General descriptions for Special Area of Conservation features and Special Protection Area supporting habitats

Contents

Purpose of this document

The feature descriptions in this document provide general information about the habitats protected by Special Area of Conservation (SAC).

The majority of 'supporting habitats' that Special Protection Area (SPA) protected bird species are reliant on, are SAC and Marine Conservation Zone (MCZ) habitats. This document also provides descriptions of additional supporting habitats that are not already covered by the SAC and MCZ habitat descriptions.

The general descriptions include:

1. Description of the habitat
2. Ecological information
3. UK status and distribution

This contextual information enhances the detail provided in the site specific descriptions in the marine protected area conservation advice supplementary advice document.

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Special Area of Conservation (SAC) descriptions

Allis shad *Alosa alosa*

Description
Allis shad is a small fish, 30-50cm long with distinctive, large circular scales along its belly. It is deep blue along its back with silvery white sides with a single black blotch behind the head. It is difficult to distinguish from its close relative, twaite shad *Alosa fallax* and the two are thought to hybridise (McLeod et al., 2008q).

Ecology
Allis shad is a migratory shoaling fish of the open sea feeding almost exclusively on plankton to a depth of around 150m with a preference for water 10–20 m deep (Taverny, 1991). Mature fish that have spent most of their lives at sea stop feeding and move up the estuaries of large rivers at the end of February. They migrate into freshwater during late spring (April–June), thus giving them the colloquial name 'May Fish'. In England, they have been recorded over 100km (OSPAR Commission, 2009a) and in Europe over 800km upstream (McLeod et al., 2008q).

Adults gather in deep, still pools before spawning at night over nearby gravelly substrates in shallow, clean, well-oxygenated waters (McLeod et al., 2008q). Good water quality and predictable water flows are vital requirements (Natural England (NE), 2013c) as are unobstructed migration routes. Studies have demonstrated

strong fidelity to traditional spawning site (Jolly et al., 2012) although the majority of adults spawn only once and then die. Juveniles require slow flowing nursery areas in freshwater before gradually moving to the sea (Maitland and Hatton-Ellis, 2003).

UK status and distribution
Allis and twaite shad are the only two members of the herring family found in freshwater in England. Allis shad is found along the entire western coastline of Europe but is rare and declining (McLeod et al. 2008).

Allis shad was once abundant in the River Severn and even supported a commercial fishery (Day, 1890, cited in (Henderson, 2003)), the only known UK breeding population is now found in the Tamar Estuary (McLeod et al., 2008q). Breeding populations have previously been recorded from the Severn, Solway and Thames (Aprahamian et al., 2003), however allis shad has declined significantly throughout its range. Individuals in breeding condition are known to occur in the Solway Firth (Maitland and Lyle, 2005) however the specific breeding grounds still require formal identification (Jolly et al., 2012).

Allis shad is regarded to be at ‘high risk’ (Joint Nature Conservation Committee (JNCC), 2007o), however, a lack of reliable information means that population estimates are not available (Natural England (NE), 2013c).

Allis shad *Alosa alosa* ©Rob Hillman

Annual vegetation of drift lines

Description
Annual vegetation of drift lines occurs on shingle beaches at or above mean high-water spring tides. Where there is little human disturbance, annual vegetation can develop where seeds and drift material are deposited by waves. Salt-tolerant annuals are the characteristic colonising plants including sea sandwort and orache (Joint Nature Conservation Committee (JNCC), 2007e). The foreshore environment restricts development of soils, but nutrients are provided by buried or surface organic matter.

Ecology

This transient habitat occupies fine (2-200mm diameter) shingle beaches sometimes mixed with a proportion of sand. Typically, this substrate is found on level or gently-sloping, high-level beaches exposed to salt-spray and periodic disturbance by storms and the highest tides. It is a very dynamic habitat and it is only annual or short-lived perennial species that are both salt tolerant and able to recolonise following wave and storm-driven disturbance that dominate the sparse vegetation (Doody and Randall, 2003).

A range of factors influence the annual development of this community. Seed production is essential to maintain its presence, and most seeds can float and are transported by wave action. As a result the location of the vegetation may vary from one year to the next. The plant species that are adapted to the conditions are limited, and there are geographical variations from north to south (McLeod et al., 2008a). This community remains highly vulnerable to man-made disturbance including trampling from recreational activities (Joint Nature Conservation Committee (JNCC), 2013c). Seeds cannot establish if they are buried too deeply.

UK status and distribution

Around one-third of the UK coastline comprises sand or shingle beach but much of this is too dynamic or disturbed to support this habitat. Where it does occur, the beaches are often small and the habitat transient with annual variations in location and density. It is, therefore, both widespread yet fragmented, and the beaches where it does persist represent the most important sites. Annual vegetation of drift lines is also well distributed around the entire European coast (Joint Nature Conservation Committee (JNCC), 2007e).

Annual vegetation of drift lines: MC6 *Atriplex prostrate – Beta vulgaris* ssp. *martima* sea-bird cliff community and other vegetation with abundant orache *Atriplex* spp. on shingle shores

Description

This is an essentially similar vegetation type to one described from cliffs with seabird colonies, but recorded on strandline debris on sandy or shingle foreshores. In these areas it comprises mainly sea beet and orache species which can re-colonise after natural disturbance. It can occur with SD2 and SD3 in similar locations, probably reflecting areas with slightly higher nutrient status, and replicating the high maritime influence and disturbance found in seabird nesting sites.

Ecology

This community type can withstand a high degree of maritime influence, and is composed of salt-tolerant species including sea beet and sea mayweed. Where there are longer periods between disturbances by wave action, short-lived perennials can establish, including curled dock and sea mayweed.

UK status and distribution
This habitat can be found on shingle beaches around the UK where conditions are suitable.

Annual vegetation of drift lines: SD2 *Honkenya peploides – Cakile martima* strandline communities

Description
The most common form of this habitat in England generally corresponds to the NVC type SD2 *Honkenya peploides – Cakile maritima* strandline communities, but this is highly variable between sites and over time depending on local conditions. It occurs in low-growing, often discontinuous bands associated with strandline deposits on flat or gently sloping shingle beaches above the mean high water mark and generally below areas of more stable shingle on larger beach complexes. Natural disturbance by spring or autumn storms re-shape beaches, keeping the vegetation in a perpetually immature state, whilst also providing conditions for recolonisation and seed movement.

Ecology
This habitat is seasonally present on beaches which are only stable in the summer months, reaching a peak of growth in late summer depending on conditions. The salt-tolerant annual species that colonise rely on organic tidal debris for nutrients which is often buried below the surface layers of sediment. The main species are sea sandwort, saltwort, sea rocket and various species of orache. Composition is influenced the proportion of finer sand. Occasionally other perennial species can colonise such as sea beet but these only have a scattered presence

UK status and distribution
This community can be found around the UK coast where conditions are suitable, associated with beaches with high shingle content.

Annual vegetation of drift lines: SD3 *Matricaria martima – Galium aparine* strandline community on stony substrates

Description
This is the northerly form of the driftline habitat, typical of wetter, cooler conditions. It is a repeatedly renewed pioneer plant community on more mixed substrates (shingle and coarse sand) and often with shell fragments. It requires the presence of tidal organic debris for nutrients and to hold moisture, and can be found growing in thickly or in quite tall stands over drift material on the strandline.

Ecology
This forms a patchy strip of nitrophilous plants at the strandline where there is periodic disturbance. It is dominated by taller plants such as the maritime form of curled dock *Rumex crispus var. littoreus* and non-maritime species such as cleavers and common chickweed. Rare species such as oyster plant may also be present in the far north.

UK status and distribution
This form of driftline habitat is generally restricted to cooler northern locations of the UK.

Atlantic salt meadows *Glauco-Puccinellietalia maritimae*

Description
Atlantic salt meadows form the most extensive saltmarsh type on the English coastline overall, although strands of the habitat on individual sites can range from a few hectares up to several thousand. They comprise a diverse range of annual and perennial species: most of which are salt tolerant confined to the habitat but also more widespread species reflecting a range of physical and management factors which in turn provide marked regional differences in their appearance (McLeod et al., 2008b).

Ecology
Saltmarsh ecology is underpinned by sedimentary and tidal processes which influence the pattern and development of vegetation. Atlantic salt meadows develop landward of pioneer saltmarsh as part of a succession when salt tolerant vegetation colonises sheltered areas of intertidal mud and sand. Low current velocities and limited wave action allow sediment to accrete vertically leading to vegetation establishment. In time, a typical saltmarsh zonation develops where frequency and duration of tidal inundation declines to landward as elevation rises. . Although the succession is a gradual continuum, distinctive sub-features are reflected in the elevation of different sections of the marsh. Vegetation surveys would enable identification of the following (although intermediate forms will occur):

- lower saltmarsh
- lower-mid saltmarsh
- mid-upper saltmarsh
- upper saltmarsh
- pioneer saltmarsh
- transition and driftline saltmarsh

These different community types are influenced by sediment type, frequency and duration of tidal inundation and grazing and geographical location (McLeod et al., 2008b). The patterns of zonation are complex, influenced by creeks and

management such as grazing. In broad terms the lower levels are characteristically species-poor, sometimes simply comprising an open sward of grasses. At higher elevations, flowering plants become more frequent, but the highest marsh is usually the most diverse especially where there are unobstructed transitions to other habitats such as sand dune or freshwater marsh. The overall saltmarsh complex provides supporting habitat both in the exposed and flooded states for plants, fish (especially as nursery areas), invertebrates and both wintering and breeding birds.

UK status and distribution
Atlantic salt meadows are widespread within sheltered estuaries all around the UK and along the Atlantic coast of Europe (Boorman, 2003).

Atlantic salt meadows *Glauco-Puccinellietalia maritimae* ©Natural England

Atlantic salt meadows *Glauco-Puccinellietalia maritimae*: lower saltmarsh

Description
The lower parts of Atlantic salt meadows occur landward of the Annex I habitats '*Salicornia* and other annuals colonising mud and sand' and along creek sides. It is characterised by the NVC communities SM10 'Transitional low marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Sueada maritima,* SM11 *Aster tripolium* var. *discoides* saltmarsh community and SM12 ,Rayed *Aster tripolium* on saltmarshes

Ecology
This is the first zone of the marsh to have a dominance of perennial species, although the overall species diversity is low. It can experience a high degree of tidal inundation, being covered by most tides. On sandier substrates it has been reported as occurring as a pioneer zone. Stands of *Aster tripolium* are taller and form a distinctive element of the marsh vegetation where present.

UK status and distribution
This has a widespread distribution in the UK where conditions are suitable, with the Aster-dominated marshes more common in the south and south east coast.

Atlantic salt meadows *Glauco-Puccinellietalia maritimae*: lower-mid saltmarsh

Description
It is generally characterised by a dominance or mosaic of NVC communities SM13 *Puccinellia maritima* saltmarsh and SM14 *Halimione portulacoides* saltmarsh communites. It is one of the most widespread perennial communities at this elevation in the saltmarsh on a wide range of substrates. There are a number of sub-communities described in the NVC that indicate the variability of this zone

Ecology
These are closed vegetation types dominated by perennial saltmarsh grass, commonly associated wth *Triglochinn maritima, Armeria maritima* and *Plantago maritima* or by *Atriplex portulacoides* which forms a more shrubby structure. The vegetation structure is influenced by grazing, where this occurs the sward is short and grass-dominated.

UK status and distribution
Puccinellia maritima dominated vegetation is widespread, with most sites having at least one form of this community. The SM14 community is also widespread and extensive in some sites, but sensitivity to grazing limits its occurrence on the west coast sites.

Atriplex portulacoides ©Sue Rees, Natural England

Atlantic salt meadows *Glauco-Puccinellietalia maritimae*: mid-upper saltmarsh

Description
This zone is generally characterised by a dominance or mosaic of NVC communities that are typically assigned to the SM 15 *Juncus maritimus – Triglochin maritima* saltmarsh and SM16 *Festuca rubra Juncetum gerardi* saltmarsh communities. It is usually grazed and is the type of vegetation favoured for turf-cutting.

Ecology
This vegetation forms a closed sward and can be present across in extensive stands. There is considerable variation depending on the range of tidal inundations, which range from as few as 25 submergences to 250. Other factors influencing the composition of the vegetation are the history of grazing, (although taller clumps of Juncus species are unpalatable, resulting in a tussocky structure), and substrate type. The sward can include a number of mesotrophic grassland species together with the halophytic element.

UK status and distribution
This has a widespread distribution in the UK where conditions are suitable, but is highly variable from site to site and may reflect history of livestock grazing.

Atlantic salt meadows *Glauco-Puccinellietalia maritimae*: upper saltmarsh

Description
Upper saltmarsh zones generally have more diverse vegetation reflecting the less frequent tidal inundations and increased number of herbaceous species. There are some distinct types as well as more localised communities. The main NVC types that distinguish this sub-feature are SM17 *Artemisia maritima*, SM18 *Juncus maritimus*, SM19 *Blysmus rufus* and SM20 *Elocharis uniglumis* saltmarsh communities

Ecology
The upper saltmarsh shows considerable variation. Communities present may include tussocks of sea rush Juncus maritimus dominating a herb-rich vegetation, and saltpans supporting patches of species-poor vegetation dominated by saltmarsh flat-sedge *Blysmus rufus* (in the north) or slender spike-rush *Eleocharis uniglumis*. (JNCC 2007)

UK status and distribution
Upper saltmarsh communities are more extensive on saltmarshes the north and west. This may reflect the truncation of succession by sea walls in the south and east, but some species (eg *Blysmus rufus*) have a northern distribution.

Atlantic salt meadows *Glauco-Puccinellietalia maritimae*: pioneer saltmarsh

Description
These communities are composed largely of annuals, occurring at lower elevations in saltmarsh or along creeksides where there is frequent tidal inundation.

Ecology
Colonisation of mudflats by annual salt tolerant species, primarily *Salicornia agg*., occurs when seedlings can establish between tides, usually where seeds are able to settle for two or three days to allow roots to establish. Within a growing season large stands can develop although they are often destroyed by winter storms, which also help to disperse seed. Sediment type and other factors can influence the vegetation composition and there are two main communities that are often found in mosaics. One is dominated by *Salicornia agg*, the other by *Suaeda maritima*. The latter community can also be found on creeksides and borrow pits (Rodwell, 2000). Stands can be tall and vigorous where they occur and contribute to trapping of sediment brought in by the tides.

UK status and distribution
These communities are widely distributed around the UK, primarily within estuaries, where suitable conditions occur.

Atlantic salt meadows *Glauco-Puccinellietalia maritimae*: transition and driftline saltmarsh

Description
Transition and driftline types are found above the upper saltmarsh around Extreme High Water Spring tides (EHWS) and at/above Highest Astronomical Tide (HAT). There is a strong influenced of the vegetation adjacent terrestrial vegetation, generally where there are no artificial defences. Commonly this will be a damp grassland community where the land gradually slopes up into higher ground. Brackish wetland communities are also common along the line of fresh water seepages from higher ground down into the marsh. Other types can include mesotrophic grassland, swamps or reed stands (Boorman 2003, Rodwell 2000)

However, there is a range of other transition communities from the transition into sand dune or dune slack to the uncommon saltmarsh woodland transitions found in the southwest of England. Where shrubby sea-blite is dominant, this forms the Mediterranean and thermo-Atlantic halophilus scrubs.

Ecology
Driftline at the extreme landward edge of saltmarshes is characterised by tall grass-dominated swards usually growing over nutrient-rich tidal litter. The transitional habitats are influenced by local conditions where there is a combination of limited or

infrequent tidal influence and low soil salinity, often linked with some influence of freshwater seepages and/or periodic light disturbance. (Rodwell 2000). There are some distinctive moderately nutrient rich (mesotrophic) grassland types with salt tolerant sub-communities (Rodwell 1992) and elements of these can occur on grassy sea walls (Adnitt et al 2007). Swamp vegetation can occur where brackish water predominates. The transitional communities support a number of rare saltmarsh species and maritime grasses (Adnitt et al 2007).

UK status and distribution
All sites will have some element of transitional and driftline vegetation which will vary depending on the presence or absence of artificial sea defences and adjacent semi-natural terrestrial habitats. Some of the wetland types are limited in extent, although reed stands are more widespread where suitable conditions occur. The transitional communities are often limited in extent and only cover a narrow band above the upper saltmarsh or saltmarsh drfiltline. Although often only covering a limited extent, unbroken sequences of saltmarsh zonation to other habitats are an important element where they occur.

Coastal lagoons

Description
Coastal lagoons are typically areas of shallow, coastal saline water, which vary in size. These are wholly or partially separated from the sea by a barrier which may be sandbanks, shingle, rocks or other hard substrates. Salinity varies, ranging from brackish, to hyper-saline (Bamber et al., 2001). Coastal lagoons may be natural or man-made and are often ephemeral (Joint Nature Conservation Committee (JNCC), 2007a). Several types of lagoon have been identified, based on the barrier type and the degree of isolation from the adjacent sea or estuary (European Nature Information System (EUNIS), 2013).

Ecology
Plant and animal communities vary considerably between lagoons, depending on the type and salinity of the lagoon (Joint Nature Conservation Committee (JNCC), 2007a). Some species occur frequently, including eelgrass, pondweeds and stoneworts and the fauna is often characterised by shrimps, worms and molluscs (McLeod et al., 2008c).

Environmental conditions in lagoons are highly variable, both in time and space and can be affected by tidal incursion, rainfall, sedimentation and vegetation encroachment; this variability causes comparatively severe environmental stress. Coastal lagoons support a number of ‘lagoon specialist species’, which are able to tolerate the stressful environment and are almost entirely restricted to lagoons. Specialist communities include species such as the starlet sea-anemone *Nematostella vectensis* and the lagoon sea-slug *Tenellia adspersa* (Bamber, 2010).

UK status and distribution
Coastal lagoons are a relatively uncommon habitat in the UK and some lagoon sub-types have a very limited distribution, e.g. soft-sediment lagoons are largely restricted to the east coast of England. They are also scarce in Europe (McLeod et al., 2008c).

Coastal lagoons ©JNCC

Dunes: dunes with *Hippophae rhamnoides*

Description
This feature usually occurs on more stable sediments, occasionally in more mobile dunes. It has been planted widely into dune systems outside its normal range of open dune grassland.

This is a tough, deciduous, spiny shrub with silvery-grey foliage and female plants show orange berries in late summer. It can form extensive stands, and can become invasive to the detriment of other dune grassland species.

Ecology
The dominant species, sea buckthorn, is tolerant of exposure, grows vigorously through suckering and produces prolific seeds. It thrives in open conditions and can tolerate a degree of sand accretion. By fixing nitrogen from root nodules it can cope with nutrient poor soils and expands in the absence of grazing. Once established, soil development and increased shade lead to shifts from open dune flora to rank species-poor understory (Joint Nature Conservation Committee (JNCC), 2007l). Different stages of the vegetation provide some variation in cover and species composition, but the climax community found in the Netherlands is not described in the UK

UK status and distribution
The natural range in the UK is restricted to the east coast of England (Joint Nature Conservation Committee (JNCC), 2007l). It is naturalised beyond these locations mainly from deliberate planting in attempts to stabilise dunes, and control visitors (Rooney et al., 2009), but is now also actively removed as part of conservation management to restore fixed dune grasslands (Joint Nature Conservation

Committee (JNCC), 2007l, McLeod et al., 2008d). It is robust and difficult to manage: without management it could develop into a form of dune scrub (Joint Nature Conservation Committee (JNCC), 2007l). There is limited knowledge of successional processes, and management activities may require designing to enable a range of different stages to develop (Rooney et al., 2009).

Dunes: dunes with *Hippophae rhamnoides* ©Natural England/Peter Roworth

Dunes: embryonic shifting dunes

Description

Embryonic sand dunes occur where seed or plant root fragments colonise low accumulations of blown sand near the tidal limit. These are ephemeral communities that can recolonize after storm events as well as acting as a pioneer community to other dune habitats, specifically the higher marram-dominated shifting dunes. A supply of sand from the beach plain and the presence of tidal litter to initiate sand trapping are essential factors (Joint Nature Conservation Committee (JNCC), 2007i).

Ecology

Embryonic sand dunes have a limited species composition, dominated by a restricted range of sand-binding perennial grasses, typically sand couch and lyme-grass. These species are more tolerant of salt water than marram grass, which can also be present but is not dominant in this dune zone. A limited number of salt tolerant annual herbaceous plants such as saltwort, sea rocket and various oraches can occur in this community, often in a band just above the strandline. The community responds to accretion and erosion and needs to recolonize after winter storms; it is highly dynamic and often varies in extent and species composition from year to year (Joint Nature Conservation Committee (JNCC), 2007i).

It is critical that the beach is big and high enough for sand to dry between tides and become mobile in onshore winds (Maddock, 2008). Where sand supply is abundant and conditions allow, the community can persist and grow in height producing hummocks up to 1-2m high. This reduces tidal inundation and enables the sand-binding, perennial grasses to colonise. In time, the community can become

dominated by grasses and develop into the marram-dominated dune building communities ('white dunes') (Joint Nature Conservation Committee (JNCC), 2007i).

This presence of embryonic dunes as part of a sequence of dune habitats, and growth of this element to seaward is indicative of an active and functional blown sand system.

UK status and distribution
Embryonic shifting dunes are widely distributed around the UK and European coastlines (McLeod et al., 2008e) but are highly fragmented and not extensive. The habitat is rare, occupying only a few hundred hectares, and is declining (Joint Nature Conservation Committee (JNCC), 2013e).

Dunes: fixed dunes with herbaceous vegetation – 'grey dunes'

Description
Fixed and semi-fixed dunes occur where sand mobility declines so that marram is less dominant and other species colonise. Natural variations in topography and other factors mean this habitat type is one of the most species-rich elements of dune systems, occurring landward of shifting dunes. Fixed dunes are usually dominated by a short grassland sward with less bare sand than the mobile dunes. Soils are typically poor which enables slow-growing species to persist, but also allows for some minor sand mobility within the systems

Ecology
Fixed dune grassland in the UK consists of a short sward characterised by red fescue and herbaceous species such as lady's bedstraw. It is also typically rich in plant species of calcareous substrates, although there is variation within and between sites. The vegetation can support a rich diversity of higher and lower plants including orchids such as pyramidal orchid.

A specific regional variation of dune grassland, in which *Geranium sanguineum* (bloody crane's-bill) is prominent, is particularly characteristic of north-east England. In areas with a drier and more continental climate, such as Norfolk, and where the substrate is more acidic, the fixed dune vegetation is rich in lichens. Although marram-grass may still be present, it loses its dominance as sand mobility decreases and organic content increases (Joint Nature Conservation Committee (JNCC), 2004c, Maddock, 2008). Unlike some of the more dynamic mobile dunes, management is an important factor to address issues of over-stabilisation, scrub encroachment and nutrient enrichment (Houston, 2008).

UK status and distribution
Fixed dunes have a widespread but fragmented distribution along the UK and European coastlines (McLeod et al., 2008g). Examples vary enormously but all are

given ‘priority habitat’ (European Commission (EC), 1992) status across Europe. The UK hosts much of the ‘Atlantic grassland’ type (Joint Nature Conservation Committee (JNCC), 2007k). Although most of this is found in Scotland, approximately 12000ha lies in England (McLeod et al., 2008g), however only 3900ha of this corresponds to the Annex 1 habitat (Radley, 1994).

Dunes: fixed dunes with herbaceous vegetation – ‘grey dunes’ ©Natural England/Ruth Critchley

Dunes: shifting dunes along the shoreline with *Ammophila arenaria* – ‘white dunes’

Description

Shifting dunes with marram form a distinctive community that links embryonic and fixed or semi-fixed dunes, sharing some characteristics with both. However, these dunes always have active blown sand deposition. Marram-grass is also always present, usually forming the highest dune ridges in the system and can exclude almost all other species (Joint Nature Conservation Committee (JNCC), 2007j, McLeod et al., 2008n).

The sand-binding ability of marram allows it to grow rapidly through accreting sand, so it plays a key role in dune-building. This is a dynamic vegetation type maintained only by sand dynamics. It can occur on both accreting and eroding dunes, but will rapidly change and disappear if stability is imposed. It rarely occurs in isolation because of its dynamic nature and because forms part of a succession with other dune habitats (Joint Nature Conservation Committee (JNCC), 2007j).

Ecology

Marram is not tolerant of high salinities, so only becomes vigorous when the beach level is raised above the tidal influence by sand accretion. It will colonise from seed and rhizome fragments and once established has the capacity to keep pace with burial by blown sand, thus promoting sand accretion. Other plant species include lyme grass, sand sedge, cat’s ear and sea bindweed as well as other grasses and

annuals reflecting the degree of sand movement, location and distance from the shoreline.

In time, this habitat can form ridges up to 15m in height and extend 100-200m inland. The characteristic sward is usually open and the amount of bare sand helps define the type and health of the system. However, as the amount of blown sand decline inland, so does the vigour of the marram and more species colonise, leading to development of semi-fixed and fixed dunes (European Nature Information System (EUNIS), 2013, Joint Nature Conservation Committee (JNCC), 2004c).

UK status and distribution
Shifting dunes with marram are found throughout the UK and European coastlines (McLeod et al., 2008n) where conditions allow the development of dune systems.

Dunes: shifting dunes along the shoreline with Ammophila arenaria – 'white dunes' ©Natural England/Paul Glendell

Estuaries

Description
Estuaries lie at the boundary of rivers and sea, extending from the highest point of tidal influence to the open sea. There is usually a strong freshwater influence but they are dynamic and experience constant change in terms of tides, salinity, freshwater flows and sea level rise. The result is a complex series of inter-dependent intertidal and subtidal habitats (McLeod et al., 2008f).

Ecology
The structure of estuaries is heavily influenced by physical factors such as geology, topography, erosion and deposition. Four main types of estuary are recognised:

- *Coastal plain* – where pre-existing valleys were flooded at the end of the last ice age
- *Bar-built* - where sand-bars or spits grow across the mouth of an estuary reducing tidal influence
- *Complex* - formed by a variety of geomorphological influences
- *Rias* - drowned river valleys typically found in south-west England (McLeod et al., 2008f)

Variable current velocities, reduced wave action, and high sediment loads typically encourage the establishment of subtidal sandbanks, intertidal mudflats, saltmarsh and reedbeds. Diversity can also be provided by rocky outcrops and reefs. These varied habitats support a range of plant and animal communities that differ in type, distribution and extent according to location, currents, sediment type and salinity (McLeod et al., 2008f). Nutrient inputs from the land make estuaries amongst the most productive environments in the world. This enables them to support important populations of invertebrates, shellfish, wintering birds and marine mammals; and provide migration routes for fish.

UK status and distribution
The UK has over 90 estuaries, around 25% of area of all north-western European estuaries (McLeod et al., 2008f)..

Estuaries ©JNCC

Grey seal *Halichoerus grypus*

Description
Grey seals are amongst the rarest seals in the world but the most numerous in English and UK waters. Adult males can weigh over 300kg and can live for over 20 years, while females usually weigh around 150 – 200kg and can live for over 30 years (Special Committee on Seals (SCOS), 2012).

Ecology
From August to December females typically return to the same breeding colony on beaches and rocky shorelines around the coast of England and the UK. Preferred sites are usually remote and allow movement inland to avoid both disturbance and bad weather (Special Committee on Seals (SCOS), 2012). Pups leave after a few weeks whilst adults undergo their annual moult. Females breed from the age of about five years, with usually one pup born each year. Adults typically feed in the same areas close to favoured haul-out sites but can also be found hundreds of kilometres out to sea (McConnell et al., 1999). They are probably capable of feeding at all depths found across the UK continental shelf and the diet comprises bottom

dwelling fish such as sandeels, whitefish and flatfish (Special Committee on Seals (SCOS), 2012).

UK status and distribution

The UK hosts around 111,000 grey seals, representing 38% of the global and 95% of the EU populations (McLeod et al., 2008r, Special Committee on Seals (SCOS), 2012). The latter, the 'East Atlantic Stock' is one of three discrete sub-species, the vast majority of which are found in and around the huge breeding grounds of the Outer Hebrides and Orkney (McLeod et al., 2008r) – about 13,000 are found in English Waters. Although overall UK population growth is levelling off, it continues to increase on English North Sea coast (Special Committee on Seals (SCOS), 2012).

Grey seal *Halichoerus* grypus ©Paul Keene/Natural England

Harbour (Common) seal *Phoca vitulina*

Description

Harbour seals are frequently seen hauled-out on remote sandflats (McLeod et al., 2008s). They are the smallest and least numerous of the two most common species in UK waters. Typically, both sexes weigh around 80-100kg, although males are slightly larger than females and, both live for up to 30 years (Special Committee on Seals (SCOS), 2012).

Ecology

Females give birth to single pups between June and August on remote sandflats or sandbanks before adults undergo an annual moult in August (Special Committee on Seals (SCOS), 2012). Whilst there are seasonal and yearly movements between sites, individuals tend to remain within the same geographical area. In winter, adults may leave inshore waters ranging up to 40-50km to feed before returning to haul out and rest. During summer they tend to forage around submerged sandbanks within a few kilometres of the haul-out sites (Joint Nature Conservation Committee (JNCC), 2013g, Thompson, 1993, Special Committee on Seals (SCOS), 2012). However, they can and do range much more widely (Special Committee on Seals (SCOS), 2012). Harbour seals are opportunistic feeders and eat a wide variety of prey including sandeels, herring and squid (Special Committee on Seals (SCOS), 2012).

UK status and distribution
Historically, harbour seal numbers have suffered from culling but collapsed following viral epidemics in 1988 and 2002 although numbers are now recovering and close to pre-2002 levels (Special Committee on Seals (SCOS), 2012). The UK now hosts an estimated 36,500 harbour seals of which just 5,500 are thought to occur in England (Special Committee on Seals (SCOS), 2012). Together, they represent about 30% of the *Phoca vitulina vitulina* sub-species which extends across the waters of north-western Europe. This is one of five discrete sub-species found throughout the northern hemisphere, In England, harbour seals are concentrated along the east coast especially at the Wash (the joint-largest colony in the UK); they remain widespread around Europe's Atlantic and Baltic coasts.

Harbour (Common) seal *Phoca vitulina* ©Allan Drewitt/Natural England

Large shallow inlets and bays

Description
Large shallow inlets and bays are found around the UK where large indentations of the coast provide some shelter from wave action (Joint Nature Conservation Committee (JNCC), 2007c). They are shallow (typically less than 30m depth) but dynamic, and experience constant change in terms of tides, salinity and sea-level rise. Unlike estuaries the freshwater influence is modest (European Nature Information System (EUNIS), 2013). The result is a complex series of diverse, inter-dependent intertidal and subtidal habitats (McLeod et al., 2008h).

Ecology
In England, two main types can be identified:

- Embayment - Where the coastline follows a concave sweep between rocky headlands, sometimes with only a narrow entrance; the two largest being Morecambe Bay and the Wash
- Ria – The lower reaches of drowned river valleys eg Plymouth Sound and the Fal Estuary (Joint Nature Conservation Committee (JNCC), 2007c)

Habitat and species diversity varies widely both between these two types and between sites according to location, size, depth, shape and geology. There is considerable variation between hard and soft coasts, and the degree of wave

exposure is a critical factor, influencing the status, composition and extent of animal and plant communities both above and below sea level (McLeod et al., 2008h). From the upper reaches of tidal influence to below the water line this habitat typically displays well-developed zonations of animal and plant communities (European Nature Information System (EUNIS), 2013).

UK status and distribution
Large and shallow inlets and bays are widely distributed around the UK coastline but display clear geographic variation. Rias are restricted to southern Wales, south-west England, and Shetland, and a third type, fjards are only found in western Scotland and Northern Ireland.

Large shallow inlets and bays ©Paul Lacey/Natural England

Mediterranean and thermo-Atlantic halophilous scrubs *Sarcocornetea fruticosi*

Description
This habitat type comprises perennial, salt-tolerant plants with a southern distribution in England. Typically, it is dominated by shrubby sea-blite and/or sea purslane but more uncommon components include rock sea-lavender and sea-heath which combine to provide a very distinctive community.

Ecology
The habitat is usually found in the upper levels of saltmarshes especially where there is a transition to dunes or shingle (McLeod et al., 2008i). Where this transition is truncated it can persist as a linear habitat along the high-tide mark or a sea wall (Joint Nature Conservation Committee (JNCC), 2007h). In an average year it will experience relatively few tidal inundations but will be subject to more regular wave-splash and sea-spray.

This community forms a Mediterranean component of the UK flora and probably reaches its northern limit in Europe on the Lincolnshire coast (Joint Nature Conservation Committee (JNCC), 2007h). However, species composition can vary and dense stands of perennial glasswort can dominate in some areas. Other variants feature fewer shrubs and more herbaceous species such as sea-lavenders alongside more common saltmarsh species, such as annual sea-blite and thrift

(McLeod et al., 2008i). There are also less common variants dominated by perennial glasswort that can be found further seawards (McLeod et al., 2008i).

UK status and distribution
This vegetation is the UK form of a habitat more typically found on the Mediterranean and Atlantic shores of southern Europe (European Nature Information System (EUNIS), 2013). The majority of the habitat is restricted to England (Joint Nature Conservation Committee (JNCC), 2007h) and substantial examples are limited to Chesil Beach, the Essex Estuaries and the Wash/North Norfolk Coast (McLeod et al., 2008i).


Mediterranean and thermo-Atlantic halophilous scrubs *Sarcocornetea fruticosi* ©Sue Rees

Mudflats and sandflats not covered by seawater at low tide

Description
Intertidal mudflats and sandflats are submerged at high tide and exposed at low tide. They are a major component of estuaries, inlets and bays but also continue along the entire open coast of England. The physical conditions of these environments determine the sediment size, from highly mobile coarse sand beaches on wave-exposed coasts, to stable, fine-sediment mudflats in more sheltered estuaries. The sediment type in turn determines the structure and composition of the intertidal communities that live in these habitats (Joint Nature Conservation Committee (JNCC), 2013b).

Ecology
Five sub-features have been identified that reflect these influences:

- Intertidal coarse sediments
- Intertidal mixed sediments Intertidal mud
- Intertidal sand and muddy sand
- Intertidal seagrass beds

Intertidal sedimentary habitats and communities are particularly dynamic and experience constant change. Sediment supplies can come from both marine and

terrestrial sources and are continuously reworked and redistributed as a result of currents, and tides. Communities are also heavily influenced by salinity, and overall extent is susceptible to changes as a result of sea-level rise. The result is a complex series of inter-dependent intertidal, subtidal and terrestrial habitats.

UK status and distribution
Intertidal mudflats and sandflats are widely distributed around the UK and European Atlantic coastlines (McLeod et al., 2008j). They can cover enormous areas and represent the largest component of estuaries (Maddock, 2008).

Mudflats and sandflats ©David Connor/JNCC

Mudflats and sand flats not covered by seawater at low tide: intertidal coarse sediment

Description
Intertidal coarse sediments are composed of pebbles and gravel, mixed with varying amounts of coarse sand (Connor et al., 2004c) – less on the upper shore and more on the lower. They are found towards the mouths of estuaries or on moderately exposed coasts between the high and low water marks where the wave action is normally too strong to allow the deposition of fine silts (Maddock, 2008). Linear coarse sediment features can also be found on less exposed shores where stormy conditions result in the deposition of coarse sediment ridges at the upper extremes of the littoral zone.

Ecology
The habitat is highly unstable – frequent wave and tidal action alongside winter storms ensures the almost constant redistribution of sediment. In addition, it drains quickly and can be subjected to extreme drying and changes of temperature between tides. Few sedentary species can tolerate this harsh environment and, if present at all, are usually robust, mobile animals such as small burrowing amphipods and crustaceans.

The habitat is very dynamic and there are transitions and overlaps between coarser and finer substrates in time and in location. During the calmer summer months, the

habitat can change markedly with juvenile barnacles establishing on larger more stable pebbles and the deposition of finer material. In winter, tidal energy increases, fine sediments are eroded and ephemeral animal communities are lost (Connor et al., 2004c). Together with a range of other estuarine habitats they form a series of interrelated habitats from subtidal channels to saltmarsh (Maddock, 2008).

UK status and distribution

Intertidal coarse sediments have a widespread but fragmentary distribution around the UK and Europe on, predominantly on exposed coasts (Connor et al., 2004c). Frequently, this habitat forms part of the 'estuary' feature.

Intertidal coarse sediment ©Amy Ridgeway

Mudflats and sand flats not covered by seawater at low tide: intertidal mixed sediments

Description

Intertidal mixed sediment is a highly variable habitat type, principally found in sheltered and moderately exposed locations in estuaries and inlets anywhere between the low and high water marks. It comprises a range of largely unsorted muds, sands, gravel and even rocks and boulders. The composition of the substrate varies both within and between sites and often grades into other, mud and sand-dominated habitats (Connor et al., 2004c, Maddock, 2008).

Ecology

Species composition and abundance is heavily influenced by exposure, salinity and sediment type. Diverse, productive examples occur in both sheltered and exposed locations, in brackish and saline waters respectively, where the mix of finer substrates supports a varied fauna and flora. Ragworms, lugworms, amphipods, molluscs, sandhoppers and shrimps are typically frequent but a broad range of animals will be present and barnacles, and red, brown and green seaweeds will establish on exposed surfaces of the larger (stable) boulders where present (Connor et al., 2004c, Maddock, 2008). Elsewhere, in estuaries, the variable salinity reveals a species-poor, but characteristic community dominated by ragworms but with cockles and oysters sometimes present (Maddock, 2008). Mixed sediments are

usually found in association with a range of other interrelated, estuarine, subtidal and intertidal habitats which together can extend over enormous areas.

UK status and distribution
Intertidal mixed sediments have a widespread but fragmented distribution around the UK (Connor et al., 2004c) and frequent form part of the 'estuary' feature.

Intertidal mixed sediments ©JNCC

Mudflats and sand flats not covered by seawater at low tide: intertidal mud

Description
Intertidal mudflats comprise clays, silts and very fine sands which often originate from land and are deposited by slow flowing rivers and streams in sheltered estuaries and inlets. In the intertidal zone, muds and clays are invariably deposited in low energy environments, and will grade into coarser muddy sand and sand where energy levels increase and fine particles are swept away. Intertidal mud in the form of estuarine mudflats can cover enormous areas (Maddock, 2008).

Ecology
Species composition and abundance is strongly influenced by salinity, sediment type, frequency and duration of inundation. All mudflats are regularly inundated for prolonged periods and little oxygen penetrates the finest sediment usually leading to the development of an anoxic layer just below the surface (Connor et al., 2004c). This prevents most vegetation except occasional patches of highly specialised pioneer saltmarsh communities. Occasionally, exposed stones and shells can provide a base for seaweeds (Maddock, 2008) and in summer, mats of algae can cover the surface where nutrient enrichment occurs. Provided conditions remain consistent, it is a stable, productive habitat populated by huge numbers of relatively few species, principally ragworms and lugworms, bivalve molluscs and snails with the greatest diversity found in more saline conditions (Davies et al., 2001). Littoral mudflats provide a vital food resource for wintering waders (Davies et al., 2001) and nursery areas for fish (Maddock, 2008). They form one of a series of interdependent estuarine habitats and usually found together and form part of a vertical transition from subtidal sediments to saltmarsh (Maddock, 2008).

UK status and distribution
Intertidal mud is widely distributed and can be abundant in sheltered estuaries and bays around the UK which hosts around 25% of the north west European resource (Davies et al., 2001).

Mudflats and sand flats not covered by seawater at low tide: intertidal mud ©Gavin Black/Natural England

Mudflats and sand flats not covered by seawater at low tide: intertidal sand and muddy sand

Description
Intertidal sands and muddy sands are a diverse mix of muds, sands and, occasionally, small shells and stones found between the low and high water marks. They occur from brackish to marine conditions with muds more frequent in sheltered estuaries and inlets, and sands more common in more exposed locations on or towards the open coast (Connor et al., 2004c).

Ecology
Specific circumstances are required to establish and maintain this habitat. Over time both sheltered and exposed conditions are required at the same location to allow the deposition and movement of muds and sands (Davies et al., 2001). In moderately exposed environments, tidal currents and wave action can cause characteristic rippling of the surface, a characteristic of the dryness of sands between tides. Coarse sands can dry quickly, are relatively mobile and support an impoverished fauna although a strandline of decaying seaweed is not uncommon, often supporting a characteristic community of sandhoppers (Connor et al., 2004c). A greater component of mud is typical of more sheltered and stable, less saline, upper estuaries and produces a typical fauna of amphipods, lugworms with locally abundant cockle populations in places. On the lower shores, mussel and seagrass (*Zostera* spp) beds can develop (Davies et al., 2001). Sandy beaches vary throughout the year, with the accretion of finer sediments in the calmer summer months before the finer sands are eroded in winter leaving a coarser substrate; muddy beaches are more stable and display a seasonal cover of green seaweeds where there are inputs of fresh and/or nutrient-rich waters (Connor et al., 2004c).

The habitat is usually found with other interrelated, intertidal habitats which together can cover enormous areas. There is frequent overlap between types and transitions with intertidal and subtidal communities are common (Maddock, 2008).

UK status and distribution
Intertidal sands and muddy sands are widespread around the UK in estuaries, inlets and bays where there is some protection from wave action (Connor et al., 2004c).

Intertidal sands and muddy sands ©Amy Ridgeway

Mudflats and sand flats not covered by seawater at low tide: intertidal seagrass beds

Description
Intertidal seagrass beds comprise dense stands of *Zostera* species on intertidal muds and sands in sheltered estuaries and bays in brackish or near-marine conditions (Connor et al., 2004c). When exposed, the long (20cm to 100cm), ribbon-like leaves collapse on the surface of the foreshore but when submerged, trail in tidal currents. They can form unbroken transitions with subtidal seagrass communities and pioneer saltmarsh (Maddock, 2008, OSPAR Commission, 2008).

Ecology
Seagrasses are amongst the very few flowering plants able to grow in the sea but each one requires differing degrees of tidal inundation from frequent to total submergence to thrive; this also determines their position on the foreshore. All possess long rhizomes which produce new shoots enabling the community to spread rapidly and stabilise what would be a fragile habitat and all provide a habitat for a range of other species throughout the tidal cycle (OSPAR Commission, 2008). On the upper shores, *Zostera* may be accompanied by the most salt tolerant pioneer salt marsh species, such as *Salicornia*.

The associated animal community comprises lugworms and ragworms, snails and bivalve molluscs although this is heavily influenced by sediment type, salinity and exposure. *Zostera* leaves can be colonised by diatoms and the algae *Enteromorpha* which can also cover the surface of the mud. However, an anoxic layer is usually present just below the surface (Connor et al., 2004c, OSPAR Commission, 2009b).

When submerged, Zostera beds are a valuable nursery for fish and when exposed are an important food resource for wintering wildfowl (Maddock, 2008). Heavy grazing may reduce the extent of the community, as can cold weather, but where the rhizomes remain in place, rapid recoveries can be made (Connor et al., 2004c). Where entire beds are lost, recovery (if possible) may take a considerable time (OSPAR Commission, 2009b).

UK status and distribution
Seagrass beds are sparsely distributed around the UK (Connor et al., 2004c) and European coasts (OSPAR Commission, 2008) although they can occupy enormous areas (Maddock, 2008).

Mudflats and sand flats not covered by seawater at low tide: intertidal seagrass beds ©Natural England

Otter *Lutra lutra*

Description
The otter is a semi-aquatic mammal found in and alongside a wide range of waterbodies across England. They are one of the largest predators in the country and are opportunistic feeders; although fish dominates their diet, they will also take amphibians, invertebrates and both small mammals and birds.

Ecology
Otters are territorial and usually occupy solitary ranges, although they are also known to occupy overlapping territories in coastal areas and in freshwater lakes. They can be found in rivers, streams, lakes, rocky shores and estuaries which ideally should have good water quality, abundant prey and suitable terrestrial habitat (e.g. vegetated river banks, reedbeds and woodland) for resting (in holts or couches) and breeding (McLeod et al., 2008t). Range size depends on gender, prey availability, shelter and population size but can extend from 4 to 40km for a male (Joint Nature Conservation Committee (JNCC), 2007p) and may incorporate areas of poor quality habitat.

Breeding can occur throughout the year and traditional sites are often returned to year after year. Females give birth to up to four cubs and they may remain with their mother for up to a year, which can limit breeding to once every 2 years (Natural

England (NE), 2011). Typically, they live for 3 or 4 years and causes of death include road-kills, accidental capture by fishing equipment, starvation, and injury/disease (Joint Nature Conservation Committee (JNCC), 2013d).

UK status and distribution

Otters once occurred throughout most of the UK but habitat loss, pollution and, especially, pesticide pollution caused a population crash from the 1960s to 1970s. However, improved protection, regulation of pesticide use, improved water quality and management have allowed numbers to increase; the otter has reclaimed much of its former range and can now be found throughout the majority of the UK (Joint Nature Conservation Committee (JNCC), 2013d). Scotland remains its stronghold but in England, it is now only really absent from coastal areas, the south-east and the urban north-west (Natural England, 2013). In 2010, the population in England was estimated at 2,788; almost double that of 10 years previously (Crawford, 2010). In Europe, it is widespread in Greece, Eastern Europe, Spain and Portugal but scarce to extinct elsewhere (McLeod et al., 2008t).

Otter *Lutra lutra* ©David Morris

Reefs

Description

Reefs are rocky or biological structures that rise from the seabed. They are generally found below sea level but may extend as an unbroken transition onto the shore where they are exposed at low tide. They support a characteristic zonation of plant and animal communities that vary according to the physical conditions at the site (European Nature Information System (EUNIS), 2013).

Ecology

Two main types of reef can be recognised: those where animal and/or plant communities develop on rock or stable boulders and cobbles (rocky reefs), and those where structure is created by the animals themselves (biogenic reefs) (Joint Nature Conservation Committee (JNCC), 2007d).

Rocky reefs are by far the most abundant and diverse. They are characterised by communities of attached seaweed (algae) and invertebrates and support a range of

mobile species such as fish and crustaceans. The different plants and animals present vary with depth (and therefore light), geology, topography and exposure to waves and currents. Shallow reefs will be dominated by algae such as kelp forests, whereas deeper reefs will be dominated by animals like sponges, corals and sea-squirts (McLeod et al., 2008k).

Biogenic reefs are created by dense populations of the same reef-building animal growing on and over one another. Like rocky reefs, they are influenced by temperature, salinity, depth and turbidity and are far less common. In English waters the main biogenic reef building species are: blue mussels; horse mussels and tube-building *Sabellaria* worms (McLeod et al., 2008k).

UK status and distribution
Reefs are widely distributed around the UK and European coastlines and seas. In the UK, they are found both inshore and offshore but rocky reefs are far more frequent and abundant, reflecting the more limited distribution of reef-building animals (McLeod et al., 2008k).

Reefs ©Natural England/Peter Wakely

Reefs: circalittoral rock

Description
Circalittoral rock comprises bedrock and, stable boulders and cobbles in waters beyond the influence of sunlight. In turbid waters the 'circalittoral zone' can begin quite close to the surface but extends down to the limits of wave influence, perhaps 200m or more. As light diminishes, seaweeds struggle to grow and are gradually replaced by animal-dominated communities (Connor et al., 2004a).

Ecology
Species composition and abundance is highly variable and influenced by a range of factors including wave action, tidal streams, water quality, geology and, especially, topography. The presence of cliffs, overhangs, gullies and large boulders, creates a variety of physical conditions that enables the establishment of extremely diverse communities. The strongest currents promote diverse, robust communities of barnacles, hydroids, sea firs, and sponges – animals that are able to attach firmly to,

and can encrust suitable, stable surfaces. In less exposed locations, cup corals, sea-fans and anemones are able to establish and mobile species, such as starfish and sea urchins become more frequent; in shallower waters, red seaweeds can occur. In sheltered, often deeper waters, soft corals and sea squirts may persist alongside encrusting red algae and brachiopods (Connor et al., 2004a, McLeod et al., 2008k).

UK status and distribution
Circalittoral rock is found all around UK and European coasts from open, exposed shores to narrow straits (Connor et al., 2004a); more sheltered examples are limited to Scottish sea lochs and isolated sites in south-west England (Connor et al., 2004a).

Reefs: infralittoral rock

Description
Infralittoral rock comprises shallow, permanently submerged bedrock, stable boulders and cobbles on open and sheltered coasts (Connor et al., 2004b). The infralittoral zone lies immediately below the low water mark and extends to the depth at which light is able to support the characteristic kelp forest and seaweed dominated communities, typically 20m.

Ecology

Light is a critical factor but the composition and distribution of infralittoral rock communities is also shaped by exposure to, and the strength of wave action and tidal currents (Connor et al., 2004b). On rocky, exposed coasts kelp forests and the smaller red algae are frequent, although in the strongest currents - and in the shade of caves and overhangs - these are replaced by sponges, sea squirts and other animals (Connor et al., 2004b). In less exposed locations, kelp forests dominate with a rich understorey of delicate red algae (Connor et al., 2004b) which may be grazed by sea slugs and sea urchins. Elsewhere, strong tidal streams can mobilise fine sediments creating turbid conditions. Seaweeds still dominate but, as light becomes a limiting factor, species composition changes with sugar kelp, coralline algae and more filamentous species often dominating (Connor et al., 2004b).

UK status and distribution
Infralittoral rock is widely distributed in a thin band around the rocky coasts of Europe. In the UK, examples are restricted to locations along the west, south-west and north-east coasts (Connor et al., 2004b).

Reefs: Infralittoral rock ©JNCC

Reefs: intertidal biogenic reefs - mussel beds

Description
intertidal mussel beds comprise extensive, robust, tightly-packed groups of blue mussels, *Mytilus edulis* on a range of muddy and sandy substrates on exposed to sheltered coastlines around the UK.

Ecology
Blue mussels are frequently found as minor components of other shoreline communities. However where conditions allow, they can colonise extensive areas of the mid to lower shores of mixed coarse sediment (ie gravels, pebbles and cobbles) on muddy and sandy beaches (Connor et al., 2004c). They can be found in huge numbers forming robust structures where dead and living individuals and other detritus are bound to each other and the surface by 'byssal' threads (OSPAR Commission, 2008). With age, this community increases in size and structural complexity and can form well-developed hummocks and/or ribbon-like structures that can occasionally extend unbroken into the subtidal zone. Where conditions are suitable, these structures create a range of constantly evolving niches and habitats for a diverse and abundant fauna and flora more often found on rocky shores to form a true 'biogenic' reef.

Species composition and abundance is highly variable and heavily influenced by location, sediment type, tidal inundation and more but characteristically include seaweeds, barnacles, bryozoans, winkles, shore crabs, other bivalve molluscs and worms (Maddock, 2008). Exposed mussel beds also provide an important food resource for a range of wintering and passage shorebirds (OSPAR Commission, 2008).

UK status and distribution
Blue mussel beds are widespread around the UK and European coastline although more extensive, true biogenic reef examples are less common, often restricted to

sheltered inlets and bays (Joint Nature Conservation Committee (JNCC), 2007d, McLeod et al., 2008k).

Reefs: intertidal biogenic reef – mussel beds ©Natural England

Reefs: intertidal biogenic reefs - *Sabellaria alveolata*

Description
Sabellaria alveolata is a polychaete worm which builds tightly packed tubes of sand and shell fragments to create a distinctive honeycomb structure on exposed beaches of coarse sediments or bedrock, in brackish or marine conditions. Where sand is plentiful, reefs can grow up to 1m thick and coalesce to produce formations hundreds of metres across (Maddock, 2008).

Ecology
Sabellaria 'biogenic' reefs are found on the lower shore of exposed, but stable gravelly beaches or hard rock with moderate to strong wave action. Crucially, they also require a supply of suspended sand to build their tubes. At low densities, tubes lie flat on the foreshore but as the colony grows, competition drives these tubes upwards and outwards to produce the characteristic shape.

Individuals live for several years but the reefs last longer. At first little else grows but brown, green and robust red seaweeds, anemones, barnacles, worms, mussels and winkles will colonise over time and older reefs can stabilise what could be a fragile beach (Maddock, 2008, Connor et al., 2004c). Typically, honeycomb reefs are found below a line of ephemeral green seaweeds and above an area of robust red seaweeds and kelp (Connor et al., 2004c).

Occasionally, the reef can form an unbroken transition with a subtidal variant of this community. They can be lost to storm damage but can be resilient as surviving adults facilitate larval settlement. They can also withstand burial under sand for several weeks and regeneration within a season is possible (Connor et al., 2004c). However, declines have been noted in recent decades (Maddock, 2008).

UK status and distribution

Their specific requirements limit honeycomb reefs to a highly fragmented distribution around the UK coastline, largely restricted to the exposed coasts of south-west England, west Wales and Morecambe Bay/Solway Estuary (Connor et al., 2004c). This forms the north-eastern limit for the species in Europe where the distribution is similarly widespread but fragmented being present from the Mediterranean to the Atlantic.

Reefs: intertidal biogenic reef - *Sabellaria alveolata* ©Natural England

Reefs: intertidal rock

Description
Intertidal rock habitats comprise 'rocky reef communities on exposed bedrock, boulders and cobbles between the low and high water marks (Connor et al., 2004c). They can be extremely variable in their structure and the communities they support (Davies et al., 2001) but typically share a characteristic fauna and flora of mussels, barnacles and seaweeds. Where these communities occur on the shore is dictated by the amount of time they are exposed to air during a tidal cycle.

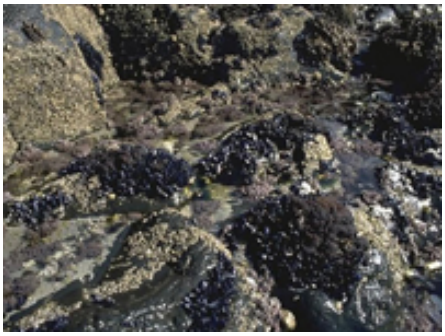
Ecology
The habitat is heavily influenced by the degree of tidal inundation and wave action (Connor et al., 2004c). In the highest energy environments, strong wave and tidal action removes fine sediments to expose rock walls, ledges, caves, pools and boulders. In sheltered conditions, fine sediment increases and rocky substrate is often associated with muddy foreshores.

Species composition varies from a typical animal-dominated community of mussels, limpets, barnacles and robust seaweeds in the most exposed conditions of strong waves and tide-swept shores (Connor et al., 2004c), to dense beds of fucoid seaweeds in sheltered locations(Connor et al., 2004c). Often distinct zones of dominate species are apparent down the shore, with robust lichens and barnacles at the top with more diverse seaweed communities, perhaps dominated by the wrack *Fucus serratus*, more abundant closer to the low water mark.

On sheltered coastlines, seaweeds typically dominate the foreshore and can be abundant although the increasing component of sand deposited between rocks and boulders can also allow extensive mussel beds to develop (Connor et al., 2004c). The composition, abundance and position on the foreshore of all these communities can also be modified by rock type, topography, salinity, freshwater input and the amount of time they are exposed to air during a tidal cycle (Connor et al., 2004c, Davies et al., 2001). Seasonal changes can also be apparent; in spring and summer red, green and brown seaweeds can dominate the foreshore (Connor et al., 2004c).

UK status and distribution

Rocky shores are found throughout the coastlines of the UK and Europe (Connor et al., 2004c, McLeod et al., 2008k); it is less abundant in estuaries (Maddock, 2008). In the UK, it is largely restricted to the south-west and north-east of England, and the west of Scotland and Wales.



Intertidal rock ©JNCC

Reefs: subtidal biogenic reefs - mussel beds

Description

Sublittoral mussel beds are permanently submerged, densely packed groups of horse *Modiolus modiolus* and/or blue mussels *Mytilus edulis*. Both can grow to 20cm or so in length (although most are much smaller) and both can have blue, brown or purple shells. They can thrive in brackish or saline conditions, on soft or rocky shores, in sheltered estuaries or on the exposed coast (Connor et al., 2004d). They can be found as extensions of intertidal mussel beds, or alone, and although blue mussels are limited to depths no more than 10m or so, horse mussels can be found as deep as 280m (Maddock, 2008, Tyler-Walters, 2007).

Ecology

Both species are often found as components of other communities, but where conditions allow, they can occur in huge numbers with living and dead individuals, and the sea bed, all bound together by ‘byssal’ threads. Together, these form robust, ‘biogenic ‘ reef structures that stabilise unconsolidated sediments and create structural diversity in what can be otherwise featureless, uniform expanses of fine sediments (OSPAR Commission, 2008). They can form mounds several metres

high and cover enormous areas enabling mussel reefs to support a diverse fauna and flora; although species composition and abundance depends on salinity, currents, depth and other factors, sponges, anemones, sea snails, starfish and worms can all be present (Maddock, 2008).

UK status and distribution
Horse and blue mussels are widespread in UK and European shallow waters (Davies et al., 2001) but extensive beds are more scarce, with large horse mussel beds, especially, largely absent south of the Irish Sea and Humber Estuary. Mussel beds represent a fundamental component of the reef habitat.

Reefs: subtidal biogenic reefs – *sabellaria* species

Description
Sabellaria spinulosa (ross worm) is a polychaete, tube-building worm usually found as individuals or small groups, perhaps encrusting pebbles or kelp. However, where conditions are favourable it can create a dense, robust, 'biogenic' reef-like structure up to 60cm high extending over several hectares (OSPAR Commission, 2008).

Ecology
Sabellaria spinulosa reef is found on a range of soft, mixed and hard substrates in the lower intertidal/subtidal fringe (OSPAR Commission, 2008), in moderately exposed coastal waters to a depth of around 30m (Connor et al., 2004e). The sometimes massive structures provide structural diversity and also consolidate surrounding sediment to allow the establishment of species not usually found in adjacent habitats (Connor et al., 2004e, Maddock, 2008). This produces a diverse community of worms, bivalves, crabs, amphipods, bryozoans, sponges and more (Maddock, 2008, OSPAR Commission, 2008). Close to the shore, reefs may support populations of the similar *S. alveolata* on the surface and form unbroken transitions with intertidal reefs. *S. spinulosa* is tolerant of a wide range of conditions and requires only a firm substrate for initial attachment, strong currents and an abundant supply of sand in suspension (Maddock, 2008).

Ross worm reefs can persist for many years but remain fragile (Maddock, 2008). They are able to recover from minor damage as surviving colonies encourage larval establishment (Connor et al., 2004e) but are vulnerable to storm damage and disease and entire colonies (e.g. Waddenzee) can be lost in a single event/season.

UK status and distribution
Given its few requirements, *S. spinulosa* is naturally common around the British Isles with a wide distribution throughout the north-east Atlantic (Maddock, 2008, Connor et al., 2004e) and is tolerant of areas of disturbed, turbid water with a high sediment load (OSPAR Commission, 2008). Ross worm reef is an integral component of the broad reef habitat.

Reefs: subtidall biogenic reef - *sabellaria species* ©Elizabeth Wood

Reefs: subtidal stony reef

Description

Stony (or cobble) reefs comprise permanently submerged cobbles and boulders that lie on or embedded in a matrix of finer sediments (Irving, 2009). It is an uncommon habitat covering small areas where rocky outcrops occur in estuaries and bays which are sheltered to moderately exposed. The structural variety provided by stable cobbles and boulders, along with a constantly changing environment can encourage a diverse array of species, including corals, anemones and sponges that is far more diverse than its surroundings (Maddock, 2008). This description does not include offshore examples of this habitat.

Ecology

Like other subtidal rocky habitats, stony reef is heavily influenced by the rock type, light, salinity, tidal currents and the erosion/siltation regime (Maddock, 2008). However, the provision of hard surfaces, niches and crevices, between and below the constituent cobbles and boulders introduces three-dimensional diversity and abundant variations in aspect, shade, shelter and protection into what could otherwise be a featureless subtidal habitat.

In shallow waters, dense stands of red, brown and green seaweeds can establish even where strong tidal currents are present if boulders are large enough or sufficiently embedded to provide a stable platform. These seaweeds can normally tolerate a degree of turbidity but as silt levels increase or as light levels fail with increasing depth they are gradually replaced by animal-dominated communities – in turbid estuaries the infralittoral zone can be very shallow. Mussels, barnacles, anemones, sponges, bryozoa, hydroids, sea mats and sea squirts can form dense crusts in this tide-swept environment (Connor et al., 2004b, Connor et al., 2004a, Maddock, 2008). These features which can persist into deeper waters but can show significant changes from the brackish upper estuary to the near marine conditions of the estuary mouth, would otherwise be absent from the estuary and help provide important nursery grounds for estuarine fish.

UK status and distribution
Subtidal stony reef has only a fragmented distribution around the UK coastline restricted to sheltered locations with rocky outcrops (Connor et al., 2004b, Connor et al., 2004a). These form a fundamental component of the overall 'reef' habitat.

River lamprey *Lampetra fluviatalis*

Description
River lamprey are members of the most primitive group of vertebrates. The adults resemble eels but lack scales, paired fins and, crucially, lower jaws. Instead, the mouth is replaced by a sucker-like disc with numerous sharp teeth which they use to attach to and parasitise their prey (Maitland, 2003). Adults grow to around 30cm and 60g in weight.

Ecology
River lamprey are anadromous, spawning in freshwater but spending part of their lives in the brackish waters of open estuaries (McLeod et al., 2008u). In winter, adults stop feeding and migrate upriver until, in March or April, they spawn over simple depressions made in fine, clean gravels. Adults die after spawning and the larvae (ammocoetes) drift downstream before settling into soft, aerobic silts in nursery areas where they mature for several years feeding on particulates and micro-organisms. Metamorphosis to the adult, parasitic form takes place in the late summer prompting their movement down to the estuary where they feed on herring, sprat and flounder (Maitland, 2003).

Throughout this life-cycle, lamprey require good water quality, suitable flows, and unobstructed migration routes between spawning sites, nursery areas and estuaries (Joint Nature Conservation Committee (JNCC), 2007n, Maitland, 2003, Natural England (NE), 2013b).

UK status and distribution
River lamprey are widespread in estuaries and rivers throughout the UK and Western Europe (McLeod et al., 2008u, Maitland, 2003) although absent from the headwaters of rivers in central England (Natural England (NE), 2013b). Populations appear relatively stable and the range may be expanding alongside better management of waterways (Natural England (NE), 2013b).

Salicornia and other annuals colonising mud and sand

Description

This pioneer saltmarsh vegetation colonises intertidal mud and sandflats in places protected from strong wave action (McLeod et al., 2008l). The habitat is generally uniform and comprises a limited number of highly specialised plants. All are strongly salt tolerant and most are annuals, able to rapidly colonise large areas of foreshore when conditions allow.

Ecology

There are two forms of this community: one typically found on frequently submerged areas of mud, where it may represent a precursor to the development of more stable saltmarsh vegetation, and the other less frequently on disturbed areas within or at the edge of established saltmarsh. Its abundance and distribution is determined by elevation, the presence of fine sediments and sheltered waters, with both regular and prolonged tidal inundation. Most occurrences are ephemeral but it can persist for longer if conditions are suitable and perennials are present (Joint Nature Conservation Committee (JNCC), 2007f).

The extreme conditions provided by inundation ensure that only a handful of highly-adapted halophytic species can persist. Despite the limited species composition, three distinct communities can be recognised which reflect sediment type and the frequency of inundation which are characterised by the relative amounts of perennial glasswort *Sarcocornia sp.*, glasswort *Salicornia sp.* and annual seablite *Suaeda maritima*. Other typical components include common saltmarsh-grass *Puccinellia maritima*, sea aster *Aster tripolium* and the invasive common cord-grass *Spartina anglica* (Adnitt et al. 2007). A further form reflects the ephemeral community that colonises open pans in upper saltmarshes which includes sea pearlwort *Sagina maritima* and knotted pearlwort *S. nodosa* (McLeod et al., 2008l).

UK status and distribution

This pioneer community is widely distributed throughout coastal areas of England, the UK and Europe (McLeod et al., 2008l).

Salicornia and other annuals colonising mud and sand ©Chris Emblow/JNCC

Sandbanks which are slightly covered by seawater all the time

Description
Sandbanks are mounds of sediment with variable topography, which rise from horizontal or sloping plains of sandy sediments and whose crests are usually within 20m of the sea surface. Sandbanks can be elongated, round or irregular in shape and may (but not exclusively) be categorised as sandy mounds, open shelf ridge sandbanks, estuary mouth sandbanks or headland-associated sandbanks (Dyer and Huntley, 1999).

Ecology
The structure of sandbanks and the diversity of marine communities they support vary due to the degree of physical stress exerted by waves and currents, degree of coastal influence and the salinity of the surrounding waters.

Sandbank sediments are typically colonised by small crustaceans, worms, molluscs and echinoderms, able to rapidly burrow following disturbance. At the sediment surface sand-eels, shrimps and crabs are preyed upon by seabirds, sea ducks, seals and porpoises that each rely upon sandbanks as key feeding grounds. Sandbanks can be important nursery areas for a variety of fish including plaice and sole. Where stable sediment is present, seagrass, seaweeds and maerl may form, but only where there is sufficient light. In areas of mixed sediment, the presence of reef-building species such as *Sabellaria spinulosa* may help to stabilise the sediment, allowing the colonisation of sessile animals such as sea squirts and hydroids (Joint Nature Conservation Committee (JNCC), 2007b, Joint Nature Conservation Committee (JNCC), 2013a).

UK status and distribution
Sandbanks occur widely around the UK coast, being widespread in inshore waters and also occur offshore in the southern North Sea and Irish Sea (Joint Nature Conservation Committee (JNCC), 2007b, Joint Nature Conservation Committee (JNCC), 2013a).

Sandbanks which are slightly covered by seawater all the time: maerl beds

Description
Maerl is the collective name for a number of red seaweeds that possess hard, calcified ‘skeletons’ that create colourful, finely-branched structures on the sea bed. In English waters, there are two main species: *Phymatolithon calcareum* and *Lithothamnion corallioides*. Maerl beds can be found on the open coast or in tide-swept channels in brackish or near-marine conditions down to a depth of around

20m or so but are occasionally found at twice this depth in the clearest of waters (Joint Nature Conservation Committee (JNCC), 2007b).

Ecology

Maerl beds develop on coarse sands and gravels where waves and tidal currents are strong enough to prevent the deposition of fine sediments but not strong enough to damage their delicate structure. The seaweed grows from nodules (*rhodoliths*) on, but not attached to, the surface. These can occur in huge numbers and allow maerl to grow in dense beds but these are amongst the slowest growing plants in the world, growing just tenths of a millimetre per year. Although individuals can live and grow for hundreds of years they are extremely fragile and dead 'branches' are easily broken off and accumulate below on the sea bed (Joint Nature Conservation Committee (JNCC), 2004b). Where conditions allow, extensive beds can develop but even a healthy community may comprise just a thin, living layer above a mound of debris that may have taken thousands of years to develop (OSPAR Commission, 2008).

Maerl beds provide a three dimensional structure and support a range of characteristic communities. Healthy, living beds support a range of crustaceans, bivalve molluscs, sea-firs, sponges, sea cucumbers and a diverse algal flora. Dead maerl can still provide the same structure and continue to support similar plant and animal communities. The accumulated debris also provides opportunities for numerous worms, molluscs and crustaceans able to burrow into this coarse material (OSPAR Commission, 2008). Extensive maerl beds can also provide nursery grounds for a range of fish and shellfish.

UK status and distribution

Maerl beds have a widespread but fragmented distribution on the open coast and in tide-swept inlets around the UK and Europe (Connor et al., 2004d). In the UK they are only found in abundance in south-west England, and in the north and west of Scotland. Diversity is greatest in the south-west but there is a marked north-south distribution of the major components (Maddock, 2008).

Sandbanks which are slightly covered by seawater all the time: subtidal coarse sediment

Description

Subtidal coarse sediments are composed of a mix of permanently submerged, coarse sands and gravels that can extend from the low water mark down, typically, to a depth of 20m (or sometimes deeper) and are subject to some disturbance by wave action and tidal currents (Connor et al., 2004d) They are found as shallow deposits in estuaries, bays and on the exposed open coast (Connor et al., 2004d) and comprise the most abundant substrate type in UK coastal waters (Maddock, 2008).

Ecology
This widespread habitat displays very different origins; those to the west and south include a high proportion of shell fragments whilst those in the east are formed from rock. However, it is tidal currents and wave action that strongly influence the topography and stability of this habitat (Maddock, 2008). Surface features including ripples, sand waves and pronounced hummocks and hollows can be present over extensive areas (Maddock, 2008).

Species composition and abundance is determined by a range of environmental conditions. Brackish (estuarine) waters and shallow, highly exposed/mobile sediments experience low species diversity composed of highly robust species of worms and isopods and, perhaps, hydroids and bryozoans, with an impoverished surface fauna of crabs and whelks. Deeper, more sheltered waters are far more diverse and amongst the most productive marine habitats. These support anemones, worms, bivalves, amphipods and a varied mobile surface fauna (Maddock, 2008). Many of these communities are highly productive and can represent important nursery areas for fish and feeding grounds for seabirds and sea ducks (Davies et al., 2001).

UK status and distribution
Subtidal coarse sediments are widely distributed around the UK and European coastlines (Connor et al., 2004d) and form unbroken transitions with extensive, deeper seabed communities.

Sandbanks which are slightly covered by seawater all the time: subtidal mixed sediment

Description
Subtidal mixed sediments are permanently submerged areas of a highly variable mix of mud, sand, gravel, pebbles and cobbles that can be found in sheltered to moderately exposed conditions from the low water mark down to a depth of 30m or more (Connor et al., 2004d).

Ecology
The distribution and abundance of the different sediment types, and the degree to which they are mixed, is determined by the strength of tidal currents and wave action, and by the geology of the estuary and catchment. This directs the composition and abundance of the animal and plant communities which are further influenced by salinity, light, turbidity and more. Therefore, this habitat can be extensive, can be found throughout an estuary, at all depths and can support diverse animal-dominated communities.

Typically, in the upper estuary the substrate is dominated by muds, sands and perhaps fine gravel that allow only a limited range of ragworms and lugworms to dominate although cockles and oysters can sometimes occur (Maddock, 2008). This is due to greater freshwater input, lower the salinity and reduced currents and wave action. In more exposed locations with more saline waters, sands and gravel become more frequent and both burrowing anemones and bivalve molluscs dominate, more closely resembling fully marine communities (Maddock, 2008). The presence of larger pebbles and cobbles embedded in mud and sand suggests that the habitat also reflects seasonal (or even older) changes in erosion/deposition regimes. However, the general absence of stable, hard surfaces ensures that even in shallower waters, seaweeds remain relatively uncommon (Connor et al., 2004d).

UK status and distribution

Subtidal mixed sediments have a fragmented but widespread distribution all around UK and European coasts in sheltered or moderately sheltered estuaries (Connor et al., 2004d). The UK hosts around a quarter of the estuarine area of north-western Europe (Davies et al., 2001).

Subtidal mixed sediments ©Lin Baldock

Sandbanks which are slightly covered by seawater all the time: subtidal mud

Description

Subtidal muds are permanently submerged expanses of fine, cohesive sediments that extend from the low water mark down to a depth of around 10m in the most sheltered locations in estuaries, inlets and bays (Connor et al., 2004d). Sediment type, salinity, tidal currents and both light and oxygen levels determine the composition and abundance of what can be a varied animal community (McLeod et al., 2008f) and also the appearance of the habitat; sub-littoral muds can appear completely bare.

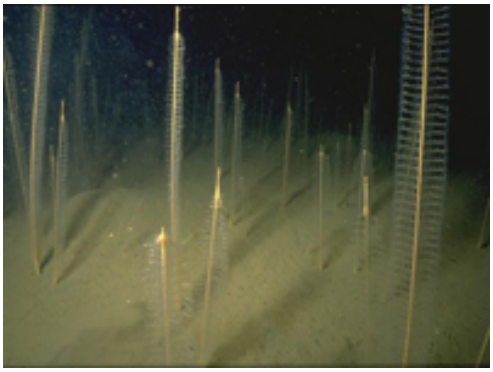
Ecology

Where freshwater flows carry large sediment loads, and the shape or depth of the estuary provides protection from the strongest waves and tidal currents, fine sediments in the water column can settle to form sometimes extensive subtidal

mudflats (McLeod et al., 2008f). These sediments, usually found in the upper reaches of estuaries, can support abundant populations of ragworms and lugworms but few other species (McLeod et al., 2008f). Elsewhere, in the finest sediments, a black, anoxic layer can develop just below the surface restricting the biota to a layer of bacterial mats (Joint Nature Conservation Committee (JNCC), 2004a). Subtidal muds are usually found, and form transitions with a range of other subtidal and intertidal estuarine habitats.

UK status and distribution

Subtidal muds have a fragmented but widespread distribution all around UK and European coasts in sheltered estuaries (Connor et al., 2004d). The UK hosts around a quarter of the estuarine area of north-western Europe (Davies et al., 2001), much of which is subtidal mud.



Subtidal mud ©JNCC

Sandbanks which are slightly covered by seawater all the time: subtidal sand

Description

Subtidal sand comprise a limited range of sandy substrates that extend from the low water mark down to a depth of around 20m (or sometimes deeper). They can be found in a range of locations from the exposed, open coast to tide-swept, sheltered locations in estuaries, inlets and bays. In exposed situations, the sediments are coarse, not usually cohesive and can be highly mobile; closer inshore, with more shelter silts and muds become more frequent and stability increases (Connor et al., 2004d).

Ecology

Typically, the high mobility of the sediment precludes a varied or abundant fauna or flora. The environment can be harsh and the fauna can be limited to opportunistic amphipods (Connor et al., 2004d). In slightly more stable conditions, sands are dominated by a robust fauna of burrowing worms, crustaceans, bivalve mollusc and echinoderms, with shrimps, crabs and perhaps sand eels on the surface, all tolerant of regular and/or periodic disturbance (Maddock, 2008). Where boulders and larger

shells provide stability and exposed surfaces, seaweeds and hydroids can be found but are normally uncommon (Connor et al., 2004d). Urchins and razor shells can establish in calmer, muddier locations.

The habitat is dynamic and considerable overlap with other both finer and coarser sediments is found. Overall, these habitats are often important nursery grounds for fish and, where near the surface, feeding grounds for seabirds and sea ducks (Davies et al., 2001).

UK status and distribution
Subtidal sands are widely distributed around the UK and European coastlines (Connor et al., 2004d).


Subtidal sands ©Lin Baldock

Sandbanks which are slightly covered by seawater all the time: subtidal seagrass beds

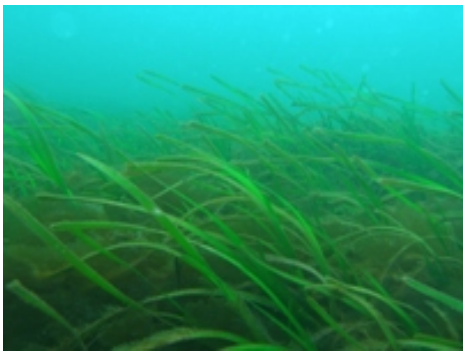
Description
Subtidal seagrass beds comprise dense, permanently submerged stands of *Zostera marina* (eel or seagrass). These grow on sandy muds, sands and gravels to a depth of 4-5m (or even deeper where light levels allow) that are sheltered from significant wave action but where tidal currents are strong enough to remove the finest sediments (OSPAR Commission, 2008) and are found in sheltered inlets, bays and estuaries in brackish or fully marine conditions (Connor et al., 2004d). Seagrass beds can stabilise subtidal sediments and promote accretion.

Ecology
Z. marina is one of very few flowering plants able to live in the sea. Extensive roots also produce new shoots enabling the plant to spread rapidly (up to 30m per year), stabilise the surface and create a diverse, productive habitat. The long, trailing, ribbon-like leaves (up to 1m in length) can be colonised by diatoms, algae, stalked jellyfish and anemones. The sediment can provide conditions suitable for a common but sometimes abundant community of amphipods, polychaete worms, bivalve molluscs and echinoderms. It is sometimes found in association with another flowering plant, *Ruppia maritime*, or *R. spiralis* (Connor et al., 2004d). Species

composition and abundance is determined by a range of factors but is both most diverse and abundant in sheltered, saline conditions (OSPAR Commission, 2008).

The combination of food resource and shelter maket seagrass beds an important nursery ground for a range of marine fish (Maddock, 2008) and a valuable feeding ground for sea birds. It can be subject to natural fluctuations and can be lost to increased turbidity, storms and disease (Maddock, 2008); recolonisation may take a considerable period of time (OSPAR Commission, 2009b).

UK status and distribution
Subtidall seagrass beds have a wide but fragmented distribution around the UK and European coastline (Connor et al., 2004d) but can be abundant covering extensive areas.



Subtidal seagrass beds ©Gavin Black

Sea lamprey *Petromyzon marinus*

Description
Sea lampreys are members of the most primitive group of vertebrates. They have an eel-like shape but lack paired fins or scales. Adult lamprey are distinct from other fish species in the British Isles as they have no lower jaw, instead the mouth resembles a sucker-like disc with numerous sharp teeth. They are the largest of the three lamprey species found around the UK and whilst they usually grow to around 50cm in length, they can reach 100cm and a weight of 2.5kg (Maitland, 2003).

Ecology
Most of the adult life is spent at sea but sea lamprey are anadromous and spawn in freshwater. On reaching sexual maturity, adults migrate from the sea to freshwater spawning grounds in slow-flowing stretches of water and in late May and June, eggs are laid onto simple nests or depressions created in gravelly stream beds (Maitland, 2003).

Adults die after spawning but the larvae (ammocoetes) drift downstream before forming burrows in silt or sand where they remain for several years, feeding on particulates and micro-organisms. Metamorphosis to the adult, parasitic form takes

place in August or September prior to their migration to the open sea. Adults feed by attaching on to the sides of other fish. Prey includes cod, sturgeon and salmon. Successful migration and spawning is strongly influenced by water flow, temperature and quality as well as the accessibility of suitable gravels and silts but little is known of their habitat requirements at sea (Maitland, 2003).

UK status and distribution

Sea lampreys are widespread in estuaries and rivers around much of the UK and the Atlantic coast of Europe (McLeod et al., 2008m, Maitland, 2003) but due to pollution and the obstruction of migration routes they occupy a more restricted range than was historically available. However, range and population are currently considered stable, with the possibility of a real expansion in both as water quality continues to improve (Natural England (NE), 2013a).

Spartina swards *Spartinion maritimae*

Description

This pioneer saltmarsh community is characterised by the presence of one or more of a small group of 'cord-grasses'. Members of this family have extensive root systems and upright stems, can grow to over a metre in height and can be found as isolated tussocks or extensive monocultures. They are robust, salt tolerant, can withstand frequent tidal inundation and are effective at trapping and stabilising soft, mobile sediments (Lacambra et al., 2004).

Ecology

In the UK, the *Spartina,* or 'cord-grass' family, comprises only four species: small cord-grass, *Spartina maritima* (the only true native species), smooth cord-grass, *S. alterniflora*, (an alien species introduced from America in the 19th Century), and two hybrids of these species, the sterile Townsend's cord-grass, *S. townsendii*, and the fertile common cord-grass *S. anglica*.

In sheltered locations in estuaries, all four species are able to colonise a range of substrates from muds and sands to shingle but are usually found on the edge of established saltmarsh where it is believed they encourage further accretion and the establishment of other saltmarsh communities.

However, whilst the first three are rare and confined to the south and/or south-east of England, the fertile hybrid, *S. anglica*, is abundant and widespread. In the 20th Century, *S. anglica* was planted extensively around the UK to stabilise mudflats and to promote land reclamation. However, it also spread to suitable habitat in estuaries around the English coastline, the North Sea and to temperate locations around the world (Lacambra et al., 2004). It is persistent and can displace other *Spartina* species, pioneer saltmarsh or seagrass (*Zostera*) communities and reduce the availability of mudflats for wintering birds (McLeod et al., 2008o).

UK status and distribution
In England, only stands dominated by *S. maritima, S. alterniflora* or that support *S. townsendii* are considered ecologically valuable and these are largely protected within the European site network. The species, *S. alterniflora* and *S. townsendii* are restricted to Southampton Water and abundant populations of *S. maritima* to the Essex coast (McLeod et al., 2008o). Elsewhere, *Spartina* swards are widely distributed along Europe's Atlantic coastline but reach their northern limit in southern England (Joint Nature Conservation Committee (JNCC), 2007g).


Spartina swards ©Iain Dixon/JNCC

Submerged or partially submerged sea caves

Description
Sea caves are found at or below sea level and can range in size from only a few metres in depth to those which may extend hundreds of metres into the rock (Joint Nature Conservation Committee (JNCC), 2007m). They are formed through a variety of mechanisms e.g. wave eroded sea caves or solutional caves, where the rock has been dissolved by freshwater to provide a range of vertical and overhanging rock faces (McLeod et al., 2008p).

Ecology
Communities living within sea caves are determined by a range of physical conditions including shade, scour, wave exposure, geology and size (Joint Nature Conservation Committee (JNCC), 2013f). These can change dramatically both within and between caves leading to a wide diversity and clear zonation of communities and species (McLeod et al., 2008p). This means each cave often has a unique make-up of wildlife ranging from scoured clean to exceptionally diverse with many rarities. All sea caves support similar habitats to, and are frequently found with rocky reefs (Joint Nature Conservation Committee (JNCC), 2007m).

Most are found in intertidal or shallow water. These are often high energy environments, subject to strong wave surge. When exposed to strong currents and waves, coarse sediment, cobbles and boulders lying on the cave floor can become mobile and scour the lower cave walls creating extreme conditions. Only a limited

range of species can tolerate these conditions including, mussels, barnacles, cushion sponges, encrusting bryozoans and colonial sea squirts (McLeod et al., 2008p). These caves can sometimes be used by seals for pupping, moulting or resting, without being disturbed.

Caves in deeper water enjoy more stable conditions. Currents and waves are less strong, silt may accumulate on cave floors and sponges, soft corals, solitary sea-squirts and bryozoans become dominant some of which are rare and unusual species. These caves, particularly where they are small, provide shelter for crabs, lobsters, crawfish and numerous fish (McLeod et al., 2008p).

With such ecological and structural variation as well as the difficulties associated with surveying caves underwater, it is difficult to identify characteristic species of sea caves (Joint Nature Conservation Committee (JNCC), 2007m, Joint Nature Conservation Committee (JNCC), 2013f); geology adds further complexity providing marked regional differences.

UK status and distribution
Sea caves are relatively scarce in Europe and the UK hosts the 'most varied and extensive sea caves on the Atlantic coast' (McLeod et al., 2008p); here, they are widely distributed around inshore rocky coasts.

Submerged or partially submerged sea caves ©Natural England/Paul Glendell

Twaite shad *Alosa fallax*

Description
Twaite shad is a small fish (40cm) with distinctive, large, circular scales 'which form a toothed edge on the lower margin' (McLeod et al., 2008v). It is deep blue along its back with silvery white sides with a line of black blotches behind the head. Although

adults are usually smaller, it is difficult to distinguish from its close relative, allis shad *Alosa alosa* and the two are thought to hybridise.

Ecology

Twaite shad is a shoaling fish of the open sea feeding on invertebrates and small fish to a depth of around 110m with a preference for water 10-20m deep (Taverny, 1991). It is migratory; each spring adults gather in estuaries of suitable rivers in early summer, hence the alternative name of 'May fish' (McLeod et al., 2008v) before moving upstream to spawn (mid-May to mid-July), in shallow, clean, well-oxygenated waters over gravel/cobble substrates. Twaite shad, unlike allis shad, may spawn several times during their lives. Eggs hatch after several days and the fry drift downstream to slow-flowing waters in the estuary to develop (Maitland and Hatton-Ellis, 2003). Good water quality, unobstructed migration routes and predictable water flows are vital requirements (Natural England (NE), 2013d). Studies have demonstrated strong fidelity to breeding grounds (Jolly et al., 2012). Twaite and allis shad are the only 2 members of the herring family found in freshwater in England.

UK status and distribution

Twaite shad is found along Europe's western coastline and recorded from many coastal waters around the UK (Aprahamian et al., 2003). However, a lack of reliable information means that accurate population estimates are not available (Joint Nature Conservation Committee (JNCC), 2013h). In the UK, it is now known to breed only in a few rivers in the Severn River Basin District, the Severn, Wye, Usk and Tywi (McLeod et al., 2008v). There are also non-breeding populations in the UK off the southern and eastern coasts, at Looe Bay, Hastings and Sizewell (Jolly et al., 2012) but otherwise, little is known of its marine requirements (Maitland and Hatton-Ellis, 2003).

Twaite shad *Alosa fallax* ©Wye and Usk Foundation

Vegetated sea cliffs of the Atlantic and Baltic coasts

Description

Vegetated sea cliffs are very variable due to differences in exposure, geology, geomorphology, abiotic processes, slope angle and level of naturalness. Maritime cliffs can broadly be classified as 'hard cliffs' or 'soft cliffs', although there are a number of intermediate types.

Hard cliffs are vertical or steeply sloping thus support few higher plants other than on ledges and in crevices or where a break in slope allows soil to accumulate. They tend to be formed of rocks resistant to weathering, such as granite, sandstone and limestone, but can be formed of softer rocks, such as chalk, which erode to a vertical profile.

Soft cliffs are formed in less resistant rocks such as shales or in unconsolidated materials such as boulder clay. Their instability means they often form less steep slopes and are therefore more easily colonised by vegetation. Soft cliffs are subject to frequent slumping and landslips, particularly where water percolates into the rock and reduces its effective shear strength (Maddock, 2008). Cliffs may often be associated with reef platform running from the foot of the cliff to the intertidal and subtidal zones as well as cliff top habitats with a maritime influence.

Ecology

On hard cliffs specialised vegetation types occur, often starting with a band of lichens in the splash zone. Ledges on steep cliffs support a maritime flora with species such as rock samphire *Crithmum maritimum* and rock sea spurrey *Spergularia rupicola*., or even saltmarsh species where sea spray or waves have a strong influence. Seabird nesting ledges enriched by guano support a particular community characterised by oraches *Atriplex* spp. and sea beet *Beta vulgaris* spp. *maritima*.

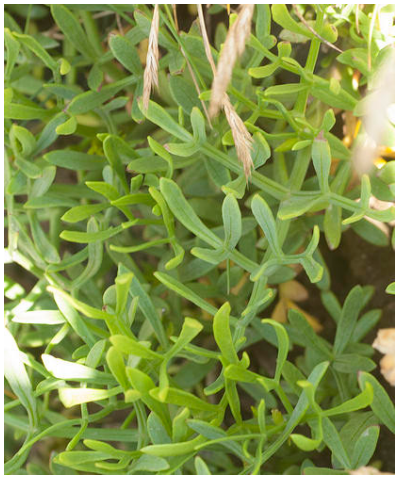
In less exposed locations, maritime grasslands occur on cliffs and slopes. Species found here include, a maritime form of red fescue *Festuca rubra,* thrift *Armeria maritima*, sea plantain *Plantago maritima*, buck's-horn plantain *P. coronopus* and sea carrot *Daucus carota* sap *gummifer*. Species of inland grasslands which also commonly occur in maritime grasslands include ribwort plantain *Plantago lanceolata*, bird's-foot trefoil *Lotus corniculatus*, common restharrow *Ononis repens* and several species of grass.

Locations which are more sheltered from the prevailing winds and salt spray support vegetation communities are more similar to those found inland, and are increasingly influenced by the chemistry of the substrate. These are also on more unstable glacial drift deposits and prone to landslips and rapid erosion. These create important niches for rare invertebrates.

UK status and distribution

Hard cliffs are widely distributed around the more exposed coasts of the UK, occurring principally in south-west and south-east England (the latter area having the bulk of the 'hard' chalk cliffs), in north-west and south-west Wales, in western and northern Scotland and on the north coast of Northern Ireland.

Soft cliffs are more restricted, occurring mainly on the east and central south coasts of England and in Cardigan Bay and north-west Wales.



Vegetated sea cliffs of the Atlantic and Baltic coasts ©Neil Pike/Natural England

Additional Supporting Habitats descriptions

Coastal Reedbeds

Description

Reed dominated vegetation can be common at the coast along the fringes of, or within, saltmarshes wherever salinity is reduced. On the inner parts of estuaries reedbeds can make up a major part of the vegetated intertidal zone, whilst on saltmarshes covered periodically by fully undiluted sea water reedbeds can be part of the transitional vegetation at the landward margin of saltmarshes, especially where freshwater seepages occur (Adam, 1981, Adam, 1990). In tidal areas, reedbeds may persist in a relatively stable state.

Unlike many inland freshwater reedbeds, coastal reedbeds in England generally have no history of commercial cutting. However, like their inland counterparts, they are easily eliminated by grazing (Buglife, 2014).

Not included are stands of reeds behind flood defences (man-made or natural), even where there may be some saline influence through seepage or occasional overtopping. Depending of their extent, these are better treated as part of the terrestrial freshwater reedbed resource or as an element of coastal grazing marshes.

Ecology

Coastal reedbeds can either occur as extensive single species stands or as part of a more mixed swamp and inundation grassland mosaic, where sea club-rush *Bolboschoenus maritimus* and creeping bent *Agrostis stolonifera* can be prominent. Like their freshwater equivalents, there tend to be few other vascular plants present within the reedbed although parsley water-dropwort *Oenanthe crocata* and brooklime *Samolus valeriandi* can be distinctive associates (Rodwell, 1995).

Unlike their freshwater comparators, coastal reedbeds support less specialist species. Nevertheless, for breeding birds, marsh harrier *Circus aeruginosus* and reed warbler *Acrcophalus scirpaceus* can be present whilst they can host major autumn roosts of hirundines and in winter be important for the survival of bearded tits *Panurus biarmicus*. For invertebrates diversity tends to be low, but specialists occur such as the hoverfly *Sphaerophoria loewi* and a number of *Limonid* craneflies. Where sea club-rush is also present, additional specialist invertebrates also occur.

UK status and distribution

Coastal reedbeds are widely distributed around the coast and can be common in the upper parts of most large estuaries (Tyler-Walters, 2002). However the rarity of any saltmarsh-terrestrial transitional zone along the east and south coasts of England is reflected in the rarity of coastal reedbeds in this situation.

Coastal reedbeds ©Paul Glendell/Natural England

Freshwater and coastal grazing marsh

Description

The defining features of freshwater and coastal grazing marshes are hydrological and topographical (Joint Nature Conservation Committee (JNCC), 2011). They are located within the flood zone of lowland rivers or the sea. At the coast they are protected from regular sea water flooding by floodbanks or occasionally natural barriers such as sand dunes or shingle ridges (Marine Biodiversity and Ecosystem Functioning (MarBEF), 2011). A majority of freshwater grazing marshes are also protected from regular flooding by floodbanks. They are additionally influenced by partial drainage with simple or complex networks of ditches, resulting in a high water table but only seasonal flooding although some pools may be permanent (Jefferson and Grice, 2000). Most are grazed in the summer (Benstead et al., 1999, Royal Society for the Protection of Birds (RSPB), 1997).

Ecology

Grazing marshes vary greatly in the wildlife they support, due to their origin and subsequent management. At the coast, salinity can vary considerably across them from distinctly brackish to fresh (Buglife, 2013). They can be especially important for breeding waders such as redshank, lapwing, curlew and snipe; and for wintering wildfowl including Bewick's and whooper swans, geese and wigeon (Milsom et al., 2000, Smart et al., 2006, Vickery et al., 1997).

Where water tables, flooding regimes and management are appropriate, botanically diverse grasslands can be present either representing species-rich floodplain meadows or brackish inundation grasslands (Gowing et al., 2002). However, most grazing marshes do not have such grasslands.

More characteristic are ditches of botanical and invertebrate interest, supporting a diversity of wetland and aquatic species depending on water quality, salinity and frequency of rotational clearance (Buglife, 2011, Drake, 2004, Drake et al., 2010).

UK status and distribution

The exact extent of grazing marsh in the UK is not known, but it is possible that there may be a total of 300,000, with a majority in England Coastal grazing marshes are concentrated, but not exclusively, along the east and south coasts of England (Dargie, 1993). Within the 300,000 figure are substantial areas of currently low conservation value, resulting usually from inappropriate hydrological management (the sites are too dry) or the grasslands are managed too intensively. However, it is not yet possibly to quantify this area of degraded marsh (Mountford et al., 1999, Mountford et al., 2006).

Freshwater and coastal grazing marsh ©Allan Drewitt/Natural England

Water column

Description

Water column as a supporting habitat is inclusive of everything from the open seas to inundated intertidal zones. Maximum and minimum depths are reached semi-diurnally and undergo cyclical variations in time and amplitude in accordance to submerged geography, weather, lunar and solar cycles and thermal expansion.

At sea, tidal ranges are relatively small and along coasts are higher, but with considerable variation in mean spring tidal range around UK coasts. Offshore salinity is reasonably consistent at 3.4% (34‰) in the North Sea and 3.5% (35‰) on Atlantic coasts. Variations within estuaries result from river outflow, evaporation and mixing. Sea surface temperature fluctuates throughout the year with February (rarely January) the coldest month and August (rarely September) the warmest; mean month temperatures range from 4.3-8.0^{o}C in February to 13.8-20.8^{o}C in August (1971-2000 dataset from 38 coastal recording stations on the England & Wales coastline; (Joyce, 2006)).

Ecology

Because the water column refers to sea water occurring anywhere between the sea surface and seabed, its ecology is exceptionally diverse, both in terms of bird prey distribution and abundance, and prey availability to avian predators. Different parts of the water column will be used by different bird species (depending on their foraging ecology, diving capabilities and other factors). Different foraging ecologies include pursuit diving (e.g. auks), plunge diving (e.g. gannet), surface feeding (e.g. terns) and benthic feeding (e.g. common scoter).

The water column is used by seabirds both to hunt and to commute to benthic feeding habitats. Fish are the most abundant prey type within the water column, with different species found at different depths and over different benthic habitats. Sand-eels *Ammodytidae* are extremely abundant in northern European waters and are the favoured prey of many pursuit diving seabirds, such as auks (Cramp and Simmons, 1977). Sand-eels undergo vertical migration through the water column during the

day and night, and at different stages of growth, and are distributed from near the sea surface to depths of 80 m (Jensen et al., 2003). Additional marine shallow water prey includes European Sprat *Sprattus sprattu*) and Whiting *Merlangius merlangus*, and progressively deeper water column prey includes Atlantic Herring Clupea harengus, Haddock *Melanogramus aeglefinus*, Capelin *Mallotus villosus* and Atlantic Cod *Gadus morhua*. Other common prey in the water column are plankton, cephalopods and invertebrates.

UK status and distribution
Surrounds the coasts of England and is the most abundant of the supporting habitats in either permanently covering or semi-diurnally inundating intertidal supporting habitats.

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