Scottish Environment LINK

Evidence for damage to marine habitats: a literature review.

Seagrass Beds *(Zostera Spp)*

Introduction:
Seagrasses are marine flowering plants found in intertidal and shallow coastal areas around the world, typically on sands and muds to a maximum depth of about 10m (James, 2004). In the UK, three species of seagrass occur, dwarf eelgrass (*Zostera noltii*) is found highest on the shore, narrow leaved eelgrass (*Zostera angustifora*) on the mid to lower shore and eelgrass (*Zostera marina*) predominantly in the sublittoral. In the UK literature *Z. marina* is distinguished from *Z. angustifora* on the basis of morphology, whereas outside the UK most authors consider *Z. angustifora* to be a phenotypic variant of *Z. marina* (Tyler-Walters, 2000 quoted from James, 2004). Seagrasses often grow in dense extensive beds or meadows, which can occur in marine inlets, bays or lagoons that are sheltered from significant wave action, but UK seagrass beds tend to be smaller in extent than other European beds.

Z. marina communities primarily occur on the west coast of Scotland, the Hebrides, the Shetland Isles and to a lesser degree, Orkney (James, 2004). The most significant Scottish populations of *Z. angustifolia* and *Z. noltii* are found along the southern shore of the Firth of Forth, near Dunbar, Aberlady and east of Bo'ness, in north east Fife in the Eden estuary and at Tayport, and in the Inverness, Beauly, Cromarty and Dornoch Firths. *Z. noltii* is also found on the west coast from Argyll southwards whilst *Z. angustifolia* is mainly restricted to Loch Sween, the Solway Firth and Loch Don, Mull. There are no significant *Zostera* populations between Berwick and Dunbar and between the Montrose Basin and the Moray Firth (James, 2004).

Zostera marina is afforded enhanced nature conservation status within the UK, within the 'Seagrass beds' UK Habitat Action Plan. *Z marina* communities are also included within several Annex 1 habitats under the EC Habitats Directive and are included in a number of SACs including Sound of Arisaig SAC and Loch nam Madadh SAC. The water framework directive (WFD) identifies angiosperms as one of the five 'biological quality elements' to be used for classification of the quality status of a transitional or coastal water body (Foden & Brazier, 2007). All UK seagrass species are included in the UK Biodiversity Action Plan (UKBAP) and are considered nationally scarce.

The importance of seagrass:
Nearshore estuarine and marine ecosystems such as seagrass beds serve many important functions in coastal waters and perhaps most notably they have extremely high primary and secondary productivity and support a great abundance and diversity of fish and invertebrates (Beck et al., 2001). Where this habitat is well developed the leaves of eelgrass plants may be colonised by diatoms and algae such as *Enteromorpha* spp, *Cladophora rectangularis, Rhodophysema georgii*, *Ceramium rubrum*, stalked jellyfish and anemones and the soft sediment infauna may include amphipods, polychaete worms, bivalves and echinoderms (UK Habitat Action Plan for Seagrass beds). Two species of pipefish, *Entelurus aequoraeus* and *Syngnathus typhie* are almost totally restricted to seagrass beds while the red algae *Polysiphonia harveyi* which has only recently been recorded from the British Isles is often associated with eelgrass beds. (UK Habitat Action Plan for Seagrass beds). *Zostera* beds have been shown to support a high production of benthic fauna as well as epibenthic invertebrates and fish, and to serve as nursery and feeding grounds for more than 40 fish species (Pihl et al., 2006). In this study, fish biomass was generally higher at

night, indicating that fish migrate into shallow water at night, and that these areas may function as a night-time feeding ground for commercially important fish such as cod and plaice. Cod and other gadoids, such as whiting (*Merlangius merlangus*) and pollack (*Pollachius virens*), used vegetated coastal habitats as nursery grounds, and the latter two species were exclusively found in *Z. marina* beds (Pihl et al., 2006). Seagrass is also an important source of food for wildfowl, particularly brent goose and widgeon which feed on intertidal beds.

The leaf canopy and the network of rhizomes and roots provide substratum for attachment, and stabilize the sediment reducing wave impacts (Borum et al., 2004). They also remove suspended solids, recycle nutrients and add oxygen to surrounding waters. In addition, the three-dimensional structure of seagrasses creates hiding places to avoid predation and produces an array of microhabitats not present in unvegetated bottoms. As a result, the abundance and diversity of the fauna and flora living in seagrass meadows are consistently higher than those of adjacent unvegetated areas (Borum et al., 2004). Seagrass meadows have high rates of primary production, fixing carbon dioxide and transforming it into organic carbon and the associated high rates of oxygen production are released into the surrounding water. Whilst seagrass primary production is only 1% of total worldwide primary production in the oceans, they are responsible for 12% of the total amount of carbon stored in ocean sediments, due, in part, to their slow rates of decomposition.

Evidence of damage to seagrass:

Throughout the world, the degradation of coastal ecosystems continues at an alarming rate and estuaries may be some of the most degraded environments because they have been the focus points for human colonisation for centuries (Beck et al., 2001; Edgar et al., 2000). Loss of seagrass abundance occurs in many coastal environments due to natural causes such as wasting disease or high energy storms. However, human activities have also led to hydro-morphological changes in seagrasses. These include: fishing activity, e.g. dredging, benthic trawling or rhizome disturbance during shellfish picking or bait digging; vessel mooring, e.g. anchor-chain scour, moorings or beaching of boats; coastal defense engineering, e.g. building groynes, sea walls or breakwaters, beach replenishment, dredging for coastal/harbour development; industrial development, e.g. land reclaim, harbor construction/ maintenance, artificial reefs; and, waste dumping, e.g. sewage discharge, cooling water discharge, storm water discharge, spoil dumping, nutrient runoff (Foden & Brazier, 2007).

Dredging is required in many ports, to deepen and maintain navigation channels, and commercial extraction of sand and gravel takes place to meet an increasing demand for sand and gravel for construction and land reclamation (Erftemeijer & Robin Lewis, 2006). Excavation, transportation and disposal of soft bottom material may lead to adverse impacts on the marine environment, and these aspects can be especially significant when dredging or disposal occurs in the vicinity of sensitive marine environments such as seagrass beds. Damage may occur due to a temporary decrease in water transparency, increased concentrations of suspended matter and increased rates of sedimentation, physical removal of substratum and associated plants and animals from the seabed, and burial due to subsequent deposition of material (Erftemeijer & Robin Lewis, 2006).

Cockle collection can be particularly damaging to seagrass beds as cockle beds and seagrass beds are frequently associated (Davidson & Hughes, 1998). In the Solway firth, harvesting of cockles by hand is a traditional practice, but the introduction of mechanical dredgers and the associated increased fishing effort has caused significant damage in this area (Perkins, 1988; quoted from Davidson & Hughes, 1998). In undredged areas, the substratum was characteristically hummocky and covered with abundant *Zostera*, whereas in dredged areas, the substratum surface was smoothed and no *Zostera* was present. This fishery was closed to all forms of mechanical harvesting in 1994 (Solway Firth Partnership, 1996). In addition, in the Solway Firth, vehicles used by hand gatherers to reach cockle grounds and transport their catch to the shore have caused furrows in the sediment, particularly in fine sediments and *Zostera* beds with disturbance reported at Auchencairn Bay, Rough Firth and Rockcliffe Bay in the Solway Firth (Solway Shellfish Management Association, 2004).

Eelgrass is known to accumulate Tributyl, tin (TBT) and possibly other metals and organic pollutants (Austen & McEvoy, 1997). Following the ban on TBT as an antifouling agent on vessels under 25m, paint manufacturers began to use organic biocides such as Irganol 1051 and Diuron (Chesworth et al. (2004). Both herbicides are commonly found in coastal waters and sediments in the UK and are often the most prevalent biocides (Thomas et al., 2001), with aquatic concentrations in ports and marinas usually highest. Both chemicals are toxic to plants, significantly inhibiting growth and photosynthetic activity (Scarlett et al., 1999; Chesworth et al., 2004). Application of both of these compounds as antifoulants was banned by the UK Health and Safety Executive in 2002, but boats over 25m are still allowed to use Irganol 1051. However, this ban is not Europe-wide and the long-half life of these chemicals suggests that these herbicides may still pose a threat to the marine environment for several years (Chesworth et al., 2004). In addition, pollutants accumulated by seagrass meadows may become concentrated through food chains.

Seagrasses are also very sensitive to nutrient enrichment. In temperate estuaries, areas of eelgrass habitat have been found to decrease and percentage loss of habitat to increase as nitrogen loading rates increase (Hauxwell et al., 2003). Nutrient enrichment may lead to excessive growth of opportunistic epiphytic algal species such as *Enteromorpha, Ulva, Chaetomorpha* and *Ectocarpus* on seagrass beds and descriptive field studies have found that such algae appear to inhibit or eliminate eelgrass by overlying and smothering (e.g. Dennison et al., 1993) and excessive growth can cause serious deterioration or even the eradication of seagrass. Decline in eelgrass has also been observed, not as a consequence of shading by increased algal growth, but as a direct effect of increased nitrogen in the form of nitrate and ammonium (Burkholder et al., 1992; van Katwijk et al., 1997).

Frost et al. (1999) found that bed fragmentation of seagrass had an influence on macrofauna community composition via modification of both the physical nature of the habitat and possibly the biological interactions that take place within. The authors noted that infaunal invertebrates may be the component of the seagrass ecosystem least likely to be affected by fragmentation and therefore, any significant effect noted for this community may be magnified for larger organisms such as fish which may be more dependent on patch size. Indeed, Pihl et al. (2006) found a significant reduction in fish species and a change in species structure in areas where seagrass had disappeared. *Z. marina* beds are therefore essential habitats in the recruitment process for fish, and losses of seagrass will most likely reduce the nursery function of the coastal zone for a number of commercially important species including cod and plaice.

Conclusion:

Seagrass 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. Seagrass beds are easily disrupted by environmental change and are vulnerable to damage by human activities.

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