells have not been recorded here in more recent times (Earll, 1982; SNH, 1995). No flame shells were recorded from the Caol Scotnish maerl bed during the 2013 survey work.</p> <p>Mooring chains put in place off Scotnish pier in the early 1990's also caused localised damage to the maerl bed but when this was realised, the moorings were promptly relocated further down the narrows and off the maerl habitat (SNH, 1995). Despite these localised instances of recorded damage to the beds, they are currently considered to be in a natural, unmodified state.</p>
Native oysters	<p>The oyster population in Loch Sween cannot be considered unmodified but is still of national importance in terms of representation of a relatively high quality example of the SS.SMx.IMx.Ost biotope (Moore and Harries, 2013). Oyster beds were once numerous along the west coast and around the islands of Scotland, reflecting the availability of suitable habitat within the many sheltered bays formed by the rugged and indented coastline. Excavated shell middens indicate the pre-historic importance of oysters as a source of dietary protein since Mesolithic times. Prior to the development of commercial fisheries during the 17th century, many rural communities harvested local beds for subsistence use. <i>O. edulis</i> continued to be a common dietary component for Scots until oysters started to become scarce during the late 1800s (UMBSM, 2007).</p> <p>Accounts of oyster cultivation in Loch Sween, based on the natural beds present there, are documented from as early as 1891. Cultivation experiments continued in the 1960s and a farm and hatchery operated in the 1980s through to the early 1990s but suffered from problems associated with the use of the antifoulant chemicals and eventually ceased to operate (SNH, 1995). There is currently no legitimate commercial exploitation of the oyster population within Loch Sween (UMBSM, 2007).</p>
Sublittoral mud and mixed sediment communities	<p>In the approaches to Loch Sween this feature may have been modified by demersal fishing activity (scallop dredging takes place around the McCormaig Islands and between the islands and Danna - SNH, 1995). An up-to-date assessment of the status of the coarser mixed sediment communities in this outer part of the possible MPA is not possible until a more detailed analysis of the 2013 records has been undertaken (to be reported upon in the Autumn). Historic flame shell bed records (SS.SMx.IMx.Lim) in 30 - 40 m depth along the outer south-western edge of the possible MPA near Keillmore (Lumb and Hiscock, 1990) were not validated in 2013 despite targeted sampling (Moore and Harries, 2013). Flame shell beds are a proposed protected feature in their own right within a number of other possible MPAs and are particularly sensitive to abrasion and physical disturbance.</p>

Guideline 2d The search location contains features considered least damaged / more natural, rather than those heavily modified by human activity	
Sublittoral mud and mixed sediment communities <i>cont.</i>	Within the main body of the loch and inlets the different component biotopes of the sublittoral mud and mixed sediment communities feature are expected to be in a comparable natural state to the burrowed mud feature with which they are spatially associated (often forming an interspersed mosaic or distributed in adjacent depth zones to one another).
2d - Result	Guideline met. A number of the features have been modified to some degree by human activity but on balance it is considered that extensive examples of all within the possible MPA can be described as being in a natural state (subject to some uncertainties regarding the mixed sediment component habitats in the approaches to the loch). Despite historic anthropogenic modification, the native oyster beds in Loch Sween represent one of the best examples of this feature in Scotland. Completely unmodified / unexploited examples of beds of this species are no longer thought to be present in our waters.
Guideline 2e The search location contains features considered to be at risk⁶ of significant damage by human activity	
Burrowed mud	The Loch Sween possible MPA lies within the West MPA region ⁷ . On the basis of a risk assessment undertaken at the level of the MPA region, there is considered to be a medium risk of significant damage to this feature arising from human activity (a <u>cumulative</u> assessment considering the range of activities known to be taking place in the MPA region). Within the region, this is largely as a result of potential exposure to pressures associated with demersal fishing activity and aquaculture (fin fish and shellfish farming).
Maerl beds	On the basis of the cumulative regional risk assessment, there is considered to be a high risk of significant damage to this feature arising from human activity. Within the <u>region</u> , this is largely as a result of potential exposure to pressures associated with demersal fishing activity (e.g. hydraulic dredging for bivalves, otter trawling and scallop dredging), which is considered to present a high risk. Creel fishing, dive fisheries and aquaculture (fin fish and shellfish farming) present medium risks.
Native oysters	On the basis of the cumulative regional risk assessment, there is considered to be a high risk of significant damage to this feature arising from human activity. This is largely as a result of potential exposure to pressures associated with fishing activity (dive fisheries, hand gathering, hydraulic dredging for bivalves and scallop dredging), which is considered to present a high risk. Aquaculture (fin fish and shellfish farming)-related activities present medium risks.

⁶ Information on the sensitivity of the MPA search features to pressures and their associated activities was taken from Tillin *et al.* (2010). The degree to which an MPA search feature is exposed to activities / pressures to which it is sensitive in each MPA region was assessed to provide a qualitative measure of risk. Risk assessments for the various activities were examined to produce an overall qualitative risk assessment by MPA region. The conclusions may therefore not reflect the level of risk at the scale of the possible MPA. Site-specific activities and pressures are considered in further detail within the management options paper produced for this possible MPA.

⁷ The seas around Scotland were split into five MPA regions (East, North, West, South-west and Far West) at the outset of the MPA Project to aid the identification of MPA search locations and the preliminary appraisal of these against the MPA Selection Guidelines (e.g. the completion of regional risk assessments). This approach provided a useful framework for the initial stages of assessment. Within SNH and JNCC's formal MPA network advice (SNH and JNCC, 2012) the MPA proposals and remaining MPA search locations were then cast within the context of broader OSPAR regions.

Guideline 2e The search location contains features considered to be at risk⁶ of significant damage by human activity	
Sublittoral mud and mixed sediment communities	Regional risk assessments have not been completed for representative features. However, information is available on the likely sensitivity of this feature to pressures arising from human activity (based on the SS.SMu.IFiMu.PhiVir biotope for the sublittoral mud communities and the SS.SMx.CMx.CiloMx biotope for the mixed sediment communities). The feature is considered to be moderately sensitive to substratum loss, smothering, changes in water flow rate, an increase in salinity, abrasion and physical disturbance (Hill, 2001; Hill and Wilson, 2005). The mixed sediment communities component of the feature is also moderately sensitive to increases in wave exposure.
2e - Result	Guideline met. This is not an assessment of activities that require management within the possible MPA. That assessment is provided in the management options paper.

Stage 3 - Assessing the appropriate scale of the search location in relation to search features it contains

Assessment
<p>The size of the search location should be adapted where necessary to ensure it is suitable for maintaining the integrity of the features for which the MPA is being considered. Account should also be taken where relevant of the need for effective management of relevant activities</p> <p>The size and shape of the possible MPA reflects the distribution and extent of the range of proposed protected features. The boundary encompasses the whole of the complex fjordic sea loch system (including Caol Scotnish, Sailean Mhor and the Achnamara arm but excluding the anchorage area within inner Loch a' Bhealaich), as well as the tide-swept waters of the Sound of Jura at its mouth that surround the Island of Danna and the McCormaig Isles. Burrowed mud floors the deeper parts of the central loch basin and inlets. Maerl beds are largely confined to the narrow tidal entrances of Linne Mhuirich and Caol Scotnish. Native oysters are scattered across the possible MPA with concentrations in some parts. The sublittoral mud and mixed sediment communities feature, representative of Scotland's seas more generally, has a more ubiquitous distribution. The shallow mud communities have been recorded around the margins of the deeper burrowed mud throughout the loch, whilst the mixed sediment communities are mainly restricted to waters beyond the exposed loch mouth. Guideline met.</p>

Stage 4 - Assessing the potential effectiveness of managing features within a search location as part of a Nature Conservation MPA

Summary of assessment

The possible MPA passed the assessment against the Stage 4 guideline. This resulted in the original MPA search location progressing as a potential area for an MPA to Stage 5.

Detailed assessment

There is a high probability that management measures, and the ability to implement them, will deliver the objectives of the MPA

The conservation objective for the protected features within this possible MPA is to 'conserve'.

A number of activities are considered capable of affecting the proposed protected features (see 2e above) and there is therefore a need to consider whether additional management is required.

Statutory mechanisms exist (e.g. Fisheries Orders or Marine Conservation Orders) to support the introduction of spatial / temporal measures to conserve the features within the possible MPA. For example, Fisheries Orders have already been used to underpin management of marine Special Areas of Conservation. There is therefore potential for management measures to be implemented successfully and the conservation objective of the MPA to be achieved. Further discussion is required with those involved in using the possible MPA to provide clarification on interactions between the protected features and known / potential activities / developments.

Additional details are provided in the management options paper produced for this possible MPA.

Stage 5 - Assessment of the contribution of the potential area to the MPA network

Summary of assessment	Guideline met - if designated the possible MPA would make a significant contribution to the MPA network.				
Detailed assessment					
The potential area contributes significantly to the coherence of the MPA network in the seas around Scotland					
Assessment of biodiversity features					
Feature	Representation	Replication	Linkages	Geographic range & variation	Resilience
Burrowed mud	An extensive and high quality example of the burrowing megafauna and mud volcano worm <i>Maxmuelleria lankesteri</i> habitat. [SS.SMu.CFiMu.MegMax biotope]	Replication of the burrowing megafauna and the mud volcano worm habitat is proposed within OSPAR Region III. It is not possible to replicate between regions because of the restricted distribution of this component habitat (see SNH and JNCC, 2012).	Not applicable ⁸	The most northerly example of this habitat within the MPA network.	Burrowed mud is on the OSPAR List of Threatened and/or Declining habitats. Combined with the proportional importance of Scotland for this habitat, it is recommended that a greater proportion is included within the network. Replication of the component habitat (SS.SMu.CFiMu.MegMax) would be delivered within the network through the possible MPAs.
Maerl beds	Good examples of the feature comprising beds of - <i>Lithothamnion glaciale</i> maerl beds in tide-swept variable salinity infralittoral gravel. [SS.SMp.Mrl.Lgla biotope] <i>Phymatolithon calcareum</i> maerl beds in infralittoral clean gravel or coarse sand. [SS.SMp.Mrl.Pcal biotope]	Replication of this feature in the network is proposed within and between OSPAR Regions II and III (see SNH and JNCC, 2012).	Not applicable ⁸	Enclosed sea loch examples in the southern part of the geographic range of this feature within Scottish waters. Taynish rapids - a notably shallow distribution, extending into the littoral zone. Caol Scotnish rapids - a dense bed of <i>L. glaciale</i> , characterised by unusually large maerl thalli.	Maerl beds are on the OSPAR T&D list. There is evidence of damage in Scottish waters. Additional replication is proposed to increase resilience. Resilience takes account of the different physiographic settings (e.g. sea lochs and open coast). <i>L. glaciale</i> has a more restricted distribution and limited coverage within the existing network.

⁸ The linkages part of the guideline has only been assessed in situations where there is a good understanding of the relationship between features in different areas to help build connectivity into the network. There is currently little evidence on which to base assessments of linkages for seabed habitats and low or limited mobility species in Scotland's seas. Whilst there is information available for some species on dispersion distances, this cannot be readily applied to areas with complicated hydrography. For this reason, Marine Scotland Science is currently completing work on connectivity which focuses on a number of seabed habitats and low or limited mobility species (see <http://www.scotland.gov.uk/Resource/0038/00389468.doc> for an outline of work being undertaken to consider connectivity within the Scottish MPA network).

Assessment of biodiversity features					
Feature	Representation	Replication	Linkages	Geographic range & variation	Resilience
Native oysters	<p><i>Ostrea edulis</i> beds on shallow sublittoral muddy mixed sediment.</p> <p>[SS.SMx.IMx.Ost biotope]</p> <p>A good example of the native oyster bed habitat, which is now thought to be present at only a handful of locations around Scotland.</p>	<p>This is the only possible MPA for native oysters within OSPAR Region III. It is not possible to replicate between regions. There are scattered historical and more recent records of the species in Region II but they are widely and sparsely distributed (see SNH and JNCC, 2012).</p>	Not applicable ⁸	Enclosed sea loch example of the native oyster bed habitat in the middle of the geographical range for the species in Scotland.	<p>The feature is listed on the OSPAR List of Threatened and/or Declining habitats and species. Replication within possible MPAs is not proposed. The managed fishery within Loch Ryan is considered to make a contribution to the conservation of this species. Wider conservation measures will also be delivered through the species protection pillar of the Scottish Marine Nature Conservation strategy (Marine Scotland, 2011).</p>
Sublittoral mud and mixed sediment communities	<p>Examples of shallow sandy muds and mixed sediment communities.</p> <p>[SS.SMu.ISaMu; SS.SMu.IFiMu; SS.SMx.IMx; SS.SMx.CMx biotope complexes]</p>	<p>Replication of the feature in the network is proposed within and between OSPAR Regions II and III.</p>	Not applicable ⁸	Enhances the southerly geographic range of the feature within the MPA network.	<p>A representative feature. Not considered to be threatened and/or declining.</p> <p>Recommended to ensure representation of the range of broad-scale habitats within the Scottish MPA network.</p>

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