

Scottish MPA Project
Assessment against the MPA Selection Guidelines

UPPER LOCH FYNE AND LOCH GOIL
POSSIBLE NATURE CONSERVATION MPA

Document version control			
Version	Date	Author	Reason / Comments
Version 1	08/02/2013	Siobhan Mannion and Lisa Kamphausen	Revised protected feature / possible MPA format, updating original MPA search location format (ver. 3).
Version 2	03/05/2013	Laura Clark	Added detail / updated to reflect 2013 survey work.
Version 3	19/06/2013	Lisa Kamphausen / Ben James	Initial review and insertion of refined map following application of boundary setting principles.
Version 4	20/06/2013	John Baxter	QA review.
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Purpose

This document provides details of the assessment of the Upper Loch Fyne and Loch Goil 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 Upper Loch Fyne and Loch Goil possible Nature Conservation MPA was identified for the following MPA search features - burrowed mud; flame shell beds; horse mussel beds. Ocean quahogs (as a species not as aggregations) and sublittoral mud and mixed sediment communities are not MPA search features but have been recommended as proposed protected features because we consider that they would add to the broader representativity of the Scottish MPA network (i.e. representative features).

Low and variable salinity habitats (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, survey work undertaken in 2013 failed to validate any significant presence of this feature which is now believed to be restricted to small areas around the shallow margins of Loch Goil in areas of direct and localised freshwater influence. The feature is already well represented in OSPAR Region III and has now been dropped as a feature of this possible MPA.

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

Details of supporting evidence are provided in the Upper Loch Fyne and Loch Goil data confidence assessment.

UPPER LOCH FYNE AND LOCH GOIL POSSIBLE NATURE CONSERVATION MPA - APPLICATION OF THE MPA SELECTION GUIDELINES

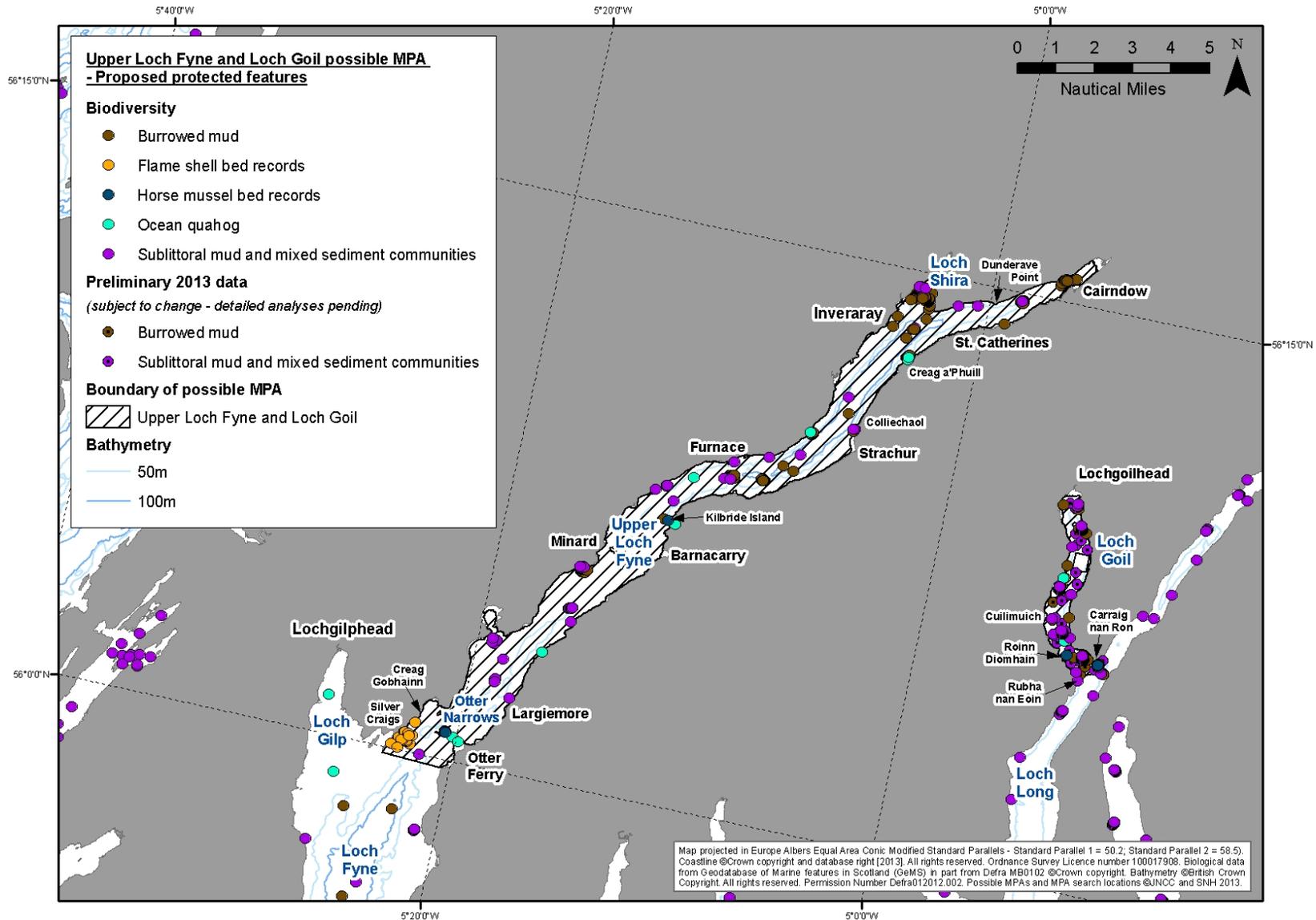
Stage 1 - Identifying search locations that would address any significant gaps in the conservation of MPA search features¹

Summary of assessment	The Upper Loch Fyne and Loch Goil possible MPA encompasses a range of MPA search features, including a number considered under threat and / or declining in Scottish waters (burrowed mud and horse mussel beds are also OSPAR Threatened and / or Declining habitats). The MPA search features are intermixed with other sublittoral mud and mixed sediment communities which are representative of Scotland's seas more generally. The Otter Narrows flame shell bed within Upper Loch Fyne represents the most southerly significant example of this seabed habitat in Scotland and the third largest known bed in Scotland (Moore <i>et al.</i> , 2013).
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Detailed assessment			
Proposed protected features	Guideline 1a <i>Presence of key features [MPA search features and geodiversity equivalents]</i>	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	
Flame shell beds	✓	✓ T&D ³	
Horse mussel beds	✓	✓ OSPAR T&D ²	
Ocean quahog (species)		<i>Representative feature (T&D⁴)</i>	
Sublittoral mud and mixed sediment communities ⁵		<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 and b).
- ³ Feature considered to be under threat and/or in decline in Scottish waters (see http://www.snh.org.uk/pdfs/publications/commissioned_reports/388.pdf for further details).
- ⁴ Ocean quahog is an OSPAR T&D species. Whilst not considered by OSPAR to be under threat / in decline in OSPAR Region III, they are considered T&D in Scottish waters (see http://www.snh.org.uk/pdfs/publications/commissioned_reports/388.pdf for further details). Aggregations of ocean quahogs are an MPA search feature (Marine Scotland, 2011). Given the conservation importance of this species but current uncertainty regarding the alignment with the MPA search feature category within the Upper Loch Fyne and Loch Goil possible MPA, the species (as opposed to aggregations) is proposed as a representative feature.
- ⁵ Comprising 'Infralittoral fine mud' (**SS.SMu.IFiMu** - A5.34) in Loch Goil only and in particular 'Ocnus planci aggregations on sheltered sublittoral muddy sediment' biotope (**SS.SMu.IFiMu.Ocn** - A5.344), 'Circalittoral sandy mud' (**SS.SMu.CSaMu** - A5.35), 'Offshore circalittoral mud' in Loch Goil only (**SS.SMu.OMu** - A5.37) and in particular 'Styela gelatinosa, Pseudamussium septemradiatum and solitary ascidians on sheltered deep circalittoral muddy sediment' (**SS.SMu.OMu.StyPse** - A5.373), and 'Sparse Modiolus modiolus, dense Cerianthus lloydii and burrowing holothurians on sheltered circalittoral stones and mixed sediment' (**SS.SMx.CMx.CiloModHo** - A5.442).

Map of the Upper Loch Fyne and Loch Goil 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

The Upper Loch Fyne and Loch Goil possible MPA encompasses five closely associated proposed protected features which differ in their spatial distribution and extent. Burrowed mud, and the sublittoral mud and mixed sediment communities features are distributed widely across both lochs in association with scattered records of ocean quahog. A single large flame shell bed is known from the Otter Narrows area in Upper Loch Fyne and there are small horse mussel beds (primarily with scattered mussels of moderate abundance rather than full coverage high density beds) in both sections of the possible MPA. The burrowed mud and adjacent sublittoral mud communities are of naturally low to moderate biological diversity. The horse mussel beds, flame shell bed and other mixed sediment communities support more diverse associated communities of plants and animals. The features are considered sensitive to a range of pressures and at a regional level are considered to be at medium risk of significant future damage by human activity. Available data indicate that the status of the flame shell bed has deteriorated in the last decade. It is currently unclear whether the horse mussel beds feature has been significantly modified within the possible MPA by human activities since first described by divers in the 1980s.

Four of the five Stage 2 guidelines have been met (2a - 2c, and 2e).

Detailed assessment

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

The Upper Loch Fyne and Loch Goil possible MPA is proposed for five protected features. The seabed sediment habitats (and the ocean quahog) are closely associated and many grade into one another across the possible MPA, e.g. the proposed features capture the transition between deep mud and sandy mud communities and between horse mussel beds and adjacent muddy mixed sediments with sparse horse mussels at densities too low to qualify as distinct 'beds'. **Guideline met.**

Previous studies have demonstrated that many of the classical associations linking specific assemblages of species with particular physical habitat parameters (the basis of the hierarchical national biotope classification - Connor *et al.*, 2004) are not clearly defined within the deeper sediment communities of the Clyde sea lochs (Pearson *et al.*, 1986; Holt and Davies, 1991). Instead, the sediments in most areas contain a wide range of species typical of a number of different but closely related biotopes.

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 biotope⁶ codes provided in bold text below**) and three specific species:

- Biotope - "Seapens and burrowing megafauna in circalittoral fine mud" (**SS.SMu.CFiMu.SpnMeg**)
- 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)

⁶ 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 ⁷ with a high natural biological diversity
Burrowed mud	<p>Within the Upper Loch Fyne and Loch Goil possible MPA the burrowed mud proposed protected feature encompasses the burrowing megafauna and the mud volcano worm <i>Maxmuelleria lankesteri</i> habitat (assigned to the SS.SMu.CFiMu.MegMax biotope) and high densities of the fireworks anemone <i>Pachycerianthus multiplicatus</i> (Davies, 1989; Howson and Davies, 1991; Moore and Atkinson, 2012). Within Upper Loch Fyne both component interests (the fireworks anemones and the SS.SMu.CFiMu.MegMax biotope) are distributed primarily towards the head of the loch, with the focus of this feature within Loch Goil being the fireworks anemones which have been recorded from outside the entrance sill at Carraig nan Ron and around the margins of the loch itself.</p> <p>Examples of the <i>Maxmuelleria</i> habitat were first recorded from the deep central basin of Upper Loch Fyne parallel to Creag a' Phuill during a remote video survey in 1988 (Davies, 1989). Soft muds at 136 m running up into Loch Shira at 46 m were described as being heavily burrowed with an extensive field of low mounds attributable to <i>Maxmuelleria</i>. Large numbers of burrows belonging to the thalassinid crustacean <i>Calocaris macandreae</i> and Occasional⁸ <i>Callianassa subterranea</i> burrows were also observed. Burrows of the langoustine <i>Nephrops norvegicus</i> were largely restricted to Loch Shira on that video run, with the species rarely recorded in the deeper channel. Several other species were seen in small numbers on the 1990 video footage from this area including Occasional fireworks anemones, seven-rayed scallops <i>Pseudamussium septemradiatum</i>, the common starfish <i>Asterias rubens</i>, spider crabs <i>Hyas araneus</i>, common whelks <i>Buccinum undatum</i>, the brittlestars <i>Ophiura ophiura</i> and <i>Ophiura albida</i> on the sediment surface and gobies, either Fries's goby <i>Lesueurigobius friesii</i> or the black goby <i>Gobius niger</i>, at burrow entrances in Loch Shira. The current broad distribution and epifaunal community composition of the SS.SMu.CFiMu.MegMax habitat in this part of the loch was validated in 2012 (Moore and Atkinson, 2012). Two stations sampled by drop-down video within and just outside Loch Shira at depths of 48 and 117 m, exhibited soft muds moderately to densely burrowed by megafaunal crustaceans including <i>C. macandreae</i>, <i>N. norvegicus</i>, <i>C. subterranea</i> and <i>Jaxea nocturna</i>, together with firm evidence of <i>Maxmuelleria lankesteri</i>.</p> <p><i>Maxmuelleria</i> mud habitat was also recorded further down the loch in 1990 within the deep central channel running from Collichaol to Minard but the proportion of the habitat here, compared to that dominated by <i>C. macandreae</i> burrows, was small. Video stations sampled on these muddy habitats in 2012 were observed to harbour similar megafaunal communities to those recorded in 1990 but lacked any conspicuous <i>M. lankesteri</i> mounds and were assigned to the 'seapens and burrowing megafauna in circalittoral fine mud' biotope (SS.SMu.CFiMu.SpM). Whilst few seapens were recorded (again comparable with records from the 1990s), where they were present, the slender seapen <i>Virgularia mirabilis</i> was dominant (Moore and Atkinson, 2012).</p> <p>At the two stations ascribed to the <i>Maxmuelleria</i> habitat here in 2012, infaunal diversity and abundance were low but not atypical for the inner regions of Scottish lochs (Moore <i>et al.</i>, 2011); with 9 and 13 taxa recorded from single grab samples at each station. A low - moderate mean diversity index (Shannon-Wiener H') of 2.4 was calculated (Allen, 2013).</p> <p>The soft muddy substrates from the head of the loch south to Dunderave Point are extensively burrowed by <i>C. macandreae</i> and <i>N. norvegicus</i>. Mounds of <i>Maxmuelleria</i> are not present here but the fireworks anemone is particularly numerous. Densities of this species at the head of the loch and within Loch Shira are amongst the highest in the UK (Davies 1989; Howson and Davies 1991; Seasearch 2005, 2006 and 2011). Diving surveys have recorded the fireworks anemones in water as shallow as - 5 m. The muddy substrates include an admixture of dead shells and stone gravel with terrestrial detritus (leaves, branches etc.) and a significant cover of <i>Beggiatoa</i> bacterial mats reflecting the lack of water movement and organic enrichment.</p>

⁷ Guideline 2b applies to seabed habitats only (ocean quahog is not assessed under this part of the guideline).

⁸ 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	
Flame shell beds	<p>Flame shells <i>Limaria hians</i> are small bivalve molluscs (about 4 cm long) that live completely hidden on the sea bed inside byssus nests, which they build from shells, stones and other materials around them. Hundreds of these nests can combine to form a dense turf or bed (assigned to the SS.SMx.IMx.Lim biotope), raising and stabilising the sea bed. Numerous plants and animals can attach to the surface of the bed, and many other animals live within or under the nest material (for more information on this habitat see Tyler-Walters <i>et al.</i> (2012)).</p> <p>The first records of <i>L. hians</i> from the Otter Narrows area were obtained during a 1988 survey by Davies (1989), who observed some of the gravel and pebbles to be incorporated in <i>Limaria</i> nest material at 9.5 - 21.5 m depth to the south-west of the spit, and Frequent <i>Limaria</i> amongst a maerl bed at 8 - 10 m depth off Creag Gobhainn. Survey work undertaken in 2012 confirmed the continued presence of an extensive bed of <i>L. hians</i> to the south of these 1988 records. At most sampling stations within the bed, the <i>Limaria</i> nest material supported Superabundant or Abundant brittlestars, with varying dominance of <i>Ophiothrix fragilis</i> and <i>Ophiocomina nigra</i>. In places the bed provided anchorage for a park of tangle <i>Laminaria hyperborea</i> or sugar kelp <i>Saccharina latissima</i>. The bed supported a rich epibiotic community (64 taxa recorded during detailed <i>in situ</i> diver studies undertaken towards the northern end of the bed in 2012). This high level of epibiotic diversity is comparable with beds studied in other locations (Moore <i>et al.</i>, 2013). Associated species included sea beard <i>Nemertesia antennina</i>, the tube anemone <i>Cerianthus lloydii</i>, the hermit crab <i>Pagurus bernhardus</i>, spider crabs <i>H. araneus</i> and queen scallops <i>Aequipecten opercularis</i>.</p> <p>Four infaunal core samples collected at 11 - 12 m included a total of 81 taxa, with a mean of 51 taxa per core (Moore <i>et al.</i>, 2013). Mean taxon richness for infaunal samples from flame shell beds generally ranges between 50 and 75, which represents high infaunal diversity, similar to that recorded for maerl biotopes (Moore <i>et al.</i>, 2013). The Otter Narrows bed was at the lower end of this indicative taxon richness range in 2012, but markedly higher numbers of species have been recorded associated with this bed in the past. In 1998 - 1999 six discrete <i>Limaria</i> nests collected over a depth range of 10 - 15 m supported a fauna of 265 species (Hall-Spencer and Moore, 2000a). Although the total area of the <i>Limaria</i> nest material studied was greater in this earlier study, and the samples were collected more widely over the bed and over a greater time period, the 2012 cores sampled both <i>Limaria</i> nest material and the underlying sediment. Most of the difference between the years lay in the greater number of molluscs collected in 1998 - 9 compared to 2012 (respectively 74 and 18) and crustaceans (respectively 56 and 14). A possible reason for this difference lies in the loss of maerl from the area (Moore <i>et al.</i>, 2013), which used to form a significant component of this habitat (Hall-Spencer and Moore, 2000b).</p>
Horse mussel beds	<p>Records of beds of horse mussels <i>Modiolus modiolus</i> exist within the Otter Narrows in Upper Loch Fyne and also from the sill and outer reaches of Loch Goil, at its confluence with Loch Long (Holt and Davies, 1991; Allen <i>et al.</i>, in prep.). Further details on this MPA search feature are provided in Tyler-Walters <i>et al.</i> (2012). The beds situated in more tide-swept conditions have been classified as '<i>Modiolus modiolus</i> beds with hydroids and red seaweeds on tide-swept circalittoral mixed substrata' (SS.SBR.SMus.ModT biotope) with the more sheltered variant '<i>Modiolus modiolus</i> beds with fine hydroids and large solitary ascidians on very sheltered circalittoral mixed substrata' (the SS.SBR.SMus.ModHAs biotope) confined to sections of deeper water off Carraig nan Ron, Loch Goil. A third horse mussel bed 'type', recorded to the west of Kilbride Island in Upper Loch Fyne in 1988 (Davies, 1989) was not validated during survey work undertaken in 2012 and may no longer be present at this location (see also 2d overleaf). Within the possible MPA, horse mussels have only been recorded in high enough densities to dominate the substratum to the north-east of Roinn Diomhain at the mouth of Loch Goil (Holt and Davies, 1991). Situated on shallow (3 - 9 m) sediments comprising mainly muddy gravels with pebbles and cobbles, a dense bed of these large bivalves was observed to bind and stabilise the surface of the sediment, providing hard substrata for a variety of species.</p>

Guideline 2b	The search location contains example(s) of features with a high natural biological diversity
Horse mussel beds <i>cont.</i>	<p>Algal diversity on the bed was low in 1989, but encrusting coralline algae were prevalent on the shells of the mussels along with the red alga <i>Phycodryus rubens</i>. The fauna on the <i>Modiolus</i> shells included the sponges <i>Haliclona urceolus</i>, and <i>Dysidea fragilis</i> and hydroids, <i>Eudendrium</i> sp., <i>Halopteris catharina</i>, <i>Kirchenpaueria pinnata</i>, <i>Bougainvillia ramosa</i> and <i>Plumularia setacea</i>. Small colonies of dead man's fingers <i>Alcyonium digitatum</i> and a few plumose anemones <i>Metridium senile</i> were found attached to both the <i>M. modiolus</i> and nearby rocks. The soft coral <i>Sarcodictyon roseum</i> was found on the deeper part of the site (where horse mussel densities were lower). A range of sea squirts including didemnids, <i>Diplosoma listerianum</i>, <i>Corella parallelogramma</i>, <i>Asciadiella aspersa</i>, <i>Polycarpa pomaria</i>, <i>Ascidia mentula</i> and <i>Dendrodoa grossularia</i> were found attached to <i>M. modiolus</i> shells or cobbles. Echinoderms were generally Common with the brittlestars <i>Ophiocomina nigra</i>, <i>Ophiothrix fragilis</i> and <i>Ophiura albida</i>, and the green urchin <i>Psammechinus miliaris</i> being particularly Abundant. Crustacean scavengers were also well represented amongst the <i>Modiolus</i> and included hermit crabs <i>Pagurus</i> spp., spider crabs <i>H. araneus</i> as well as squat lobsters <i>Galathea</i> spp. and <i>Munida rugosa</i>. The exposed sediment between cobbles and <i>M. modiolus</i> shells was colonised by other bivalves such as the blunt gaper <i>Mya truncata</i> and the queen scallop <i>Aequipecten opercularis</i> as well as widespread burrowing anemones <i>Cerianthus lloydii</i> (Holt and Davies, 1991). The associated community was considerably more diverse than the adjacent sediment plains in this area. The habitat below the <i>Modiolus</i> bed was also surveyed down to 12 m depth as part of the 1989 survey. Due to the reduced density of horse mussels this was ascribed to the 'Modiolus modiolus, dense <i>Cerianthus lloydii</i> and burrowing holothurians on sheltered circalittoral stones and mixed sediment' biotope (SS.SMx.CMx.CIloModHo), one of the components of the sublittoral mud and mixed sediment communities proposed protected feature.</p> <p>Records of scattered horse mussels from the deeper more sheltered waters off Carraig nan Ron from the 1989 survey were assigned to the SS.SMx.CMx.CIloModHo biotope and subsequent remote video observations in 2010, around this record have been ascribed in places to the SS.SBR.SMus.ModHAs biotope but only as part of a habitat mosaic. Both the 1989 and 2010 surveys recorded the SS.SBR.SMus.ModT horse mussel bed biotope from shallow parts of this survey station where horse mussels are locally Common in sediment patches amongst large cobbles and boulders on the sloping sea bed from 9 - 14 m at the base of a short sublittoral bedrock cliff face.</p> <p>Scattered horse mussels were recorded as locally Common in 2010 within the Otter Narrows between 19 - 27 m (Allen <i>et al.</i>, in prep.). The SS.SBR.SMus.ModT biotope was assigned to only parts of this video sample, however, intermixed within a brittlestar bed on sublittoral mixed sediment biotope (SS.SMx.CMx.OphMx). Partially embedded in gravelly sand amongst pebbles, scattered cobbles and lots of shell debris, the clumps of horse mussels support a range of associated epifaunal species. Barnacles and keelworms were visible on the shells of the mussels themselves together with brittlestars <i>O. fragilis</i> and <i>Ophiopholis aculeata</i>, hydroids <i>Halecium</i> sp., dead man's fingers <i>A. digitatum</i>, common whelks <i>Buccinum undatum</i>, queen scallops <i>Aequipecten opercularis</i>, and assorted echinoderms including edible urchins <i>Echinus esculentus</i>, the seven armed starfish <i>Luidia ciliaris</i> and the cushion star <i>Porania pulvillus</i>. The small areas of the video run assigned to the SS.SBR.SMus.ModT biotope represent the most recent new record of this feature within the possible MPA. Horse mussels were recorded at a lower density on a video sample collected from this area in 2012, from similar substrates in 19 - 41 m water depth about 1 km to the south-west. An uncertain record of a fan mussel <i>Atrina fragilis</i> was assigned to another of the 2012 video stations approximately 1.2 km to the east of the 2010 horse mussel bed records. It is possible that additional more dense records of horse mussels on coarse mixed sands exist in this tide-swept triangle at the entrance to the Otter Narrows.</p> <p>No data are available for the Upper Loch Fyne and Loch Goil horse mussel beds to compare indices of biological diversity within the habitat.</p>

Guideline 2b	The search location contains example(s) of features with a high natural biological diversity
Sublittoral mud and mixed sediment communities	<p>The proposed protected feature comprises three biotope complexes: 'circalittoral sandy mud' (SS.SMu.CSaMu) in both lochs; and 'infralittoral fine mud' (SS.SMu.IFiMu) and 'offshore circalittoral mud' (SS.SMu.OMu) in Loch Goil only. The feature also encompasses a finer resolution biotope closely associated with the horse mussel beds feature - 'sparse <i>Modiolus modiolus</i>, dense <i>Cerianthus lloydii</i> and burrowing holothurians on sheltered circalittoral stones and mixed sediment' (SS.SMx.CMx.CiloModHo).</p> <p>The majority of records are of circalittoral sandy mud habitats (SS.SMu.CSaMu). The biotope complex encompasses five finer resolution biotopes in the possible MPA although the majority of records are assigned at the biotope complex level on the basis of diver or remote video samples lacking detailed infaunal or sediment particle size information to aid finer categorisation. This component habitat is distributed around much of the periphery of Upper Loch Fyne but also from Loch Goil, on gently sloping margins below ca. 10 m and down to greater than 70 m in places. The sea bed comprises cohesive sandy mud often with shells and pebbles. Characterising epibiota include sparse and scattered slender seapens <i>Virgularia mirabilis</i>, squat lobsters <i>M. rugosa</i>, brittlestars <i>O. albida</i>, sea squirts <i>A. aspersa</i>, low densities of scallops <i>Pecten maximus</i> or <i>A. opercularis</i>, the pelican's foot mollusc <i>Aporrhais pespelecani</i>, hermit crabs and assorted starfish species. In places the sediment surface has sparse small burrows and signs of an infaunal community including emergent tubes and bivalve siphons. Infaunal samples collected in Upper Loch Fyne during surveys in 2010 and 2012 were assigned to different biotopes reflecting the differences in species composition. A grab sample taken in 2010 in 29 m in the centre of Loch Shira (SS.SMu.CSaMu.LkorPpel - <i>Lagis koreni</i> and <i>Phaxas pellucidus</i> in circalittoral sandy mud) had a moderate taxon richness of 33 and a low - moderate diversity (Shannon Wiener $H' = 2.5$). A sample taken from further down the loch in the central channel off Furnace in 2010 was assigned to the more commonly recorded SS.SMu.CSaMu.VirOphPmax biotope (<i>Virgularia mirabilis</i> and <i>Ophiura</i> spp. with <i>Pecten maximus</i> on circalittoral sandy or shelly mud). This sample contained the only specimens of the slender seapen encountered during the grabbing stage of that survey (Allen <i>et al.</i>, in prep.). This sample also had large numbers of <i>Amphiura</i> spp. brittlestars but little other infauna and a comparably low diversity value ($N= 20$; $H' = 2.54$). A grab sample collected in 2012 closer to the Otter Narrows in 45 m supported a more diverse community ($N= 33$; $H' = 4.42$) reflecting the presence of a number of ocean quahogs in the sample (the location of the possible aggregation of this proposed protect feature - see 2c overleaf). This sample was assigned to a mosaic of SS.SMu.CSaMu.AfilMysAnit (<i>Amphiura filiformis</i>, <i>Mysella bidentata</i> and <i>Abra nitida</i> in circalittoral sandy mud) and SS.SMu.CSaMu.VirOphPmax biotopes (Allen, 2013).</p> <p>To the SE of Cuilimuich in Loch Goil a rarely recorded epibenthic species of small sea cucumber, <i>Ocnus planci</i>, was recorded forming a large aggregation (clumps of sea cucumbers) on mixed sediments and on horse mussels <i>M. modiolus</i> on a gently shelving slope from 8.5 - 11 m. Numerous parchment worms <i>Chaetopterus variopedatus</i> and burrowing anemones <i>C. lloydii</i> were present in the surrounding sediment. Brittlestars and sea squirts were also present (Holt and Davies, 1991). The record was ascribed to the SS.SMu.IFiMu.Ocn biotope which is only known from two other sea lochs in Scotland. At this location in slightly shallower waters (5 - 8.5 m) horse mussels were recorded at Common abundance and the habitat description is similar to that given for the dense horse mussel bed to the north-east of Roinn Diomhain. It is possible that the density of horse mussels was somewhat lower (SS.SMx.CMx.CiloModHo) but it is currently unknown whether either horse mussels or <i>Ocnus planci</i> are still present at this location.</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>Another particularly unusual find made in Loch Goil during the 1989 Northern Clyde sea lochs survey (Holt and Davies, 1991) was the presence of large numbers of <i>Styela gelatinosa</i>, a deep-water Arctic species of sea squirt, sampled by anchor dredge from muddy substrates along the eastern side of the inner basin at ca. 65 m. The SS.SMu.OMu.StyPse biotope assigned to this habitat is only known from Loch Goil. The dredge collected a surface sample rather than actually taking a 'bite' out of the mud but the sediment that was recovered was soft and black and contained a lot of terrigenous detritus (oak leaves, etc.). The sample included large numbers of other ascidians, especially <i>A. aspersa</i> and <i>A. scabra</i>. Other recognisable species in the dredge sample included the sea loch anemone <i>Protanthea simplex</i>, plumose anemones <i>Metridium senile</i>, terebellid worms, seven-rayed scallops <i>Pseudamussium septemradiatum</i>, white furrow shells <i>Abra alba</i> and the burrowing sea cucumber <i>Paracucumaria hyndmani</i>. Despite the lack of information provided by the sample about sediment type and infauna, the abundance of the sea squirts indicated that the sediment surface was liberally covered in these species, possibly in clumps. Remote video sampling undertaken in 2013 did observe clumps of ascidians on the surface of the muddy substrates in this broad area but no sea squirt specimens were collected using a Day grab. Future work in this location will attempt to sample these communities using an anchor or naturalist dredge to clarify the current status of this biotope. The results of the video sampling and infaunal grab sampling undertaken in Loch Goil in March 2013 will be published later in the year.</p> <p>The proposed protected feature also encompasses sheltered circalittoral mixed muddy sediments that support horse mussels at densities to low to count as true beds of the species, with burrowing sea anemones <i>C. lloydii</i> and sea cucumbers such as <i>Psolus phantapus</i> (SS.SMx.CMx.CIloModHo). Most of the records of this habitat occur around the two known horse mussel beds at the entrance to Loch Goil (to the north-east of Roinn Diomhain and off Carraig nan Ron). Burrowing sea cucumbers weren't recorded here during the summer 1989 survey (Holt and Davies, 1991) but a potential seasonal dimension to their appearance was theorised on the basis of earlier records (Chumley, 1918). Large numbers of emergent sea cucumber tentacle crowns were visible around scattered horse mussels during a Marine Scotland-led remote video sampling survey undertaken here in March 2013, confirming the seasonality in 'visibility' of the relevant species.</p>
2b - Result	Guideline met.
Guideline 2c The search location contains coherent examples of features, rather than smaller, potentially more fragmented ones	
Burrowed mud	<p>Within Upper Loch Fyne the burrowing megafauna and mud volcano worm <i>Maxmuelleria lankesteri</i> habitat (SS.SMu.CFiMu.MegMax) and the majority of the fireworks anemone <i>P. multiplicatus</i> records occur primarily in the upper reaches of the loch (Davies, 1989; Howson and Davies, 1991; Moore and Atkinson, 2012). There is no clearly defined boundary for the <i>Maxmuelleria</i> habitat but fragmentation is minimal and the megafaunal communities associated with the habitat are considered typical for the sea loch setting on the south-west coast of Scotland. Loch Goil contains only isolated records of SS.SMu.CFiMu.MegMax and the majority of burrowed mud records here are for <i>P. multiplicatus</i> which occurs outside the mouth of the loch, on coarser muddy sediments across the entrance sill and along the gently sloping shelves on the eastern side and at the head of the loch (Holt and Davies, 1991; Allen <i>et al.</i>, in prep.).</p> <p>There has been very little research on burrowing megafaunal communities to assess their natural spatial and temporal variability. However, there have been consistent records of both components since the late 1980s (Howson and Davies, 1991; Davies 1989; Seasearch 2005, 2006 and 2011) and it is likely that large cerianthid anemones dredged from Loch Goil in the early 1900s (Chumley, 1918) were specimens of <i>P. multiplicatus</i> (referred to as "sheep's' guts") (Holt and Davies, 1991) suggesting a level of permanency. In the absence of significant disturbance, the burrowed mud habitat is considered stable and expected to persist.</p>

Guideline 2c The search location contains coherent examples of features, rather than smaller, potentially more fragmented ones	
Flame shell beds	<p>The Otter Narrows flame shell bed is located approximately 500 m to the south of Creag Gobhainn, in depths of 5 - 15.4 m. The bed covers an area of ca. 50 ha and around half this area (27 ha) is estimated to consist of dense <i>Limaria</i> nest material of spongy consistency (>50% cover), with nest thickness ranging from 3 - 10 cm with a mean of 6 cm (Moore <i>et al.</i>, 2013). The bed is marginally smaller than the second largest recorded bed in Scotland in the Laudale Narrows, Loch Sunart (Moore <i>et al.</i>, 2013). The bed is considered to represent a good quality example of the SS.SMx.IMx.Lim biotope and the only known extant bed of a significant size within the Clyde. <i>Limaria</i> density is moderate (ca. 370 per m²) and the bed supports a typically rich associated epi-faunal and floral community.</p> <p>The area required for a minimum viable population of flame shells is not known. Hill <i>et al.</i> (2010) suggest using a figure of 5,000 individuals. On the basis of the 2012 sampling the estimated density of ca. 370 ind. / m² would equate to an area of less than 14 m² to maintain genetic variation. However, whilst <i>Limaria</i> larvae have a 3 week planktonic phase and an estimated maximum larval dispersal distance of 40 km, larval supply within the Clyde Sea is likely to be restricted. Protection of all patches or beds within an area is therefore recommended (Hill <i>et al.</i>, 2010). The bed in Upper Loch Fyne is comparatively large and has been recorded in the vicinity of the narrows since the late 1980s (Davies, 1989), suggesting a level of permanency despite the recent declines (Moore <i>et al.</i>, 2013). In the absence of disturbance and changes in the suitability of the habitat, the flame shell bed in Upper Loch Fyne would be expected to persist.</p>
Horse mussel beds	<p>The level of fragmentation found within this feature across Scotland is highly variable. <i>M. modiolus</i> can occur as relatively small, dense beds of epifaunal mussels (such as at Roinn Diomhain, Loch Goil) or as scattered clumps of <i>M. modiolus</i> across more areas of sea bed (as seen in the Otter Narrows). No estimates of size exist for any of the horse mussel bed records within the possible MPA. However, on the basis of the distribution of adjacent 'null' records (of other confirmed seabed habitat types); none of the beds are likely to exceed 0.4 km². No specific information is available on the size of area required to ensure the viability of the feature. Horse mussels are long-lived, with individuals over 25 years old frequent in British populations and occasional records of specimens up to 35 years old (Hill <i>et al.</i>, 2010). Maximum ages are thought likely to be in excess of 50 years (Anwar <i>et al.</i>, 1990). <i>Modiolus</i> has a dispersive larval life history stage and the species is widely distributed throughout the sea lochs in the Clyde so connectivity between individual beds within the between lochs is likely to be high. Temporal variability of horse mussel beds has not been well studied but in the absence of regular disturbance and despite intermittent and variable recruitment, they appear to be fairly stable in the long-term with beds known from the same location for 80+ years (Seed and Brown, 1975; Anwar <i>et al.</i>, 1990; Hill <i>et al.</i>, 2010).</p>
Ocean quahog	<p>Ocean quahog records are scattered throughout Upper Loch Fyne with a smaller number from Loch Goil. Most of the records relate to observations of individual quahogs, either within the sediment or dead shells on the surface of the sediment. In a number of locations, further work is required to confirm whether siphons observed at the surface of the sea bed on remote video samples are indeed <i>Arctica islandica</i>. Siphons recorded using drop-down video in 2012, in sandy mud substrates at 44 m near Otter Ferry in Upper Loch Fyne (Moore and Atkinson, 2012) were subsequently confirmed as those of <i>Arctica</i> following infaunal grab sampling at the same location (Allen, 2013). The record in this location represents a potential aggregation of the species with four individual quahogs (or relevant parts thereof) being recovered from a single (0.1m²) grab sample. Photos of the sieve contents (Allen, 2013) reveal that the specimens were of varying sizes and included smaller, young quahogs.</p>

Guideline 2c The search location contains coherent examples of features, rather than smaller, potentially more fragmented ones	
Ocean quahog <i>cont.</i>	It is currently unclear how typical the 2012 infaunal sample is of the population of this species in suitable substrates in Upper Loch Fyne. Drop-down video sampling in 2010 recorded individual quahogs only in Loch Goil (Allen <i>et al.</i> , in prep.). <i>Arctica</i> is exceptionally long-lived; recent work suggests that individuals may live for up to 400 years (Ridgway and Richardson, 2010). They have a very small home range but widely dispersing larvae (in excess of 40 km depending upon local hydrographic conditions). There is no information regarding the area required for a minimum viable population (Hill <i>et al.</i> , 2010) but in the absence of disturbance or changes in habitat suitability, populations of the species are considered likely to persist.
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 the south-west coast sea loch physiographic setting. Detailed information on the extent of these habitats, a number of which are quite small and / or have a scattered distribution around the margins of the two lochs is not available. There has been very little research on the assorted biotopes that comprise the feature to assess natural spatial and temporal variability but summary reviews presented in Hill <i>et al.</i> (2010) [based on sheltered muddy gravels, estuarine sands 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. Survey work undertaken in 2010, 2012 and 2013 has validated the continued presence and broad distribution of the main biotope complex classes across the possible MPA, updating the knowledge-base from previous studies undertaken in the late 1980s.
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	There is some evidence of human modification of the burrowed mud feature within the possible MPA. Video footage collected in 1990 and 2012 showed occasional trawl scarring on the sea bed in the upper reaches of Loch Fyne in the proximity of the proposed protected features (Howson and Davies, 1991; Moore and Atkinson, 2012). However, densities of langoustine <i>N. norvegicus</i> in this part of the loch are relatively low and there has historically been a correspondingly low level of associated fishing activity. It is therefore currently unclear whether this has had any effect on the range / distribution and abundance of fireworks anemones or the presence of the mud volcano worm habitat. The voluntary management agreement put in place by the Clyde Fishermen's Association in 2007, that restricts trawling in depths shallower than 20 m on the east side of Loch Shira and in waters shallower than 50 m north of Dunderave Point to the head of Loch Fyne, may have helped maintain both components in the upper reaches of the loch (as evidenced by assorted surveys - Seasearch 2005, 2006 and 2011; Allen <i>et al.</i> , in prep.).

Guideline 2d	The search location contains features considered least damaged / more natural, rather than those heavily modified by human activity
Flame shell beds	<p>There was no direct visual evidence of damage from anthropogenic activities to the Otter Narrows flame shell bed during the most recent survey work (Moore <i>et al.</i>, 2013). However, the bed has declined over part of its former range over the past decade and levels of associated biodiversity also appear to have diminished (Moore <i>et al.</i>, 2013).</p> <p>The flame shell bed lies well to the south of historical records of the feature in this area, which are clustered around Creag Gobhainn (Davies 1989, Hall-Spencer and Moore, 2000a). The closest of these records is that of Hall-Spencer and Moore (2000a), which lies 200 m to the north. This fairly recent record (1999), whose position is GPS derived, is of a continuous byssus reef at 15 m depth extending over several hectares, 10 - 20 cm in thickness with <i>L. hians</i> nests a stable feature on the seabed from 4 m to at least 28 m depth. <i>Limaria</i> densities exceeding 700 individuals m⁻² were recorded (Hall-Spencer and Moore, 2000a). In 2012 no evidence of the presence of <i>Limaria</i> could be found in this area, and indeed nowhere were <i>Limaria</i> turfs of 10 - 20 cm thickness encountered.</p> <p>The flame shell bed was also previously recorded as a mosaic with a maerl bed at this location. No evidence of a maerl bed was found in 2012 despite fairly high intensity surveying in areas of previous records. Hall-Spencer (1999) described a maerl band 300 m to the south of Creag Gobhainn between depths of 6 - 14 m occupying 17.5 ha. Only scattered live rhodoliths with a maximum density of 1% cover were observed at three stations surveyed in 2012 in the Creag Gobhainn area, compared to a density of 25% cover cited by Hall-Spencer (1999). A maximum of 10% cover of dead maerl was recorded at only two sites here in 2012. It seems likely that this maerl bed has now been lost and that the flame shell bed has declined over part of its former range, with a southward migration of its northern boundary by several hundred metres (Moore <i>et al.</i>, 2013) and a reduction in depth distribution.</p> <p>A possible reason for the observed reduction in taxon richness lies in the loss of the maerl, which used to form a significant component of the flame shell bed habitat (Hall-Spencer and Moore, 2000a and b; Moore <i>et al.</i>, 2013). Reduced salinity levels in shallow surface waters have been suggested as a possible causative factor, but whilst maerl is known to be sensitive to changes in salinity (Jackson, 2006), in the absence of other disturbance dead maerl gravel would remain. The total loss of the maerl bed, inclusive of maerl gravel material, strongly suggests physical disturbance. Any activity that may have removed the maerl would also have removed flame shell nests from this location.</p> <p>Hall-Spencer and Moore (2000a) reviewed the evidence for a decline in <i>L. hians</i> populations in the Clyde Sea area over the last 40 years and implicated scallop dredging as a likely factor in their disappearance from a number of locations (e.g. Skelmorie Bank, Stravanan Bay and the Tan Buoy off Great Cumbrae). In the same paper they report direct observations of damage to the Otter Narrows flame shell bed by commercial scallop dredging.</p>

Guideline 2d	The search location contains features considered least damaged / more natural, rather than those heavily modified by human activity
Horse mussel beds	There was no direct visual evidence of damage from anthropogenic activities to areas supporting horse mussels during the most recent surveys (Moore and Atkinson, 2012; Moore <i>et al.</i> , 2013; Allen <i>et al.</i> , in prep.). However, areas previously assigned to horse mussel beds within the possible MPA are believed to have deteriorated since the late 1980s and horse mussels are known to have been harvested historically in Loch Goil (Holt and Davies, 1991). A validation dive undertaken in 2012 off Kilbride Island (to the north of Barnacarry on the southern shore of Upper Loch Fyne) where Davies (1989) recorded <i>Modiolus modiolus</i> at Common abundance on a mixed sediment slope from 19.5 - 27.5 m in 1988 (classified as a ' <i>Modiolus modiolus</i> bed with <i>Chlamys varia</i> , sponges, hydroids and bryozoans on slightly tide-swept very sheltered circalittoral mixed substrata - SS.SBR.SMus.ModCvar biotope) recorded only scattered dead <i>Modiolus</i> shells (Moore <i>et al.</i> , 2013). It has not been possible to make meaningful comparisons between diver observations from Carraig nan Ron at the mouth of Loch Goil in 1989 and drop-video samples collected in 2010 (Allen <i>et al.</i> , in prep.) due to the differences in sampling methodologies / resolution and the depth range covered. The broad habitat composition observed in 2010 aligns with the 1989 records and scattered <i>Modiolus</i> were still present. Within the narrows at the entrance to Loch Goil the dense bed of horse mussels present in shallow water (3 - 9 m depth) has not been resurveyed since first recorded by divers in 1989.
Ocean quahog	No indicators of change / damage to this feature were reported in the most recent surveys (Moore and Atkinson, 2012; Allen, 2013; Allen <i>et al.</i> , in prep.). However, we currently know very little about the status of populations of the species within the possible MPA and whether they have been modified by human activity.
Sublittoral mud and mixed sediment communities	No indicators of change / damage to the component biotopes of this representative feature were reported in the most recent surveys (Moore and Atkinson, 2012; Allen, 2013; Allen <i>et al.</i> , in prep.). However, survey work in 2013 (and 2010) failed to validate the continued presence of habitats characterised by rarely recorded sea cucumbers and sea squirts in Loch Goil. This may be related to the sampling methods, sampling intensity or seasonality in appearance but none-the-less, it is currently unclear whether these finer resolution components are still present within the loch.
2d - Result	Guideline not met. Available evidence indicates that there has been significant modification to the Otter Narrows flame shell bed over the last 10 years. The cause of this modification is currently unknown but may be related to human activities taking place within the possible MPA. Uncertainties exist regarding the current status of the other proposed protected features.

Guideline 2e The search location contains features considered to be at risk⁹ of significant damage by human activity	
Burrowed mud	The Upper Loch Fyne and Loch Goil possible MPA lies within the South-west MPA region ¹⁰ . On the basis of a risk assessment undertaken at the level of the MPA region, there is considered to be a low 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). This is largely as a result of potential exposure to pressures associated with demersal fishing activity (primarily otter trawling and creel fishing which are considered to present a medium risk), with shellfish farming, tourism and recreation, and infrastructure developments presenting low risks.
Flame shell beds	On the basis of the cumulative regional risk assessment, there is considered to be a medium risk of significant damage to this feature arising from human activity. This is largely as a result of potential exposure to pressures associated with demersal fishing activity (primarily hydraulic dredging for bivalves, otter trawling and scallop dredging which are considered to present a high risk), with creel fishing, dive fisheries and set netting presenting medium risks.
Horse mussel beds	On the basis of the cumulative regional risk assessment, there is considered to be a medium risk of significant damage to this feature arising from human activity. This is largely as a result of potential exposure to pressures associated with demersal fishing activity (primarily hydraulic dredging for bivalves, otter trawling and scallop dredging which are considered to present a high risk), with creel fishing, dive fisheries, seine netting and set netting presenting medium risks. Military activities pose a low risk.
Ocean quahog	Regional risk assessments have not been completed for representative features. However, ocean quahogs are subject to the same risks as ocean quahog aggregations, which on the basis of a risk assessment undertaken at the level of the MPA region are considered to be at medium risk of damage by human activity (a <u>cumulative</u> assessment considering the range of activities known to be taking place in the MPA region). This is primarily a result of potential exposure to pressures associated with demersal fishing activity (hydraulic dredging for bivalves and scallop dredging are considered to present a high risk and otter trawling a medium risk), while infrastructure developments, sediment extraction (dredging) and sewage disposal pose a low risk.
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 SS.SMx.CMx.CIlOmx , SS.SMu.OMu.StyPse , SS.SMu.IFiMu.Ocn and SS.SMu.CSaMu.VirOphPmax biotopes). The feature is considered to be moderately sensitive to substratum loss, changes in water flow rate and increases in wave exposure. It is considered to have a low sensitivity to abrasion and physical disturbance (apart from SS.SMx.CMx.CIlOmx which has a moderate sensitivity) and a very low sensitivity to increases in suspended sediment levels (Hill, 2001; Hiscock, 2002; Tyler-Walters, 2002; Hill and Wilson, 2004).
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.

⁹ 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.

¹⁰ 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.

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

Assessment

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

The boundary of the Upper Loch Fyne and Loch Goil possible MPA encompasses Upper Loch Fyne from just south of Silver Craigs to the head of the loch (including Loch Shira), and the whole of Loch Goil out to Carraig nan Ron, where it merges with Long Long. Initially developed around the burrowed mud feature, and specifically the high numbers and distribution of fireworks anemones in both lochs, as well as the presence of the mud volcano worm *Maxmuelleria lankesteri* habitat across Upper Loch Fyne, the size and shape of the possible MPA now reflect the distribution and extent of the full range of proposed protected features. The southern boundary in Loch Fyne was defined upon validation of the continued presence and scale of the flame shell bed off Castleton in 2012 (Moore *et al.*, 2013). The outer boundary of Loch Goil encompass the horse mussel bed record off Carraig nan Ron (Dog Rock) and adjacent mixed muddy substrates supporting lower densities of horse mussels. The proposed boundary runs across the mouth of Loch Goil to Rubha nan Eoin. **Guideline met.**

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 burrowed mud, horse mussel beds, ocean quahog and sublittoral mud and mixed sediment communities within this possible MPA is to 'conserve (feature condition uncertain)'. The current status of these features is unclear. The conservation objective for flame shell bed is to 'recover'. There is evidence that the condition of this feature within the MPA has deteriorated since last surveyed in the late 1990s.

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 / recover 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 objectives 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.
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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	<p>A good example of the burrowing megafauna and mud volcano worm <i>Maxmuelleria lankesteri</i> habitat in Upper Loch Fyne.</p> <p>[SS.SMu.CFiMu.MegMax biotope]</p> <p>Multiple records of fireworks anemones <i>Pachycerianthus multiplicatus</i> (particularly high densities within Loch Shira and towards the head of Loch Fyne. Also widely distributed within Loch Goil).</p>	<p>Replication of the burrowing megafauna and the mud volcano worm habitat is proposed within OSPAR Region III.</p> <p>It is not possible to replicate between regions because of the restricted distribution of this component habitat.</p> <p>Replication of fireworks anemones is proposed within possible MPAs in OSPAR Region III only.</p> <p>Records outwith Region III are sparse (see SNH and JNCC, 2012).</p>	Not applicable ¹¹	The most southerly examples of two components of the burrowed mud feature (mud volcano worm habitat and fireworks anemones) within the MPA network.	<p>Burrowed mud is included on the OSPAR T&D list. 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 components (mud volcano worm habitat and fireworks anemones) would be delivered within the network through the possible MPAs.</p> <p>Additional replication within OSPAR Region III is proposed to address the lack of replication between OSPAR regions.</p>

¹¹ 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
Flame shell beds	The third largest known flame shell bed in Scottish waters (marginally smaller than the Laudale Narrows bed in Loch Sunart). A good quality example of this habitat. [SS.SMx.IMx.Lim biotope]	Replication is proposed within OSPAR Region III. It is not possible to replicate between regions because of the restricted distribution of flame shell beds (see SNH and JNCC, 2012).	Not applicable ¹²	The most southerly known flame shell bed of a significant size in Scotland (only small patches of this habitat have been recorded in other parts of the Clyde in recent years). Extends coverage of the geographic range of the feature within the MPA network to the south.	Additional replication within OSPAR Region III is proposed to address the lack of replication between OSPAR regions and known damage / decline within Scotland's seas. The condition of the flame shell bed at the Otter Narrows (size, distribution and levels of associated biodiversity) has deteriorated since 1999.
Horse mussel beds	Examples of two variants of the horse mussel beds feature. [SS.SBR.SMus.ModT and SS.SBR.SMus.ModHAs biotopes]	Replication of this feature in the network is proposed within and between OSPAR Regions II and III (see SNH and JNCC, 2012).	Not applicable ¹²	The most southerly examples of feature within the MPA network.	The horse mussel beds in the possible MPA are not required to achieve adequacy because of the protection already afforded to the feature by existing measures across OSPAR Region III. Recommended to add to the integrity of the possible MPA and to complement existing coverage within the OSPAR region. Scottish waters are of proportional importance for this OSPAR Threatened and/or Declining habitat and the condition of the feature within the Clyde Sea is believed to have deteriorated.

Assessment of biodiversity features					
Feature	Representation	Replication	Linkages	Geographic range & variation	Resilience
Ocean quahog (species)	<p>One of two examples of potential ocean quahog aggregations in Scottish territorial waters in OSPAR Region III.</p> <p>[no definitive biotope - the feature is categorised as a low / limited mobility species that occurs in a range of sandy and muddy sediment types]</p>	<p>Replication of this representative species in the network is proposed within OSPAR Region III.</p> <p>Replication of the MPA search feature <i>ocean quahog aggregations</i> is proposed within OSPAR Region II. There are currently no confirmed records of aggregations in Scottish territorial waters (see SNH and JNCC, 2012).</p>	Not applicable ¹²	<p>An example of ocean quahogs (and potential aggregations of the species which would represent an MPA search feature) in a sea loch setting on the south-west coast of Scotland.</p>	<p>Additional replication of this feature is proposed because ocean quahogs are considered to be threatened and declining in Scottish waters. No records of aggregations of the species exist in Scottish territorial waters. Potential aggregations have been recorded recently and are recommended as proposed protected features within two possible MPAs in the Clyde Sea (Upper Loch Fyne and Loch Goil; and South Arran) to help achieve broader representativity in the network.</p>
Sublittoral mud and mixed sediment communities	<p>Examples of shallow mud and deeper sandy mud and mixed sediment communities.</p> <p>[SS.SMu.IFiMu, SS.SMu.CSaMu, SS.SMu.OMu, SS.SMx.CMx.CIlModHo, biotopes / complexes]</p>	<p>Replication of the feature in the network is proposed within and between OSPAR Regions II and III (see SNH and JNCC, 2012).</p>	Not applicable ¹²	<p>The most southerly known examples of each of the component biotopes within the MPA network.</p> <p>Examples of the feature in a sea loch setting on the south-west coast of Scotland.</p> <p>Encompasses the only known records of the Loch Goil sea squirt <i>Styela gelatinosa</i> (SS.SMu.OMu.StyPse biotope) in Scottish waters. Would provide representation of rarely recorded aggregations of the sea cucumber <i>Ocnus planci</i> within the network. (SS.SMu.IFiMu.Ocn biotope). Only recorded from three sea lochs in Scotland.</p>	<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> <p>Preliminary field analyses of video and infaunal grab samples collected in 2013 failed to confirm the continued presence of habitats supporting the rarely recorded <i>Styela gelatinosa</i> and <i>Ocnus planci</i>. The current status of these finer resolution seabed habitats within Loch Goil remains unclear.</p>

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