MarLIN
Marine Information Network
Information on the species and habitats around the coasts and sea of the British Isles

Common eelgrass (*Zostera (Zostera) marina*)

MarLIN – Marine Life Information Network
Biology and Sensitivity Key Information Review

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A report from:
The Marine Life Information Network, Marine Biological Association of the United Kingdom.

Please note. This MarESA report is a dated version of the online review. Please refer to the website for the most up-to-date version [https://www.marlin.ac.uk/species/detail/1282]. All terms and the MarESA methodology are outlined on the website (https://www.marlin.ac.uk)

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Zostera marina plants.
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See online review for distribution map

Distribution data supplied by the Ocean Biogeographic Information System (OBIS). To interrogate UK data visit the NBN Atlas.

Researched by	Dr Harvey Tyler-Walters	**Refereed by**	Dr Leigh Jones
Authority	Linnaeus, 1753		
Other common names	-	**Synonyms**	*Zostera marina*

Summary

Description

Grass like flowering plant with dark green, long, narrow, ribbon shaped leaves 20-50 cm in length (exceptionally up to 2 m long) with rounded tips. Leaves shoot from a creeping rhizome that binds the sediment. Leaves and rhizomes contain air spaces, lacunae, that aid buoyancy. Numerous flowers occur on a reproductive shoot similar to those of terrestrial grasses. Forms dense swards in the subtidal, supports a diverse fauna and flora and may act as a nursery for fish and shellfish.

Recorded distribution in Britain and Ireland

Zostera marina has a wide but patchy distribution in southwest of England, the Solent and Isle of Wight on the south coast, Wales, western Ireland, western and eastern Scotland including Orkney and the Shetland Islands.

Global distribution

Widespread through the Atlantic and Pacific. It is the only seagrass species that extends into the Arctic Circle. It has a restricted distribution in the Mediterranean.

Habitat

Dense swards found primarily on sand to fine gravel in the subtidal, typically down to 4 m, in sheltered waters such as shallow inlets, bays, estuaries and saline lagoons.

Depth range

0 to 5m

Identifying features

- Relatively thin, flattened, blade-like leaves, dark green in colour.
- Leaves usually 20-50 cm but up to 2 m in length, 4-10 mm wide, with 5-11 veins and rounded leaf tips, sometimes with a sharp point (mucronate).
- Leaf sheath forms a tube around stem.
- Reproductive shoot, terminal, branched and up to 15 m long.
- Seeds ovoid or ellipsoid with 16-25 distinct ribs.
- Rhizome with fibre bundles in the outermost layer of cortex.

Additional information

Other common names include, wigeon grass, broad leaved grass wrack, marlee, sedge and slitch. Perennial populations show a seasonal changes in leaf growth, the long leaves found in summer are replaced by shorter, slow growing leaves in winter. The morphological characteristics, especially leaf width may vary with environmental conditions (Phillips & Menez 1988). In the UK literature *Zostera marina* is distinguished from *Zostera angustifolia* on the basis of morphology. However, outside the UK most authors consider *Zostera angustifolia* to be a phenotypic variant of *Zostera marina*. To avoid confusion only data relating to *Zostera marina* is presented.

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Further information sources

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Biology review

Taxonomy

Phylum	Tracheophyta	Vascular plants (seagrasses, pondweeds, and reeds)
Class	Magnoliopsida	
Order	Alismatales	
Family	Zosteraceae	
Genus	Zostera	Eelgrasses
Authority	Linnaeus, 1753	
Recent Synonyms	Zostera marina	

Biology

Typical abundance	High density
Male size range	
Male size at maturity	
Female size range	Medium-large(21-50cm)
Female size at maturity	
Growth form	Foliose
Growth rate	5m/year
Body flexibility	
Mobility	
Characteristic feeding method	Autotroph
Diet/food source	
Typically feeds on	Not relevant
Sociability	
Environmental position	Epifloral
Dependency	No text entered.
Supports	Substratum *Entocladia perforans*, a green alga; *Rhodophysema georgii*, a crustose red alga; and brown algae *Halothrix lumbricalis*, *Leblondiella densa*, *Myrionema magnusii*, *Cladosiphon zosterae*, and *Punctaria crispata*.
Is the species harmful?	No information

Biology information

The stated growth rate refers to vegetative growth recorded in perennial populations whereas annual populations may expand at 30m / year in good conditions (Holt *et al.* 1997). The following species have been recorded only from seagrass leaves:

- the hydroid *Laomedea angulata*;
- the algae *Rhodophysema georgii*, *Halothrix lumbricalis*,*Leblondiella densa*, *Myrionema magnusii*, *Cladosiphon zosterae*, *Punctaria crispata*; and
- *Cladosiphon contortus*, which is larger and found primarily on *Zostera*sp.

- rhizomes.

Habitat preferences

Physiographic preferences	Estuary, Isolated saline water (Lagoon), Enclosed coast / Embayment
Biological zone preferences	Sublittoral fringe, Upper infralittoral
Substratum / habitat preferences	Gravel / shingle, Muddy gravel, Muddy sand, Sandy mud
Tidal strength preferences	Very Weak (negligible), Weak < 1 knot (<0.5 m/sec.)
Wave exposure preferences	Sheltered, Very sheltered
Salinity preferences	Variable (18-40 psu)
Depth range	0 to 5m
Other preferences	
Migration Pattern	Non-migratory / resident

Habitat Information

In 1920s and 1930s the previously extensive beds of eelgrass were severely reduced by an outbreak of 'wasting disease', which appears to affect sublittoral *Zostera marina* primarily. To date, recovery has been poor or slow. An exceptional bed of *Zostera marina* occurs in the clear waters of Ventry Bay, south-west Ireland and extends from 0.5 to 10m in depth and up to 13m deep in some patches. It should be noted that the global distribution of *Zostera marina* includes records of *Zostera angustifolia* which is considered synonymous outside the UK. It extends from Arctic Circle in northern Russia to near Gibraltar, Spain along the European coast. In has a restricted distribution in the Mediterranean, limited to northern parts of Adriatic and Aegean Seas, brackish etangs and lagoons in southern France. On the western Atlantic coast it extends from west coast of Alaska to North Carolina. In the Pacific it is recorded from Japan, Korea and from Alaska to Baja California, Mexico.

Life history

Adult characteristics

Reproductive type	Vegetative
Reproductive frequency	Annual episodic
Fecundity (number of eggs)	100-1,000
Generation time	1-2 years
Age at maturity	1-2 yr.
Season	May - September
Life span	20-100 years

Larval characteristics

Larval/propagule type	-
Larval/juvenile development	Oviparous
Duration of larval stage	Not relevant

Larval dispersal potential	100 -1000 m
Larval settlement period	

Life history information

Zostera sp. are perennials but may act as annuals under stressful conditions (Phillips & Menez 1988). Eelgrass reproduces vegetatively, i.e.. by growth of rhizome. Vegetative reproduction probably exceeds seedling recruitment except in areas of sediment disturbance (Reusch *et al.* 1998; Phillips & Menez 1988). Examination of the population structure of a *Zostera marina* bed in the Baltic Sea suggested that individual genotypes (vegetatively produced clones) may be up to 50 years old and further suggested that the eelgrass bed at that site had been present for at least 67 years (Reusch *et al.* 1998).

Methods of dispersal:

- All parts of the plant may float if they become detached from substrate. Pieces of rhizome or shoots (if displaced by for example storm action) may take root if they settle on suitable substratum.
- The generative stalk may be released together with the seed compliment and may be carried great distances (Phillips & Menez, 1988).
- In New York, USA, Churchill *et al.* (1985) recorded 5-13 percent of seeds with attached gas bubbles and achieved an average dispersal distance of 21m and up to 200m in a few cases.
- Wildfowl may disperse seeds on their feet, or in their gut.. For example, 30 percent of freshwater eelgrass (*Naja marina*) seeds fed to ducks in Japan survived and successfully germinated after passage through their alimentary canals and potentially transported 100-200km (Fishman & Orth 1996).

Phillips & Menez (1988) state that seedling mortality is extremely high. Fishman & Orth (1996) report that 96 percent of seeds were lost from uncaged test areas due to transport (dispersal) or predation. Ecological genetics studies of *Zostera marina* in False and Padilla Bays on Pacific coast of USA (Ruckelhaus 1998), detected genetic differentiation between intertidal and subtidal zones and between the bays. Estimates of gene flow suggested that seed dispersal was more important than pollen dispersal, effective migration (2.9 migrants/generation) occurred between the bays (14 km apart) and that the population subdivision was in part explained by disturbance and recolonization. Phillips & Menez (1988) note that seedlings rarely occur within the eelgrass bed except in areas cleared by storms, blow-out or excessive herbivory.

Sensitivity review

This MarLIN sensitivity assessment has been superseded by the MarESA approach to sensitivity assessment. MarLIN assessments used an approach that has now been modified to reflect the most recent conservation imperatives and terminology and are due to be updated by 2016/17.

Physical Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Substratum Loss	High	Very low / none	Very High	Moderate

The rhizome occupies the top 20cm of the substratum. Substratum loss will result in the loss of the shoots, rhizome and probably the seed bank. Recoverability will depend on recruitment from other populations. Although *Zostera marina* seed dispersal may occur over large distances, high seedling mortality and seed predation may significantly reduce effective recruitment. The slow recovery of *Zostera* populations since the 1920s - 30s outbreak of wasting disease suggests that, once lost, eelgrass beds take considerable time to re-establish.

	Intolerance	Recoverability	Sensitivity	Confidence
Smothering	High	Very low / none	Very High	Moderate

Sediment disturbance, siltation, erosion and turbidity resulting from coastal engineering and dredging activities have been implicated in the decline of seagrass beds world wide (Davison & Hughes 1998; Holt *et al.* 1997). Seagrasses are intolerant of smothering and typically bend over with addition of sediment and are buried in a few centimetres of sediment (Fonseca 1992). Recoverability will depend on recruitment from other populations. Although *Zostera marina* seed dispersal may occur over large distances, high seedling mortality and seed predation may significantly reduce effective recruitment. The slow recovery of *Zostera* populations since the 1920s - 30s outbreak of wasting disease suggests that, once lost, eelgrass beds take considerable time to re-establish.

	Intolerance	Recoverability	Sensitivity	Confidence
Increase in suspended sediment	Intermediate	Moderate	Moderate	Moderate

Increased sediment erosion or accretion have been associated with loss of seagrass beds in the Australia, the Mediterranean and USA. Increased sediment availability may result in raised eelgrass beds, more likely to be exposed to low tide, desiccation and high temperatures. Seagrass beds demonstrate a balance of sediment accretion and erosion. Sediment deposited during summer months may be lost again due to winter storms, resuspension by grazing wildfowl, and increased erosion due to die back of leaves and shoots in autumn and winter. Seagrass beds should be considered intolerant of any activity that changes the sediment regime where the change is greater than expected due to natural events.

Decrease in suspended sediment

	Intolerance	Recoverability	Sensitivity	Confidence
Dessication	Intermediate	High	Low	Moderate

Zostera marina is mainly subtidal and intolerant of desiccation compared to other species of eelgrass. If exposed at low tide the shoot bases are stiff and upright for a few centimetres, and leaf bases will be killed by 30 min exposure on a warm, sunny day (Holt *et al.* 1997). Even short periods of drying kills the flowers. However, if the rhizomes are undamaged the leaves will grow back but repeated exposure to desiccation may exhaust the energy stores in the rhizomes. *Zostera marina* may be more intolerant of activities that cause the sediment to drain or dry.

Increase in emergence regime	Intermediate	High	Low	Low

Zostera marina that extend into the intertidal are likely to be highly intolerant of change increase in the emergence time (see desiccation).

Decrease in emergence regime

Increase in water flow rate	Intermediate	Moderate	Moderate	Low

Seagrasses require sheltered environments, with gentle longshore currents and tidal flux. Where populations are found in moderately strong currents they are smaller, patchy and vulnerable to storm damage and blow outs. Increased water flow may also increase sediment erosion (see siltation above). Populations present in moderately strong currents may benefit from decreased water flow rates.

Decrease in water flow rate

Increase in temperature	Tolerant	Not relevant	Not sensitive	Moderate

Populations of *Zostera marina* occur from the Mediterranean to Arctic Circle and are regarded as tolerant between about 5 - 30 deg C and tolerant of up to 20 deg C without stress. Therefore, they may tolerate the range of temperatures likely in the British Isles (Davison & Hughes 1998). However, intertidal populations may be damaged by frost (Hartog 1987). Populations at the edge of the range are likely to be more intolerant of temperature change. Phillips & Menez (1988) report death of seagrass as the result of a thermal plume in Biscayn Bay, Florida that raised ambient temperature by 5 degrees C, however, the species concerned were not cited. Long term temperature increase may increase the relative contribution of sexual reproduction and seed germination to population structure.

Decrease in temperature

Increase in turbidity	High		Very High	

Light attenuation limits the depth to which *Zostera marina* can grow and is a requirement for photosynthesis. Turbidity resulting from dredging and eutrophication caused a massive decline of *Zostera* populations in the Wadden Sea (Geisen *et al.* 1990). Seagrass populations are likely to survive increased turbidity for a month however prolonged increase in light attenuation will probably result in loss or damage of the population.

Decrease in turbidity

Increase in wave exposure	High		Very High	Low

Seagrasses require sheltered environments, with gentle longshore currents and tidal flux. Where populations are found in moderately strong currents they are smaller, patchy and vulnerable to storm damage and blow outs. Increased wave exposure may also increase sediment erosion (see siltation above). Populations present in moderately strong currents may benefit from decreased water flow rates. Small patchy populations or recently established population and seedling may be highly intolerant of increased wave action since they lack an extensive rhizome system.

Decrease in wave exposure

Noise	Tolerant	Not relevant	Not sensitive	

The effect of sound waves and vibration on plants is poorly studied. However, it is likely that sound waves will have little effect at the benchmark levels suggested.

	Intolerance	Recoverability	Sensitivity	Confidence
Visual Presence	Tolerant	Not relevant	Not sensitive	

Continuous shading will affect photosynthesis and therefore viability. However, occasional shading caused by surface movements of vessels at the level of this benchmark is unlikely to have an effect on seagrass beds.

	Intolerance	Recoverability	Sensitivity	Confidence
Abrasion & physical disturbance	Intermediate	Moderate	Moderate	Moderate

Small scale sediment disturbance may stimulate growth and small patches of sediment allow recolonization by seedlings (Davison & Hughes, 1998). However, seagrasses are not physically robust and rhizomes are likely to be damaged, and seeds buried too deep to germinate, by activities such as trampling, anchoring, digging, dredging, power boat and jet-ski wash (Fonseca, 1992). Suction dredging for cockles in Solway Firth removed *Zostera* in affected areas while *Zostera* was abundant in un-dredged areas (Perkins, 1988). Physical disturbance and removal of plants can lead to increased patchiness and destabilization of the seagrass bed, which in turn can lead to reduced sedimentation within the seagrass bed, increased erosion, and loss of larger areas of *Zostera*(Davison & Hughes, 1998). Therefore, the impact from a scallop dredge is likely to remove a proportion of the population and result in increased erosion of the bed. Therefore, intolerance has been recorded as intermediate.

	Intolerance	Recoverability	Sensitivity	Confidence
Displacement	High	Low	High	Low

Seagrass rhizomes are easily damaged by trampling, anchoring, dredging and other activities that disturb the sediment. The seagrass bed is unlikely to survive displacement. However, Phillips & Menez (1988) reported that rhizomes and shoots can root and re-establish themselves if they settle on sediment long enough.

Chemical Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Synthetic compound contamination	Intermediate	Moderate	Moderate	High

Zostera marina is known to accumulate TBT but no damage was observable in the field (Williams *et al.*, 1994). Naphthalene, pentachlorophenol, Aldicarb and Kepone reduce nitrogen fixation and may affect *Zostera marina* viability. Triazine herbicides (e.g. Irgarol) inhibit photosynthesis and sublethal effects have been detected. Terrestrial herbicides may damage eelgrass beds in the marine environment. For example the herbicide Atrazine is reported to cause growth inhibition and 50 percent mortality in *Zostera marina* exposed to 100 ppb (ng/ l) Atrazine for 21 days (Davison & Hughes 1998).

	Intolerance	Recoverability	Sensitivity	Confidence
Heavy metal contamination	Low	Very high	Very Low	Moderate

The concentration and toxicity of heavy metals in salt marsh plants, including *Zostera marina* was reviewed by Williams *et al.* 1994. Growth of *Zostera marina* is inhibited by 0.32 mg/l Cu and 10 mg/l Hg but Cd, Zn, Cr and Pb had measurable but less toxic effects (Williams *et al.*, (1994). Davison & Hughes (1998) report that Hg, Ni and Pb reduce nitrogen fixation which may affect viability. However, leaves and rhizomes accumulate heavy metals, especially in winter. Williams *et al.* (1994) did not observe any damage to *Zostera marina* in the field.

	Intolerance	Recoverability	Sensitivity	Confidence
Hydrocarbon contamination	Low	Very high	Very Low	Moderate

- Healthy populations of *Zostera* can occur in the presence of long term, low level, hydrocarbon effluent, for example in Milford Haven, Wales.
- *Zostera marina* may be partially protected from direct contact by oil due to its subtidal

habitat.

- The Amoco Cadiz oil spill off Roscoff blackened *Zostera marina* leaves for 1-2 weeks but had little effect on growth, production or reproduction after the leaves were covered in oil for six hours.
- Experimental treatment of *Zostera* sp. with crude oil and dispersants halted growth but had little effect on cover whereas pre-mixed oil and dispersant caused rapid death and significant decline in cover within 1 week suggesting that dispersant treatments should be avoided.
- Removal of oil intolerant grazers may result in smothering of eelgrasses by epiphytes.

Radionuclide contamination Not relevant

Insufficient information

Changes in nutrient levels High Very High Moderate

Where nutrients are limiting, additional low levels of nutrients may improve growth of *Zostera marina* . The reported effects of nutrient enrichment include:

- High nitrate concentrations implicated in decline of *Zostera marina*(Davison & Hughes 1998). Burkholder *et al*. (1992) demonstrated that nitrate enrichment could cause decline of *Zostera marina* in poorly flushed areas. In addition they noted that increasing or high temperatures associated with spring exacerbated the adverse effects of nitrate enrichment and that growth and survival were significantly reduced by nutrient enrichment levels of between 3.5 and 35 micro Molar nitrate per day with the most rapid decline (weeks) at high nitrate levels. Plant loss resulted from death of the meristem tissue.
- van Katwijk *et al*. (1999) noted that adverse effects of nitrate were dependant on salinity. Estuarine *Zostera marina* plants were more intolerant of high nitrate concentration than marine *Zostera marina* plants at high (30 psu) salinity than at lower salinities (23 psu) and that both populations benefited from nitrate enrichment (0-4 to 6.3 micro Molar nitrate per day) at 23 or 26 psu.
- Increased growth of epiphytes or blanketing algae, for example Den Hartog (1994) reported the growth of a dense blanket of *Ulva radiata* in Langstone Harbour in 1991 that resulted in the loss of 10ha of *Zostera marina* and *Zostera noltii* ; by summer 1992 the *Zostera* sp. were absent, however this may have been exacerbated by grazing by Brent geese
- Encouragement of phytoplankton blooms which increase turbidity and reduce light penetration.
- The levels of phenolic compounds in *Zostera* sp. (involved in disease resistance) are reduced under nutrient enrichment and may increase their susceptibility to infection by wasting disease.

Increase in salinity Low Very high Very Low Low

Zostera sp. have a wide tolerance of salinity from 10 - 39 ppt (Davison & Hughes 1998). Germination in *Zostera marina* occurs over a range of salinities.

Decrease in salinity

Changes in oxygenation Low Very high Very Low

The effects of oxygen concentration on the growth and survivability of *Zostera marina* are not reported in the literature. *Zostera marina* leaves contain air spaces (lacunae) and oxygen is transported to the roots where it permeates into the sediment, resulting in a oxygenated microzone. This enhances the uptake of nitrogen. The presence of air spaces suggests that seagrass may be tolerant of low oxygen levels in the short term, however, prolonged deoxygenation, especially if combined with low light penetration and hence reduced photosynthesis may have an effect.

Biological Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Introduction of microbial pathogens/parasites	High		Very High	High

A major outbreak of wasting disease resulted in significant declines of *Zostera marina* beds in 1920s to 1930s. Wasting disease is thought to be caused by the marine fungus, *Labyrinthula macrocystis*. The disease is less likely at low salinities however, *Zostera marina* prefers full salinities. The disease causes death of leaves and after 2-3 seasons death of regenerative shoots, rhizomes and loss of up to 90 percent of the population.

	Intolerance	Recoverability	Sensitivity	Confidence
Introduction of non-native species	Intermediate	Low	High	Moderate

Spartina anglica (a cord grass) is an invasive pioneer species, a hybrid of introduced and native cord grass species. Its rapid growth consolidates sediment, raises mudflats and reduces sediment availability elsewhere. It has been implicated in the reduction of common eelgrass cover in Lindisfarne, Northumberland due to encroachment and changes in sediment dynamics. Wire weed (*Sargassum muticum*) invades open substratum and may prevent recolonization of areas of eelgrass beds left open by disturbance (Davison & Hughes 1998). *Zostera marina* and *Sargassum muticum* may compete for space in the lower shore lagoons of the Solent. However, evidence for competition is conflicting and requires further research. If the invasive species prevent recolonization then recoverability from other factors will be reduced.

	Intolerance	Recoverability	Sensitivity	Confidence
Extraction of this species	Intermediate	Moderate	Moderate	Low

Wildfowl grazing can consume significant amounts of seagrass and reduce cover mainly in autumn and winter. Grazing is probably part of the natural seasonal fluctuation in seagrass cover and *Zostera* sp. can recover from normal grazing. However, where a bed is stress by other factors it may not be able to withstand grazing (Holt *et al.* 1997; Davison & Hughes 1998). Eelgrass rhizomes are easily damaged by trampling, anchoring, dredging and other activities that disturb the sediment. The seagrass bed is unlikely to survive displacement or extraction. However, Phillips & Menez (1988) reported that rhizomes and shoots can root and re-establish themselves if they settle on sediment long enough.

	Intolerance	Recoverability	Sensitivity	Confidence
Extraction of other species	Intermediate	Moderate	Moderate	Moderate

Seagrass rhizomes are easily damaged by trampling, anchoring, dredging and other activities that disturb the sediment. Seeds may be buried too deep to germinate. Mechanical dredging of cockles in Solway Firth, in intertidal *Zostera* beds, resulted in the loss of the seagrass bed and was closed. Dredging for bivalves has been implicated in the decline of seagrass beds in the Dutch, Wadden Sea. Damage after the *Sea Empress* oil spill was reported as limited to the ruts left by clean up vehicles.

Additional information

Importance review

Policy/legislation

Berne Convention	Appendix I
IUCN Red List	Least Concern (LC)

Status

National (GB) importance	Not rare/scarce	**Global red list (IUCN) category**	Least Concern (LC)

Non-native

Native	-		
Origin	-	**Date Arrived**	-

Importance information

In the Mediterranean, *Zostera marina* is strictly protected under the Berne Convention. In the UK, it does not have an species Biodiversity Action Plan (BAP) but is covered by a Habitat Action Plan (HAP).
Zostera is an important component of the diet of Brent geese (*Branta bernicla*), wigeon (*Anas penelope*), mute and whooper swans (*Cygnus olor* and *Cygnus cygnus*). The Brent geese population in Europe declined as a result of the decline in eelgrass populations due to wasting disease. *Zostera noltei* has replaced *Zostera marina* as the preferred food species.
Seagrasses have been put to a number of uses in the past for example, sound-proofing, insulation, roofing thatch, binding soil, packaging, basket weaving and in the manufacture of 'coir' matting (see Kuelan, 1999 for review).

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