PRIORITY MARINE FEATURE (PMF) - FISHERIES MANAGEMENT REVIEW

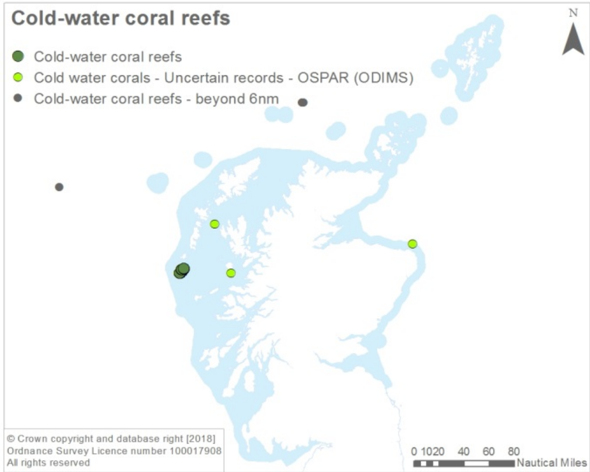
Feature

COLD-WATER CORAL REEFS

Image


Image: BERR/Defra/JNCC

Map



Description

Characteristics - The cold-water coral *Lophelia pertusa* forms patches of bushy growths composed of a network of branches that grow into thickets and eventually reefs, under favourable conditions (Perry & Tyler-Walters, 2016). Reefs can be up to several km long and more than 20 m high. *L. pertusa* reefs often occur in association with other hard corals (e.g. *Madrepora oculata* and *Solenosmilia variabilis*). Mobile species present can include redfish (*Sebastes* spp.), ling (*Molva molva*) and tusk (*Brosme brosme*). Reefs may also support early life stages of deepwater elasmobranchs (Henry *et al*., 2013) as well as extremely rich assemblages of invertebrates - particularly starfish, sea urchins, anemones, squat lobsters and sponges.

Definition - The morphology and size of cold-water coral reefs are highly variable. They may be circular, halo-shaped, domed or elongate, forming distinct patches or arranged in lines. To qualify as a reef, individual coral thickets should be greater than 1-2 m across and collectively cover an area of at least 5 m x 5 m. The biogenic structures form a substantial, raised habitat which is very different from the surrounding seabed. The coral provides a complex 3-dimensional structure and a variety of microhabitats that provide shelter and a surface of attachment for other species (Perry & Tyler-Walters, 2016).

Environmental preferences - Cold-water corals typically occur within a depth range of 200-400 m on the continental slope although may occur at extremes between 40 m and >3000 m. Larval settlement requires hard substrates, which may comprise coral rubble from an old colony, glacial deposits or bedrock. Cold-water corals have also been found on man-made structures (including in the North Sea - Roberts, 2002). Generally found in water temperatures of between 4 and 8°C and moderate current velocities (0.5 knots). They are often associated with the slopes of seafloor elevations including seamounts, carbonate mounds and iceberg plough-mark areas.

Distribution

Scottish distribution - In nearshore waters, cold-water coral reefs are currently only known in the Sea of Hebrides, ~13 km east of Mingulay below the 110 m contour line. In offshore waters, reefs are present on Rockall, Hatton and George Bligh banks; on Anton Dohrn, Rosemary Bank and Hebrides Terrace seamounts, Wyville-Thomson Ridge and at the Darwin Mounds.

Estimated known Scottish extent - The Mingulay cold-water coral reefs comprise characteristic mounds at a relative height of approximately 90 m from the surrounding seabed and cover an area of about 5.4 square kilometres (Davies *et al*., 2009). The habitat is much more extensive in offshore waters around Scotland.

Wider distribution - Cold-water corals have a fairly cosmopolitan distribution throughout the world's oceans, with a geographic range from 55°S to 70°N where water temperatures typically remain between 4 - 8°C. However, the majority of cold-water reef records occur beyond the shelf break around the NE Atlantic and off Britain, mainly on the continental slopes of west Scotland and Ireland.

Status

Lophelia pertusa reefs are an OSPAR threatened and / or declining habitat (OSPAR, 2008 & 2009) and are recognised as biogenic reefs under the EU Habitats Directive (Holt *et al*., 1998; European Commission, 2013).

Demersal fishing activities are known to have impacted the Mingulay cold-water coral reefs. Visual surveys have recorded lost / snagged fishing nets and cabling on the corals and high resolution acoustic mapping revealed trawl marks around the reefs (Davies *et al*., 2009).

Sensitivity (including recovery)

[Key sources: Fisheries Management Guidance]

Cold-water coral reefs are highly sensitive to abrasion and physical disturbance as well as localised effects of smothering and marine pollution. The hydrocarbon industry and deep sea mining have been found to degrade the health of cold-water coral reefs (Roberts, 2009).

The predicted impacts of climate change also threaten cold-water coral reef populations through ocean warming (Roberts & Cairns, 2014), potential disruption of larval transport and ocean acidification. It has been estimated that by 2060, over 85% of known cold-water coral reefs in UK waters could be exposed to waters that are corrosive to them (MCCIP, 2015), weakening the skeletons of the live coral and their associated dead coral framework (Hennige *et al*., 2015). The Mingulay cold-water corals may be one of the few UK examples of the habitat that are still in non-corrosive waters by 2099 (MCCIP, 2015).

Towed bottom-contacting fishing gear can cause direct mortality to the living cold-water coral polyps as well as breaking up and removing the coral framework, thus limiting future recruitment. Fosså *et al*. (2002) documented damage caused to west Norwegian cold-water coral reefs by trawling activity. Overall, they estimated that between 30 and 50% of reefs had been either impacted or destroyed. Hall-Spencer *et al*. (2002) reported widespread trawling damage to cold-water coral reefs at 840-1300 m depth along the West Ireland continental shelf. Trawling impacts on the Darwin Mounds, a field of small, coral-topped mounds in the northern Rockall Trough are detailed in Wheeler *et al*. (2004). There is no evidence for the natural recovery of damaged reefs (Huvenne *et al*., 2016; Perry & Tyler-Walters, 2016).

Growth rates of cold-water corals are variable with estimates of between 4 - 25 millimetres per year corroborated by reports of colonies growing on man-made structures (Roberts, 2002; Gass & Roberts, 2006). Wilson (1979a) estimated that a single colony 1.5 m in height would probably be 200 - 366 years old (based on growth rates between 7.5 and 4.1 mm per year respectively). The oldest cold-water coral reefs in the North East Atlantic are believed to be between 7800 - 8800 years old (Mikkelson *et al*., 1982; Hovland *et al*., 1998; Hovland & Mortensen, 1999). Coral material dated at 7700 years old has been recovered from the Mingulay reefs (Douarin *et al*., 2013).

Connectivity

Between cold-water coral reefs - *L. pertusa* is gonochoristic (separate sexes) and is thought to spawn annually (Waller, 2005). Samples from the NE Atlantic showed a seasonal reproductive cycle with a single cohort per year and a spawning event around February (Waller & Tyler, 2005).

Asexual replication of cold-water coral polyps occurs by budding (Cairns, 1979, 1994; Roberts, 2009; Brooke & Jarnegren, 2013). Fragmentation of the coral skeleton is part of the process of reef growth and development (Wilson, 1979a; Rogers, 1999). Coral fragments fall or break off, and under suitable conditions either continue to grow or are colonized by coral larvae. As the new colonies grow and merge they surround the central colony forming a 'thicket'. The central colony dies back, probably due to reduced water flow within the patch, and is reduced to coral debris. The living coral at the top of the reef grows on top of fragments of dead coral and sediment (Wilson, 1979a; Rogers, 1999). Cold-water coral larvae settle on hard substrata but the reefs can spread over soft sediment.

Roberts (2002) suggested that cold-water coral colonies recorded on infrastructure in North Sea oil fields in 1999 originated as larvae from the offshore banks of the Atlantic margin, carried into the North Sea in cooled Atlantic waters, possibly via the Atlantic Shelf Edge Current and the Fair Isle Current (Gass & Roberts, 2006). The coral colonies are now believed to be self-recruiting to the platforms. Transport of larvae by prevailing water currents may provide the opportunity for long distance dispersal but evidence suggests that asexual reproduction predominates in reef growth and that the contribution from larval dispersal may be limited. Molecular genetic data suggests that recolonization of disturbed areas is likely to be slow (Perry & Tyler-Walters, 2016).

With other PMFs - The coral reef framework and adjacent hard substrates may be colonised by sponges, providing a connection to the *northern sea fan and sponge communities* PMF. Extensive sponge communities were recorded around the Mingulay cold-water coral reef complex during survey work undertaken in 2003 (Roberts *et al*., 2004) and subsequent Marine Scotland Science sampling in 2010 (Moore & Roberts, 2011). Sponges play a key role in carbonate recycling (Beuck *et al*., 2007) and help to bind coral structures; enhancing survival and mediating regeneration of physically damaged reefs (Wulff, 2001). Though Wulff (2001) worked on tropical corals, the functional role played by sponges is considered relevant to temperate reefs (Bell, 2008). Submersible observations on cold-water coral reefs on the Rockall Bank in the 1970s concluded that coral patch development may be stimulated by clionid sponge attacks weakening and breaking-up living colonies, generating additional hard substrates for subsequent settlement and lateral patch expansion (Wilson, 1979a). Modification of the coral structures in this way increases habitat complexity and helps enhance biodiversity (Lancaster *et al*., 2014).

In offshore waters, reef forming hard corals are found within the *coral gardens* PMF and often occur on *seamounts*. Cold-water corals also contribute to the development of *carbonate mounds* (OSPAR, 2009) and may be associated with the *deep sea sponge aggregations* PMF.

Ecosystem services

- Larval/gamete supply (supporting connectivity)
- Nutrient cycling
- Formation of habitat for other species (supporting biodiversity)
- Formation of physical barrier
- Carbon storage and climate regulation
- Socially valued places/seascapes
- Watching/studying nature

Existing Marine Protected Areas

All extant, inshore records of cold-water coral reefs occur within the East Mingulay MPA.

Existing and proposed fisheries measures providing PMF protection

Details of existing fisheries measures associated with the East Mingulay MPA are provided on Marine Scotland's web pages (http://www.gov.scot/Topics/marine/marine-environment/mpanetwork/MPAMGT/protectedareasmgt).

Examples of PMFs that have no or partial coverage by fisheries measures

There are currently no other known, verified records of cold-water coral reefs outside the existing MPA network in Scottish territorial waters.

Assessment against National Marine Plan General Policy 9:
Development and use of the marine environment must not result in significant impact on the national status of Priority Marine Features.

Cold water coral reefs are functionally important, biodiverse, sensitive, with a slow growth rate and if lost completely may not recover. They are an OSPAR T&D habitat with evidence of decline in Scotland. Therefore any activities that lead to the loss of entire colonies or damage reefs to the extent that function or provision of ecosystem services cannot be maintained should be considered a significant impact on national status.

Existing licensing and consenting processes will continue to consider the potential for significant impacts on the national status of development proposals on cold-water coral reefs. Please refer to the *consultation overview* for further details.

All recent, extant records in Scottish nearshore waters are already afforded protection against damage from towed bottom-contacting and static gear fisheries within the East Mingulay MPA (Marine Scotland, 2016). Any new records of this habitat would also warrant protection.

Knowledge gaps and other records

Knowledge gaps - It is possible that cold-water coral reefs exist elsewhere in Scottish inshore waters. Three knowledge gap areas have been identified: **NW Skye - Coral**; **South of Rum**; and, **East of Barra**.

The first two areas are based on poorly located historical records of cold-water corals (Wilson 1979b). Fleming (1846) reported live coral (initially termed *Madrepora prolifera*) that had become entangled in fishing lines in the sea between Rum and Eigg. This record is cited in Johnston (1847) and Gosse (1860) and represents one of the first records of *Lophelia pertusa* in the UK. Wilson (1979b) concluded that the specimen was likely to have come from the deep channel between the islands and provided an estimated position. Another sample collected in Victorian times was recovered ~six miles (11 km) west of Dunvegan Head, Skye in 1852 (Gosse, 1860) where water depths are similarly deep (>145-190 m).

Survey work undertaken in 2003 (Long & Wilson, 2003; Roberts *et al*., 2004) failed to validate the presence of cold-water corals in these broad geographic areas but sampling intensity was low and hampered by positional uncertainties. The 2003 work took place some way to the north of the estimated position of the west of Skye record but on potentially more suitable substrates. White coralline structures observed on a number of the 2003 Skye video runs (and one of the runs to the south-east of Rum) resembled small coral formations but may have been globular colonies of *Filograna implexa* or *Salmacina dysteri* tube worms. *F. implexa* was subsequently identified from higher resolution video footage collected at Mingulay in 2010 (another of the 2003 survey locations) and colonies of this species were also observed in comparable deep water conditions in the Sound of Canna that year (Moore & Roberts, 2011).

The third knowledge gap, **East of Barra** is not based on any historical records of coral presence; rather, on the basis of proximity to East Mingulay and the apparent presence of suitable physical conditions for coral development (high rugosity, current-swept terrain with exposed bedrock ridges in water depths from 110 - >200 m - Long & Wilson, 2003).

The South of Rum and East of Barra areas have also been identified as knowledge gaps for the fan mussel *Atrina fragilis* (please refer to the fan mussel PMF paper and Stirling, 2016 for further details). Any opportunistic sampling to explore these areas could be guided by initial predictive habitat modelling (akin to that presented in Ross & Howell, 2012).

Other records - Prior to the discovery of opportunistic cold-water coral development on oil platforms in the late 1990's (Bell & Smith, 1999), the only published record of *Lophelia pertusa* from the Scottish North Sea was from a dead specimen recovered by a trawl in the outer Moray Firth in 1965 (Wilson, 1979b). There have been no subsequent reports of cold-water corals from this area. This record is encompassed within the boundary of the Southern Trench MPA proposal.

Data confidence

All extant records of cold-water coral reefs in territorial waters are situated within the East Mingulay MPA[1]. The data underpinning the MPA are recent (2003-2010) and robust (Davies *et al*., 2009). The maps provided in this paper include records from the 2003 MINCH Project (Roberts *et al*., 2004) that are not currently held within the PMF database. The historical records from 4 other locations in Scottish territorial waters - to the west of Skye; between Rum and Eigg; at the Southern Trench; and, off Rockall (the last of these is not shown on the map) were derived from the OSPAR *Lophelia pertusa* reefs T&D dataset[2]. These records are old and have poor associated positional information (Long *et al*., 1999).

Cold-water coral was first recorded off Mingulay during dredge survey work undertaken by Aberdeen University on the RRS *John Murray* in 1968. A subsequent, manned submersible dive in 'Pisces II' in 1970 recorded a small reef on the summit of a rock ridge here at a depth of 105 m (Eden *et al*. 1971).

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[1] Mingulay Reef Complex - http://www.lophelia.org/case-studies/mingulay-reef-complex

[2] Available for download from ODIMS - OSPAR's Data & Information Management System [https://odims.ospar.org/]

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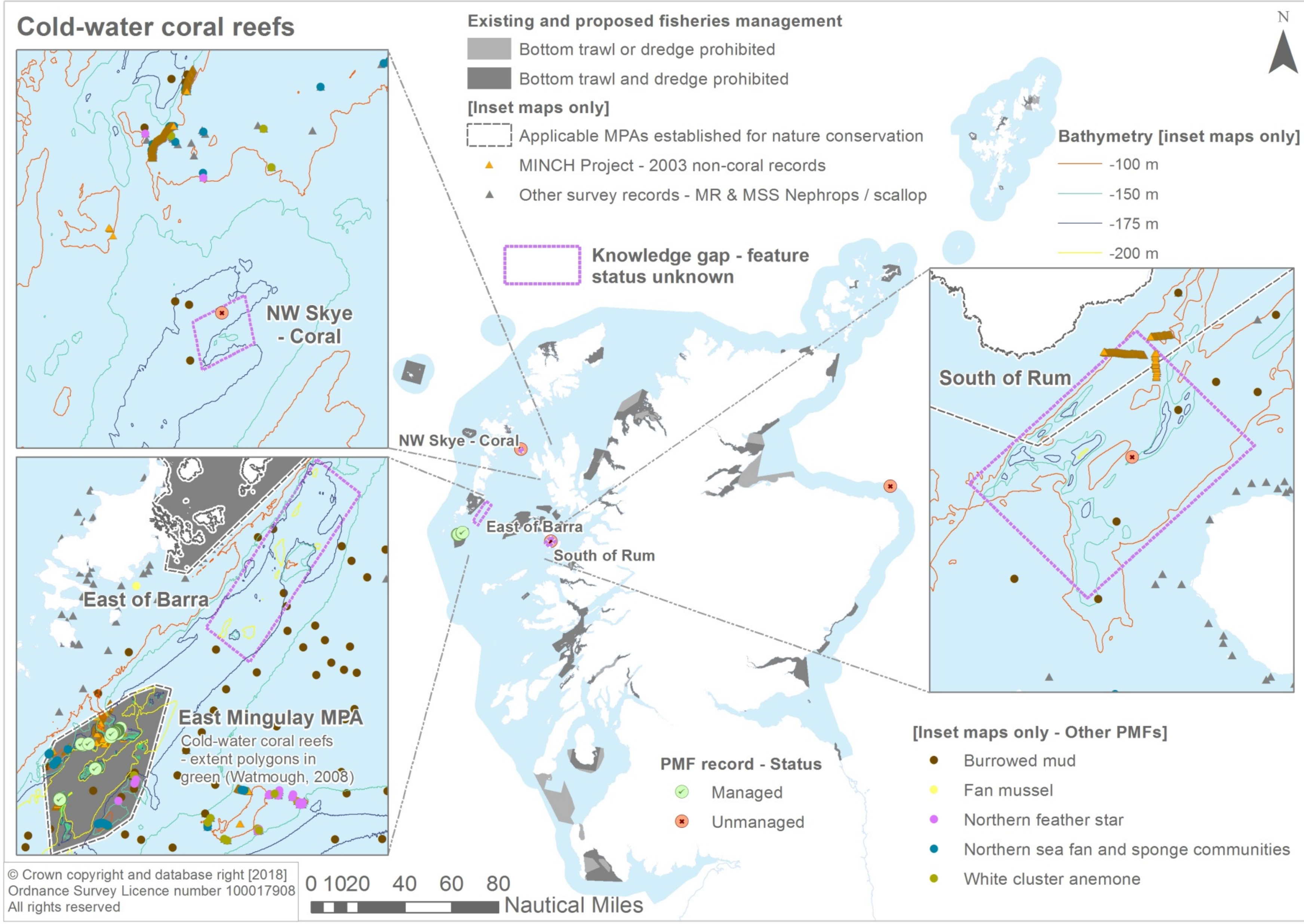
Areas where fisheries management should be considered to avoid a significant impact on the national status of the PMF



Towed bottom-contacting fishing pressure - East of Barra knowledge gap area
(Areas supporting potentially suitable physical conditions and comparatively lower levels of fishing pressure are highlighted)