

SUBTIDAL ROCK

Priority Action (SR1)

Improve knowledge of the biodiversity importance of subtidal rock habitats in Dumfries & Galloway.
Lead Partner: Scottish Natural Heritage.

1. Habitat Description

1.1 Physical Characteristics

The type of bedrock in subtidal rock habitats has less of an influence on biodiversity than in terrestrial habitats, as food and nutrients are supplied in the seawater, the rock providing little more than an anchorage. However, the strength of the tidal streams and the exposure to wave action are major influences on the biodiversity of subtidal rock habitats, particularly in shallow areas. They influence the turbidity of the water, the quantity of food carried in suspension and the levels of oxygenation. The nature of the rock surface can therefore be important, with a surface cut by **gullies and crevices** supporting a wider range of environmental conditions and much more diversity than unbroken bedrock. The rocky walls of surge gullies in particular support rich invertebrate communities.



Dense aggregations of Oaten Pipe Hydroids Tubularia indivisa are found on rock faces exposed to strong currents. (Paul Naylor)

The depth of water above subtidal rock governs the degree of light penetration and therefore also has a significant influence on biodiversity. Well-lit **rock surfaces in shallow water** are dominated by seaweeds, but **rock surfaces in deep water** are colonised by a range of encrusting animals. **Reefs** are usually associated with tropical corals, but in certain circumstances colonies of temperate water marine animals can form reefs, which may provide a habitat for other species. The **open water** above subtidal rock supports many species.

1.2 National and International Context

Subtidal rock in the UK tends to occur around headlands, fringing islands and in rocky inlets. Most of the UK's inshore areas, including most of those off Dumfries & Galloway, are dominated by soft sediments.

2. Dumfries & Galloway Status

2.1 Recent Trends

Subtidal rock habitats are generally robust, with no evidence of significant damage in Dumfries & Galloway. Climate change and fishing, including shellfish dredging over reefs, may have affected species composition, but little monitoring has been carried out.

2.2 Current Distribution

Subtidal rock exposures occur along the Solway between Auchencairn Bay and Mull of Galloway and along the west coast of the Rhins. The rocky seabed to the west of the Isle of Whithorn is richest in biodiversity. To the east it is restricted to a shallow fringe around the coast

2.3 Site Examples

The deepest area of subtidal rock (and other sediments) is the **Beaufort's Dyke** in the North Channel. This trench is up to 302m deep, about 50km long and 3.5km wide. Particularly important subtidal rock communities are found around the **Mull of Galloway** (SAC/SSSI) and **Scare Rocks** (SSSI), where this habitat extends to a depth of 20m. It also occurs at the mouth of **Loch Ryan** (MCA). A number of wrecks provide a habitat similar to shallow subtidal rock, most notably the wreck of 'The Jasper' in **Wigtown Bay**. *Sabellaria spinulosa* reefs are found in a few locations, most frequently around **Burrow Head**.

2.4 Associated Habitats

A number of habitats occur in close association and/or overlap with subtidal rock, and the following action plans may also contain relevant information:



Subtidal Sands and Gravels, Subtidal & Intertidal Scar Grounds, Honeycomb Worm Reefs, Intertidal Rocky Shores.

3. Importance for Associated Species

3.1 Invertebrates (very high importance)

To the west of the Isle of Whithorn tunicates and sponges dominate the seabed community. On **rock surfaces in deep water** where there is insufficient light for algae to grow, the sponge *Amphilectus fucorum* may cover up to 30% of the rock surface. Other typical species include Oaten Pipe Hydroid *Tubularia indivisa* and Elephant's Ear Sponge *Pachymatisma johnstonia*.

At Burrow Head the boulder habitats and **rock surfaces in shallow water** are current swept and dominated by sea squirts and important reefs of the polychaete worm *Sabellaria spinulosa*. These solid, but fragile, reefs are several centimetres thick and raised above the surrounding seabed. They provide a habitat that allows many other species to become established. There are also dense stands of the bryozoans Hornwrack *Flustra foliacea* and *Bugula plumosa* and populations of Rosy-feather Stars *Antedon bifida*.



Rosy-feather Stars Antedon bifida are abundant in some locations. (Paul Naylor)

Many species of crab and the Common Lobster *Homarus gammarus* take refuge in **gullies and crevices**, emerging to feed at night. The uncommon Brown Sea-cucumber *Aslia lefevrei* has been recorded from crevices in bedrock at the entrance to Loch Ryan and the crevice-dwelling Daisy Anemone *Cereus pedunculatus*, uncommon in Scotland, has also been recorded at one site in Loch Ryan. To the east of the Isle of Whithorn the fauna is less diverse and erect bryozoans and hydroids dominate.

3.2 Fishes (high importance)

Fishes such as Tompot Blenny *Parablennius gattorugine* and Conger Eel *Conger conger* find shelter in **gullies and crevices** of subtidal rock. The fearsome looking Wolf Fish *Anarhichas lupus* occurs in a similar habitat, usually only in deeper waters. Other demersal (bottom dwelling) fish include Greater Spotted Dogfish *Scyliorhinus stellaris*, commercial species such as Cod *Gadus morhua* and Haddock *Melanogrammus aeglefinus*, Ballan Wrasse *Labrus bergylta* in shallow water and young Pollack *Pollachius pollachius* amongst seaweeds.



Tompot Blenny (on sponge), a common inhabitant of rock crevices and wrecks. (Paul Naylor)

Amongst many **open water** (pelagic) fishes are Atlantic Herring *Clupea harengus* and Mackerel *Scomber scombrus*. Basking Sharks *Cetorhinus maximus* are sometimes recorded during the summer.

3.3 Mammals (high importance)

Harbour Porpoises *Phocoena phocoena* and Bottlenose Dolphins *Tursiops truncatus* are regularly recorded in **open waters** around the Rhins of Galloway, along with smaller numbers of Minke Whales *Balaenoptera acutorostrata*, Common Dolphins *Delphinus delphis* and other cetaceans.

3.4 Birds (medium importance)

A number of fish-eating birds feed in the **open waters** above subtidal rock, including Gannets *Morus bassanus*, Guillemots *Uria aalga*, and Razorbills *Alca torda*.

3.5 Non-flowering Plants (medium importance)

Rock surfaces in shallow water are dominated by kelp forests, which form a transition between subtidal and intertidal rocky shores. These consist



of a range of brown seaweeds, including Oarweed *Laminaria digitata*, Sugar Kelp *Saccharina latissima* and Dabberlocks *Alaria esculenta*. Many, smaller, red seaweeds find refuge amongst the kelp. The Bootlace Weed *Chorda filum* occurs in Drummore Bay, where it is sheltered from excessive wave exposure.

Kelp thins out with increasing depth and red algae dominate; *Rhodochorton purpureum* is a common species of **crevices**. *Drachiella heterocarpa*, a small red seaweed confined to the subtidal zone of wave-exposed coasts, particularly subtidal cliffs, has an extremely limited western distribution in Britain with few Scottish records. It occurs at Burrow Head. On **rock surfaces in deep water** seaweed may be absent altogether.

3.6 Reptiles and Amphibians (low importance)

Marine turtles such as the Leatherback *Dermochelys coriacea* and Loggerhead *Caretta caretta* feed in **open water** over subtidal rock during part of their annual migrations.

3.7 Fungi (low importance)

Fungi are well represented in marine environments but virtually all are microspecies. Nevertheless, several species associated with seaweed are likely to play a role in the ecology of subtidal habitats.

4. Environmental, Economic & Social Importance of Biodiversity

- Inshore fishing, using both static and mobile equipment, in waters above subtidal rock habitats is economically important to some coastal communities.
- Sea angling for species associated with this habitat is of recreational importance for a large number of people, and therefore of economic importance.

5. Factors affecting the Habitat

- A **lack of knowledge** of species and habitats present, due to limited research and surveys.
- Very little **statutory protection**, even in designated sites.
- Beaufort's Dyke and surrounding waters were used as a **munitions disposal** site during the 20th century, with significant quantities dumped

after the two world wars and the last dumping in 1976. Surveys have not shown contamination of seabed sediments or commercially exploited fish and shellfish.

- **Bottom fishing gears**, though rarely deployed in rocky areas, can damage fragile communities.
- **Marine litter** can kill some species which ingest it or become tangled in it. Lost fishing gear may continue to catch fish ("ghost fishing").
- Discharge of contaminants and nutrient enrichment from **run-off and sewage**, or even **ship-based pollution**, can result in localised changes to seabed communities.
- **Dumping of spoil** from dredging operations or coastal development work would seriously damage subtidal rock habitats.
- **Recreational diving** has the potential to result in minor localised damage. This is not likely to apply to Dumfries & Galloway where diving conditions over most areas are highly dangerous for all but the most experienced divers.

6. Strategic Actions

6.1 Recent and current activity

- Schemes of Management have been prepared by **Solway Firth Partnership**, on behalf of SNH for The Solway and Luce Bay & Sands SACs. These include some areas of reef, and SNH is undertaking broadscale habitat mapping of Luce Bay.

6.2 Other recommended actions

- **Assess the distribution and biodiversity importance** by collating existing information and identifying known locations for subtidal rock habitats.
- **Protect** from potentially damaging activities. In other parts of the UK this has been achieved through marine nature reserves and voluntary codes of conduct.
- Undertake **research and survey work**, including promotion of the Marine Conservation Society's Seasearch programme.
- **Raise awareness** of the biodiversity of subtidal rock habitats to generally benefit marine conservation issues.

SUBTIDAL SANDS & GRAVELS

Priority Action (SSG1)

Assess the distribution and biodiversity importance of subtidal sand and gravel habitats in selected areas by collating and making available existing information.

Lead Partner: Scottish Natural Heritage

1. Habitat Description

1.1 Physical Characteristics

Subtidal sands and gravels are derived either from shells, as in most of the west of the UK, or from bedrock, as in the North Sea. Although often extensive in area, they usually form only thin **sand banks** and **gravel banks** above the bedrock, glacial drift or mud. Their stability, and therefore much of their biodiversity, is greatly influenced by particle structure, the strength of tidal currents and the degree of exposure to wave action.

Horse Mussel beds form at depths of 5-70m. They may carpet steep rocky surfaces, but are more frequent in gravels, muds or mixed sediments. Individual mussels are frequently 25 years old or more and the best examples of beds are raised up by a metre or more above the surrounding seabed.

The **open water** above subtidal sands and gravels also supports many species.

1.2 National and International Context

Sands and gravels are the most common sediments found on UK seabeds. The Solway is dominated by fine sandy sediments, but does include some areas of subtidal gravel.

2. Dumfries & Galloway Status

2.1 History

Fish and shellfish have been harvested around the coasts of Dumfries & Galloway for hundreds of years.

2.2 Recent Trends

Commercial shellfishing, particularly for Scallops and Queen Scallops, has become the main fishing activity since the mid-20th century, which has had a significant impact on habitat quality. Improvements to boats and fishing gear have generally increased efficiency and catching capacity, though landings have declined since the late 20th century.

2.3 Current Distribution

Subtidal sands and gravels are most extensive in the inner Solway but also occur in the outer Solway and Loch Ryan. Small Horse Mussel beds are found in a few places on the Wigtownshire coast.

2.4 Site Examples

Subtidal sand banks are extensive throughout the **inner Solway** (SAC/SPA/Ramsar/SSSI) and are unusually dynamic, separated by the six main river channels which are continuously changing their patterns of erosion and accretion. Subtidal sands and other sediments also occur in the outer Solway, especially in **Luce Bay** (SAC). Sediments in **Loch Ryan** (MCA) grade from clean sands and gravel in the mouth to mixed sediments and mud in the sheltered central and very sheltered inner basin. Horse Mussel beds are found at **Burrow Head** and **Loch Ryan** (MCA).



Common Cuttlefish, a master of colour-change camouflage.
(Paul Naylor)

2.5 Associated Habitats

A number of habitats occur in close association and/or overlap with subtidal sands and gravels, and the following action plans may also contain relevant information: Subtidal Rock, Subtidal & Intertidal Scar Grounds, Seagrass Beds, Intertidal Sand and Mud Flats.



3. Importance for Associated Species

3.1 Invertebrates (very high importance)

Due to the dynamic nature of the **sand banks** in the inner Solway, few invertebrates are found within or on them other than small polychaete worms and amphipods. Numbers of species increase towards the outer estuary, in the silty areas between Castlehill Point and Wigtown Bay, with the bivalve molluscs *Fabulina fabula*, *Nucula sulcata* and *Abra alba*. In Luce Bay the variety of sediments and the sheltered environment leads to a much richer invertebrate fauna. This includes Sand Brittlestars *Ophiura ophiura*, Sand-burrowing Brittlestars *Amphiura brachiata*, Sand Stars *Astropecten irregularis*, Burrowing Heart Urchins *Echinocardium cordatum*, and Masked Crabs *Corystes cassivelaunus*. Common Cuttlefish *Sepia officinalis* lie buried in the sand during the day but emerge at night to search for prey. They spawn gregariously on shallow sandy bottoms.

Commercially exploited shellfish include Great Scallops *Pecten maximus* and Queen Scallops *Aequipecten opercularis* in firm sand and gravel. In Loch Ryan there is one of the largest beds of Native Oyster *Ostrea edulis* found in Britain, if not the world. Brown Shrimps *Crangon crangon* are abundant throughout the Solway, but mainly fished to the east of Hestan Island. They are a vital component in the ecology of the Solway Firth.



The Solway is an important summer feeding area for Basking Sharks. (Paul Naylor)

Loch Ryan supports a number of other uncommon invertebrates, most notably Gravel Sea Cucumber *Neopentadactyla mixta* found in coarse **gravel banks** at the entrance to the loch and Chinaman's Hat Shell *Calyptraea chinensis*, associated with the oyster beds.

Hundreds of species, including sponges, soft corals, anemones, hydroids, tubeworms, brittlestars, urchins, starfish, barnacles, and crabs may occur on dense Horse Mussel *Modiolus modiolus* beds, depending on depth, degree of water movement, substrate, and mussel density.



Gravel Sea Cucumber *Neopentadactyla mixta* is uncommon in Scotland. (Paul Naylor)

3.2 Fishes (very high importance)

Lesser Sand Eels *Ammodytes tobianus* shoal in shallow open waters above subtidal sand and are an extremely important food for many seabirds and fish. Commercial fish include: Plaice *Pleuronectes platessa*, the most commonly caught flatfish in the Solway, on muddy bottoms; Common Soles *Solea solea*, widespread on soft muddy ground; Flounders *Pleuronectes flesus* on the surface of mud and sand banks including brackish waters; and small numbers of Haddock *Melanogrammus aeglefinus* on hard, coarse sand banks.

Lesser Spotted Dogfishes *Scyliorhinus caniculus* are relatively common on sandy or muddy grounds, feeding at night, but the largest dogfish is the shark-like Tope *Galeorhinus galeus*, also found in inshore waters over sand and gravel in summer, but only in deeper water in winter. There is some evidence from local anglers of a substantial decline in this species. Basking Sharks *Cetorhinus maximus* sometimes move into quite shallow waters over subtidal sand during the summer, in pursuit of plankton shoals.

3.3 Birds (very high importance)

The waters of the region's bays and estuaries support enormous numbers of birds, especially during the winter. The following are of national importance: Red-throated Diver *Gavia stellata* in Loch Ryan, Great



Crested Grebe *Podiceps cristatus* in the inner Solway and Loch Ryan, Slavonian Grebe *Podiceps auritus* in Loch Ryan, Cormorant *Phalacrocorax carbo* in the inner Solway, Eider *Somateria mollissima* in Loch Ryan, Common Scoter *Melanitta nigra* in the outer Solway, Scaup *Aythya marila* in the inner Solway, Rough Firth and Loch Ryan, and Red-breasted Merganser *Mergus serrator* in the inner Solway and Loch Ryan. Numbers of Scaup in Dumfries & Galloway (over 3,300 each year between 1999 and 2004) are particularly notable, making the region by far the most important British area for this species.

3.4 Mammals (medium importance)

Harbour Porpoises *Phocoena phocoena* are regularly seen throughout the Solway. Small numbers of Grey Seals *Halichoerus grypus* are also recorded.

3.5 Reptiles and Amphibians (medium importance)

Marine turtles in Scottish waters were once thought to be infrequent wayward wanderers, but it is now believed that Leatherback Turtles *Dermochelys coriacea* regularly visit the Solway in late summer and autumn as part of their annual migration. Loggerhead Turtles *Caretta caretta* are also sometimes recorded.

3.6 Non-flowering Plants (low importance)

Although subtidal sands and gravels generally do not have extensive seaweed communities some species do occur, including a nationally rare red seaweed *Spyridia filamentosa* that reaches its northern limit and is locally common in Loch Ryan. It is found throughout the loch, particularly in the southern basin. Another red seaweed *Chondria dasyphylla*, rare in Scotland, grows on **gravel banks**, pebbles and shells in Loch Ryan. The common red seaweed *Rhodothamniella floridula* binds coarse sand into **sand banks**.

3.7 Fungi (low importance)

A number of fungal microspecies are associated with seaweeds and fish.

4. Environmental, Economic & Social Importance of Biodiversity

- Scallop fishing and processing is an important local industry.
- Loch Ryan supports the largest Native Oyster fishery in Scotland.

- Sea angling for species associated with this habitat is of recreational importance for a large number of people, and therefore also of economic importance.



Great, or King, Scallops *Pecten maximus* excavate their own hollows in sand or gravel beds. (Paul Naylor)

5. Factors affecting the Habitat

- Disturbance from **bottom-fishing** gear.
- Potential pollution from future aquaculture activities, and **chemical and sewage discharges**, both directly and via inflowing rivers.
- **Radioactive discharges** from Sellafield and Chapelcross, and the firing of over 6000 depleted uranium projectiles into the Solway by the Ministry of Defence may have some impact, though this is not proven.
- **Oil spills and ballast water** from shipping. Also TBT (tri-butyl tin) has been used as an anti-fouling paint on ships and leisure craft since the 1980s. It has affected the reproductive capacity of molluscs, including Native Oysters.
- High levels of **suspended sediment** in Loch Ryan detrimentally affects Native Oysters and other shellfish.
- **Sea-borne litter**, especially plastic bags and balloons (often released in large numbers as part of charity events) are ingested by marine turtles in mistake for jellyfish, frequently leading to their death.
- Offshore developments such as **wind turbines, aggregate extraction** and the laying of **undersea pipelines and cables** may pose a threat to some species.



- **Dumping of dredging spoil** may smother important habitats.
- **Non-native invasive species** such as Wireweed *Sargassum muticum* and Leathery Sea-squirt *Styela clava* have been recorded in Loch Ryan. Others such as the American Oyster Drill *Urosalpinx cinerea* and the Slipper Limpet *Crepidula fornicata* may potentially spread to Dumfries & Galloway in the future. All can reduce native species.



Masked Crab, common on sandy seabeds. (Paul Naylor)

6. Strategic Actions

6.1 Recent and current activity

- Loch Ryan's marine environment was recognised in 1990 when it was designated as a **Marine Consultation Area (MCA)** following a survey carried out by the Marine Nature Conservation Review Survey. This is a non-statutory mechanism for site protection that recognises the quality and sensitivity of the marine environment.
- Schemes of Management have been prepared by **Solway Firth Partnership**, on behalf of SNH, for The Solway and Luce Bay & Sands SACs.
- **Scottish Natural Heritage** is undertaking broadscale habitat mapping of Luce Bay.
- The **Solway Firth Partnership** and **Loch Ryan Forum** bring user groups together to discuss management issues.
- Monthly bird counts and annual beached bird surveys are undertaken on most sites during the winter.

- The commercial significance of Loch Ryan's oyster population provides a mechanism for monitoring the water quality and general health of the loch's coastal waters through the **Marine Laboratory** in Aberdeen and by SEPA.
- Upgrading of Stranraer sewage treatment works has taken into account the biodiversity of Loch Ryan.
- TBT has been banned and use is being phased out.

6.2 Other recommended actions

- **Maintain high water quality** from direct and indirect discharges or run-off.
- **Guide inappropriate development** away from sensitive sites or the adjacent coastal land to reduce damage to benthic communities and species, especially where they are particularly fragile, vulnerable or unusual. Where this has already occurred examine the feasibility of re-establishment or restoration.
- **Agree codes of practice** between conservationists and ferry operators that minimise impacts on biodiversity from ferries.
- Implement Schemes of Management for **European Marine Sites**.
- Examine the potential of Loch Ryan to qualify for **higher level designation** than Marine Consultation Area.
- **Promote and highlight the value** of the marine wildlife resource.

SUBTIDAL & INTERTIDAL SCAR GROUNDS

Priority Action (SISG1)

Ensure that the biodiversity importance of subtidal and intertidal scar grounds is taken into account in decision-making by ensuring that they are included in all relevant coastal strategies.

Lead Partner: Dumfries & Galloway Council

1. Habitat Description

1.1 Physical Characteristics

Scar grounds are intermediate between rocky and sandy seabeds and occur in both subtidal and intertidal situations. They consist of coarse sediments such as pebbles, cobbles and boulders that are raised above the level of surrounding sandy seabed. Low-lying scar ground may be periodically covered or scoured by sand, with only brief periods of exposure and colonisation by marine life before being covered by sand again. Colonisation is influenced by the time of year when the rock becomes exposed, as the spawning and recruitment of many marine plants and animals is seasonal. Other areas away from periodic inundation by sand support greater biodiversity.

1.2 National and International Context

Subtidal scar grounds occur throughout the world. Substantial areas are found off the coast of British Columbia in Canada and the west coast of Scotland.



Dahlia anemone Urticina felina, a colourful inhabitant of offshore scar grounds. (Paul Naylor)



Common Mussels Mytilus edulis often occur in large numbers on scar grounds. Mossyard. (Peter Norman)

2. Dumfries & Galloway Status

2.1 Recent Trends

There does not appear to have been any significant change in the extent or distribution of scar grounds in recent years.

2.2 Current Distribution

Scar grounds are more common on the English side of the Solway. On the north side, this habitat has a patchy distribution.

2.3 Site Examples

Examples of subtidal scar grounds are found at **Powfoot** (SAC/SPA/Ramsar/SSSI), **Southernness** (SSSI), **Hestan Rock**, **Ravenshall Point** (SSSI) in Wigtown Bay and on the east side of **Luce Bay** (SAC).

2.4 Associated Habitats

A number of habitats occur in close association and/or overlap with subtidal and intertidal scar grounds, and the following action plans may also contain relevant information: Subtidal Rock, Subtidal Sands and Gravels, Intertidal Sand and Mud Flats, Honeycomb Worm Reefs, Intertidal Rocky Shores.



3. Importance for Associated Species

3.1 Invertebrates (very high importance)

The invertebrate fauna of scar grounds is often richer than surrounding muds, sands and gravels, though species composition can change rapidly over time.



Mussels on intertidal scar at Southernness. (Richard Meams)

Early colonisers of exposed scar grounds include barnacles *Semibalanus balanoides* and *Elminius modestus*, with Common Periwinkles *Littorina littorina* arriving later. Even on scar ground exposed for longer periods, the dominant species can change rapidly. The Breadcrumb Sponge *Halichondria panicea* is typical. Others include Dahlia Anemones *Urticina felina*, Rosy-feather Stars *Antedon bifida* and Common Starfish *Asterias rubens*.

Mussels *Mytilus edulis* can vary enormously in abundance. In years following a good settlement, they may out-compete other invertebrates and seaweeds, but mussel populations may then be reduced following sand inundation.

3.2 Non-flowering Plants (high importance)

Colonisers of newly exposed scar grounds include gutweeds *Enteromorpha linza* and *E. intestinalis*, Sea Lettuce *Ulva lactuca*, and Purple Laver *Porphyra umbilicalis*. Some of these may later become abundant, joined by Bladder Wrack *Fucus vesiculosus*, a brown seaweed *Fucus ceranoides*, a red seaweed *Dumontia contorta* and Carrageen *Chondrus crispus*. Many species of invertebrate are associated with these seaweeds.

3.3 Fishes (medium importance)

Common Gobies *Pomatoschistus microps* and Sand Gobies *P. minutus* may be present throughout the warmer months from May onwards.

3.4 Birds (low importance)

Due to their relatively limited distribution scar

grounds do not support important numbers of birds. Nevertheless, common species such as Oystercatchers *Haematopus ostralegus* and Curlews *Numenius arquata* feed on intertidal scar grounds.

4. Environmental, Economic & Social Importance of Biodiversity

Subtidal scar grounds make a contribution to fisheries, either directly or as a source of food for commercially fished species.

5. Factors affecting the Habitat

- Physical damage of intertidal scar grounds by manual shellfish harvesting, which may be associated with disturbance from tractors and off road vehicles.
- Physical damage can result from recreational pressure, though the number of people walking over scar grounds is unlikely to be high.



Oystercatchers, regular visitors to scar grounds. (Gordon McCall)

6. Strategic Actions

6.1 Recent and current activity

- Scar grounds are protected from damage from shellfish harvesting in the **Solway Shellfish Management Association's** management plan.

6.2 Other recommended actions

- **Map the location of all scar grounds**, survey their biodiversity importance and monitor changes.
- **Raise awareness** of subtidal and intertidal scar grounds, their location, biodiversity importance and possible threats.

INTERTIDAL SAND & MUD FLATS

Priority Action (ISMF1)

Assess the distribution and biodiversity importance of intertidal sand and mud flats in selected areas by collating existing information and increasing its availability, by 2012.

Lead Partner: Scottish Natural Heritage

Priority Action (ISMF2)

Increase knowledge of the biodiversity intertidal sand and mud flats in Dumfries & Galloway by encouraging universities to carry out research in the Solway.

Lead Partner: Solway Firth Partnership

1. Habitat Description

1.1 Physical Characteristics

Intertidal sand and mud habitats form a major component of estuaries and bays, but also occur on open coasts. They range from mobile coarse **sand flats** to fine sediment **mud flats**. Despite the fact that they often appear to show little or no conspicuous signs of life, they are extremely rich in biodiversity according to sediment type, stability and water salinity.



*Nith estuary mudflats. January 2008.
(Richard Mearns)*

Coarse sands occur where sediments are exposed to wind and/or wave action, or where strong tidal currents prevent the deposition of silt. These banks are highly mobile and may dry out considerably at low tide. More sheltered sands offer more stable environments. Muds form in the most sheltered areas, usually where large quantities of river derived silt are deposited. They remain saturated with water but have little water exchange and often have little oxygen present in the sediment, even just below the surface. Between these extremes a wide range of sediment types exist.

Input of freshwater has a major influence on biodiversity. Most marine organisms are unable to survive in areas with variable and low salinity, so

species variety generally increases with distance away from freshwater. Only a relatively small number of species have adapted to estuarine conditions, but they may occur in vast numbers.

Intertidal flats can be very mobile due to the ever-changing erosional and depositional regime and exposure to strong tidal streams and wave action. River channels are in particular subject to constant change, whilst fringing sandbanks are generally more stable.

1.2 National and International Context

About 50% of the UK coastline (9849km) is estuarine and the 163 estuaries which make up this figure represent nearly a third of the total estuarine area of the North Sea and Atlantic seaboard of western Europe. A significant proportion of the UK's sand and mud flats is found in Dumfries & Galloway, with at least 32,000ha.

2. Dumfries & Galloway Status

2.1 Recent Trends

The harvesting of cockles rose dramatically in the 1980s and 1990s, affecting not only cockle stocks, but also the associated biodiversity of intertidal sand and mud flats. The fishery was closed to mechanical dredging in 1994 and completely closed in 2001, but a regulated fishery re-opened in 2006.

2.2 Current Distribution

Highly mobile intertidal sediment flats of fine sands, rather than muds, dominate much of the Solway. The estuary is shallow in nature, leading to considerable fluctuation in water temperature.

2.3 Site Examples

The **inner Solway** (SAC/SPA/Ramsar/SSSI) has the third largest area of estuarine intertidal flat in the UK,



covering some 26,000ha. **Rough Firth, Auchencairn Bay** (SSSI) and **Orchardton Bay** (SSSI) are predominantly composed of intertidal sand and mud flats, with around 1,150ha in total extent. A greater proportion **Kirkcudbright Bay** is constantly covered by the sea, but around 750ha of intertidal areas are also present, and a similar area in nearby **Fleet Bay**. Approximately 2,900ha of intertidal sand and mud flats are found in **Wigtown Bay** (LNR/SSSI), and 1,160ha at **Luce Bay** (SAC). **Loch Ryan** (MCA) is shallow over its entire area with an average depth of 2 to 5 metres. The southern basin of the loch includes intertidal areas with little freshwater input.

2.4 Associated Habitats

A number of habitats occur in close association and/or overlap with intertidal sand and mud flats, and the following action plans may also contain relevant information: Subtidal Sands and Gravels, Subtidal & Intertidal Scar Grounds, Seagrass Beds, Coastal Sandy Beaches.

3. Importance for Associated Species

3.1 Invertebrates (very high importance)

Most of the invertebrates of intertidal sand and mud flats burrow in the sediment to prevent themselves from drying out and being eaten by surface living predators such as birds and fish. They feed on other invertebrates, plants, or detritus filtered out from overlying water or within the sediment.



Empty shell of Burrowing Heart Urchin or Sea Potato Echinocardium cordatum. Torrs Warren, June 2007. (Peter Norman)

The composition of invertebrate communities varies according to the sediment type and salinity, but typical species on the Solway include the Peppery Furrow Shell *Scrobicularia plana*, the Baltic Tellin *Macoma balthica* and the Common Cockle *Cerastoderma edule*. The latter species can fluctuate widely in numbers as a result of natural processes. A single successful settlement of spat can result in densities of more than 1000 per square metre, but there can be a reduction of up to 80% during a hard winter. The Laver Spire Shell *Hydrobia ulvae* is commonest in the upper half of the intertidal zone and may occur at densities of 200,000 per square metre. The Estuary Ragworm *Hediste diversicolor* and the Lugworm *Arenicola marina* are also common.



Brown Shrimp, a crucial species in the food chains of subtidal and intertidal sandy seabeds. (Paul Naylor)

Brown Shrimps *Crangon crangon* occur at between 3-50 million shrimps over 20 square kilometres of **sand flat**, whilst in clean medium to fine sand flats, such as in the centre of Luce Bay, there are dense populations of the burrowing heart urchin *Echinocardium cordatum* and razor shells *Ensis* spp.

The nationally rare Wine-glass Hydroid *Obelia bidentata* grows up to 2.5cm long in tree-like pink colonies in intertidal areas in the inner Solway.

A few terrestrial species occur on the upper shore, especially where freshwater flows over the sediment. This includes a ground beetle *Bembidion maritimum* at its only Scottish site in Wigtown Bay.

3.2 Birds (very high importance)

The invertebrate rich sand and mud flats of the Solway support nationally and internationally important numbers of over-wintering birds. Winters are generally mild and many species spend the whole season in the area, but the region's intertidal flats are also of critical importance to birds refuelling on migration. The number of birds using the inner Solway during the winter swells to over 140,000, making the estuary the seventh most important in the UK in terms of bird numbers. Internationally important species are as follows (all in inner Solway): Shelduck *Tadorna tadorna*, Pintail *Anas acuta*, Oystercatcher *Haematopus ostralegus*, Knot *Calidris canutus*, Dunlin *Calidris alpina*, Bar-tailed Godwit *Limosa lapponica*, Curlew *Numenius arquata* and Redshank *Tringa totanus*. Barnacle Geese *Branta leucopsis* also use the sand and mud flats as night-time roosts. Nationally important species are as follows (all in inner Solway): Shoveler *Anas clypeata*, Ringed Plover *Charadrius hiaticula*, Golden Plover *Pluvialis apricaria*, Grey Plover *Pluvialis squatarola*, Lapwing *Vanellus vanellus*, Sanderling *Calidris alba* and Greenshank *Tringa nebularia*.



Plaice spend most of their time on the seabed. (Paul Naylor)

3.3 Fishes (high importance)

Sand and mud flats support fish such as the Common Goby *Pomatoschistus microps* and Flounder *Platichthys flesus* and provide an essential nursery ground for fish such as Sea Bass *Dicentrarchus labrax*, Plaice *Pleuronectes platessa*, Common Sole *Solea solea* and Atlantic Herring *Clupea harengus*. A number of pelagic species, such as the Lesser Sand Eel *Ammodytes oobianus* and mullets *Mugilidae* and are resident for part of the year, whilst others, including the scarce Sea Lamprey *Petromyzon marinus*, River Lamprey *Lampetra fluviatilis*, Allis Shad *Alosa alosa* and Twaite Shad *Alosa fallax*, migrate over sand and mud flats to their freshwater spawning grounds. The Cree estuary holds one of the very few spawning grounds for Sparling *Osmerus eperlanus* in Scotland.

3.4 Mammals (medium importance)

Harbour Porpoises *Phocoena phocoena* are frequently seen in shallow water over sand and mud flats.

3.5 Flowering Plants (medium importance)

Seagrass forms dense beds (see separate Habitat Action Plan) but few other flowering plants are able to survive in these hostile environments. A few species occur on the landward edge of sand and mud flats, including glassworts *Salicornia* spp., Common Cord Grass *Spartina anglica* and Townsend's Cord Grass *S. x townsendii*.

3.6 Non-flowering Plants (low importance)

The surface of intertidal flats may be covered with green algae such as Gutweed *Enteromorpha intestinalis* or Sea Lettuce *Ulva lactuca* during the summer months. The nationally scarce brown seaweed *Sphacelaria plumigera* occurs in intertidal, often shaded, sandy pools. It has been recorded in Wigtown Bay.

3.7 Fungi (low importance)

Fungi are well represented in marine environments but virtually all are microspecies. Nevertheless, several species associated with seaweed are likely to play a role in the ecology of subtidal habitats.

4. Environmental, Economic & Social Importance of Biodiversity

- Sand and Mud Flats play an important role in coastal defence, dissipating wave energy.
- Sand and mud flats provide feeding and nursery areas for commercially exploited fish.
- Intertidal communities are directly exploited for shellfish such as cockles and shrimps, or for angling bait including lugworms and ragworms.
- Important economic benefits result from wildlife (especially bird) watching, and recreational sea angling.

5. Factors affecting the Habitat

- Creation of enclosed bays through barrages, for power generation, amenity and perceived aesthetic reasons destroys mud flats and the associated wildlife interest.
- Coastal defences could interfere with existing patterns of movement of sediments.
- Industrial and agricultural run-off or polluted storm-water discharge, including eutrophic river water, can create abiotic areas or encourage the growth of algal mats that will adversely affect invertebrate communities.
- Piping or channelling freshwater over the upper shore may remove critical invertebrate habitats.
- Intertidal fisheries such as cockling and dredging for fish can damage the seabed.
- Aquaculture has the potential to cause damage if not carefully located and managed.
- Recreational pressure, including bait digging, can in exceptional circumstances lead to depletion of certain species.
- Vehicle use over sand and mud flats at low tide affects sediment structure, influencing suitability for invertebrates and disturbing feeding birds.
- Introduction of non-native invasive species. For example Cord Grass has spread along coasts



and colonised some upper-shore mud flat areas, disrupting the ecology. Auchencairn Bay and Fleet Bay have been particularly affected.

- Sea level rise may result in insufficient mobile sediment to adjust to new tidal levels in some cases; in other circumstances erosion of mud flats may reduce their extent and quality.
- Capital and maintenance dredging for navigation has a negative impact on sediment supply and the sediment biota.

6. Strategic Actions

6.1 Recent and current activity

- A Regulatory Order for shellfishing in the Solway was introduced in 2006. Fishing effort, locations and methods are currently regulated and monitored by the Solway Shellfish Management Association under a permit system.
- The first stage of a Shoreline Management Plan was published by Dumfries & Galloway Council and SNH in 2005 as an aid to the planning of sea defences.



Cockle shells. (Richard Mearns)

- Schemes of Management have been prepared by Solway Firth Partnership, on behalf of SNH for The Solway and Luce Bay & Sands SACs. SNH is undertaking broadscale habitat mapping of Luce Bay.
- Wigtown Bay Management Committee oversees sustainable management of this site using local bylaws.
- Implementation of a Scheme of Management, prepared by SNH for the inner Solway SAC is underway, and a Scheme of Management is in preparation for Luce Bay SAC. All 'Competent Authorities' must ensure that any operations under their management do not cause disturbance or deterioration of the interest features of these European Marine Sites.
- The Wetland Bird Survey gathers information and monitors bird populations of estuaries. A study of

areas important for birds roosting on the tideline was carried out on behalf of BNFL in 1993.

- Implementation of the Solway Firth Partnership's Management Strategy is in progress.



Mud flats with lugworm casts. Sandyhills Bay, June 1991. (Peter Norman)

6.2 Other recommended actions

- Ensure that development plan policies protect estuaries from coastal development and other activities that could, individually or cumulatively, cause environmental damage.
- Promote management within the framework of SACs and other coastal zone strategies that permit the natural functioning of sediment systems.
- Meet and maintain Class A (Excellent) water quality standards in all of the region's estuaries using the Scottish Environment Protection Agency Estuary Classification Scheme to monitor chemical, biological and radiological quality.
- Review current and future dredging operations to ensure minimum impact on the estuarine environment.
- Consider the value of further site protection systems outwith designated sites using mechanisms such as local sites, voluntary reserves, no-take zones and sanctuary areas.
- Ensure that all inshore fisheries operate using methods that have a minimum impact on the firth.
- Encourage collaboration between bait diggers and conservationists to establish methods for maintaining bait digging areas such that there is minimum impact on biodiversity
- Highlight the importance of intertidal habitats to decision-makers, tourism bodies and the public.
- Increase the use of information packs and marine chests in schools in association with the Solway Firth Partnership. Develop their information content for different age groups. Offer all schools education/interpretation facilities about estuaries.



SEAGRASS BEDS



Priority Action (SB1)

Assess changes in the extent and species composition of seagrass beds.

Target: Repeat the 1993-94 survey of *Zostera angustifolia* and *Z. noltii* in the Solway Firth by 2013.

Lead Partner: Scottish Natural Heritage.

1. Habitat Description

1.1 Physical Characteristics

Seagrass beds develop in the intertidal and shallow subtidal areas on sands and muds. They are found in estuaries, marine inlets and bays, and in other areas such as lagoons and channels which are sheltered from significant wave action. Three species of seagrass (also called eel grass) have been identified in the UK, though *Zostera marina* and *Z. angustifolia* are now considered to be variants of one species:

- Common Seagrass *Zostera marina* is found in fully marine situations and occasionally in estuaries, on sheltered gravel, sand or mud from Low Water Spring tide to 4m.
- Narrow-leaved Seagrass *Zostera angustifolia* is found on mud banks, creeks and estuaries from half-tide to Low Water Spring.
- Dwarf Seagrass *Zostera noltii* occurs in similar habitats to *Z. Angustifolia* but may extend to the lower saltmarsh communities around Mean High Water.



Seagrass, Rough Firth, August 2006. (Peter Norman)

Seagrass beds have higher silt content in the sediment since it is less disturbed by wave action, hence they are less adapted to physical disturbance.

1.2 National and International Context

All three species of seagrass are currently regarded as nationally scarce in the UK. In some areas of the UK seagrass beds are declining due to physical disturbance and nutrient pollution. A report on the status of seagrass in Scotland was published in 1993 covering the latest information on distribution and threats, but there is currently no estimate of the extent of these communities in Scotland.

2. Dumfries & Galloway Status

2.1 Recent Trends

Although there has only been limited recent monitoring, seagrass beds appear to have continued to expand since the 1990s.

2.2 Current Distribution

All three species of seagrass are present in Dumfries & Galloway, recorded from seven 10km squares between 1831 and the present. Work during 1993-94 on the Dumfries & Galloway populations of the Solway assessed the occurrence and abundance of the two intertidal species (*Z. noltii* and *Z. angustifolia*). Approximately 5 square km (500ha) of seagrass at a variable density was recorded during the survey, but this did not include Loch Ryan. No recent survey has been carried out in the region for the subtidal *Z. marina*.

2.3 Site Examples

Beds of *Zostera marina* occur on the extreme lower shore and in shallow subtidal areas, for example at **Loch Ryan** (MCA) on sheltered fine or muddy sands. *Zostera noltii* is found at **Manxman's Lake** in Kirkcudbright Bay, around **Rough Island** in Rough Firth, in **Auchencairn Bay** (SSSI), in **Fleet Bay** and at **Baldoon Sands** in Wigtown Bay (LNR and SSSI). *Zostera angustifolia* occurs in many of the same locations in Kirkcudbright Bay, Rough Firth and Auchencairn Bay. Seagrass beds have also been recorded in the Nith Estuary.



2.4 Associated Habitats

A number of habitats occur in close association and/or overlap with seagrass beds, and the following action plans may also contain relevant information: Intertidal Sand and Mud Flats.

3. Importance for Associated Species

3.1 Flowering Plants (very high importance)

Apart from the three species of seagrass themselves, no other flowering plants are associated with this habitat. However, the three species of seagrass are the only marine flowering plants found in Britain and they cannot be found in any other habitat.

3.2 Invertebrates (high importance)

The invertebrate fauna of seagrass beds typically consists of those species associated with the particular sediment type, but the roots of the seagrass increases stability of the sediments and provides shelter and attachment for a number of species.

Seagrass provides an important nursery area for shrimps and, in some areas, cephalopods such as Common Cuttlefish *Sepia officinalis*. Various invertebrates take refuge and sometimes breed on and around seagrass leaves, including Snakelocks Anemones *Anemone viridis*, Harbour Crabs *Liocarcinus depurator*, Sea Hares *Aplysia punctata*, and Netted Dog Whelks *Hinia reticulata*. Invertebrates in the surrounding sediment include Common Cockles *Cerastoderma edule*, Common Periwinkles *Littorina littorea*, Lugworms *Arenicola marina*, and Sand Mason Worms *Lanice conchilega*. A dense seabed fauna of non-selective deposit feeders is usually present in *Z. noltii* beds.



Sea Hares *Aplysia punctata* (mating trio) graze amongst seagrass beds. (Paul Naylor)

3.3 Fishes (medium importance)

Adult pipefish *Syngnathus* spp. and various species of goby make use of the shelter provided by seagrass beds. Seagrass beds provide important nursery areas for Plaice *Pleuronectes platessa* and Common Soles *Solea solea*.

3.4 Birds (medium importance)

Seagrass provides an important source of food for wildfowl such as Wigeons *Anas penelope* and Brent Geese *Branta bernicla*, though the latter species only occurs in small numbers in the region at Loch Ryan.

3.5 Non-flowering Plants (low importance)

The green seaweeds *Pringsheimiella scutata* and *Epicladia perforans* are epiphytic on seagrasses and other seaweeds.

4. Environmental, Economic & Social Importance of Biodiversity

- Seagrass beds are generally regarded as valuable and important habitats because productivity is high and large amounts of organic material are contributed to the surrounding areas. This increases food and nutrient levels for other organisms.
- Seagrass binds mud and sand, reducing erosion and encouraging deposition of suspended material. In some areas, the sediment is raised above the general level, such that in the subtidal areas, waves break further offshore, thus sheltering the adjacent beach. In intertidal areas, the raised level may decrease erosion of the fragile habitats, including saltmarsh, higher up the shore.

5. Factors affecting the Habitat

- Physical damage from **shellfish harvesting** by suction or clam dredges has been recorded in Rough Firth and Auchencairn Bay, manual gathering of shellfish in the same locations, and bait digging in Wigtown Bay. The most dramatic effect of hydraulic suction dredging was reported in Auchencairn Bay when the complete disappearance of *Zostera marina* was recorded from the dredged areas.



Greater Pipefish make use of the shelter provided by seagrass beds. (Paul Naylor)

- **Construction of pipelines** can directly impact on seagrass beds, though none are known to have so far affected beds within Dumfries & Galloway.
- Coastal engineering projects such as **flood and sea defence works**, **dredging** of harbours and navigation channels, and **land reclamation** can damage seagrass beds and cause changes in depth, turbidity and current regimes. Only minor operations have so far occurred within the region, none of which are known to have affected local beds.
- A **wasting disease** caused by slime moulds is believed to have affected local seagrass beds in the 1930s, especially in Wigtown Bay. It has been reported more recently in some parts of the UK, though there is currently no evidence of its return to Dumfries & Galloway.
- Domestic **sewage discharges** and **agricultural run-off** is high in nitrate levels and may reduce seagrass biomass whilst increasing epiphytic plankton and phytoplanktonic blooms. Most of the beds in Dumfries & Galloway are in locations with high water quality. The *Z. noltii* beds in Wigtown Bay below Orchardton Farm are thought to be beneficially affected by agricultural run-off.
- The extent of seagrass beds may alter as a result of natural factors such as severe **storms**, **exposure to air**, **freshwater pulses**, or the seasonal effects of **wildfowl grazing**. In Dumfries & Galloway, these factors are not considered significant.

- **Warmer sea temperatures** as a result of global warming, coupled with low levels of sunlight, may cause significant stress and dieback of seagrass.
- Seagrass is known to accumulate tributyl tin and possibly some other **marine pollutants**, which may reduce nitrogen fixation in the plant and possibly cause a build up of pollutants in the food chain. There is no evidence to suggest that local seagrass beds have been affected.
- Colonisation of intertidal muds by **invasive cordgrass** *Spartina anglica* has occurred in parts of Wigtown Bay, Fleet Bay, and Auchencairn Bay but has not so far impacted on seagrass beds.

6. Strategic Actions

6.1 Recent and current activity

- The Loch Ryan non-statutory Marine Conservation Area is in place to promote consultation and conservation safeguards.
- The **Solway Firth Partnership, Wigtown Bay LNR Management Committee** and **Loch Ryan Forum** provide opportunities for users of these areas to discuss activities that may affect seagrass beds.
- Seagrass beds are specifically protected from potentially damaging shellfish harvesting under the management plan drawn up by the **Solway Shellfish Management Association**.

6.2 Other recommended actions

- **Survey** *Zostera marina* beds to determine the current distribution and extent of Dumfries & Galloway populations.
- **Raise awareness** of the importance of the marine environment of Dumfries & Galloway.

Priority Action (HWR1)

Encourage identification and recording of Honeycomb Worm reefs through the production of public information.

Lead Partner: Dumfries & Galloway Environmental Resources Centre.

1. Habitat Description

1.1 Physical Characteristics

Honeycomb worm reefs are composed of tubes of sand built by the marine polychaete Honeycomb Worm *Sabellaria alveolata*. They can cover extensive areas over the shore around the low water mark, particularly where there is a rocky substrate, water with a good supply of suspended sand grains, and strong to moderate wave action. They can also form on other substrates, including pebbles and cockle shells.



Honeycomb Worm reef. Barlocco-Orroland coast, February 2008. (Richard Mearns)

The worms, which are filter feeders, construct tubes in tightly packed masses with a distinctive honeycomb appearance. The reefs can be 30-50cm thick and take the form of hummocks, sheets, overlays or more massive reef formations. Larvae are strongly stimulated to settle by the presence of existing colonies or their dead remains. Individual worms have a life span of 3-5 years, possibly up to 9 years, but reefs last longer as a result of further settlement of larvae onto existing colonies. In the long term, the location of reefs tends to be relatively stable.

New reefs have few associated species, but by their second year a range of seaweeds and animals will have colonised, with some animals eventually living within the older vacated tubes.

1.2 National and International Context

Britain is the northern extremity of the range in the northeast Atlantic, which extends south to the

Mediterranean and Morocco. In Britain honeycomb worm reefs are restricted to the west coast between south Devon and the Clyde. Honeycomb worm reefs in the Solway are near their northern limit, but there are some of the best developed and most extensive reefs in Britain here.

2. Dumfries & Galloway Status

2.1 Recent Trends

Recent trends are imprecisely known, but there is no evidence to suggest a decline.

2.2 Current Distribution

Greatest concentrations of honeycomb worm reefs are in the outer Solway, but they occur in several locations from Annan in the east to the Rhins coast in the west.

2.3 Site Examples

The most extensive reefs are found in the **Southernness** (SAC/SPA/SSSI), **Rascarrel/Balcary Bay** (SSSI), **Meikle Ross** (SSSI), **Kirkandrews Bay/Islands of Fleet** (SSSI), and **Stairhaven/Auchenmalg** (SAC) areas.

2.4 Associated Habitats

A number of habitats occur in close association and/or overlap with honeycomb worm reefs, and the following action plans may also contain relevant information: Subtidal Rock, Intertidal Rocky Shores.

3. Importance for Associated Species

3.1 Invertebrates (high importance)

A number of marine invertebrates are found on and within crevices of the reefs, including small crabs, barnacles, dogwhelks, winkles, mussels and other bivalves such as a nut shell *Nucula nucleus* and a gaper shell *Sphenia binghami*. Small worms such as *Fabricia stellaris* and *Golfingia* spp, and their predators, may also occur within the colonies.



3.2 Non-flowering Plants (high importance)

Over time, seaweeds including Dulse *Palmaria palmata*, *Polysiphonia* spp, *Ceramium* spp, gutweeds *Enteromorpha* spp and Sea Lettuce *Ulva lactuca* colonise the reefs.



Rock Goby (eating prawn), one of several fish that may be found in the reef crevices. (Paul Naylor)

3.3 Fishes (low importance)

Blennies *Blenniidae* and other common seashore fish are found within the crevices.

3.4 Birds (low importance)

Several species of wading bird occasionally feed on the reefs at low tide, including Oystercatchers *Haematopus ostralegus* and Turnstones *Arenaria interpres*.

4. Environmental, Economic & Social Importance of Biodiversity

The formation of honeycomb worm reefs may lead to the creation of more rockpools on the lower shore, which can be of educational and recreational value as well as biodiversity value.



Close-up of individual Honeycomb Worm tubes. Ravenshall, July 2007. (Peter Norman)

5. Factors affecting the Habitat

- Dieback occurs following extremely **cold winters**, particularly at higher shore levels.
- Although they can tolerate burial by sand for days or even weeks, prolonged **burial** causes mortality.
- **Coastal engineering** works, where it affects supply of sand can cause both positive and negative impacts depending upon the nature of the work.
- **Competition** with Common Mussels.
- **Wave exposure** may affect recruitment
- **Recreational activities** such as trampling by beach users and bait digging by anglers have the potential to cause damage, though on a localised and limited scale.



Turnstones feed on intertidal rocky shores, including Honeycomb Worm reefs. (Gordon McCall).

6. Strategic Actions

6.1 Recent and current activity

- Honeycomb worm reefs are identified in the Solway Firth and Luce Bay & Sands SACs.

6.2 Other recommended actions

- **Locate and map** all honeycomb worm reefs in Dumfries & Galloway.
- **Raise awareness** of honeycomb worm reefs through interpretation.

Priority Action (IRS1)

Examine the current extent and future potential for the sustainable collection and co-ordinated local marketing of shellfish from intertidal rocky shores.

Target: Complete a study on shellfish gathering by 2015.

Lead Partner: Solway Firth Partnership

1. Habitat Description

1.1 Physical Characteristics

Intertidal rocky shores consist of bedrock outcrops or boulders, and can be located anywhere from exposed open coasts to sheltered bays. Although the geology and topography determines the type of shore, wave action is the biggest influence on biodiversity. Sheltered rocky shores are dominated by large brown seaweeds, whilst on exposed shores barnacles, limpets and small red seaweeds predominate. Most rocky shores have a wide variety of microhabitats and therefore have a high diversity of species, if a lower overall biomass than intertidal sand and mud flats.



*Ranger-led school visit at Wigtown Bay.
(Dumfries & Galloway Council)*

Kelp forests occur on the seaward edge of some rocky shores. The kelp stipes are often seen sticking out of the sea at low water, but only on the lowest tides are some of the uppermost plants completely exposed. The remainder of these seaweed forests extends offshore up to depths of 20m or more.

The main intertidal zone can be divided into the **lower shore**, the **mid shore**, and the **upper shore**. Although the precise boundaries between each are not always easy to distinguish, the differing wave exposure and length of time covered by seawater often results in a zonation of flora and fauna rarely seen in other habitats.

The biodiversity of rockpools is dependent on their size, depth, shape and position on the shore, with deep pools on the lower shore providing the richest habitat. Shallower pools on the upper shore are subject to extreme daily, tidal and seasonal fluctuations in temperature, salinity and pH so that they are only inhabited by the most environmentally tolerant organisms.

The **splash zone** is found just above the level of ordinary high tides and consists of rock faces and boulders influenced by wave splash and sea spray. However, the small difference in elevation results in quite different environmental conditions and biodiversity, with much more similarity to terrestrial rather than marine habitats.

1.2 National and International Context

Intertidal rocky shores are common around the coast of the UK. The Solway Firth has a large proportion of the rocky seashore found within the whole of the Irish Sea basin.

2. Dumfries & Galloway Status

2.1 Recent Trends

Intertidal rocky shores are robust and few, if any, recent human activities have had a significant impact on this habitat.

2.2 Current Distribution

Extensive kelp forests are rare in Dumfries & Galloway, but other intertidal rocky shore habitats are diverse and extensive, particularly to the west of Southernness. Most rocky shores are on the south facing and sheltered Solway coast, but the western coast is far more exposed, resulting in a diverse assemblage of species throughout the region.

2.3 Site Examples

There are extensive rocky shores at numerous sites. Kelp forests are found at **Lady Bay** in Loch Ryan and at **Mull of Galloway**. The rocky pond at **Port Logan**,



used to keep fish, provides an unusual feature, now promoted as a visitor attraction and marine life centre.

2.4 Associated Habitats

A number of habitats occur in close association and/or overlap with intertidal rocky shores, and the following action plans may also contain relevant information: Subtidal & Intertidal Scar Grounds, Intertidal Sand and Mud Flats, Honeycomb Worm Reefs, Coastal Strandlines, Coastal Shingle Beaches, Coastal Sandy Beaches, Coastal Cliffs and Slopes.



Rockpools are fascinating subjects for outdoor education and enjoyment. Orroland, April 2007. (Richard Mearns)

3. Importance for Associated Species

3.1 Non-flowering Plants (very high importance)

Seaweeds are the main producers of energy in this habitat, and show clear zonation on most intertidal rocky shores.

Kelp forests consist of a range of brown seaweeds, including Oarweed *Laminaria digitata*, Sugar Kelp *Saccharina latissima* and Dabberlocks *Alaria esculenta*. Many smaller red seaweeds find refuge amongst the kelp.

On the **lower shore** brown seaweeds are frequently dominated by Serrated Wrack *Fucus spiralis*. *Petrospongium berkeleyi* has been recorded at Mull of Galloway, one of only a handful of Scottish records, but is otherwise restricted to southwest England and Wales. Another scarce brown seaweed *Corynophlaea crispa* at Mull of Galloway is epiphytic on a common red one, *Chondrus crispus*. Red seaweeds are found throughout the intertidal zone, but are perhaps most diverse on the lower shore. Two tiny bright red-purple species *Erythrotrichia investiens* and *E. bertholdii* grow on other algae in the lower intertidal and shallow subtidal zone. They are recorded from very few other

sites in the UK, although identification and taxonomy problems mean that they are likely to be under-recorded.

The **mid shore** is often dominated by Bladder Wrack *Fucus vesiculosus*, though Egg Wrack *Ascophyllum nodosum* may be abundant in sheltered conditions. On more exposed shores other species dominate; a brown seaweed *Alaria esculenta* is common in exposed conditions, whilst the red *Aglaothamnion sepositum* is confined to extreme wave battered shores. The green seaweed *Tellamia contorta* is known from the Rhins, but is difficult to find and probably widespread, being largely restricted to the inside of living periwinkle shells.

The **upper shore** is characterised by Channel Wrack *Pelvetia canaliculata* and sometimes Spiral Wrack *Fucus spiralis*, though Sea Lettuce *Ulva lactuca* and Gutweed *Enteromorpha intestinalis* can be common in brackish conditions.

Rockpools support many of the same species of algae found elsewhere on rocky shores, but seaweeds rarely dominate.

The pool rims are typically encrusted with red coralline algae, especially *Lithothamnion* species and *Corallina officinalis*, which are difficult to find elsewhere on the mid and upper shores.

A few mosses can also withstand sea spray and are found in the splash zone. Most typical is Seaside Grimmia *Schistidium maritimum* on boulders just above the high tide mark.

3.2 Invertebrates (high importance)

Invertebrates on rocky shores are predominantly marine species, with smaller numbers of terrestrial species on the upper shore.



Sea Ivory lichen *Ramalina siliquosa*, common on upper shores. Powillimount, March 2008. (Peter Norman)



Wave exposure is the biggest influence on biodiversity. Black Head, Killantringan, March 2007. (Peter Norman)

The gaps between holdfasts in **kelp forests** support a diverse range of invertebrates including the Blue-rayed Limpet *Helcion pellucidum*, sea urchins, sea squirts and sponges.

The **lower shore** also includes marine species such as Edible Crab *Cancer pagarus*, whilst some species of the **mid and upper shores** are virtually restricted to intertidal rocky habitats, including Rough Periwinkle *Littorina saxatilis*, Common Limpet *Patella vulgata*, and Dog Whelk *Nucella lapillus*. Of terrestrial species, two nationally scarce ground beetles are associated with the upper shore. *Aepus marinus*, recorded in the Machars, is found under stones on fine sand or shingle and in rock crevices; *Aepus robini* (Kirkcudbrightshire and Wigtownshire) shows a greater tendency to inhabit deep sand or silt-filled rock crevices.

Although the invertebrate fauna of **rockpools** generally reflects local rocky shore communities, a few species appear particularly well adapted to pool living including some tiny sea slugs, cushion stars and brittlestars. Beadlet Anemones *Actinia equina*, Shore Crabs *Carcinus maenas*, and several species of prawn are more typical rockpool inhabitants.

The hoverfly *Eristalinus aenus* is found in rotting seaweed in rockpools, as well as brackish pools on saltmarshes, and has been recorded in several locations along the coast of Dumfries & Galloway.

3.3 Fishes (medium importance)

Intertidal rocky shores are the main habitat for a number of fish species, although most are present in the **mid and upper shores** only during the spring and summer, moving downshore, or even offshore, in the winter. The Common Blenny *Lipophrys pholis*, Rock Goby *Gobius paganellus* and Butterfish *Pholis gunnellus* are typical species.

3.4 Birds (medium importance)

Purple Sandpipers *Calidris maritima* feed in the **splash zone** of rocky shores. In Dumfries & Galloway they are only regularly recorded in small numbers around the lighthouse at Southernness. Other birds that feed on rocky shores include Turnstones *Arenaria interpres*, Oystercatchers *Haematopus ostralegus*, and Rock Pipits *Anthus petrosus*. The latter two species regularly nest just above the intertidal zone.



3.5 Fungi and Lichens (medium importance)

A range of colourful lichens dominate the **splash zone**, including the black *Verrucaria maura*, the orange *Caloplaca marina*, the yellow *Xanthoria parietina*, the grey *Lecanora atra* and the green Sea Ivory *Ramalina siliquosa*.

3.6 Mammals (medium importance)

Otters *Lutra lutra* feed on intertidal rocky shores and undisturbed rocky shores are used by Grey Seals *Halichoerus grypus* and rarely Common Seals *Phoca vitulina* as haul-out sites, but few other mammals make extensive use of this habitat.

3.7 Flowering Plants (low importance)

Typical flowering plants of the upper shore include Common Scurvy Grass *Cochleria officinalis*, Thrift *Armeria maritima* and Buck's-horn Plantain *Plantago coronopus*.

3.8 Reptiles and Amphibians (low importance)

Adders *Vipera berus* and Common Lizards *Zootoca vivipara* occasionally visit intertidal rocky shores, but the habitat does not support important reptile and amphibian populations.

4. Environmental, Economic & Social Importance of Biodiversity

- Intertidal rocky shores provide the classic outdoor classroom for teaching ecology from pre-school up to post graduate levels.
- Rockpooling is a popular recreational activity for visitors to the coast.

5. Factors affecting the Habitat

- Pollution from **shipping wastes** and cargoes, such as oil and chemicals.
- Pollution from the land, including **sewage discharges, run-off from roads and farmland**, and the **dumping** of garden waste and other commercial waste, including rubble tipped to prevent erosion.
- The extent and impact of **commercial shellfish gathering** is not accurately known.

6. Strategic Actions

6.1 Recent and current activity

- Guided walks and school activities are run by the Ranger Services of Dumfries & **Galloway Council, National Trust for Scotland and Hoddum and Kinmount Estates**. These include annual participation in World Oceans Day.
- "The Sea Chest", which contains books, CDs and activities related to the sea shore is available for loan from **Scottish Natural Heritage** to schools and community groups throughout Dumfries & Galloway.

6.2 Other recommended actions

- Promote the use of intertidal rocky shores for **educational visits**.



Serrated Wrack Fucus serratus, a typical seaweed of the mid shore. Port Kale, June 2003. (Maggi Kaye)