Appendix 8. Key information review as background to the OSPAR IMPACT meeting in September 1998

Compiled by: Keith Hiscock, English Nature, Northminster House, Peterborough PE1 1UA. UK.

[This example uses a previous 5-level scale for sensitivity assessment]

Derived, in part, from: the UK marine biotope classification (Connor *et al.*, 1997b) and a review undertaken for the UK Marine SACs Project (Davison, 1998).

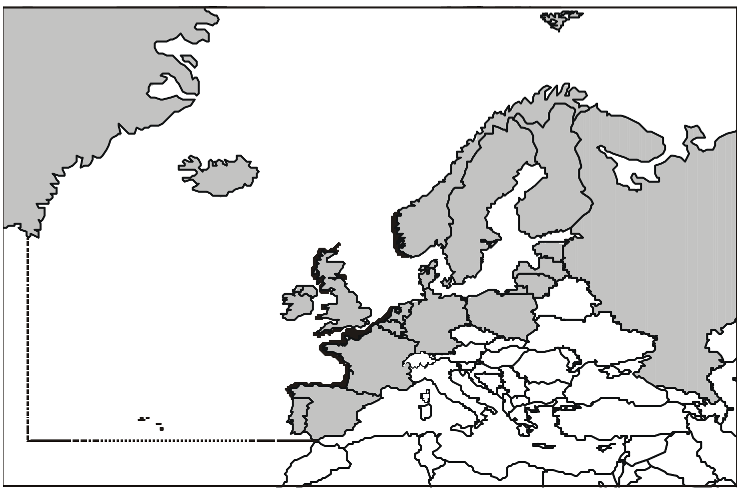
Classification

Classification	*Code*	*Biotope(s)*
Wadden Sea (1996)	03.02.05	Benthic zone of the shallow coastal waters with muddy and sandy bottom, rich in macrophytes
UK (MNCR BioMar – 97.06)	IMS.Zmar	*Zostera marina*/*angustifolia* beds in lower shore or infralittoral clean or muddy sand
France (ZNIEFF-MER)	II.3.3	Herbiers de *Zostera marina*, *Zostera noltii* (= *Z. nana pro parte*) du médiolittoral inférieur
	III.3.4	Herbiers de *Zostera marina*

Description

IMS.Zmar. Expanses of clean or muddy fine sand in shallow water and on the lower shore (typically to about 5 m depth) can have dense stands of *Zostera marina/angustifolia* [Note: the taxonomic status of *Z. angustifolia* is currently under consideration but is most likely a dwarf form of *Zostera marina*]. In IMS.Zmar the community composition may be dominated by these *Zostera* species and therefore characterised by the associated biota. Other biota present can be closely related to that of areas of sediment not containing *Zostera marina*, for example, *Laminaria saccharina*, *Chorda filum* and infaunal species such as *Ensis* spp. and *Echinocardium cordatum* (e.g. Bamber, 1993) and other bivalves listed below. It should be noted that sparse beds of *Zostera marina* may be more readily characterised by their infaunal community. Beds of this biotope in the south-west of Britain may contain conspicuous and distinctive assemblages of Lusitanian fauna such as *Laomedea angulata*, *Hippocampus* spp. and Stauromedusae. Some examples of *Zostera marina* beds have markedly anoxic sediments associated with them. (from Connor *et al.*, 1997b)

Distribution



Habitat requirements

Habitat factor	*Range of conditions*
Salinity	Fully marine; Variable; Reduced; Low. McRoy (1966) suggests optimum salinities of 10 to 39‰, den Hartog (1970) reports tolerances as low as 5‰ in the Baltic. Laboratory studies indicate that maximum germination occurs at 30ºC and 1‰ salinity (Hootsmans *et al*,. 1987). Field studies indicate that germination occurs over a wide range of temperatures and salinities (Churchill, 1983, Hootsmans *et al.*, 1987). In brackish waters along the Atlantic coast, *Zostera marina* behaves as an annual plant, shedding its leaves in winter (Jacobs, 1982). Low salinities may encourage production of reproductive shoots and stimulate leaf production. *Zostera marina* beds survived disease especially in low salinity conditions in the eastern United States (Muehlstein *et al.*, 1988).
Wave exposure	Sheltered, Very sheltered, Extremely sheltered, Ultra sheltered
Tidal streams	Weak, very weak
Substratum	Clean sand, muddy fine sand, mud
Zone	Lower shore, Upper infralittoral
Depth range	0-5 m
Temperature	Optimum temperature range for *Zostera marina* appears to be between 5 and 30 ºC (Marsh *et al*., 1986, Bulthius, 1987). Seasonal growth is closely associated with temperature. Yonge (1949) suggested that growth ceases below 10 ºC and that flowers could only open and seeds form when the temperature exceeded 15 ºC. *Zostera marina* beds which occur intertidally may be damaged by frost although the rhizomes most likely survive (Covey & Hocking, 1987).
Water quality	*Zostera marina* requires high light levels. It most commonly occurs shallower than 2m below chart datum, exceptionally to 5m and the deepest recorded depth it has been found in Britain and Ireland is 13m below chart datum off south-west Ireland (Cullinane *et al.*, 1985). Harrison (1987) describes how the extent of a *Zostera marina* bed expanded after construction of a causeway blocked the flow of silty water.
Nutrients	It seems most likely that nitrogen is the limiting nutrient. In carbonate-based sediments, phosphates may be limiting due to adsorption onto sediment particles (Short, 1987). Mild nutrient enrichment of sediments may stimulate growth of *Zostera marina* shoots (Roberts *et al.*, 1984).

(from Connor *et al.* (1997b), unless otherwise stated)

Species composition and biodiversity

Characterising species

For IMS.Zmar in the UK	*% Frequency*	*Faithfulness*	*Typical abundance*
Anemonia viridis	••	••	Frequent
Arenicola marina	••	•	Occasional
Lanice conchilega	••	•	Occasional
Pagurus bernhardus	••	•	Occasional
Carcinus maenas	•••	•	Occasional
Gibbula cineraria	••	•	Occasional
Hinia reticulata	••	••	Occasional
Chorda filum	••	••	Frequent
Laminaria saccharina	••	•	Occasional
Ulva sp.	••	•	Frequent
Zostera marina	•••••	•••	Abundant

(from Connor *et al*., 1997b)

Species found uniquely in biotope

The hydroid *Laomedia angulata* and the algae *Rhodophysema georgii*, *Halothrix lumbricalis, Leblondiella densa*, *Myrionema magnusii, Cladosiphon zosterae* and *Punctaria crispata* have only been recorded attached to seagrass leaves. The endophytic green alga *Entocladia perforans* is also host specific to *Zostera marina*.

Number of species recorded in biotope

Ecological relationships

Zostera marina provides a habitat for a wide range of species to find shelter or a suitable substratum on which to live. Fish occur amongst the seagrass and include the wrasse and goby species also found in kelp. The green wrasse (*Labrus turdus*) is normally associated with seagrass beds in the Mediterranean and may be present in Isles of Scilly *Zostera marina* beds (Fowler, 1992). Especially found in sea grass beds are pipe fish *Syngnathus typhle* and *Entelurus aequoraeus* and, rarely, sea horses *Hippocampus ramulosus*. Cuttlefish, *Sepia officinalis*, are also found and lay their eggs amongst seagrass. Small prosobranchs, especially *Rissoa* sp(p) and *Lacuna vincta* graze on the leaves. The mud snail *Hydrobia ulvae* is found on leaves in estuarine conditions. At open coast sites, stauromedusae (stalked jellyfish), *Haliclystus auricula* and *Lucernariopsis campanulata*, may be present on leaves. The hydroid *Laomedia angulata* and the algae *Rhodophysema georgii*, *Halothrix lumbricalis*, *Leblondiella densa*, *Myrionema magnusii*, *Cladosiphon zosterae* and *Punctaria crispata* have only been recorded attached to seagrass leaves. The endophytic green alga *Entocladia perforans* is also host specific to *Zostera marina*. Seagrass rhizomes help to stabilise sediments and may thereby increase species diversity. Sea anemones (*Cereus pedunculatus, Cerianthus lloydii*) and the prosobranch *Nassarius reticulatus* are often common in the sediment. In the Isles of Scilly, the sea anemone *Anthopleura ballii* is unusually present.

Habitat complexity

Seagrasses provide shelter and hiding places. The leaves and rhizomes provide substrata for the settlement of epibenthic species which in-turn may be grazed upon by other species.

Recruitment processes

Zostera marina provides refuges for many species of fish and nursery areas for some.

Sediment stabilisation

The slowing of water movement by leaves encourages accumulation of sediments whilst the dense rhizome and root system stabilises the sediment preventing or reducing sediment loss. The consolidation of the sediments enables the development of richer infaunal communities with higher densities of individuals than those in adjacent bare sediments (reviewed most recently in Boström & Bonsdorff (1997).

Productivity

Sea grasses have high rates of primary production and are an important source of organic matter whose decomposition provides a starting-point for detritus-based food chains. They also provide a substratum for other plant species.

Keystone (structuring) species

Zostera marina, *Labrynthula macrocystis*

Importance of biotope for other species

Intertidal and probably shallow subtidal *Zostera marina* beds provide a source of food for a variety of wildfowl, although not to the extent that intertidal *Zostera noltii* do. Studies of feeding on *Zostera* rarely differentiate which species is being referred to. Tubbs & Tubbs (1983) reported that brent geese grazing contributed to the cover of *Zostera marina* and *Zostera noltii* being reduced from between 60-100% cover in September to between 5-10% cover between mid-October and mid-January. The observation (den Hartog, 1977) that the decline in *Zostera marina* during the wasting disease of the 1930's was followed by very heavy losses of the Brent goose and the Canada goose suggests that they rely on *Zostera marina* for a large proportion of their food. However, it remains unclear and seems unlikely that subtidal *Zostera marina* beds are affected by wildfowl grazing.

Although much referred to as a nursery area for fish, there is little evidence to support the assertion that beds of *Zostera marina* provide such a facility.

Temporal changes

Zostera marina beds are naturally dynamic, at least in open coastal areas. In the Isles of Scilly, beds have 'advancing' and 'receding' edges. The fungus *Labrynthula macrocystis* caused the loss of over 90% of *Zostera marina* beds in the 1920's and 1930's and a full recovery has not yet occurred (Vergeer *et al.*, 1995 for a recent review). *Zostera marina* beds may show marked annual changes. In brackish conditions, there is die-back of the leaves in the autumn and regrowth in the spring and early summer (Jacobs, 1982, Dyrynda, 1997). This die-back has been observed to be almost complete in The Fleet in Dorset, UK (Dyrynda, 1997) and resulted in sediment destabilisation as well as loss of cover for fish and substratum for invertebrates.

Time for community to reach maturity

Zostera marina beds most likely do not seed and establish rapidly. There has been little recovery of *Zostera marina* beds following the wasting disease in the 1930's. Olesen & Sand-Jensen (1994) reported that, in Danish waters, new *Zostera marina* beds could take at least five years to become established and stable with small patches (<32 shoots) showing high mortalities. However, these observations are near to established beds and seeding over a distance particularly between isolated water bodies is likely to be slow. An extensive series of experiments has been undertaken to try to re-establish beds (see, for instance, Fonesca *et al.*, 1994).

Sensitivity to human activities

Sensitivity to:	***Human activity***	***Score***	***Comments***
Physical impact (fragility)	Mobile (bottom) fishing gear Shipping – anchoring	2	Seagrass is flexible and likely to be resilient to impact
Physical disturbance (displacement)	Dredging (navigation channel maintenance) Aggregate dredging Maerl gravel and shell sand dredging	3	Displacement may happen as a result of anchors being dragged through a seagrass bed or over-vigorous foraging by wildfowl. The most frequent and probably severe effect is from storms. Severe or prolonged storm events may cause significant losses. Floods in estuarine situations may also increase water flows sufficiently to wash-out seagrasses or sediments (for instance, Wyre *et al.*, 1977, den Hartog, 1987).
Siltation	Land claim	2	Siltation following normal events (for instance sediment taken into suspension by high river flows) is likely to be transitory and result in negligible impact.
Turbidity	Spoil dumping Land drainage	4	Prolonged increases in turbidity would reduce light penetration and prevent adequate photosynthesis by deeper populations of *Zostera marina*. Geisen *et al.* (1990) suggest that turbidity caused by eutrophication, deposit extraction and dredging activities were major factors in the decline of *Zostera* in the Wadden Sea.
Deoxygenation	Salmonid fish farming	4	No evidence of effects found in the literature but de-oxygenation would be likely to adversely affect plants.

Salinity change	Estuarine barrages	2	*Zostera marina* seems to be highly tolerant of changes in salinity. However a severe event such as replacement of seawater by a layer of freshwater after prolonged rain may have an effect.
Temperature change	Global warming		den Hartog (1970) suggested that *Zostera marina* generally tolerates temperatures up to 20ºC without showing signs of stress. There is likely to be damage through frost to beds exposed at low water (den Hartog, 1987).
Oil Pollution	Oil spills	3	Apparently healthy *Zostera marina* beds are known to exist in areas subject to low level chronic hydrocarbon contamination (see, for instance, Howard *et al.*, 1989). Smothering by stranded oil is likely to occur on lower shore populations but little is known of effects [check *Amoco Cadiz*]
Contaminants	Inorganic mine and particulate wastes Pesticides Shipping (anti-fouling paints)	?	Terrestrial herbicides have been found to inhibit growth and cause decline in *Zostera marina* (Delistraty & Hershner, 1984) Some effects may be indirect. For instance, *Zostera marina* readily uptakes heavy metals and TBT (Williams *et al.*, 1994). Whilst plants appeared unaffected, any loss of grazing prosobranchs due to TBT contamination in the leaves or externally would result in excessive algal fouling of leaves and poor productivity and possible smothering. Lead accumulation (from shotgun pellets) in sediments may stress *Zostera* plants.
Eutrophication	Sewage discharge	3	High nitrate concentrations have been implicated in the decline of *Zostera marina* by Burkholder *et al.* (1993). Such eutrophication may increase the cover of epiphytic algae and prevent photosynthesis of sea grass plants. Eutrophication may increase abundance of *Labrynthula macrocystis* (see below). However, nutrient enrichment may stimulate growth of *Zostera marina* (Fonesca *et al.*, 1994)
Other (name)		4	**Wasting disease.** An infection by the fungus *Labrynthula macrocystis* which decimated *Zostera marina* in the 1920's to the mid 1930's. Continuously present at low levels; reason for epidemics unclear but stress including pollution incidents suggested (see, for instance, Rasmussen, 1977, Short *et al.*, 1988, Vergeer *et al.*, 1995).
		2	**Wildfowl grazing**
		2	**Smothering by algae.** Smothering by algae may be linked to eutrophication. *Zostera marina / angustifolia* plants were overwhelmed by *Enteromorpha* in Langstone Harbour but their final demise may have been due to grazing by brent geese (den Hartog, 1994).
	Mariculture Shipping (As main causes of the importation of non-native species)	?2	**Exclusion by non-native species (esp. *Sargassum muticum*)**. *Sargassum* seems to colonise seagrass beds without displacing the seagrass. (For instance, Critchley, 1983, Covey & Hocking 1987). Future non-native species may be more 'aggressive' and have a greater affect.

Recovery potential

In relation to a single event causing mortality = 3

(Beds affected by chronic wasting disease could take longer.)

Assessment of regeneration ability in the Wadden Sea: B – Regeneration conditionally possible (less than 15 years) (Von Nordheim *et al.*, 1996)

Conservation, protection and management

Conservation status

Region	*Status*
OSPAR area	Not known
Wadden Sea	1 – Threatened by complete destruction (Von Nordheim *et al.*, 1996)
UK	TBA
Other sub-regions	Not known

Protected status

Protection mechanism	*Habitat*
EC Habitats Directive	A named component of *Lagoons* (a priority habitat*) and Shallow sandbanks slightly covered by seawater all of the time*. Also a characteristic feature *of Large shallow inlets and bays* and *Estuaries* and occurs on the lower shore in *Mudflats and sandflats not covered by the tide at low water.*
UK Biodiversity Action Plan	Seagrass beds

Management measures

To maintain biotope in natural state: Avoid activities that result in increased levels of turbidity in the long term. Prevent excessive nutrification of water bodies.

To restore biotope to natural state: Remove or reduce sources of contaminants that may adversely affect associated grazing species. Minimise anchoring and prohibit the use of mooring chains, which drag the seabed in *Zostera marina* beds.