Scottish Environment LINK

Evidence for damage to marine habitats: a literature review.

Maerl Beds

Introduction:

Maerl is a collective term for several species of calcified red seaweed including *Phymatolithon calcareum*. It grows as unattached nodules on the seabed and, under favourable conditions, can form extensive beds. Maerl is slow-growing, but over long periods its dead calcareous skeleton can accumulate into deep deposits (an important habitat in its own right), overlain by a thin layer of pink, living maerl. Maerl develops when crust-forming coralline red algae, impregnated with calcium carbonate, become free-living due to fragmentation (Birkett et al., 1988).

Scotland, is home to many of the most extensive maerl beds in Europe. Maerl beds are generally found in areas characterised by relatively shallow, clear water with a degree of tidal flow (Donnan & Moore, 2003a). The key physical factor affecting both the distribution of maerl and the type of maerl biotope is the occurrence of moderate to strong seabed currents (Birkett et al., 1988). These physical conditions favour maerl growth and therefore maerl beds tend to be confined to coastal waters and frequently in narrow channels between islands or at headlands. The depth to which living algae are found will depend on the turbidity of the water, although banks of dead maerl material may accumulate in considerably greater depths (Donnan & Moore, 2003a).

The EU Habitats and Species Directive gives protection to maerl features as *Lithothamnion corallioides* and *Phymatolithon calcareum* are both included in Annex V of the directive, requiring member states to ensure that appropriate management measures are in place to control the exploitation of these species. However, *Lithothamnion glaciale*, an important constituent of maerl beds in the north, is not included in Annex V. In addition, maerl is included as a key habitat within four different habitat types in Annex I of the EC Habitats Directive: 'Sandbanks which are slightly covered by seawater at all times'; 'Large shallow bays and inlets'; 'Estuaries' and the priority habitat 'Lagoons'. This means that a number of Special Areas of Conservation (SACs) provide protection to the maerl they contain. However, it should be noted that potentially deleterious human activities including scallop dredging are permitted within some marine SACs (UK Marine SACs website), depending on the designated feature being protected. In the Sound of Arisaig for example, where maerl is featured under 'Sandbanks which are slightly covered by seawater at all times', the impact of scallop dredging is limited through a voluntary agreement not to dredge shallower than 20m.

The importance of maerl beds:

The branched or nodular structure of maerl plants creates a complex three-dimensional matrix that greatly increases the complexity of the habitat. Maerl beds are of considerable conservation value because they support a very rich community of associated algae and animals and their high biodiversity is one of the key characteristics of this biotope (Birkett et al., 1988). For example, 622 species were recorded between 1996 and 1999 in the Clyde Sea area (Barbera et al., 2003). These included 66 species of macroalgae, 120 species of annelid worms, 104 crustacean species, 138 species of mollusc and 32 species of fish. Maerl beds can also be of importance to sustainable fisheries, providing nursery grounds for commercial species of fish and shellfish (Barbera et al., 2003) which utilise Maerl habitats for the provision of food and shelter from predation. For example, maerl consistently harbours significantly higher numbers of juvenile queen scallops and other juvenile invertebrates than adjacent habitats (Kamenos et al., 2004a). In a further laboratory based study Kamenos et al (2004b) demonstrated that juvenile queen scallops consistently preferred pristine live maerl over impacted dead maerl, sand or gravel as a habitat. Pristine live maerl allows scallops both to seek refuge from predators and optimise their food supply (Kamenos 2004c). Kamenos et al. (2004d) demonstrated that juvenile gadoids (cod, saithe and pollack) were found in greater densities over maerl than over heavily vegetated rock and gravel substrata. Considering the high organic biomass (e.g. polychetes) associated with maerl, such areas may help to increase the localized holding capacities of inshore waters, and destruction of maerl beds may lead to a significant reduction in this holding capacity. Degradation of maerl habitat will therefore diminish nursery-area function and reduce regional biodiversity, possibly damaging commercial fisheries (Kamenos et al., 2004a).

Evidence of damage to maerl:

Maerl-forming algae are among the slowest growing of all algal species with individuals only growing a few millimetres per year. As a consequence of this slow growth, and the physical and biological characteristics of maerl thalli, and the habitat they form, maerl is particularly sensitive to physical disturbance or to anything that would reduce the three-dimensional complexity, whether by smothering or by breaking-up their structure.

Maerl beds are under threat from a number of human activities including: land reclamation; coastal structures that change the nature of the local marine environment (e.g. breakwaters, quays); effluent discharges (e.g. domestic and/or industrial wastes discharged through short pipelines); offshore dumping (e.g. domestic and/or sewage sludge and industrial waste discharges to sea through long pipelines; dumping of harbour dredged sediments); extraction (for use as a soil conditioner; extraction of sand for artificial beaches); bottom fisheries; aquaculture (fin fish and shellfish); recreation (mooring of boats); and alien species (Barbera et al., 2003).

Scallop Dredging:

Scallop dredging on French and UK maerl beds has significantly reduced the complexity, biodiversity and long-term viability of these habitats (e.g. Hall-Spencer & Moore, 2000; MacDonald et al. 1996). Scallop dredges, which are widely used on northeast Atlantic maerl beds, have teeth that can penetrate 10cm into the sediment and may erase natural bottom features, compact the open-lattice upper layer of maerl and bring fine sediment particles to the surface (Barbera et al., 2003). When a pristine maerl bed (Creag Gobhainn, Loch Fyne) was damaged by experimental scallop dredging, there were profound, long-term impacts, with no measurable recovery in terms of area of living maerl after four years (Hall-Spencer & Moore, 2000). The authors noted that had the study been restricted to previously fished maerl grounds (2 of the 3 sites included in the study) long term effects (over several years) would not have been detected against a back-drop of natural variation. Haughton et al. (2003) demonstrated that experimental hydraulic dredging removed maerl from the surface of the sea bed and this maerl was either smashed and dispersed along the dredge track or ploughed into the sea bed. Thus hydraulic dredging is detrimental to the conservation status of maerl beds; it has the potential to kill the maerl and it reduces habitat complexity and niche space for the local fauna. De Grave and Whitaker (1999) demonstrated a clear shift from the abundance of omnivorous crustaceans in an area exposed to experimental suction dredging to filter-feeding bivalves in an area fallowed following previous dredging. However, in this study the extent of recovery could not be quantified as there was no suitable reference site due to prior fishing in the area.

Aquaculture:

The effects of organic deposition on the benthos are well documented for fish farms situated in areas with slow water movements in muddy fjord habitats (Brown et al., 1987; Gowen & Bradbury, 1987). These effects include an initial decline of suspension feeders and an increase in deposit feeders followed, with greater enrichment, by the community becoming increasingly dominated by a few pollution-tolerant opportunistic species and finally, in grossly polluted environments, the sediment may be covered by sulphur-reducing bacteria. The environmental effects of marine cage fish farming are generally most prevalent within close proximity to the cage groups. However, in the light of a shift in management policy, which encourages the movement of fish cages away from sites with low current speeds to areas with stronger current speeds in order to disperse wastes and reduce the impacts upon the seabed below the cages (Fernandes et al., 2001; Henderson et al., 2001), Hall-Spencer et al. (2006) examined the impact of fish farms on maerl beds in strongly tidal areas. An increasing number of sea cage fish farms are located over these areas (16 in 2003), a habitat for which no previous environmental impact assessments have been made (Hall-Spencer et al., 2006). Initial expectations were that particulate wastes from the fish farms would be dispersed with minimal effects on the benthos. However, during periods of slow water flow, fish farm particulates settled in seabed depressions and became trapped within the complex matrix of maerl thalli. Farmed sites which had been in use for 4-12 years had each caused long-term environmental damage, because slow-growing photosynthetic maerl thalli had been killed, inhibiting regeneration and growth of the habitat. Maerl was predominantly dead or in poor condition close to cages, but increased in live cover with distance from the farms. This effect is consistent with laboratory evidence showing that maerl is particularly sensitive to siltation and lowered oxygen tension (Wilson et al. 2004). Reference sites had no visible sign of organic pollution and were highly biodiverse. In contrast the farm sites had visible signs of organic enrichment and significantly lower biodiversity. Donnan & Moore (2003b) recommended a moratorium on fish farm licences above unexploited maerl beds and this study confirms that maerl habitats are highly susceptible to the effects of fish farm deposition, with significant effects recorded to at least 100m from the sites.

Commercial Extraction:
One of the most obvious threats to maerl habitats is commercial extraction (Barbera et al., 2003). Maerl is of commercial value as a soil conditioner on acidic ground, as an animal food additive, for the filtration of acid drinking water and in pharmaceutical and cosmetic products. This has led to the wholesale removal of maerl habitats in Brittany, whilst areas adjacent to extraction sites show significant reductions in diversity and abundance (Grall & Hall-Spencer, 2003). In 1978 a licence was issued by the Crown Estate Commissioners (CEC) to dredge 30,000 tonnes per year of dead maerl from the Fal Estuary (UK Habitat Plan for Maerl), although the board of Falmouth Harbour Commissioners decided to cease licensing Maerl extraction from January 2005 (Hall-Spencer, 2005). The first licence for the extraction of maerl in Scotland was granted in 1996 by the CEC under the Government View Procedure, in Wyre Sound, Orkney, to dredge 4,000 m^3 a year for five years. An exploratory licence was awarded to a company to remove 20 tonnes of maerl off Barra, but was not subsequently taken up. There has been an assumption that dead maerl grounds are ecologically worthless and therefore ripe for direct exploitation, but dead maerl grounds can, in fact, harbour high biodiversity due to their complex physical structure (Donnan & Moore, 2003b).

Conclusion:
Maerl beds are clearly of considerable importance both in terms of their high biodiversity and as nursery grounds for commercially important species of fish and shellfish. An obvious way to protect this habitat is to designate selected areas as marine protected areas in which no deleterious activities can occur. Maerl beds meet the criteria for designating marine protected areas as they are unique, biogenically produced habitats that occupy discrete and localized areas within coastal waters and which require particular physio-chemical conditions for their formation (Barbera et al., 2003). They are easily disrupted by environmental change and are vulnerable to damage by human activities especially considering their slow growth rate. Moreover, maerl beds show high biodiversity, harbouring many rare and unusual species, including the maerl forming algae themselves (Barbera et al., 2003).

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For further information please contact.

Alan Wells

Marine Bill Research Officer, Scottish Environment LINK

Tel: 01350 728200, Mobile: 07920 287086, Email: alan@scotlink.org